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A Review on Encryption Techniques in Signal Processing

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Abstract— In today's digital communication era sharing of information is increasing significantly. The information being transmitted is vulnerable to various passive and active attacks. Therefore, the information security is one of the most challenging aspects of communication. Cryptography plays an integral role in secure communication and it provides an excellent solution to offer the necessary protection against the data intruders. Over a significant time, data encryption techniques took a massive leap from simple methods to complicated mathematical calculations in order to achieve secure communication. However still with all its complexity cryptographic algorithms are prone to one or more attacks. Therefore this paper presents a detailed study on various symmetric key encryption techniques, its comparison and the attacks to which they are vulnerable too.

IndexTerms— Image Encryption; Encryption Quality; Filter Bank

1. INTRODUCTION

Due to the rapid advances in computer and communication networks and the recent progress in multimedia technologies (*i.e.* audio, video, image, etc.), multimedia information can easily be exchanged over different types of networks like the Internet. Usually, these networks are not secure. Therefore, users must pay more attention to the security of their networks and information transmission against unauthorized users. Due to this, the multimedia information security has become a vital concern in military applications, audio and videoconferencing, imaging, E-Commerce, and mobile phone applications [1,2]. Moreover, over these networks, people may be required to send personal and sensitive information or exchange important documents. In such situations; security, integrity, authenticity and confidentiality of digital data should be provided. Therefore, these applications must be secured from various kinds of attacks like interruption, interception, modification and fabrication [3,4]. As a result, it is essential to protect this information using some encryption and cryptography algorithms. Encryption (enciphering) is a procedure utilized for converting and scrambling of data to insure its security.

Consequently, several security approaches have been proposed to insure the required protection [2]. The use of these security techniques allows the information transmission and cryptanalysis are two major kinds of cryptography, where the cryptology is to keep plaintext secret from eavesdropper while cryptanalysis is to conquer such techniques to reconstruct this information [3]. The process of encryption includes that the multimedia data is protected and a key is across insecure networks to prevent any danger of attack. Cryptology provide for decryption process (deciphering). The encrypted data are usually called the cipher text and unencrypted data are called the plain-text. To decide whether one is allowed to view the encrypted data or not, a key is used. Based on this point, there are two main types of algorithms used for data encryption; symmetric-key algorithms and public key algorithms

.

2. VARIOUS ENCRYPTION TECHNIQUES

Recently, finite field versions for fractional Fourier trans- forms were introduced. In [5], such transforms are referred to as fractional number-theoretic transforms and their definition is based on complete generalized Legendre sequences over finite fields. In[1], the finite field fractional fourier transform is identified by the acronym GFrFT, where "G" alludes to "Galois field";in this case, the transform is defined by using an extension to the finite field scenario of the commuting matrix method of transform fractionalization [2] and the construction of GFrFT over GF(p), where p=3 (mod 4) is emphasized. A specific A specific GFrFT is then constructed and an image encryption scheme based on such a transform is introduced. In the proposed method, blocks of the plain- image are sequentially transformed by the GFrFT. The fractional parameter used in the transformation of each block is obtained from a secret key. Since there is superposition among two

consecutive blocks taken from the plain-image, the encryption/decryption of a block affects all subsequent blocks. This property provides good results related to the robustness against differential attack and the key sensitive- ness of the method [6]. In the proposed technique, only modular arithmetic is necessary to compute the GFrFT. This avoids rounding and assures that the decrypted image and the corresponding plain-image are identical, if the correct key is used. Additionally, the application of the finite field trans- form leads to the uniformization of the histogram of the ciphered-images, which makes the scheme secure against statistical attacks [6]. In [7] A methodology to construct cryptographic primitives by using nonlinear wavelets. One interesting aspect of the proposed system is that it is easy to analyze. The system can be implemented by filters (shift registers) and a simple inverse operation. The wavelet encryption system with effective key size of 128 possesses computational complexity lower than DES and comparable to AES with key sizes of 64 and 128, respectively. It is also imperative to note that the wavelet decryption has almost half the complexity of the encryption. However, the complexity of the decryption of DES is the same as the encryption and that of AES is 30% slower than the encryption. Therefore, the complexity of the wavelet decryption is lower than both DES and AES decryption. This method having variants of interpolation, data function, and DFT- based attacks which cannot do better than the exhaustive key search method. In [8],A procedure to encrypt digital image based on the finite field cosine transform was introduced. In the first step, 64 subimages are constructed from the original image. Such subimage then regularly divided into 8 × 8 blocks to which the Field Finite Cosine Transform (FFCT) is recursively applied, the transformed subimages are regrouped in order to produce an intermediate image, with the same dimension of original image. In the second step, the encrypted image is obtained. The decryption process is implemented by using the encryption steps in reverse order.

The interest in digital filter banks has grown dramatically over the last few years. Owing to the trend toward lower cost, higher speed microprocessors, digital solutions are becoming attractive for a wide variety of applications. Filter banks allow signals to be decomposed into sub bands, often facilitating more efficient and effective processing. They are particularly visible in the areas of image compression, speech coding, and image analysis. In this system, the encryption process is carried out using the analysis filter bank while the decryption process is achieved using the synthesis filter bank. This means that the encryption and the decryption processes are based on a "linear" circular convolution process, which is well-known to provide an excellent diffusion. To add the necessary nonlinearity (confusion) to the cipher, a lifting scheme is used with a nonlinear function over $GF(2^8)$ [9]. The encryption and decryption process are shown in Figure 1[6]. Filter bank cipher has many advantages [6]. Its implementation is simple, since it is based on digital filter design, which offers a high speed implementation in software and hardware. Also, it offers a high security level using small number of rounds. In addition, the most important is the scalability of this cipher, as it can deal with different length of key or plaintext which can be adjusted according to a particular encryption application.

3. PARAMETERS FOR ANALYSIS AND ASSESSMENT OF AN IMAGE ENCRYPTION ALGORITHM

There are some specific parameters that can be used to evaluate the effectiveness and robustness of any proposed image encryption technique. These parameters include:

3.1 Histogram Analysis

One of the main characteristics of any image encryption scheme is to produce a random-like plaintext image [10]. This can be checked by histogram analysis which displays how image pixels are distributed with respect to the color or gray scale intensity level. The histogram of the cipher image must be uniformly distributed in order not to provide any sign for possible statistical attack. Histogram of the encrypted image is very different from that the original image. Usually, the original image histograms contain large spikes due to pixels gray scale values [11].

3.2 Correlation Coefficient Analysis

Correlation is a factor that determines how much two variables are similar to each other. This is commonly used to measure the encryption quality of any cryptography scheme
The correlation coefficient is computed as follows [11]:

$$r_{xy} = \frac{Cov(x,y)}{\sigma_x \sigma_y} \quad (1)$$

$$\sigma_x = \sqrt{VAR(x)} \quad (2)$$

$$\sigma_y = \sqrt{VAR(y)} \quad (3)$$

$$VAR(x) = \frac{1}{N}\sum_{i=1}^{N}\left(x_i - E(x)\right)^2 \quad (4)$$

$$VAR(y) = \frac{1}{N}\sum_{i=1}^{N}\left(y_i - E(y)\right)^2 \quad (5)$$

$$Cov(x,y) = \frac{1}{N}\sum_{i=1}^{N}\left(x_i - E(x)\right)\left(y_i - E(y)\right) \quad (6)$$

Where *x* and *y* are the values of two pixels in the same location in the original and ciphered images, respectively.

3.3 Entropy Analysis

Entropy is one of the significant measures for evaluating any encryption system. Information entropy shows the degree of uncertainties and randomness in systems like cryptography, network security, and data compression [11].

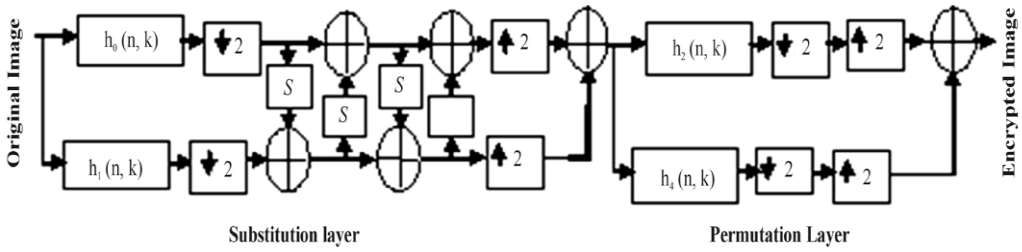

Figure 1. One round for filter bank encryption system

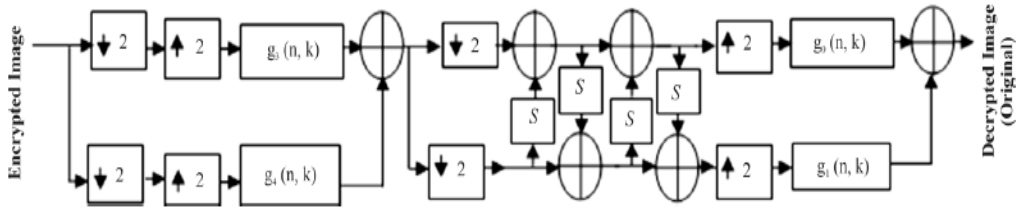

Figure 2. Two round for filter bank encryption system

$$H(m) = -\sum_{i=0}^{2^N-1} p(m_i)\log_2\left[p(m_i)\right] \quad (7)$$

where *p*(*m i*)is the probability of occurrence of the symbol *mi*.

3.4 Mean Square Error

Mean Square Error (MSE) is one of the most commonly used measures of the avalanche effect. *MSE* is the average squared difference between two images. It is computed pixel-by-pixel as follows [11]:

$$MSE = \frac{1}{MxN}\sum_{i=0}^{M-1}\sum_{j=0}^{N-1}\left[I(i,j) - K(i,j)\right]^2 \quad (9)$$

3.5 Number of pixel change rate

The NCPR computes the ratio of different pixels between the plaintext and the cipher text images as follows [12].

$$\text{NCPR} = \frac{\sum_{i,j} D(i,j)}{M \times N} \times 100\%. \quad (10)$$

where

$$D(i,j) = \begin{cases} 0 & \text{if } I(i,j) = K(i,j) \\ 1 & \text{otherwise} \end{cases}$$

3.6 Unified Average Change Intensity

UACI computes the number of averaged changed intensity between cipher text image [2] UACI can be calculated as [11]:

$$UACI = \frac{1}{M \times N}\left[\sum_{i,j}\left[\frac{[I(i,j) - K(i,j)]}{255}\right]\right] \times 100\% \quad (11)$$

4 FILTER BANK AS AN IMAGE ENCRYPTION SYSTEM: APPROACH

Filter bank cipher has many advantages [9]. Its implementation is simple, since it is based on digital filter design, which offers a high speed implementation in software and hardware. Also, it offers a high security level using small number of rounds. In addition, the most important is the scalability of this cipher, as it can deal with different length of key or plaintext which can be adjusted according to a particular encryption application. The histogram can be employed to illustrate the quality of image encryption. A secure image encryption system should produce a uniformly distributed histogram of the encrypted image. **Figures 3** present the histograms representation of the original and the encrypted image using different number of rounds.

Table 1. Correlation coefficient of two adjacent pixels for House image.

Direction of Adjacent Pixels	Original Image	Encrypted Image
Horizontal	0.9790	0.0510
Vertical	0.9257	−0.0115
Diagonal	0.9432	0.0096

Table 2. Global entropy for the House image

Key	One Round	Two Rounds
Key One	7.9971	7.9975
Key Two	7.9972	7.9974

Table 3. Mean square root result

Encrypted Image	One Round	Two Rounds
House Image	40.2 dB	40.35 dB

Table 4. NPCR and UACI results

Images	One Round NPCR	Two Rounds NPCR	One Round UACI	Two Rounds UACI
House Image	99.60	99.65	33.37	33.60

5. Statistical Comparison Result

The simulation results for two rounds filter bank cipher are compared with two image encryption ciphers; namely, advanced encryption standard (AES) and Compression Friendly Encryption Scheme (CFES). The values in Table 5demonstrate that, the filter bank cipher is stronger than CFES; in addition it has the same results as AES and some results better than the AES results. Moreover, the filter bank cipher supports simpler implementation and scalability.

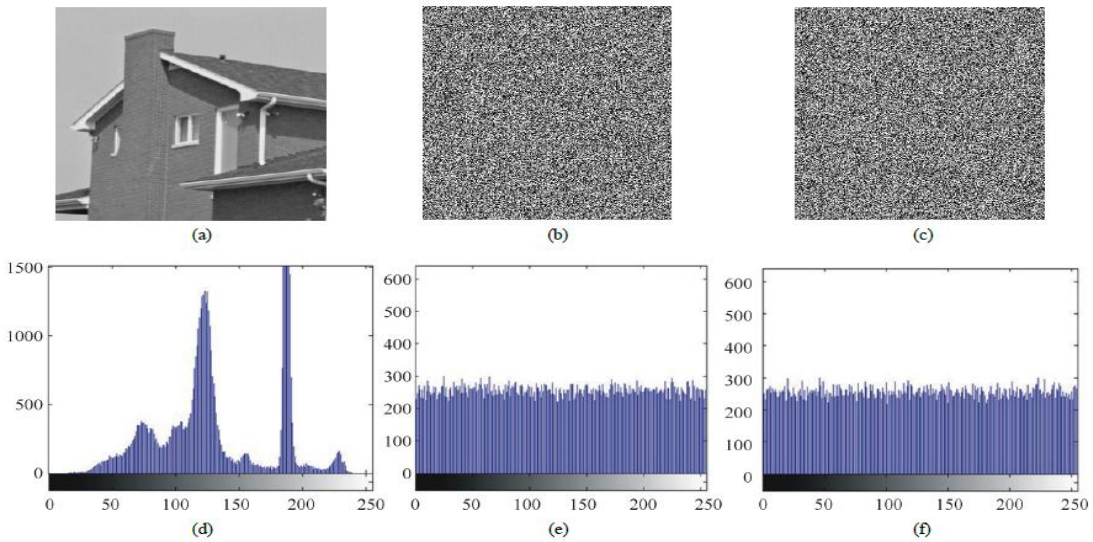

Figure 3. (a) Original House image; (b) Encrypted image using one round; (c) Encrypted image using two rounds; (d) Histogram of the original image; (e) Histogram of encrypted image using one round; (f) Histogram of encrypted image using two rounds.

Table 5. Parameter evaluation with AES and CFES

Cipher	Horizontal Correlation Coefficient	Vertical Correlation Coefficient	Diagonal Correlation Coefficient	Global Entropy	Block Entropy	NPCR	UACI	MSE	Key Sensitivity
AES [4]	−0.0067	−0.0067	−0.0030	7.9975	7.1722	99.64	33.60	40.41 dB	99.6506%
CFES [4]	0.9522	0.0152	−0.0011	7.1455	-	99.18	15.49	33.86 dB	99.2279%
Filter Bank	−0.0081	−0.0115	−0.0013	7.9972	7.1988	99.65	33.60	40.35 dB	99.66%

CONCLUSION

In this paper, various important encryption techniques have been presented and analyzed in order to make familiar with the other encryption algorithms used in encrypting the image which has been transferred over network. Many evaluation parameters were used to analyze the image encryption quality using filter bank cipher with one and two rounds. The valuation parameters are histogram analysis, correlation coefficient, global entropy, mean square error, NPCR, UACI.

The simulation results for histogram showed that the distribution of the encrypted image is uniform. In correlation coefficient analysis, the correlated adjacent pixels of the original images are completely distributed in the encrypted image with very small correlation coefficient in all directions (horizontal, vertical and diagonal). The global and block entropy are very close to ideal, so the encrypted image represent random—like image. the encryption process is considered as a strong and robust process to resist many existing cryptography attacks and cryptanalysis technique.

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A Review on Effect of Sprouted, Insect and Mold Damaged Corn and Sorghum Grains on Ethanol Production

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Abstract: Owing to environmental problems associated with fossil energy and rising concern of fuel sustainability, global ethanol production is rapidly increasing. Worldwide majority of bioethanol production is from crops like corn, barley, oat, rice, wheat, sorghum, and sugar cane. These crops are mainly used as food for human being and animals. To avoid conflict among industrial and human food use, only damaged grains are considered in this paper as a feedstock. Corn and sorghum are important cereals as they are major potential source of fuel energy. Globally corn and sorghum are ranked second and fifth respectively important cereals. To produce ethanol from starch of damaged sorghum and corn grains, the simultaneous Saccharification and fermentation is considered. It utilizes crude amylase and an amylolytic yeast strain S. Cerevisiae. Various types of damaged corn and sorghum grains are studied for their effect on ethanol yield. All damaged grains lose some of the starch and increased soluble sugars, ash and crude fiber. It is observed that sprout-damaged grains contained the highest amounts of reducing sugars. Ethanol yields based on the already damaged grains indicated that sprout-damaged grains yielded similar amounts compared to undamaged grains. The insect-damaged and mold-damaged corn and sorghum have reduced ethanol yields. As per exhaustive study it is observed that already damaged insect, mold or sprouted, corn and sorghum grains are having vast potential for ethanol production and could be good alternative for fossil fuel.

Introduction

The energy is significantly needed for the economic progress of modern societies. The local and global environment is strongly get affected by the way energy is produced, supplied, and consumed thus it is a main concern in sustainable development. Worldwide energy utilization has increased regularly with the increase of human population and industrialization. The global energy consumption increased 17-fold in preceding century. The International Energy Agency reported that due to growth in the developing countries, energy consumption will more than double by 2030[1-3].

At present, the world's economy greatly depends on fossil energy sources (coal, oil, natural gas) which are used to produce fuels, electricity, chemicals, and other goods. In the long run, the utilization of these conventional fossil energy sources is not sustainable [4]. To meet the rising energy demand and to supply raw material for the industry in a sustainable way is the utmost challenges for the society in the 21st century. Non-renewable energy sources such as fossil fuels are inadequate and have a significant negative environment impact [5]. To meet the growing requirement for bioenergy new and abundant raw materials have to be considered. Today, Bioenergy from renewable resources is an alternative to fossil fuels. All petroleum-based fuels can be replaced by renewable fuels produced from biomass such as bioethanol, biodiesel, biohydrogen etc. In this point of view, particularly after 2000, global production of renewable energy from the biomass of energy crops has been growing speedily. Bioethanol produced from renewable biomass is supposed among the dominating renewable biofuels. Several different biomass feedstocks and conversion technologies can be used to produce liquid bifuel known as bio ethanol. The sugars obtained by prior chemical or enzymatic treatment of the biomass or fermentation of simple sugars present in biomass produce bioethanol. The bioethanol fermentation is performed by microorganisms, conventionally by yeasts (Saccharomyces strains), [6, 7]

Crops such as corn, sorghum, barley, oat, rice, wheat, and sugar cane used to produce bioethanol. Only wasted crops are assumed to be available for producing ethanol, to avoid conflicts between food use and industrial uses of crops. Damaged grains are defined as the grains lost in distribution or which are not useful for human or animal consumption. Crops lost during the year at all stages between the farm and the household level during handling, storage, and transport is known as wasted crops. Waste of the edible and inedible parts of the commodity that occurs after the

commodity has entered the household and the quantities lost during processing are not considered. The agricultural residues include corn stover, crop straws, and sugar cane bagasse, generated during sugar cane processing. [8] Because of increasing demand for ethanol which is considered to an alternative energy source, significant attention has been given to the production of ethanol from various sugary substrates such as molasses, starchy materials like corn, wheat and potato and cellulolytic materials. Sweet sorghum has the appropriate potential as a useful energy crop though; fresh starchy materials are required for human consumption. In India, due to unfavorable climatic conditions and inadequate transport and storage facilities, A large quantity of different grains is spoiled every year. Grains those are unfit for human consumption are known as damaged grains. The damage consists of discolored, broken, cracked, attacked by fungi, insect damaged, chalky, partially softened by being damp, dirty and bad smell, etc. The Food Corporation of India (FCI) classes the damaged grains in five categories based on percentage of sound grains. Recent estimates by the FCI reveal that there are about 50 x 10' tons of damaged grains lying unutilized in FCI stores. Damaged grains are cheaper than the fresh grains and are available in large quantities. [9]

1. Effect of Field Sprouted grains on ethanol production

A. Effect of Field Sprouted Sorghum grains on ethanol production

Ethanol yield of five field-sprouted sorghum varieties and the non-sprouted control (DK5400C) are shown in figure no.1. The ethanol fermentation process essentially was completed within 36 h for the sprouted sorghum, and ethanol yield did not increase significantly after the 36th hour, indicating the fermentation process using field-sprouted sorghum could be stopped at the 36th hour after yeast inoculation in the beginning of fermentation. This result agrees with results from a study on laboratory-germinated high-tannin sorghum and further confirms that using sprouted grains sorghum for ethanol production could shorten the fermentation time without significantly decreasing ethanol yield. [10]

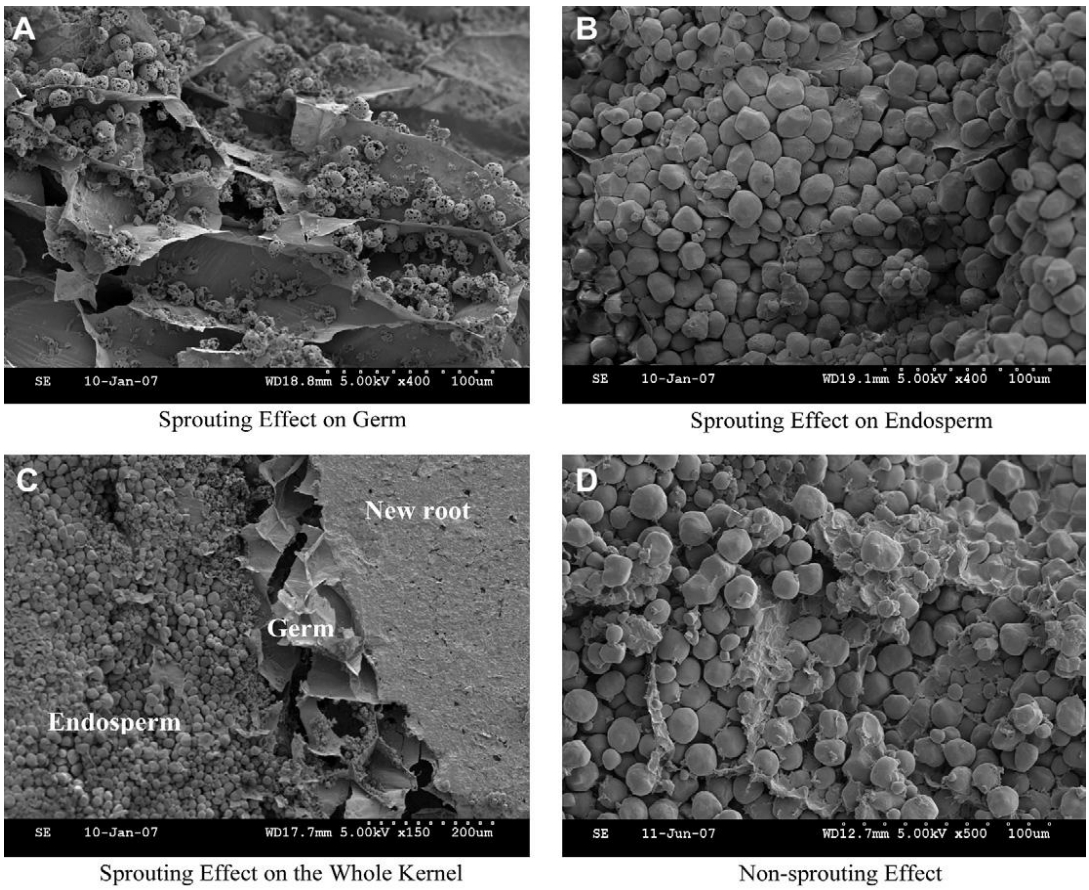

Fig. 1. Scanning electron microscope images of starch granules: A: Germ of field-sprouted sorghum. B: Endosperm of field-sprouted sorghum. C: Cell walls of field-sprouted grains sorghums. D: Non-sprouted sorghum. [10]

Grains damaged by sprouting may not affect ethanol production and final ethanol yield but may lose value for food applications. Ethanol yield from field-sprouted sorghum actually was slightly higher than that from the non-sprouted control sorghum (Fig. 2). The actions of cell-wall-degrading enzymes in the field-sprouted sorghum might have contributed to this high yield. The fermentation process for sprouted grains could be much shorter than that required for normal grains. [10]

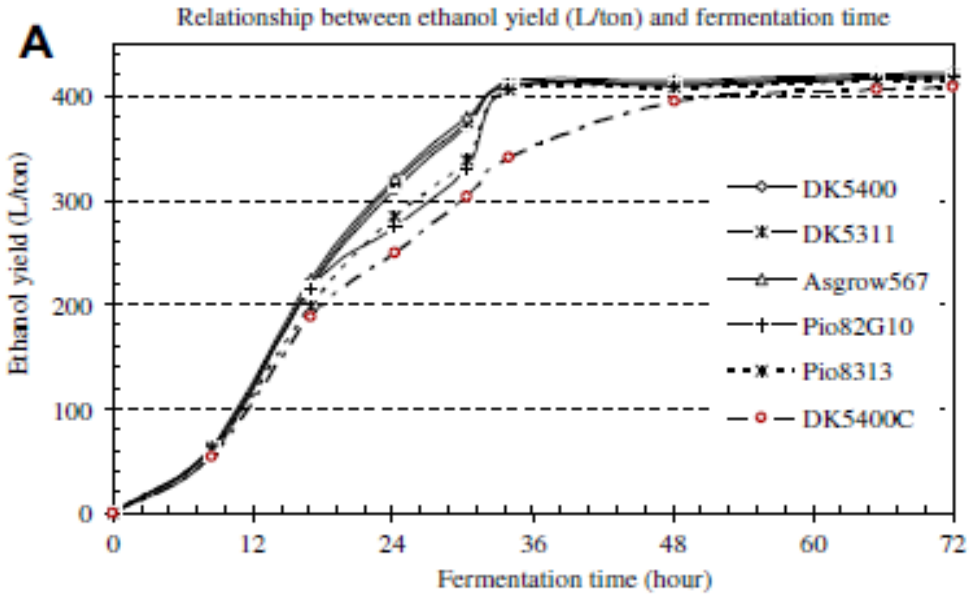

Fig. 2.Ethanol yields of five field-sprouted sorghum varieties and a non-sprouted (DK5400C). [10]

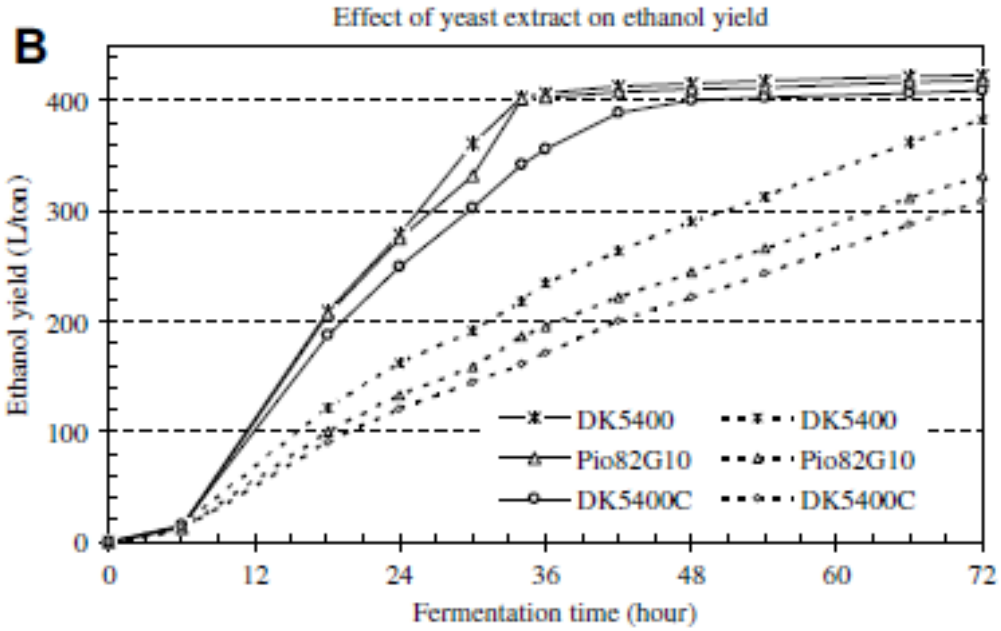

Fig. 3.Effect of yeast extract on ethanol yield (solid lines: with yeast extract; dashed lines: without yeast extract). [10]

Fermentation course varied among sorghum varieties in the 18th& 30th hour (Fig. 2). Two varieties had lower ethanol yield than the other three varieties within the same fermentation period (at 24 h). This might be due to grains hardness, particle size, and availability of nutrients for yeast in the mash. The harder sorghum had larger particles, which might prevent nutrients from being released rapidly to the mash during this period. However, as the fermentation process proceeds in the mash and water continues penetrating

into larger particles, the structures of larger particles eventually would be disrupted and nutrients would be released into the mash. [10]

Table No. 1 Chemical composition, kernel hardness and kernel size of grains sorghum samples. [10]

Sorghum samples	Chemical Composition (%wb)						FAN (mg/L)	α-amylase activity (CU/g)	Hardness index	Kernel weight (mg)	Kernel Diameter (mm)
	MC	Ash	Protein	Fiber	Lipids	Starch					
DK5400C	10.38^{f}	1.62^{a}	11.59^{a}	1.15^{e}	3.22^{a}	64.50^{d}	162.0^{e}	5.60^{c}	78.97^{a}	30.00^{a}	1.98^{a}
DK5400	10.28^{d}	1.18^{c}	6.66^{e}	2.12^{ab}	2.27^{c}	60.30^{c}	221.9^{c}	12.03^{b}	49.12^{e}	24.76^{c}	1.68^{c}
DK5311	12.97^{a}	1.19^{c}	7.02^{d}	2.24^{a}	2.29^{c}	66.78^{c}	234.8^{bc}	12.60^{b}	52.56^{d}	24.42^{bc}	1.73^{bc}
Asg567	11.92^{e}	1.26^{d}	7.60^{b}	2.07^{bc}	2.34^{c}	67.80^{bc}	284.3^{a}	15.79^{a}	56.75^{c}	25.53^{b}	1.76^{b}
Pio82G10	12.71^{b}	1.10^{e}	7.27^{c}	1.95^{cd}	2.40^{bc}	69.28^{ab}	189.5^{d}	13.35^{b}	68.30^{b}	25.98^{b}	2.01^{a}
Pio8313	12.52^{c}	1.15^{d}	6.96^{d}	1.91^{d}	2.49^{b}	69.65^{a}	258.4^{ab}	13.89^{b}	66.19^{b}	26.00^{b}	1.78^{b}

Superscript letter in the same column indicates significant difference (P< 0.05)
FAN= Free amino Nitrogen
MC= Moisture content

The non-sprouted control sample, DK5400C, had the lowest Free Amino Nitrogen (FAN) among the samples (Table 1) and the lowest ethanol yield at the end of the 72 h fermentation both with and without added yeast extract. Without the addition of yeast extract, fermentation rates depended on the availability of FAN in the mashes. Sprouted DK5400 had the highest FAN content among three samples and the fastest fermentation rate and highest ethanol yield both with and without added yeast extract. This further supports the idea that FAN is important for yeast growth and fermentation rate, especially for yeast proliferation. Sprouted sorghum with high FAN content benefits ethanol fermentation efficiency and reduces fermentation time. [10]

B. Effect of Field Sprouted Corn grains on ethanol production

The sprout-damaged corn kernels had the highest fermentation efficiencies followed by the controls, indicating the positive effect of intrinsic enzymes generated during sprouting. The processing of sprout-damaged corn kernels also saved liquefaction time increased FAN and produced similar amounts of ethanol compared to sound kernels. The similar fermentation efficiencies between corns differed from previous research works (Pérez-Carrillo and Serna-Saldívar, 2007).In Corn, the detrimental influence of amylose content in fermentation has been reported. Wu et al. (2006) achieved 88.7% conversion for normal starch Corn while, for a fermentation media with 35, 55 and 70% of amylose, efficiencies were 80.4, 61.8 and 52.9% respectively. [11]

Interestingly, fermentation efficiencies seem to be slightly lower compared to previous reports. This can be associated with the temperature used during liquefaction. For example, Wu et al. (2006) employed a cooking temperature of 95 C during 45 min before a-amylase addition whereas liquefaction in this study was conducted at temperatures that never exceeded 90 C. A higher temperature enhances starch gelatinization and susceptibility to enzymatic hydrolysis and therefore is directly related to conversion efficiencies, mainly in kernels containing high amylase (Wu et al., 2006). Glycerol, determined at the end of fermentation, is a by-product of sugar metabolism. The role of this alcohol is to maintain the cytosolic redox balance by consuming NADH during its formation. According to Vriesekoop et al. (2009), an elevated glycerol is observed in fermentations under osmotic stress conditions, where it accumulates intracellularly acting as a stress protectant. Other authors indicate that glycerol differences are more related to yeast strain rather than compositional changes in the fermentation media (Attfield and Kletsas, 2000). As expected, there were no differences in glycerol concentration in fermented mashes and this is a sign of the adequate initial sugar concentration in worth for the fermenting yeast. The calculation of ethanol yields/ton initial grains indicated that sprout-damaged kernels yielded similar amounts compared to sound kernels (381 and 376 L/ton of maize grains - wet basis, respectively). Undoubtedly, the sprout-damage was the least detrimental because these kernels yielded similar amounts of ethanol compared to sound kernels. Comparatively, these kernels were more susceptible to amylases and thus can save hydrolysis and fermentation times.[11]

2. Effect of insect damaged grains on ethanol production

For insect infestation, grains were infested with 200 unsexed adult weevils (S. zeamais) no older than 7-days and then stored under controlled conditions (27 C, 70% RH) with a photoperiod of 12:12 h (dark/light). The infestation experiments were run during 7 weeks or until the level of

damage reached 17.6 and 14.8% of dry matter losses for corn and sorghum (53 and 18% of damaged kernels, respectively). Mesh sieves (No. 10 and 16) were used to sort grains and adult weevils. Grains weight loss was calculated by subtracting the final from the initial dry grains weight. Damaged kernels were separated and counted based on visible tunneling or emergence holes. The initial test weights of corn and sorghum were within ranges specified by Serna-Saldívar (2010), indicating that both types of kernels were initially sound and healthy. As expected, all sorts of damaged kernels had a lower bulk density and average kernel weight. The mashes used in SSF had an original pH of 5.6 & 5.9. [11]

A. Effect of insect damaged Sorghum grains on ethanol production

Test weight loss due to insect damage in sorghum is 10.7%. Insect damage is less detrimental in sorghum because of the higher resistance of the sorghum pericarp which contains more phenolics and harder endosperm texture of sorghum. These compounds are related to kernel resistance through two main mechanisms: physical (hydroxycinnamic acids bound to cell wall) and toxicological (due to the effect of phenolic acid amides in the invasive organism) (Bergvinson and García-Lara, 2011; García-Lara et al., 2004). According to Dicko et al. (2006), fifty different sorghum varieties contained from 0.5 to 3% (w/w) of total phenolics and these compounds were mainly associated with pericarp cell walls. Phenolics have an important role in protecting kernels against biotic and abiotic stresses (Serna-Saldívar, 2010). Ramputh et al. (1999) reported a positive relationship between phenolic content of sorghum and Sitophilus oryzae resistance. The FI was also greatly affected by the different sorts of damages. This parameter estimates the relative density of the grains and therefore is an indicator inversely related to grains hardness (Roselena et al., 2009). In ethanol production, an intermediate or soft endosperm texture is desired because these kernels usually have a higher proportion of starch (Serna-Saldívar, 2010). In all treatments, an increase of FI was observed because of the reduction of density due to endosperm damage or starch consumption or degradation. The thousand-kernel weight was severely affected by the different types of damage. This parameter is an important quality criterion because a larger grains usually contains a higher proportion of endosperm and starch. The use of insect-damaged sorghum reduced yield around 23%. [11]

B. Effect of insect damaged Corn grains on ethanol production

Test weight loss due to insect damage in corn is 18.6%. Insect damage and sprouting were more detrimental in maize compared to sorghum. The initial glucose in all worts was between 130 and 140 g/L. After 72 h fermentation, all the glucose was metabolized by the fermenting yeast. This indicates a complete and high efficient fermentation and the effectiveness of the liquefaction step that rendered dextrins highly susceptible to amyloglucosidase and pullulanase. Therefore, the presence of S. zeamais and intrinsic enzymes did not affect yeast and a-amylase or amyloglucosidase/ pullulanase activities. For insect damaged kernels, a reduction in yield was indeed observed. A decrease of 29 % was calculated in the case of insect damaged corn. These findings are crucial in geographic regions where S. zeamais is the principal infesting agent and indicates the robustness of sorghum against this particular insect. The negative impact of the use of insect or mold-damaged kernels is mainly due to dry matter losses incurred during storage and stresses the importance of first-rate storage practices. However, this research clearly demonstrates the use of already damaged kernels is feasible. These kernels can be acquired at a discount price by biorefineries and subsequently converted into bioethanol with similar efficiencies. [11]

3. Effect of Mold damaged grains on ethanol production

The mashes used in SSF had an original pH of 5.6 &5.9, except for the mold-damaged sorghum which was slightly more acidic (pH 5.45). This is below the average of the other treatments, probably because of the metabolites produced by A. flavus. This mold has potent lipases that hydrolyze stored triglycerides to fatty acids. Thus, both FAN and pH assays can be useful to evaluate the extent of grains damage. During SSF of mashes adjusted to 15 Plato, FAN was assayed at the beginning and at the end of fermentation (Fig. 4).

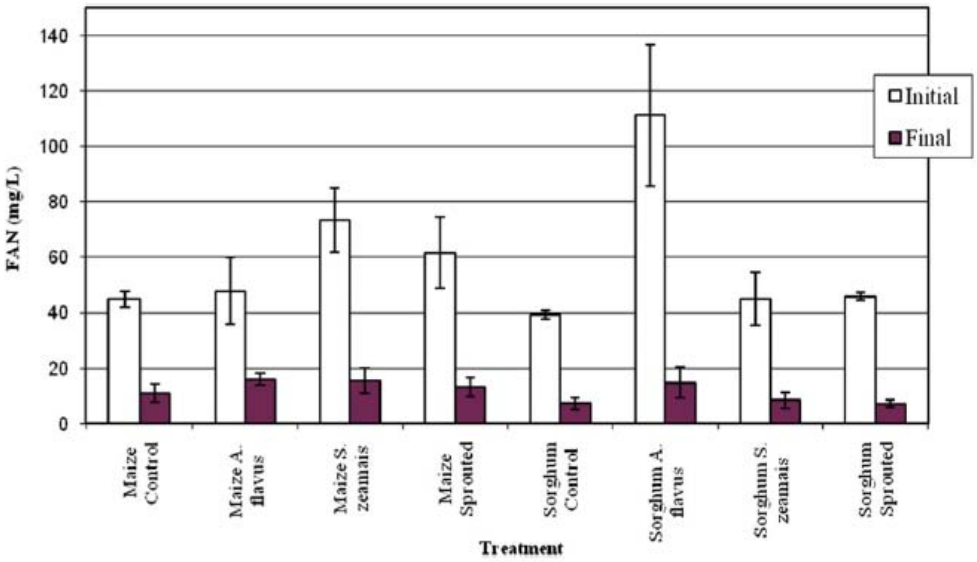

Fig. 4.Free Amino Nitrogen (FAN) concentration (mg/L) at the beginning and at the end of SSF [11]

In the case of maize, mashes produced from damaged kernels showed a higher FAN compared to the control. This difference was not observed in sorghum except in mold-damaged kernels which contained 110 mg/L (almost twice the amount detected in the rest of the sorghum treatments). At the end of SSF, all treatments had almost the same leftover FAN (10 &20 mg/L), indicating that yeast metabolized these nitrogenous compounds. Despite the differences in initial FAN, this parameter was not positively correlated with fermentation efficiencies. The concentrations of glucose and ethanol at the beginning and end of SSF are depicted in Table 2. [11]

Table No. 2 Effect of Insect, mold, and sprout damage of corn and sorghum on glucose before fermentation and ethanol, glycerol and ethanol yields and efficiencies obtained after 72 h fermentation [11]

Samples			Glucose(mg/ml)	Ethanol (ml/ml)	Glycerol[b] (mg/ml)	Fermentation efficiency (%)	`Ethanol yield (L/ton starch)	(L/ton of already damaged grain)	(L/ton grain)
Maize	Control Damaged	A flavus s. zeamais sprouted	133.11 ± 4.86a	92.31±8.13a	9.00±0.86a	84.24±2.44a	520.79±15.09a	376±10.91a	376.59±10.91ab
			127.63 ± 9.95a	81.43±2.87a	1.65±0.23a	77.54±3.84a	479.40±23.71a	344.74±17.05a	331.70±16.41a
			128.50 ±7.68a	83.09±2.87a	10.37±0.17a	76.10±1.63a	470.47±10.10a	320.81±6.89a	264.44±5.68c
			133.56 ± 6.51a	90.11±4.94a	9.73±0.08a	89.04±1.07a	550.48±6.59a	374.82±4.49a	333.67±4.00a
Sorghum	Control Damaged	A flavus s. zeamais sprouted	140.02 ± 2.30a	95.11±10.02a	9.89±1.03a	83.70±7.86a	517.48±48.57a	381.12±35.77a	381.12±35.77ab
			132.56±1.31a	91.65±8.31a	8.74±1.13a	81.83±6.65a	505.47±41.10a	353.96±28.75a	326.00±26.48a
			134.89±1.83a	87.14±1.94a	10.92±0.07a	78.72±1.28a	486.67±7.91a	351.50±5.55a	290.75±4.73abc
			141.2±5.95a	94.12±8.71a	10.78±0.08a	89.90±8.18a	555.78±50.55a	382.60±34.80a	349.85±31.82a

[a]All calculations are based on dry matter basis and are average of three replicas ± standard error of mean. Means with different letter (S) within columns were statistically different (P<0.05)
[b]The initial glycerol concentration was zero
[c]Yields calculated on 14% moisture basis
[d]Ethanol yields considering solid losses incurred during storage

The initial glucose in all worts was between 130 and 140 g/L. After 72 h fermentation, all the glucose was metabolized by the fermenting yeast. This indicates a complete and high efficient fermentation and the effectiveness of the liquefaction step that rendered dextrins highly susceptible to amyloglucosidase and pullulanase. Therefore, the presence of A. flavus, and intrinsic

enzymes did not affect yeast and a-amylase or amyloglucosidase/ pullulanase activities. The final ethanol concentration varied from 81.43 mL/L in mold damaged maize to 92.31 and 95.49 mL/L in the sound maize and sorghum, respectively. The negative impact of the use of mold-damaged kernels is mainly due to dry matter losses incurred during storage and stresses the importance of first-rate storage practices. However, this research clearly demonstrates the use of already damaged kernels is feasible. These kernels can be acquired at a discount price by biorefineries and subsequently converted into bioethanol with similar efficiencies.

Conclusion:-

Sprouted, insect, and mold damaged Corn and Sorghum grains have some influence on the process or end products. Though broken grains are not of major concern for ethanol production, sprouted, insect, and mold damaged Corn and Sorghum grains can have a considerable effect on ethanol yield. Nevertheless, all already damaged kernels had similar fermentation efficiencies, indicating that these feedstocks are suitable for fuel ethanol production. Field sprouted grains had more rapid fermentation rate than healthy grains. Field-sprouted grains shorten fermentation time without decreasing ethanol yield. Low test weight is considered to reduce ethanol yield because the kernels are not as densely packed with starch. As per the above study, it is concluded that already damaged insect, mold or sprouted corn and sorghum grains could be effectively used for ethanol production and can be a good alternative for bio-refineries, instead of using them for animal feed or manure which is unhealthy. Ethanol production using damaged grains is an economical method of using waste to produce valuable products.

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Experimental Investigation of an Innovative Flat Plate Solar Collector

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Abstract: This paper presents experimental investigation regarding performance and reliability of a newly designed flat plate solar collector. Flat Plate Collector (FPC) is widely used for domestic hot-water, space heating or drying and many industrial applications requiring fluid temperature less than 100^{0}C. Conventionally, absorbers of all flat plate collectors are straight copper or aluminum sheets. However, this limits on the heat collection surface transfer area. Many types of conventional collectors have been commercialized; their investment costs are still relatively high. Overcome this problem, a new low cost solar collector is developed, replacing the absorber and copper tube arrangement by fabrication of a simple copper box. Experimentation is conducted on existing and new flat plate collector for various operating condition and data is recorded. The outlet temperature variations in existing and new flat plate collectors are compared in this paper.

Keywords: Flat Plate Collector (FPC), solar water heater, Copper box.

I. INTRODUCTION

The sun is responsible for all of the earth energy. Solar energy is the sun's nuclear fusion reactions within the continuous energy generated. Plants use the sun's light to make food. Decaying plants hundreds of millions of years ago produced the coal, oil and natural gas that we use today. Solar energy is the sun's nuclear fusion reactions within the continuous energy generated. Earth's orbit, the average solar radiation intensity is 1367kw/m^2.Circumference of the Earth's equator is 40000km, thus we can calculate the energy the earth gets is up to 173,000 TW [1][12] [13].

Solar hot water systems play a vital role in low temperature applications such as domestic hot water, space heating or drying and for many industrial applications [11].Solar water heating system has been developed around for many years because it is the easiest way to use the direct solar radiations from sun to save energy and money [14].Solar hot water systems function as heat exchangers [7].The most important and most expensive single component of solar hot water system is the collector field. Solar collectors are the heart of most solar energy systems [15].

Solar collector absorbs the solar radiation from sun, converting it into thermal energy at the absorbing surface, and transferring the energy to a fluid flowing through the collector [6][8][9][10][11].

The principle components of conventional flat plate collector are shown in fig 1.

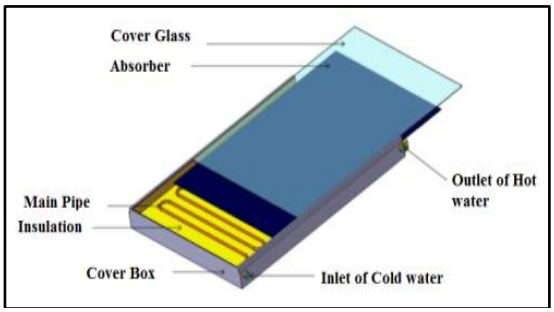

Fig. 1: Principle layout of conventional flat plate collector.

In fig. 1, the cover box contains insulation to prevent losses [4]. Cover box is made of either copper or aluminium. The main pipe is made of material of copper to transfer the absorbed heat to the water, a dark-coloured shows the absorber and a cover glass.Absorber plate made of any material, which will rapidly absorb heat from sun's rays and quickly transfer that heat to the tubes or fins attached in some manner, which produces a good thermal bond [1] [2][3]. Especially absorber plate is made of copper plate because of its high thermal conductivity [1][5].

A. Applications of Solar Energy

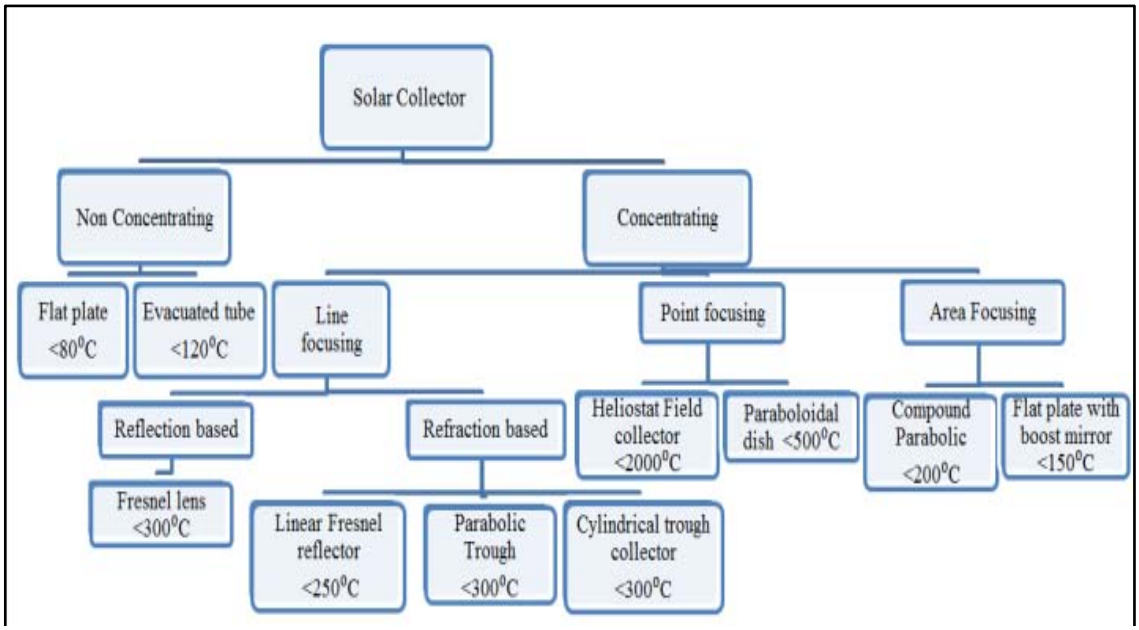

Fig. 2: Application of solar energy

Number of systems are developed to convert the solar energy into useful for many applications. Table 1.1is developed to show the various systems for solar energy conversion, application and uses of solar energy.

In non-concentrating type collectors' collector area is equal to absorber area. These are mostly used for low temperature (<120^{0}C) heating purposes for e.g. heating water in the houses, hospitals, restaurants, hotels and solar air heating for to preheat air in buildings. Advantages of non-concentrating collectors over the concentrating collectors are: low maintenance, use both diffuse and beam radiations, no tracking system required, easy to operate and high reliability. Non concentrating collector can produce high temperature but because of following reasons these are not used for high temperature application:

i) The cost of absorber higher than the cost of mirrors.
ii) The heat losses from the collector are proportional to the absorber area.
iii) Radiation losses are proportional to so there is great increase in radiation loss due to high temperature.

In concentrating collectors the solar radiations falling on large area (collector) are concentrated on the small area (absorber). Thus the energy falling per unit area increases on the concentrating surface as compare to any other surface. This increases the energy input rate per unit area due to which high temperatures can be achieved. So point focusing collectors are used for much higher temperature applications.

II. COMPONENT OF SOLAR WATER HEATING SYSTEM

Solar water heating systems can be broadly divided into three main parts i.e. solar collector, Storage tank and Pipe.

- Solar collector: Solar collector is the heart of solar water heating system used to convert solar energy into heat energy. Solar collector with associate absorber (absorb the solar radiation) collects and converts the solar energy into heat energy that can be used in many applications. Copper is the best material is used for collector due to its high thermal conductivity, but it is very expensive. Figure 1show the working principal of solar collector.

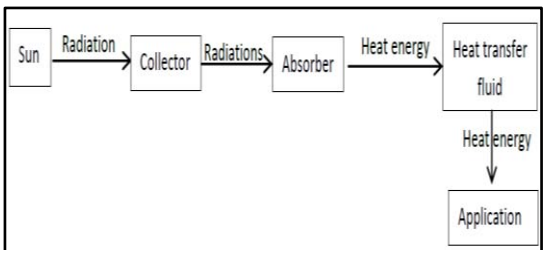

Fig. 3: Working Principle of solar collector

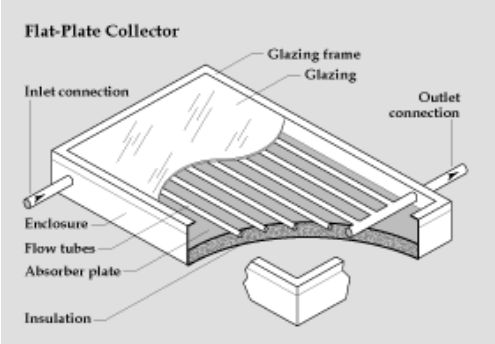

Fig. 4: Flat plate collector

- Storage tank: The storage hot water tank is made of a rolled galvanized. Heated water is transferred into the storage tank from the collector loop. A small outlet at the bottom section of the tank can be used for drainage purposes.
- Pipe: Galvanized steel pipes were used due to its rigidity and resistance to corrosion. This is very important since they hold the water to be used domestically as well as industry [15].

III. NEW FLAT PLATE SOLAR COLLECTOR

A new flat-plate solar collector has the simplest designs and requires neither tracking nor as much maintenance as the other collector designs [3]. Figure 5 shows the real of new flat plate collector

Fig. 5: Real view of new flat plate collector

In new type flat plate collector, we replaced the copper tubes arrangement by simple putting a copper box of dimensions 1100 x 1100 x 15 mm in collector frame. Copper has atomic number 29 with an atomic weight of 63.54, exhibits a face-centered cubic crystal structure. Copper is a transitional element and, being a noble metal, it has inherent properties similar to those of silver and gold. Its excellent conductivity, malleability, corrosion resistance and bio functionality stem from copper's elemental origins.The thickness of copper plate is 1 mm having 22 gauges. The copper box is fixed in collector frame with a transparent cover. The provision for inlet cold water from the water tank as given from one side of the frame into the copper box and outlet of hot water is also given from the another end. The rise of the water temperature inside the copper box collector is due to the absorption of incident solar radiation gives rise to water uprising motion into the storage tank.The 3-D view of copper made flat plate collector is as shown in figure 6

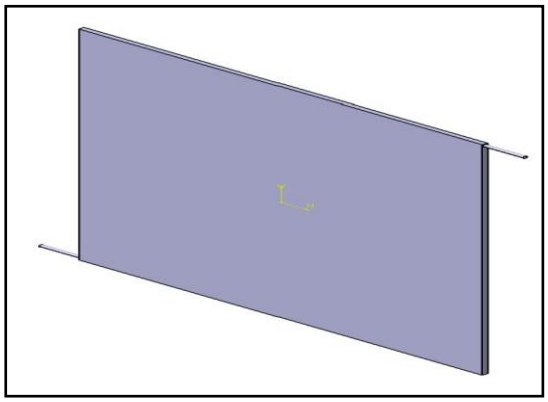

Fig. 6: 3-Dview of flat plate collector

IV.EXPERIMENTATION

The experimental setup is designed with the existing Flat plate collector and new flat plate collector, Collector frame, rotameter and thermocouple.Figure 7 shows the schematic representation of experimental setup [16].

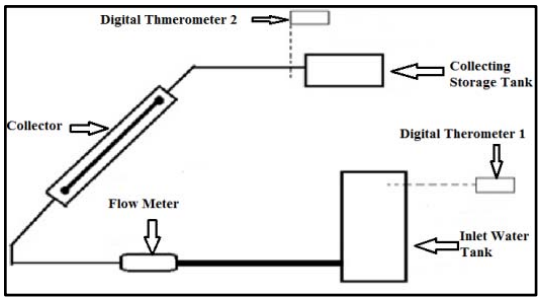

Fig. 7: Experimental Setup

Figure 7 shows the experimental setup in which two digital thermometer are required whose ranges up to 150 ^{0}C for measurement inlet and outlet temperatures. Digital Thermometer 1 is fitted in the inlet of solar water heating system for measuring the temperature of inlet cold water temperature and Thermometer 2 is fitted in the exit of the collector for measuring the hot water

temperature, which is after the heating of water. Flow meter is also fitted in the inlet side system to measure the flow of water before the water is admitted in the collector.Figure 8 shows the experimental setup.

Fig. 8: Experimental setup

The cold water tank was filled with water after proper filtration. The valve was opened to allow water flow to the circulating pipes. Water flows through the collector at a constant flow rate during all the measurements. The water was heated up from the heat supplied by the absorber plate to the copper box integrated beneath the absorber plate; hence, by virtue of density difference between the cold water and hot water (i.e., the cold water goes down, while the hot water comes up), a flow is initiated (thermo-syphon or natural convection).The hot water flows to the hot water storage tank, which has a valve to allow tapping when needed for use.

Observations are recorded after performing the measurement of important operating parameters of the experimental setup at selected location as per the procedure specified during the experimental work. Throughout the complete trials conducted, the day was sunny and no any cloudy conditions were present [17].

V. RESULT AND DISSCUSSION

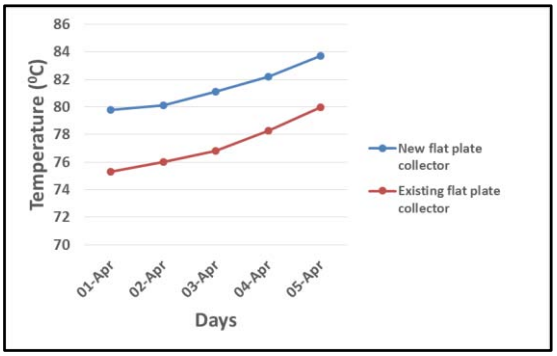

Fig. 9.1: Variation in Water outlet temperature vs days at 2 pm

Experimental test has been carried out at 2 pm for five consecutive days from 1st to 5th April 2015. It is observed from figure9.1variations in water outlet temperature vs. days, temperature of water increases 5 to 6 % in new flat plate collector as compared to existing flat plate collector.

Also it is seen from figure9.2 Variation in Water outlet temperature Vs Time duration during consecutive 6 hoursfrom 11.00 A.M. to 5.00 P.M. It is observed that temperature of water increases 5

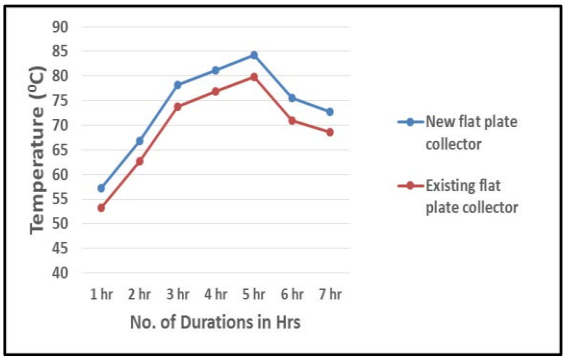

Fig. 9.2: Variation in Water outlet temperature vs Time duration in hours

to 7 % in new flat plate collector as compared to existing flat plate collector. New flat plate collector shows maximum water outlet temperature after 4 hour start of test. Increase in water outlet temperature for new flat plate collector is due to increase in heat transfer area.

VI. CONCLUSIONS

The following conclusions are drawn from the present study. Flat plate solar water heater is successfully designed and it is observed that through experimental analysis increase in heat transfer area of flat plate solar water heater increases the heat transfer rate.

1. It is observed from experimental results; the water outlet temperature from collector is linearly increases with increase in day time up to a certain limit.
2. It is also concluded from the results that the maximum outlet temperature is reached between 2.00 p.m. to 3.00 p.m. with maximum temperature up to 86^0 C.
3. It is observed that outlet temperature of water is high in new flat plate collector for the same collector area of existing flat plate collector.

4. It seems from the results that the temperature increases linearly and afterwards decreases linearly as per increase in day time.
5. As per experimental results increase in heat transfer rate is observed as compared to existing flat plate solar water heater with respect to time in water heating keeping other parameters constant.

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Experimental Investigation on a Single Cylinder Compression Ignition Engine System Performance with Jatropha oil Blends

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ABSTRACT: In this era of modernization and industrialization day by day, the transportation sector is most fossil energy consuming sectors. Combustion of fossil fuels contributes to increased greenhouse gas concentrations in the atmosphere. Depletion of the petroleum reservoir on the earth is increasing concerns about the environment which leads to the quest for fuels which are eco-friendly and safe for human beings. Use of bio-fuels helps to stabilize the greenhouse gas levels in the atmosphere also dependency of fossil fuels could be decreased. This situation leads to seek an alternative fuel for diesel engine. Biodiesel is an alternative fuel for diesel engine. Esters of vegetables oil animal fats are known as Biodiesel. Properties of biodiesel are similar to that of diesel. Deployment of Jatropha blends with diesel in C.I. engine performance and combustion characteristics of B10, B20 and B30 blends of Jatropha with diesel is reviewed in this paper. Use of the higher blends is restricted due to loss of efficiency and long term problems in the engine. Thus it is seen that blends of biodiesels such as Jatropha with diesel might be a substitute instead of pure diesel as an alternative fuel in future to save natural resources.

Introduction

Diesel engines have provided power units for road transportation systems, ships, railway locomotives, equipment used for farming, construction, and in almost every type of industry due to its fuel efficiency and durability. However, Diesel engines are the major sources of NOx and particulate matter emissions which are environmental concerns. For automotive industry the reduction of NOx and PM emission is the most important task. National governments are imposing stringent emissions on automotive sector to reduce NOx and PM emissions. Also global house warming gases (GHG) are going to receive more focus from future auto sector. Therefore, the stringent emission regulation requirements give a major challenge to comply emission targets while maintaining its performance, drivability, durability, and fuel economy. The use of alternative fuels for internal combustion engines has attracted a great deal of attention due to fossil fuel crisis and also GHG impact. Alternative fuels should be easily available, environment friendly, and techno economically competitive. Successful alternative fuel should fulfill environmental and energy security needs without sacrificing engine operating performance [1]. Renewable resources offer the opportunity to tap local resources and reduce dependency on fossil energy resources. Most biodiesel oils, particularly of the nonedible type can be used as fuel in diesel engines. They contain significant amount of oxygen [2, 3]. The idea of using vegetable oils as fuel for diesel engine is not new. When Rudolf diesel invented diesel engine and demonstrated in the 1900 world exhibition in Paris, using peanut oil and presented that "The use of vegetable oils for engine fuels may seem insignificant today, but such oils may become in course of time as important as petroleum and coal tar products of present times" [4].

One of the promising alternative fuels considered for diesel engine is biodiesel. Biodiesel fuels are renewable, as the carbon released by the burning of biodiesel fuel is used when the oil crops undergo photosynthesis. Biodiesel also offers the advantage of being able to readily use in existing diesel engines without engine modifications [5-9]. Even

though biodiesel has many advantages, because of engine problems its use is restricted to maximum 20% only [10, 11]. Also when biodiesel is used as fuel in existing engines, there is decrease in power, drop in thermal efficiency, increase in specific fuel consumption, and higher NOx emissions [12]. In order to overcome these problems various modifications in engine operating parameters are suggested. The various modifications suggested are varying the compression ratio, injection pressure, use of multiple injections, oil preheating, and so forth. Table 1 presents the comparison of properties of Jatropha oil.

Table No. 1 Properties of Jatropha oil

SR.NO.	PROPERTIES OF JATROPA OIL	VALUES
01	Density at 150C g/cm3	0.852
02	Kinematic viscosity at 400 C cSt	2.781
03	Water content % volume	0.055
04	Rams bottom carbon residue %wt.	0.10
05	Pour Point ^{0}C	20
06	Flash point ^{0}C	49
07	Cetane number	46
08	Sulphur content %wt.	0.0165
09	Ash content %wt.	0.010
10	Acid value mg KOH/g	0.104
11	Oxidation stability g/100ml	0.01
12	Copper strip corrosion	1a
13	Calorific value(gross) kJ/g	45.013
14	IBP/FBP 0C	139/370

Table 2: Engine specifications

1	Make -	Kirloskar Make, single cylinder,4-stroke compression ignition on engine
2	Rated power output-	5H.P.
3	Speed-	1500 R.P.M.
4	Stroke length-	110 mm
5	Bore diameter-	80mm
6	Loading type-	Water resistance type load, With copper element and load changing arrangement
7	Moment arm-	0.2 meter
8	Orifice diameter (for air box) -	25mm
9	Co-efficient of discharge of orifice -	0.64

Experimental Setup and Experimentation

A typical 3.5kW single-cylinder 4-stroke water-cooled diesel engine at 1500 rpm was used for the research work, and Table 2 presents engine specifications. The schematic diagram of the experimental set up is shown in Figure 1. An eddy current dynamometer was used for load control on the engine. The piezoelectric pressure transducer was mounted on cylinder head. Various thermocouple temperature sensors were installed at appropriate locations to measure water inlet and outlet, manifold air temperature, exhaust outlet, and heat exchanger outlet temperatures. A temperature thermocouple was installed on the surface of high pressure fuel pipe. A precision crank angle encoder was coupled with the main shaft of the engine. Two openings were made in exhaust gas pipeline for sampling purposes. Fuel metering was done using a burette fitted with a three-way valve measuring unit installed on fuel tank as shown in Figure 1. The mass flow rate of intake air was measured with an orifice meter connected to a manometer. A surge tank was used to damp out the pulsations produced by the engine, for ensuring a steady flow of air through the intake manifold. An gas analyzer was used for measuring the CO, HC, and NOx emissions and the smoke density was measured using AVL 437 smoke meter. The engine was warmed up prior to data acquisition. All the engine test runs were carried out in fair constant ambient conditions. During the tests with Jatropha biodiesel, the engine was started with diesel until it was warmed up and then fuel was switched to various diesel-biodiesel blends. After finishing the tests with diesel-biodiesel blends, the engine was always switched back to diesel fuel and the engine was run until the biodiesel had been purged from the fuel line, injection pump, and injector. This was done to prevent starting difficulties at the later time. Initially the test engine was operated with base fuel

diesel for about 10 minutes to attain the normal working temperature conditions. After that the baseline data was generated and the corresponding results were obtained. The engine was then operated with blends of Jatropha biodiesel and diesel, namely, B5, B10, B20, B40, B60, B80, and B100. At every operation the engine speed was checked and maintained constant. All the measurements were repeated five times, and the arithmetic mean of these five readings was employed for calculation and analysis. The different performance and emission parameters analyzed in the present investigation were brake thermal efficiency (BTE), brake specific fuel consumption (BSFC), exhaust gas temperature (EGT), carbon monoxide (CO), unburned hydrocarbons (UHC), nitrogen oxides (NOx), and smoke opacity. For baseline data, the engine compression ratio was set to 17.5 and fuel injection pressure (Pinj) was maintained at 180 bar. Then compression ratio was increased from 17.5 to 19.5 in the step of 1 and fuel injection pressure was varied from 180 bar to 220 bar in the step of 20 bar.

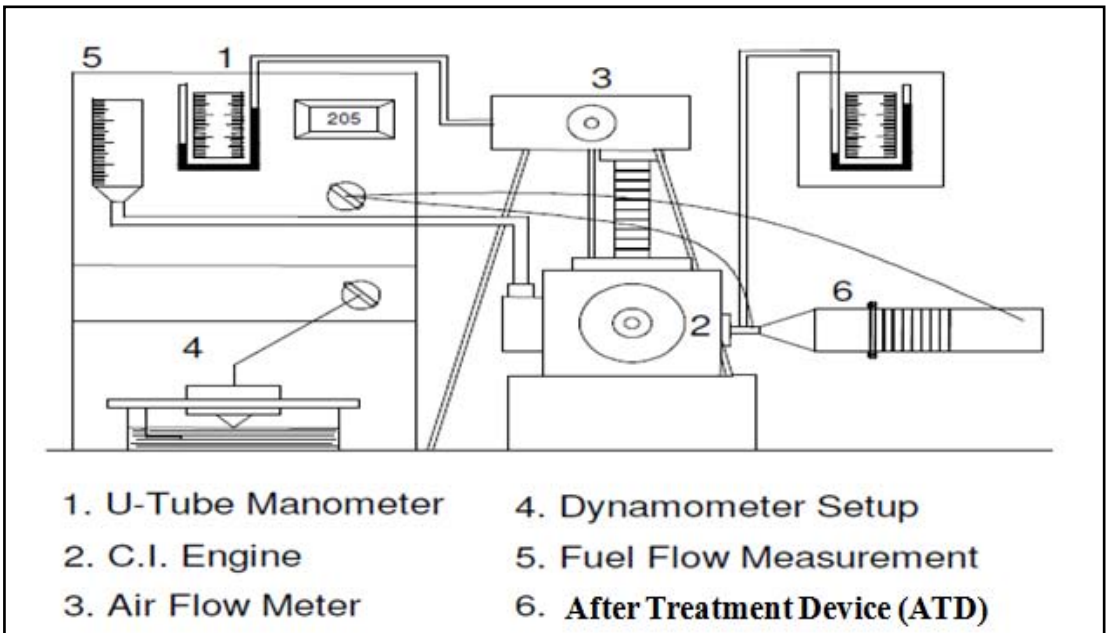

Figure 1 Experimental Set-up

Results & Discussion:-

4.1. Emissions for Biodiesel Blends. Figure 2 shows the variation in smoke opacity for all biodiesel blends at various load points. The smoke opacity was reduced in the range from 19.4% to 44.4% for various biodiesel blends as compared to that of diesel. This was mainly due to complete combustion, as additional oxygen is available from fuel itself. The smoke opacity increases with increase in engine loads. As the blend concentration was increased, smoke also increased even at lower loads and was higher than mineral diesel. This is due to poor atomization of Jatropha oil. Heavier fuel molecules, higher viscosity, and low volatility result in poor atomization of fuel. Figure 3 shows the variation in NOx emission at various load points and for various biodiesel blends. NOx was increased in the range from 2.6% to 16.2% for various biodiesel blends for no load to full load as compared to diesel. As the engine load is increased, the mass emission of NOx reduces. The most important factor for the formation of NOx is the combustion temperature in the cylinder and the availability of oxygen. The Jatropha oil has considerable higher viscosity which results into longer combustion duration and demonstrates significant energy release during the last phase of burning. Figures 4 and 5 show the variation of CO and THC emission trends at various loads for biodiesel blends. Continuous reduction in CO was observed at 0.5 kW, 1.5 kW, 2.5 kW load whereas at 3.5kW load and B20 blends onwards CO emission was increased. Increase in THC emissions was noticed at full load point with increased biodiesel blends. CO emissions were reduced by 4% to 9.33% for various biodiesel blends, respectively, at full load. THC emission was reduced by 4.1% and 6.66% for B5 and B10 blends and then was increased for B20 to B100 blends. With increased Biodiesel blends, the energy content in the fuel reduces and to get

same power, more quantity of fuel needs to be injected and there are chances of wall wetting and fuel trapped in crevices zones causes more THC emissions. Blends higher than 20% showed higher CO emissions than diesel fuel at high engine load. Due to higher viscosity, the air fuel mixing process is affected by the difficulty in atomization and vaporization of Jatropha oil blends. The resulting locally rich mixtures cause more incomplete combustion products such as CO and HC.

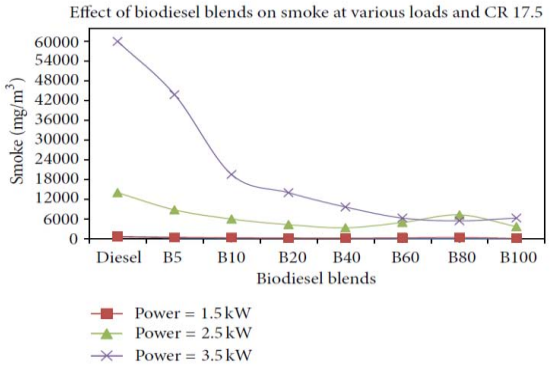

Figure 2: Variation in smoke opacity for various biodiesel blends at different loads.

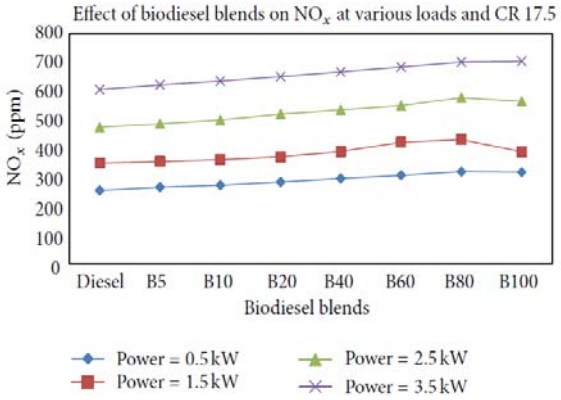

Figure 3: Variation in NOx for various biodiesel blends at different loads.

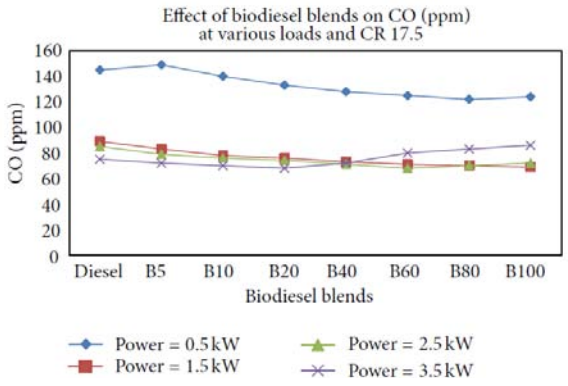

Figure 4: Variation in CO for various biodiesel blends at different loads.

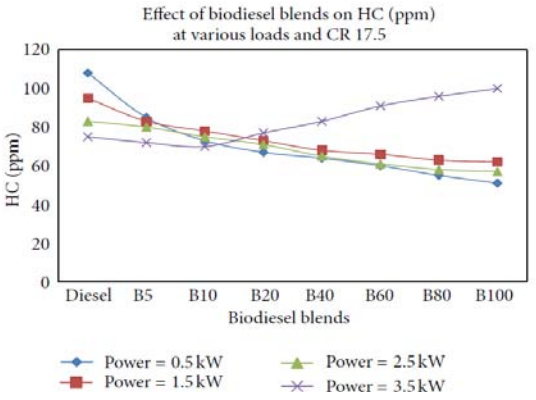

Figure 5: Variation in HC for various biodiesel at different loads.

4.2. Engine Performance for Biodiesel Blends. The engine performance indicators considered were brake specific fuel consumption (BSFC), brake thermal efficiency (B_{th}) and exhaust gas temperature. Figure 6 shows the BSFC plots for various biodiesel fuel blends at all loads points. Brake specific fuel consumption is a measure of volumetric fuel consumption for any particulate fuel. Diesel fuel had the lowest BSFC throughout the tests. BSFC increased in the range from 2.26% to 13.58% for various biodiesel blends, respectively, than that of diesel. The increase in BSFC for the biodiesel blends may be due to biodiesels having less energy content (lower heating value) than the diesel. The higher the biodiesel content in the blend and the lower their heating values result in higher BSFC. Figure 7 shows variation in thermal efficiency for biodiesel. It was observed that for all the loads, the diesel fuel showed higher thermal efficiency as compared with blends. The thermal efficiency was decreased by 3.10% to 10.34% for various biodiesel blends, respectively, than that of diesel from no load to full load condition.

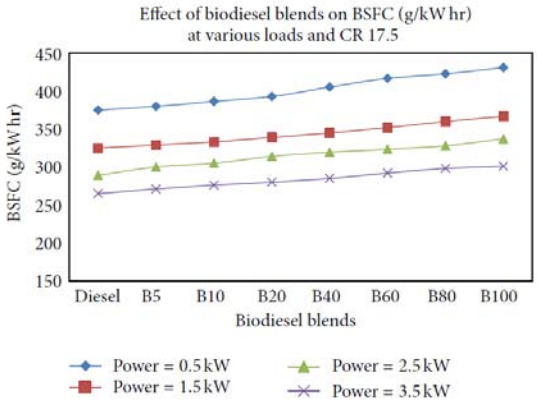

Figure 6: Variation in BSFC for various biodiesel blends at different loads.

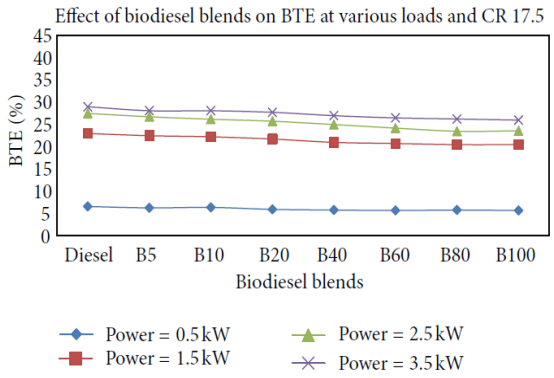

Figure 7: Variation in BTE for various biodiesel blends at different loads.

Figure 8 shows the effect of exhaust gas temperature on diesel-biodiesel blends at 1500 rpm. The results showed that the exhaust gas temperature increased with increase in load. This is due to the poor combustion characteristics of the Jatropha curcas oil because of its high viscosity. The combustion characteristics of the blends were improved by increasing the percentage of diesel fuel in the biodiesel fuel. All the test fuels exhibited lower exhaust gas temperature as compared to diesel fuel and this phenomenon can be understood that poor BSFC can be because of poor combustion efficiency.

Conclusion:-

As per the experimental investigations using Jatropha biodiesel blend in a single-cylinder diesel engine, the following conclusions could be drawn. Single-cylinder diesel engine requires no modification in hardware during testing. The effect of various blends of B5, B10, B20, B40, B60, B80, and B100 on engine performance is given below-.
(1) Improvement in BTE and BSFC was observed at higher compressions ratio 19.5 as compared to 17.5 at all blends. It showed that the higher compression ratio compensate the loss of BTE with biodiesel blends. The brake thermal efficiency was found to increase with increase in compression ratio and there is no significant difference in the brake thermal efficiency of biodiesel blends and neat diesel. (2) Low smoke opacity was observed with higher com- pression ratio due to better combustion. Maximum reduction in smoke opacity was 22% at compression ratio 19.5. (3) A practical conclusion can be drawn that all tested fuel blends can be used safely without any modification in engine. So blends of methyl esters of Jatropha oil could be used successfully. (4) On the whole it is concluded that Jatropha oil can be used as fuel in diesel engine directly and by blending it with diesel fuel. Use of Jatropha oil can give better performance and reduced smoke emissions.

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Investigation of Storage Tank Performance Using Phase Change Material in a Solar Water Heating System

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Abstract: In this paper main objective is to investigate storage tank performance using Phase Change Materials (PCMs) in a solar water heating and utilize this energy for domestic purpose. This ensures that hot water is available throughout the day. The system consists of two simultaneously functioning heat-absorbing units. One of them is a solar water heater and the other a heat storage unit consisting of PCM. The water heater function is to absorb the radiant heat, stores it and supplies hot water during the day. The storage unit stores the heat in PCMs during the day and supplies hot water during night. The stainless steel water tank has a capacity of about 30 litres, with an internal diameter of 28 cm and a height of 48 cm, it houses the 9 kg PCM inside the square tank having length 40 cm and width 28cm, this allows for heat transfer between the surface and the water. Experiment results shows that with using PCM charging-discharging efficiency decreases and higher mean temperature of storage tank at lower mass flow rate of water is obtained.

Keywords: Solar Water Heating System, Phase Change Materials, Storage Tank

1 Introduction

1.1 Phase Change Material

These materials can store energy by the melting at a constant temperature. No material has all the optimal characteristics for a PCM, and the selection of a PCM for a given application requires careful consideration of the properties of various substances. Over 20,000 com-pounds and/or mixtures have been considered in PCM, including single component systems, congruent mixtures, eutectics and peritectics [3]. The isothermal operating characteristics (i.e. charging/discharging heat at a nearly constant temperature) during the solidification and melting processes, which is desirable for efficient operation of thermal systems [9].

The value of the latent heat is very important, because the higher latent heat results higher storable heat quantity. According these aspects we can choose from several materials. We have to mind the chemical properties, the thermal expansion and the aspects of safety. PCMs in the 50 to 1000 temperature range have been proposed to water heating and o -peak electrical heater applications.

Wax is the most commonly used commercial organic heat storage PCM [10]. Paraffin waxes are cheap and have moderate thermal energy storage density but low thermal conductivity and, hence, require large surface area [10]. In our current project we are considering the same PCM.

Abbreviations

SWH	Solar Water Heater
PCM	Phase Change Material
FPC	Flat Plate Collector
MS	Mild Steel
PVC	Poly Vinyl Chloride
ICS	Integrated Collector Storage
SHS	Sensible Heat Storage
TES	Thermal Energy Storage
LHTES	Latent Heat Thermal Energy Storage
HTF	Heat Transfer Fluid
CE	Charging Efficiency
DE	Discharging Efficiency
MTST	Mean Temperature of storage tank

2 Experimentation Process

2.1 Experiment setup

Photographs of the experimental setup shown with the solar collector connected to the water tank are shown in Figures 1. The setup consists of a cylindrical water tank which holds the PCM inside inner square tank, solar flat plate collector. The stainless steel water tank has a capacity of about 30 litres, capable of supplying water for a family of four members. With an internal diameter of 28 cm and a height of 48 cm, it houses the PCM inside the square tank having length 40 cm & width 28cm and allows for heat transfer between the surface

and the water. The tank is insulated with 5 cm of Rock wool and is provided with an aluminium cladding. The PCM storage tank contains 9 kg of paraffin wax. RTDs are provided at inlet & outlet.

Fig 1: Experimental setup

2.2 Experiment trial

During the charging process the water is circulated through the tank and the solar collector unit continuously. The water absorbs solar energy sensibly, and exchanges this heat with the PCM in the PCM storage tank, which is initially at room temperature. The PCM slowly gets heated, sensibly at first, until it reaches its melting point temperature. As the charging proceeds, energy storage as Latent heat is achieved as the Paraffin wax melts at constant temperature (62±2°C). After complete melting is achieved, further heat addition from the water causes the PCM to superheat, thereby again storing heat sensibly. The charging process continues till the PCM and the water attain thermal equilibrium. Temperatures of the PCM and water at the outlet are recorded at intervals of 3 hours. The PCM is charged through the day, whenever hot water is not demanded by the user.

The discharging process used is termed as batch wise process. In this method, a certain quantity of hot water is withdrawn from the water tank and readings are taken. This is then repeated for intervals of 3 hours, in which time transfer of energy from the PCM would have occurred. This procedure is continued till PCM reaches a temperature of 56^0C.
First of all we have taken the trial on the Solar Water Heater without using phase change material (WAX).

Testing Procedure

The tests to be performed are the heat loss test and two charge-discharge tests for determining the storage capacity.

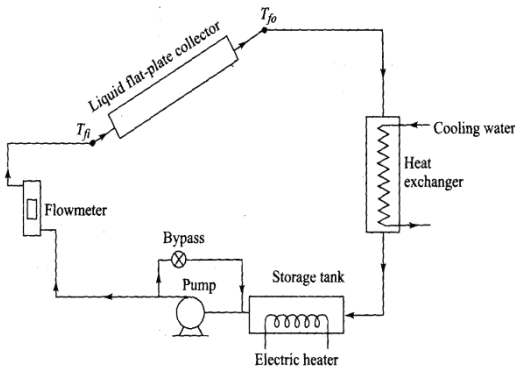

Fig 2 Closed loop testing set up

In the heat loss test, the transfer fluid is passed through the storage device at a fixed mass flow rate (m) and at an inlet temperature (T_{fi}) 25°C above the ambient air temperature (T_a). After steady state conditions are achieved, the difference between the inlet and outlet fluid temperature is measured. The heat loss factor $(UA)_t$ is calculated from the expression

$$(UA)_t = \frac{mC_p(T_{fi} - T_{fo})}{(T_{fi} - T_a)}$$

In the charge-discharge test, the transfer fluid at a constant temperature is first passed through the device and the device brought to a uniform initial temperature T_i .Then the flow is adjusted to the test flow rate (m) and the temperature of the transfer fluid is suddenly increased in a step-wise manner to $T_i + \Delta T_i$ The difference between the temperature of the transfer fluid entering and leaving the device is continuously recorded over a specified time period t_p, as charging takes place. The temperature of the transfer fluid is maintained at $(T_i + \Delta T_i)$ until the exit temperature of the transfer fluid reaches a steady value. Thereafter with the same mass flow rate, the temperature of the transfer fluid is suddenly decreased in a step-wise manner back to the initialvalue T_i .The difference between the temperatures of the transfer fluid entering and leaving

The device is again continuously recorded over the same time period t_p as discharging takes place. The charge-discharge cycle is performed for two test conditions. If the transfer fluid is a liquid, the value of ΔT_i is taken as 15°C for both test conditions, while the values of t_p are taken to be 2 and 4 hours.

If the transfer fluid is air, the corresponding values are ΔT_i = 35°C, and t_p = 2 and 4 hours. The variation of the inlet and exit temperature of the transfer fluid during a typical charge-discharge cycle is shown in Fig. 3

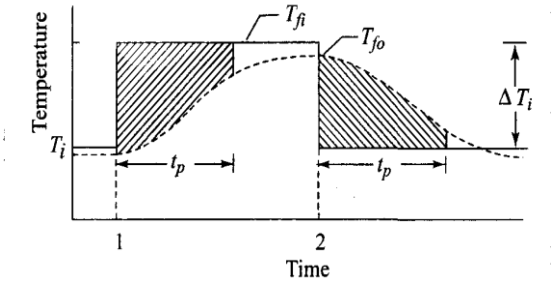

Fig 3 Charge-discharge test cycle

The value of T_i the initial temperature of the storage device, is chosen by considering the intended temperature range of the device during use, while the value of the mass flow rate maintained during charging and discharging is calculated from the expression

$$m = \frac{TSC}{t_p C_p \Delta T_i}$$

Where, TSC = theoretical storage capacity of the device for a temperature change from ΔT_i to (T_i + ΔT_i).

From the data recorded, the charge and discharge capacities of the device are obtained by integration as follows.

$$C_c = m \int_0^{t_p} C_p \left(T_{fi} - T_{fo}\right) dt - (UA)_t t_p \left[\frac{T_{fi} + T_{fo}}{2} - T_a\right]$$

$$C_d = m \int_0^{t_p} C_p \left(T_{fi} - T_{fo}\right) dt$$

Phase 1

We calculated the cooling rate of the water in the water tank after heating the water for 6 hrs sunlight. The analysis is shown in the Table 1

Table 1: Cooling rates of Water in General SWH

Time elapsed (hrs)	Temperature ^{0}C
0	75
3	70
6	66
9	62
12	59
15	56
18	54
21	52

Phase 2

In this phase we were calculating the efficiency of Solar Water Heater. The parameter s for calculating the efficiency of Solar water heater as shown in Table 2

Table 2: Efficiency Parameters

Parameters	Symbol	Value
Volume of water	V	20 Liter
Initial Temperature of water	Ti	36^{0}C
Heat radiated in day	Pin	1170 Watts
Time elapsed	t	6hrs
Final Temperature of water	T_f	75^{0}C

We know the standard formula for efficiency calculation

Efficiency, $\eta = \frac{\text{Heat Enrgy Output}}{\text{Heat Energy Input}}$

= Qout /Qin

Now, to calculate output Heat energy Qout = Heat energy absorbed by water

$$\rho \times V \times C_{pw} \times (T_f - T_i)$$

let's calculate heat supplied by solar radiation
Average heat radiated in a day, Pin = 1170 W/m^2
Hence, Qin = Pin ×area of panel× Δ t
The absorption of radiated heat is only 96% effective. So, effective heat radiated on panel Q_{in}, effective = 0.96 Qin

Now, calculating efficiency of general solar water heater without using phase change material

$$\eta = Q_{out} / Q_{in}, \text{ effective}$$

Now, calculating cooling rate and the efficiency of the solar water heater by adding PCM (Wax).

We added 9kg PCM (wax) in PCM tank as 100 liter water requires 36kg of PCM. Phase 1

We calculated the cooling rate of water in the water tank by adding PCM and heating water for 6 Hrs. The analysis is shown in the Table 3

Table 3: Cooling rates of Water in SWH with PCM

Time elapsed (hrs)	Temperature ^{0}C
0	68
3	65
6	63
9	61
12	60
15	59
18	57
21	56

Then calculate the efficiency of solar water heater.

The parameters for calculating the efficiency of solar water heater are shown in Table 4.

Table 4: Efficiency Parameters

Parameters	**Symbol**	**Value**
Volume of water	V	20 Liter
Initial Temperature of water	Ti	40^0C
Heat radiated in day	Pin	1170 Watts
Time elapsed	t	6hrs
Final Temperature of water	T_f	78^0C

Now, specification of PCM,
Initial temperature of PCM = 36^0C
Temperature of fusion = 60^0C
Final temperature of PCM = 65^0C
Specific heat of solid PCM = $2.5\frac{KJ}{KgK}$
Specific heat of molten PCM = $215\frac{KJ}{Kg\ K}$
Heat of Fusion=$2.13\ \frac{KJ}{Kg\ K}$
Now, calculating efficiency of solar water heater,
Efficiency, η = = Qout / Qin
Now, calculating heat accumulated in the solar collector, which is sum of energy gained by water and same by PCM.
Energy gained by water = $\rho \times V \times C_{pw} \times (T_f - T_i)$
Energy gained by water = Energy accumulated by solid PCM + Heat of fusion + Energy accumulated by molten PCM
Q_{out} = Energy gained by water + Energy gained by PCM
η= Qout / Qin; eff

3 Results and Discussion

The temperature distributions of water and the PCM in the water tank for different time intervals are recorded during charging and discharging processes. The cumulative heat stored and system efficiency of process is studied in detail during the discharging process.

3.1 Charging Process

3.1.1 Operating parameters for storage tank of a 30 liters water capacity is given below in the table-
:

Table 5: Charging Process

Charging without PCM		Charging with PCM	
Time elapsed (hrs)	Temperature of water^{0}C	Time elapsed (hrs)	Temperature of water^{0}C
0	36	0	40
1	38	1	42
2	42	2	44

3	47	3	47
4	55	4	55
5	61	5	61
6	65	6	63
7	70	7	66
8	75	8	68

The graphical representation is as follows:

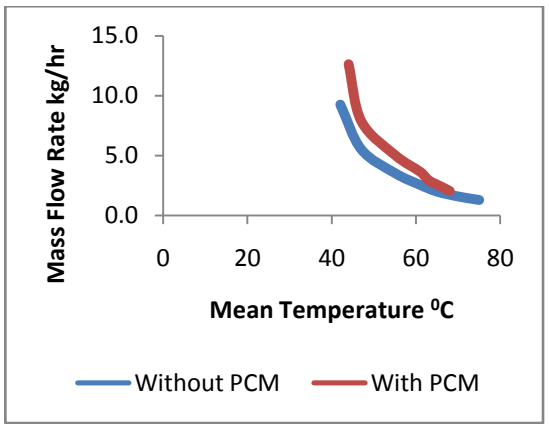

Fig 4 Mass flow rate Vs MTST

3.1.2 Charging & Discharging Efficiency

Charging efficiency is introduced to analyze the charging performance of water tank. The charging efficiency is defined as the ratio of the actual average temperature rise to the maximum temperature difference.

Discharging efficiency is introduced to analyze the performance of discharging that is heat released during discharging. The discharging efficiency is defined as the ratio of energy released to the initial energy stored.

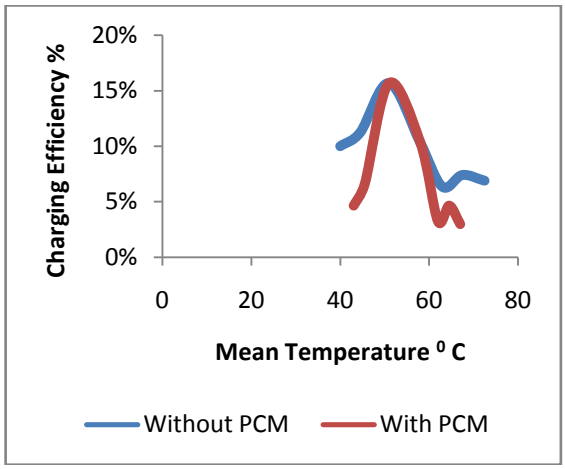

Fig 5 Charging Efficiency Vs MTST

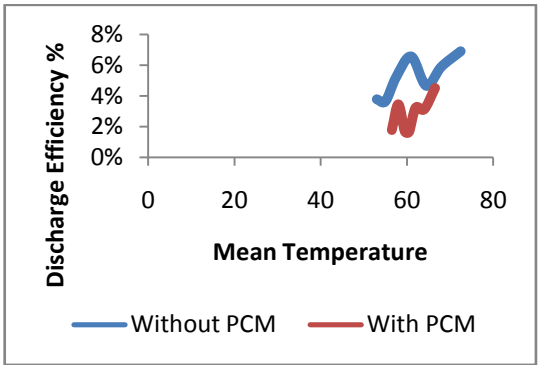

Fig 6 Discharging Efficiency Vs MTST

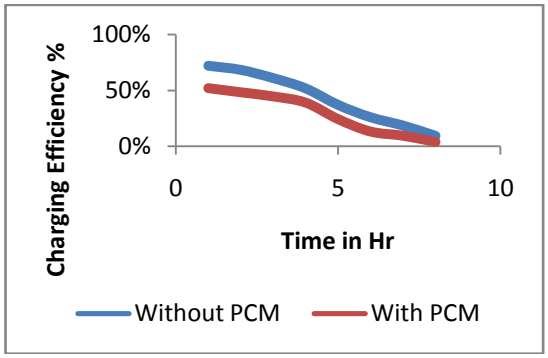

Fig 7 Charging Efficiency Vs Time in Hrs during day

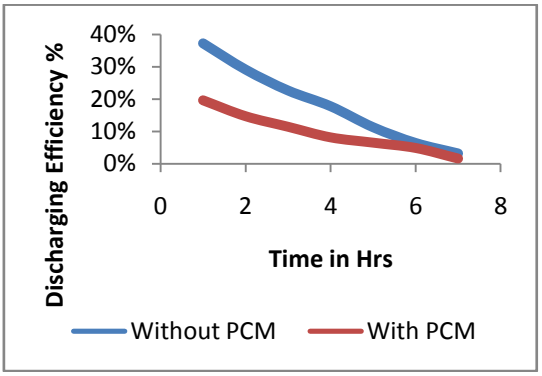

Fig 8 Discharging Efficiency Vs Time in Hrs during night

4 Conclusions:

Experimentation carried out on stainless steel hot water storage tank has a capacity of 30 litres, with an internal diameter of 28 cm and a height of 48 cm, it contains 20 kg of water and 9 kg PCM inside the square tank having length 40 cm and

width 28cm this allows for heat transfer between the surface and the water. Experimental results show that maximum charging efficiency is 72% without PCM and 52% with PCM. Using PCM Charging efficiency decreases because PCM take heat and heat transfer rate is low during PCM heating. While maximum discharging efficiency is 37% without PCM and 20% with PCM. It shows that PCM contains high internal energy during, latent heat transfer is at constant temperature, in storage tank, which reduce night heat losses and hence reduce discharging efficiency. Result also shows that higher mean temperature of water could be obtained by lower mass flow rate of water through the storage tank.

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A Review on Human Power Utilization for Direct and Electricity Generation

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Abstract---In the present paper human-powered products for energy crisis are discussed. Exhaustive reviews on eco-design are presented; with specific focus on the use of human power as a renewable energy source. Opportunities for human-powered energy systems are must option to reduce life cycle costs and energy self-sufficiency. There is vast scope in identifying where the concept of human power utilization is adopted by consumers. Eco-design proves helpful in providing a platform for radical innovations driving the introduction of Human powered technology. In the present scenario of energy shortage energy conversion efficiency; energy storage and energy conservation issues are of special interest. Human powered energy systems are offering these possibilities of achievement of energy needs. It is observed that one of the easiest ways to convert human power into electricity is with the bicycle mechanism. Direct utilization of human power is also possible like in prime mover, water pump, propel a boat, and even grind wheat etc. The concept of system as well as surrounding is reversible or balanced in this system of energy use; it fully satisfies needs of human health and environmental concerns. Future scope lies in further research and development in this area of human-powered energy systems that is conversion of human power into versatile form of electrical power should be more used.

Keyword --- Human Power, Economic trend, Eco-Friendly.

1. Introduction

Human-powered energy systems are powered by muscular work from the Human body. Product design cases applying human-powered energy systems are concentrated for study. The steadily increasing global energy consumption causes growing numbers of environmental problems. Also, it is becoming clear that World is most likely not able to comply fully with the Kyoto agreement son CO2 reduction. For this reason, the societal and political pressure to develop products with lower energy consumption is starting to build. A GARDEN typically consists various children playing equipments like see-saw, swing, merry-go-round etc & other equipments like revolving door. Generally in gardens the equipments are used only for playing purpose. Some equipments in garden are revolving door, merry-go-round, see-saw, swing. These can be effectively used for electric energy generation. Manual work involves the natural movements of a human with regards to direction, speed and frequency. A man exerts his physical strength directly by walking, pushing, pulling, pressing, lifting, carrying and throwing activities [8]. When there is restricted use of natural movements, it causes more fatigue. Also the repetitive movements without an implement results in laborious and tedious task. It recommends the use of tools and equipments to reduce fatigue and to improve human efficiency.

2. HUMAN-POWERED PRODUCTS:

Nowadays we see a growing number of portable electric consumer products, mainly batteries. Examples are; audiovisual, communication and information products, in which the electronics provide the main functionality, but also an increasing number of products that deliver mechanical work at their output. Considering the clear advantages of rechargeable batteries (high energy density, wide availability and international standardization), they will remain the main source of power in the forthcoming period. Nevertheless, the use of batteries can be cumbersome as well. Batteries run out of energy when you need them most, they are not always available, they have to be replaced or charged in a troublesome way and in the long run batteries turn out to be a rather expensive power source. Moreover, due to the increasing number of battery-powered portable products, the environmental impact of battery use might increase as well. Driven by consumer perception and environmental concern, the

Personal Energy System (PES) group at DUT aims at finding alternatives for the increased use of batteries in portable energy products. In this scope the PES-group focuses on the application of renewable energy sources in consumer products. Special emphasis is given to low power2energy sources such as; human power (i.e. the use of human work for energy generation), direct methanol fuel cells, and photovoltaic solar cells. In this paper we will focus on human power. In our research project we defined human power as; using the human body as an energy source for electric products. The main advantages of human powered products are; they operate independent of energy infrastructures, have a long "shelf-life" and can be environmentally beneficial in the long run. [8]

3. SYNTHESIS OF EQUIPMENT'S IN GARDEN

3.1 Revolving door:-

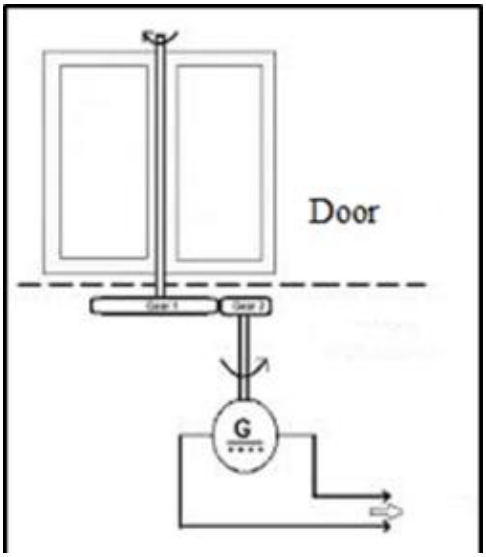


Fig 3.1: Revolving Door

It mainly consists of rotating door around central shaft & planetary gear arrangement. It comes under actual contact of people. All parts are made up of specially designed materials with given specifications. Depending upon the availability of space the no of wings can be three or four.

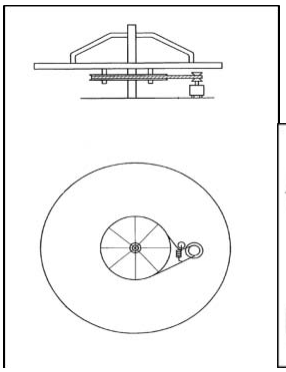


Fig. 3.2: Merry-Go-Round

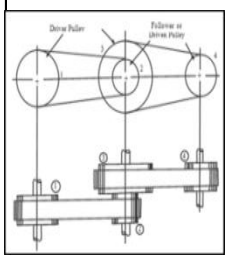


Fig. 3.3: See-Saw

3.2 Merry-Go-Round

Merry go round consist of central shaft on which bigger pulley is mounted & smaller pulley is mounted on generator shaft. Both pulleys are connected with the belt.

All parts are made up of specially designed materials with given specifications. Depending upon circumferential area of equipment's.

3.3 See-Saw

See-saw consists of two shafts placed at a certain distance on which pulleys & free wheel are mounted. It's connected in specific manner with arrangement of belt as shown in fig. below

All parts are made up of specially designed materials with given specifications. Depending upon circumferential area of equipment's.

3.4 Swing

Swing consists of two shafts placed at a certain distance on which pulleys & free wheel are mounted. It's connected in specific manner with arrangement of belt as shown in fig. above.(same mechanism as see-saw.)All parts are made up of specially designed materials with given specifications. Depending upon circumferential area of equipments actual models of garden equipment's are as follows.

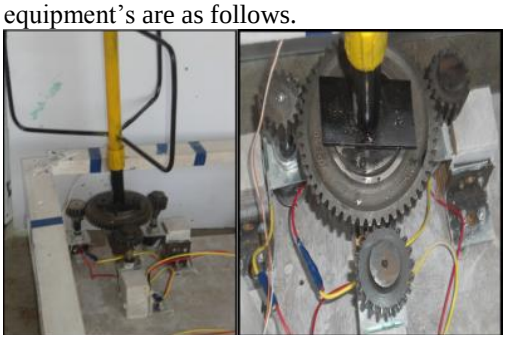


Fig. 3.4: Construction of Model of Revolving Door

Fig.3.5: Construction of Model of Merry-Go-Round

Fig 3.6: Construction of Model of See-Saw

Fig 3.7: Construction of Model of Swing.

4. ACTUAL CALCULATION

Based on readings and results obtained from trials, calculations of prototype are made to obtain maximum possible power from it. Also calculations for torque at motor shaft are made in this section. In this calculations few aspects are constant they mentioned below -

This prototype is tested for optimum power generation in steps. We have carried out trials using geared motors of power capacity ranging from 20W to 360W. Therefore trials are carried in following manner-

- **Revolving door**

Power measured = 34.6 watt.
RPM measured = 66.
Torque calculation:-
By using formula power = $(2\times\pi\times N\times T)/60$
Where, N = RPM measured
T = Torque to be calculated
By putting the values in formula,
$34.6= (2\times\pi\times66\times T)/60$
Therefore Torque= 5Nm

- **Merry-Go-Round:-**

Power measured = 35.8 watt.
RPM measured = 68.
Torque calculation =
By using formula power = $(2\times\pi\times N\times T)/60$
Where, N = RPM measured
T = Torque to be calculated
By putting the values in formula,
$35.8= (2\times\pi\times68\times T)/60$
Therefore Torque= 5.02Nm

- **<u>See-Saw</u>:-**

Power measured = 22.9 watt.
RPM measured = 42.
Torque calculation =
By using formula power = $(2\times\pi\times N\times T)/60$
Where, N = RPM measured
T = Torque to be calculated
By putting the values in formula,
$22.9= (2\times\pi\times42\times T)/60$
Therefore Torque= 5.20Nm

- **<u>Swing</u>:-**

Power measured = 22.8 watt.
RPM measured = 44.
Torque calculation =
By using formula power = $(2\times\pi\times N\times T)/60$
Where, N = RPM measured
T = Torque to be calculated
By putting the values in formula,
$22.8= (2\times\pi\times44\times T)/60$
Therefore Torque= 5.12Nm

The readings of power produced to corresponding torque at door are given below in table-

Table 4.1: Readings of torque applied and power produced

Torque applied at motor shaft (Nm)	**Power produced at motor terminal. (W)**			
	Revolving door	**Merry-go-round**	**See-saw**	**Swing**
1.5	13.5	12.6	6.2	6.4
2.5	17.36	16.22	9.14	9.54
3	22.12	22.14	12.38	13.1
4.5	28.33	29.35	17.54	17.65

5.5	34.6	35.8	22.9	22.8
7.5	48	48	30	30

The above readings for indicate characteristics behavior of motor in terms of torque and power produced. The torque in above table is torque at motor shaft which is different from torque applied at doors because of lever effect explained earlier. These readings for 90W motor capacity are plotted on graph given below.
This chart indicates the effect of torque on amount of power produced from revolving door. On x-axis torque is plotted while on y-axis power in watts is plotted.

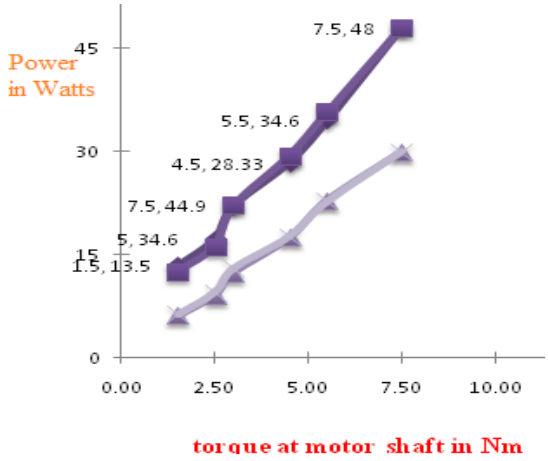


Fig 4.1: Graph between torque and power produced

The curve obtained from plotting above point is found to be somewhat linear. It shows that as the applied torque increases the power produced from motor increase but up to motor rating. As soon as motor rating increases now power is produced due to damage of motor winding. And hence load applied at motor should be limited up to respective motor ratings. The motor windings get damaged due to excess current produced and hence care should be 1taken to avoid motor from becoming useless.

- **D.C Motor 3 (15V 2Amp)** - This is small capacity motor. It is mainly employed for testing of L.E.D s. the back output of motor is limited to 30W and any increase in load more than that may result in damage of motor. It is also tested for steps given below-
  - **With L.E.D s** - As mentioned earlier this motor is especially used for L.E.D s mounted on bread board circuit with large number of capacitors. This motor is used to test the effect of capacitors on glowing time. It is found that capacitor discharge time for series of 10 L.E.D s is approximately 12 s. Here 4 capacitors of 1000µf are used.
  - **CFL lights** - Due to its low capacity it can glow CFL lights up to 25-30W capacity.

Hence this motor can also charge small battery but will perhaps require larger people passing, than above two motors. This motor is primarily used for testing of LED's as they get damaged at higher capacity motors.

4.1Variations in lever arm distance

The next part of testing is done by varying the width i.e. lever arm distance and studying its effect on torque applied. This effect which is called lever effect is explained in earlier topics. The fig indicates the effect of leverage on our prototype.

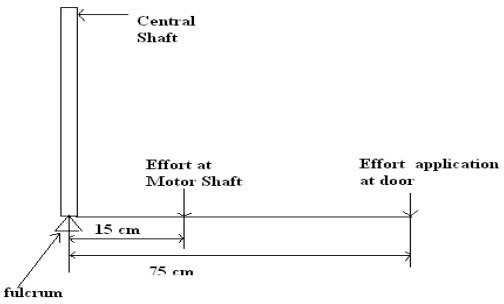


Fig 4.2: Lever effect on prototype

The fig 4.2 indicates that lever ratio in our case is 1:5. In our case the fulcrum is the central shaft. The smaller gear is at distance 15 cm from fulcrum which is fixed during testing while the distance which keeps on varying is width. From results and analysis width of door selected is 75mm. Hence the ratio obtained is 1:5.

Readings obtained for various varying distances of door are given in table below. The readings are taken 30V 3amp motor at full load of 90 W powers.

Table 4.2: Readings for torque at various lever arm distances

Reading (1)	**Gear distance from fulcrum (fixed) In cm** (2)	**Torque at gear at a distance as in column 2 (Nm)** (3)	**Torque Application distance (varying) In cm (torque applied at door)** (4)	**Applied Torque at varying distance (Nm)** (5)	**Effective torque F × l= CONSTANT** (6)
A	15	15	30	7.5	15
B	15	15	45	5	15
C	15	15	60	3.75	15
D	15	15	75	3	15
E	15	15	90	2.75	15

From these readings a chart is plotted in which x-axis denotes lever arm distance in cm while y-axis denotes torque in Nm. The chart is shown below in next page.

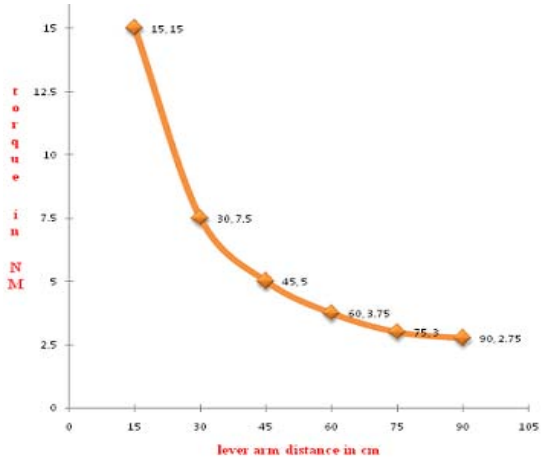


Fig 4.3: Graph of Lever arm distance and torque

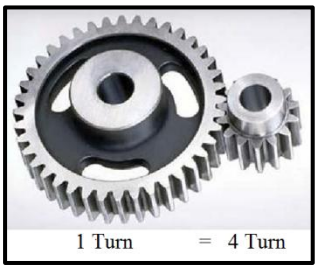
The above curve shows lever effect on torque applied. It indicates that as distance from fulcrum point increases the effort applied decreases. With the prototype we have chosen width as **21/2** feet and gears are placed at distance of 15cm from fulcrum i.e. center shaft. Hence the lever ratio obtained in this case is **1:5**. The curve depicts that if we keep maximum width of door, we could obtain maximum torque at motor shaft for minimum effort for pushing the doors. Hence the torque at gears is through 15 Nm but due longer lever arm it becomes 3Nm at doors.

5. THEORETICAL CALCULATION:-

Based on section of components of mechanisms and according to their dimension and working ratio calculations are made. There are some assumption are stated by actual observation. The calculation are carried by following manner-

5.1 Revolving Door:

For three wing door the minimum opening is 1/3 i.e. 120 degree due enclosure construction. For that rotation, we have designed a torque of 5Nm. The opening or passing time for is found out to be approximately 2s.Hence door rotates 1/3 for 2s,
Therefore speed of door is – Door revolution/min = 1/3 × 30s = 10 rpm



Gear ratio

I=Ng/Np=4

Door revolution/min. = 1/3×30s=10rpm
Motor shaft revolution= (10×4) ×3=120rpm
Full rated capacity of motor = 24v & 1.5amp at100rpm
Power = V×I = 24×1.5 = 36 watt.

5.2 Merry-Go-Round:-

Assume one complete revolution of merry-go-round takes 3sec.
Revolution/min = 60/3 = 20rpm.
Motor shaft revolution = 20×6 =120rpm.
Full rated capacity of motor = 24v & 1.5amp at 100rpm
Power = V×I = 24×1.5 = 36 watt.

5.3 Sea-Saw:-

See-saw with combination of belt drive & sprocket arrangement -
Cross belt & open belt drive used.
Oscillatory motion converts in rotary motion.
Pulley ratio – 1:4

1 oscillation =1/2 rotation of 1st =2 rotation of 2nd pulley.
= 2 rotation of 3rd = 8 rotation of 4th pulley.
Revolution/min. = 10 oscillation/min. = 80rpm.
Power = V×I = 24v×1amp = 24 watt.

5.4 Swing:-
1 oscillation =1/2 rotation of 1st =2 rotation of 2nd pulley.
= 2 rotation of 3rd = 8 rotation of 4th pulley.
Revolution/min. = 10 oscillation/min. = 80rpm.
Power = V×I = 24v×1amp = 24 watt.

6. COST ESTIMATES

6.1 Cost Estimate of self lightning garden

Table 6.1: Cost Estimate of self lightning garden

Parts	Approx. Cost (Rs)
Shafts	250
Iron Strips	100
Plywood	550
Wooden blocks	210
Gears & Bearings	700
Motors	720
Pulleys & belts & free wheel	500
Electronic components	150
Labor Cost & fixing material (nut & bolt)	700
Total Cost	**Rs 3880**

The cost estimate of self-lightning garden producing power is shown in above table. But normally the all equipment's is already present then only mechanisms and suitable generator is the only additional components required. The cost of these equipments considering our prototype is given in table below –

6.2: Cost Estimate of Mechatronic System

Table 6.2: Cost Estimate of Mechatronic System

Parts	Approx. Cost (Rs)
Gears & Bearings	400
Motors	720
Electronic components	150
Total Cost	**Rs 1270**

7. ADVANTAGES & LIMITATIONS:

7.1 Advantages:

- CO_2 emissions are nil. So it is called Green power.
- Efficient as compare to other renewable energy sources.
- Energy obtained is mostly from wastage.
- Energy efficient systems since direct conversion reducing heating or cooling.
- Amount of fossil fuels would be saved.
- Cost effective with minimum payback period.

7.2 Limitations:-

- It is intermittent power source i.e. instantaneous power source which depend upon human capacity.
- It has low energy density as compare to conventional power generation resources.

8. CONCLUSION:

It is found that human power is an important source of renewable energy in the form of direct and electricity generation. If it is employed in every garden with proper designing it could acquire sufficient power from it. In order to save world from global warming this may be an important step in next few decades.

Taking eco-design as a starting point for the design of human-powered products proves to be 'seedlings in fertile ground'. Nevertheless, this differs from the consumers' viewpoint. From various literature, environment as such plays no dominant role in the buying behavior of consumers. Only small consumer groups (approx. 5%) can be labeled as 'green buyers'. The majority of consumers are interested in human power due to its other attributes as; long shelf life (in toys/emergency equipment), independent from (energy) infrastructure, low life cycle costs, convenience (not having to think of batteries) and fun! Eco-design really works in commercial practice if it brings benefits to both users, the environment, the company involved and society as a whole. Customer benefits should be a mixture of material, immaterial and emotional benefits. Embracing human-powered energy systems early in the design process can be quite radical; it forces the design engineer to take a different approach towards all energy related issues of certain functionality. It also offers the design engineer a new starting point for the redesign of products that existed for a long time in a more specific way. A new method for human power conversion based on children's energy on playground equipment has been proposed. The power harnessed can be used as an auxiliary or back-up source for electricity,

especially in developing countries. Pneumatic components are used as power conversion devices along with equipment such as seesaw, swing, etc. A laboratory prototype based on a seesaw is developed, and experimental results obtained illustrate the practical effectiveness of the proposed method.

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Investigation of Material Properties for Thermoelectric Generator System Application

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ABSTRACT: In the conventional method for generation of electricity is converting thermal energy into mechanical energy then to electrical energy. In recent years, due to environmental issues like emissions, global warming are the limiting factor for the energy resources resulting in extensive research and novel technologies to generate electric power. Thermoelectric power generator system is emerged as a promising another green technology due to their diverse advantages. Thermoelectric Power Generator system directly converts thermal energy into electrical energy. There are no moving parts in the system. It eliminates emission and frictional losses. Thermoelectric power generation offer a potential application in the direct exchange of waste-heat energy into electrical power where it is unnecessary to bear the cost of the fuel energy input. The application of this option green technology in converting waste-heat energy directly into electrical power improves the overall efficiencies of energy conversion systems. Heat source which is needed for this conversion is less in contrast to conventional methods. In this paper, increasing the power factor and better figure of merit for thermoelectric materials are revealed. A novel, fast combustion method for synthesizing anatase TiO_2 nanoparticles (average diameter 14 nm) codoped with N and N_b in a single step are revealed and discussed.

INTRODUCTION

A Thermoelectric power generator is a solid state device that provides direct energy conversion from thermal energy (heat) into electrical energy based on "Seebeck effect". The thermoelectric power cycle, with charge carriers serving as the working fluid, follows the fundamental laws of thermodynamics and intimately resembles the power cycle of a conventional heat engine. Advantages of Thermoelectric power generators over other technologies.

- They are extremely reliable and they have no mechanical moving parts and require considerably less maintenance.
- They have very small size and weightless.
- They have the capacity to operating at elevated temperatures.
- The source for the power generation is Heat not light, so day and night operation is possible.
- They are mostly used for convert the waste heat so it is considered as a Green Technology.
- We can increase the overall efficiency of the system (4% to &7%).
- They can be alternative power sources.
- When compare to exciting conventional power system it require less space and cost
- Less operating cost.

The Drawback of thermoelectric power generator is their relatively low conversion efficiency (typically ~5%) and less power output. Application over the past decade included industrial instruments, military, medical and aerospace and home reason and applications for portable or remote power generation. Though, in recent years, an increasing anxiety of environmental issues of emissions, in particular global warming has resulted in extensive research into nonconventional technologies of generating electrical power. Analyze the thermoelectric property of the module material is very important. Good thermoelectric material has Seebeck property in between 200-300μV/K. Material thermoelectric material figure-of-merit property should be near or more than 3×10-3 for good material. This TEG is used to convert the waste heat emitted from Jet Engine, IC

Engines, Furnace, Heat water conveyor tubes. In general, the cost of a thermoelectric power generator essentially consists of the device cost and operating cost. The operating cost is governed by the generator's conversion efficiency, while the device cost is determined by the cost of its construction to produce the desired electrical power output. Since the conversion efficiency of a module is comparatively low, thermoelectric generation using waste heat energy is an ideal application. In this case, the operating cost is negligible compared to the module cost because the energy input (fuel) cost is cheap or free. Therefore, an important objective in thermoelectric power generation using waste heat energy is to reduce the cost-per-watt of the devices. Moreover, cost-per-watt can be reduced by optimising the device geometry, improving the manufacture quality and simply by operating the device at a larger temperature difference. In addition, in designing high performance thermoelectric power generators, the improvement of thermoelectric properties of materials and system optimization have attracted the attention of many research activities. Their performance and economic competiveness appear to depend on successful development of more advanced thermoelectric materials and thermoelectric power module designs.

METHODOLOGY AND INSTRUMENTATION

METHODOLOGY:

1. N and N_b codoped TiO_2 powders were synthesizes by a fast combustion method using urea (Co-$(NH_2)_2$) as the burning fuel.
2. TiO_2 (anatase) powder (-01, particle size= 7nm) was mixed with NbCl5 (99.99%) powder in the molar ratio [NbCl5]: [TiO_2] + [$NbCl_5$] =x: 1 Where x=was varied; the amount of urea added was based on the mass ratio m (urea): m (TiO_2 +NbCl5)
3. $NbCl_5$ hydrolyses rapidly readily in humid air, so to avoid formation of NbO_5 (using evacuated box in N_2 atmosphere); the relative humidity was kept below 60% when mixing the raw materials. The mixed reagents were transferred rapidly to a muffle furnace and heated in air atmosphere at 600c isothermally for 45min.
4. After natural cooling to room temperature yellow powder was obtained.
5. Next powders were pressed into circular pallets (dia. 13mm) by a cold pressing process at a pressure of 1x 10^4 Kgf/cm^2.
6. In some cases, Ti metal particles were added to TiO2 powders (4g) in the molar ratio [Ti metal]/ [Ti (1-x)-Nbx (0, N) 2] =Y; where y= was varied.
7. By milling in 20ml of absolute ethanol with a planetary ball mill at 600rpm for 24h. The dark blue precipitation were washed with 600mL of absolute ethanol and dried at 120oc for 2 h.
8. Finally, the presses pieces in a tube furnace and sintered in a pure N2 with 0.2 L/min at 1100oc for 10 h using a constant heating rate of 5oC/min. During sintering the samples were placed on graphite boat, with another boat containing carbon powder placed in front of it. A small amount of CO gas is expected to be generated in the furnace because the N2 atmosphere still contains small quantities of O2 and H2O gas.
9. After cooling naturally to room temperature, the blue black and black sintered samples were incised and polished ready for thermoelectric characterization.

INSTRUMENTATION:
MANUAL HYDRAULIC PRESS (PALLET MACHINE):

A Manual Hydraulic press, commonly shortened to press, is a machine tool that changes the Shape of a work piece by the application of pressure.

Fig.: Manual Hydraulic Press

TWO PROBE:
The Two Probe Method is one of the standards and most commonly used method for the measurement of resistivity of very high resistivity samples like

sheets/_lms of polymers. The resistivity measurement of such samples is beyond the range of Four Probe Method.

Fig.: Two Probe

VACCUM BOX:

Some operations i.e., transfer of very air sensitive and pyrophoric compounds will be carried out in a glove box. It is a chamber, which is kept under an inert atmosphere (nitrogen or argon).

Fig.: Vacuum Box

FOUR PROBE

To find resistivity of semiconductors by four probe method at different temperatures. Four sharp probes are placed on a flat surface of the material to be measured, current is passed through the two outer electrodes, and the floating potential is measured across the inner pair. If the at surface on which the probes rest is adequately large and the crystal is big the semiconductor may be considered to be a semi-infinite volume.

Fig. Four Probe

HEAT SINK

A heat sink minimizes temperature rise on the other side of the TEG. One side of the TEG must be in intimate thermal contact with the heat sink and the other with the hot surface.

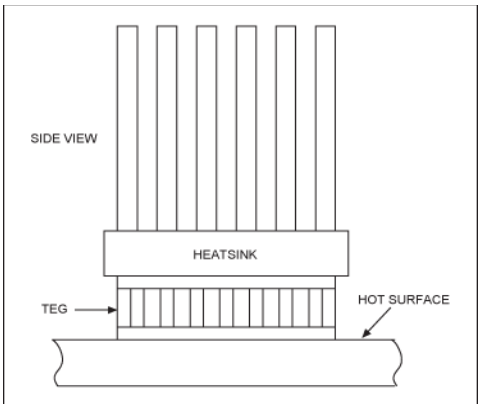

Fig.: Heat Sink

ELECTRONIC DIGITAL WEIGHING MACHINE:

The purpose of weighing system is to deliver the accurate result. To weigh systematically, uncompromisingly, and precisely. The instrument helps to weigh materials in micro-grams

Fig: Electronic Digital Weighing Machine

THERMOELECTRIC MATERIALS FOR POWER GENERATORS:

In addition most conventional alloy-based thermoelectric material such as Bi2Te3 PbTe, suffer from poor thermal instability, high toxicity and high cost. Transition metal oxide ceramics in contrast are free of these disadvantages and have the added advantages of being stable at high temperature (greater than 500c). Transition metal oxides are thus promising candidates for the core component in thermoelectric power generator.

Titanium dioxide TiO2 is one of the most widely used and intensively studied transition metal oxides, with potential application in photo catalysis dye-sensitised solar cells, lithium ion batteries and display panels and other optical devices, which take advantage of its tunable semiconductor properties. TiO2 also displays tantalising thermoelectric behaviour due to the large Seebeck coefficient. If the other thermoelectric properties, electrical conductivity, could be improve. TiO2 would make an excellent thermoelectric material because of its non-toxicity chemical and thermal stability and natural abundance.

Recently Dynys et al. Investigated the thermoelectric properties of undoped and doped (Ti0.75Sn0.25O2) and demonstrated that the electrical conductivity was enhanced by three order of magnitude when Nb2O5 or Ta2O5 is added, while the thermal conductivity was reduced to below 4 W/m.K . Portehault et al. Prepared percolated nanocomposites using sub-stiochiometric TiO2 , nanoparticle embedded in a carbon matrix . These nano composites have low electrical resistivity (2x 10-4 ohm meter) and reduced thermal conductivity (1 W/m.K) with respect to bulk materials Xu et al. reported that Al doping can lead to pho-ton scattering at grain boundary interface and consequently decrease thermal conductivity of TiO2. Other studies have also focused on the thermoelectric properties of TiO2-based materials. These shows that the properties of TiO2 bases material depend strongly on the preparation process, particle size and microstructure, making their behaviour difficult to predict using thermoelectrical method such as first principle calculations.

- For TiO2 to be competitive as thermoelectric material, ZT needs to be increases because most values reported so far are below 0.2 like other transition metal oxide TiO2, processes lower electric conductivity as compared to thermoelectric alloys.
- Doping is the most common way of tailoring electric properties. For instance, uniform porous based on Nb-doped TiO2 can be made because replacement of a small amount of Ti with Nb drastically increases the electrical conductivity of TiO2. Moreover a reducing atmosphere is more favourable for increasing the electrical conductivity of Nb doped TiO2 than oxidising atmospheres, including air, due to the difference in oxygen activity. However current method of preparing foreign atom doped TiO2, including sol-gel process and hydrothermal and solvothermal reactions involves numerous time-consuming steps, which adds to the cost and complexity and may compromise the reproducibility of the materials.
- Apart from doping, crystalline defects are known to affect the electrical properties of TiO2, resulting in absorption of visible light and relatively high electrical conductivities, highly detective materials are thus of intense interest for use in photovoltaic and photo catalytic applications.
- Chemical tuning by combining both doping with foreign atoms and formation of large numbers of intrinsic defects (i.e., vacancies and interstials) is powerful approach for improving the electrical conductivity of oxide materials. To be a good thermoelectric material, the Seebeck coefficient brought about by an in- crease in number of charge carrier should be outweighed by increased in electrical conductivity contributing to a higher power factor.
- Chemical tuning can also be used to reduce the thermal conductivity for example both doping and generation of intrinsic defects can increase the scattering of phonons with relative short wavelengths which is usually the domient process at high temperature.
- In addition, nano particle technology enables the preparation of materials with high concentrations of grain boundaries which can scatter phonons with relatively long wavelengths. Consequently to prepare a good thermoelectric material using a bottom-up approach precursors with sufficiently small particles size need to be prepared which provides high concentration of grain boundaries.
- Appropriate sintering process also should be chosen to minimize the negative effect

of grain boundaries on the electrical conductivity because grain boundaries could degrade transport of charge carries by scattering in reasonably conductive systems.

- The aim of present study is to enhance the n-type thermoelectric properties of TiO_2 using as straight forward synthesis method as possible. Herein combustion synthesis is reported for the first time which is an attractive route for achieving this because it is fast and direct with nanopowders obtained in the single step. In this study, urea was used as the fuel to prepare anatase TiO_2 nanoparticles as well as the source of N. NbCl5 was used as the source of N_b. This synthesis process provides precursors with sufficiently small particles sizes, which in the key point in bottom up approaches. After combustion, powders were pressed into bars or pallets and sintered, in some case under strongly reducing conditions by addition of Ti power. In short the chemical tuned was carried out to enhance the thermoelectric properties by controlling three factors :-

1. The amounts of N and N_b co doping
2. The grain boundary density and
3. The concentration of intrinsic defects

- As a result, the figure of merit , ZT is improved to 0.35 at 700oc ,which is the highest value reported for a TiO2 material to date and is comparable with the highest values of any n-type thermoelectric oxides such as SrTiO3 (ZT=0.37 at 1000k,_lm).
- In2O3 (ZT=0.3 at 1000k) and ZnO (ZT=0.44 at 1000k). The enhanced thermoelectric performance and advantage of TiO2 mentioned above suggest that the chemically tuned TiO2 is an excellent candidate for thermoelectric application. Consequently, the chemical tuning approach, a combination of foreign-atom-doped nano particle synthesis and optimized sintering process can be applied to prepare superior thermoelectric materials.

XRD (X-ray Diffraction Method) ANALYSIS ON PLANE AND DOPED TiO2

The XRD outputs for the following three elements named below are shown in figures.
1. 45nm TiO2 doped with Nb
2. 25nm TiO2 doped with N
3. Plain TiO2

RESULTS FOR THERMAL BEHAVIOR OF DOPED AND UNDOPED SAMPLE

SAMPLE: 45 NON-COOLED WITH N2 WITHOUT Ti

TEMP	ZT	TEMP	ZT
50	0.006967	350	0.224863
100	0.059158	400	0.262404
150	0.114145	450	0.264369
200	0.113019	500	0.278049
250	0.121635	550	0.285088
300	0.189836	600	0.34745

SAMPLE: 45 COOLED WITH N2 WITHOUT Ti

TEMP	ZT	TEMP	ZT
50	0.005593	350	0.086746
100	0.051561	400	0.096493
150	0.055593	450	0.123896
200	0.061076	500	0.238567
250	0.069038	550	0.25669
300	0.071539	600	0.279232

SAMPLE: 25 NON COOLED WITH N2 WITHOUT Ti

TEMP	ZT	TEMP	ZT
50	0.016563	350	0.085494
100	0.015257	400	0.095314
150	0.020202	250	0.054942
200	0.044444	300	0.060534

SAMPLE: 25 COOLED WITH N2 WITHOUT Ti

TEMP	ZT	TEMP	ZT
50	0.022896	350	0.068033
100	0.019625	400	0.124945
150	0.026167	450	0.184801
200	0.065416	500	0.329005
250	0.071304	550	0.329482
300	0.025349	600	0.349613

SAMPLE: 25 COOLED WITHOUT N2 WITH Ti

TEMP	ZT	TEMP	ZT
50	0.030762	350	0.142125
100	0.055931	400	0.162992
125	0.069576	500	0.211482
225	0.090531	525	0.236096
250	0.103915	550	0.257954
300	0.130839	600	0.287117

SAMPLE: 25 COOLED Nb DOPED WITH N2 WITH Ti

TEMP	ZT	TEMP	ZT
50	0.042177	350	0.186921
100	0.051544	400	0.231484
150	0.065154	250	0.078135
200	0.067288		

SAMPLE: 25 NON-COOLED WITH N2 WITHOUT Ti

TEMP	ZT	TEMP	ZT
50	0.010756	350	0.083467
100	0.052243	400	0.096356
150	0.055483	450	0.18667
200	0.063264	500	0.250228
250	0.062453	550	0.249113
300	0.072311	600	0.307967

SAMPLE: 25 COOLED WITHOUT N2 WITH Ti

TEMP	ZT	TEMP	ZT
50	0.030762	350	0.082125
100	0.055931	400	0.092992
125	0.059576	500	0.148217
225	0.060531	525	0.205381
250	0.103915	550	0.21179
300	0.070839	600	0.240727

CONCLUSION

Thermoelectric conversion technology is receiving increasing attention because of the worldwide energy and environment problems. Nanostructures such as anatase TiO_2 have been found to be effective in reducing thermal conductivity to a greater degree than electrical conductivity, resulting in an enhanced figure of merit for the bulk thermoelectric material. However, additional approaches will likely be indispensable for increasing the power factor to achieve further significant figure of merit improvements. A novel, fast combustion method for synthesizing anatase TiO_2 nanoparticles (average diameter 14 nm) codoped with N and Nb in a single step is reported. XRD measurements confirm that Nb ions are incorporated into the tetragonal lattice on Ti sites, while N ions occupy O sites, and likely also interstitial sites. The figure of merit, ZT, is improved to 0.36 at 700 C, which is the highest value reported for a TiO_2 material to date, and is comparable to the highest values of any n-type thermoelectric oxide. This material (ZT=0.34) also exhibits good thermal stability in a pure N_2 atmosphere and is a better material for thermoelectric power generator system. Consequently, the combustion technique represents a promising new strategy for preparing foreign-atom- doped metal oxides; the chemical tuning approach, a combination of foreign-atom-doped nanoparticle synthesis and optimized sintering process, can be applied to prepare superior thermoelectric materials. Provided that thermal conductivity can be reduced and Figure of merit improvement, Nb doped anatase TiO_2 could be very promising for thermoelectric applications even in Carnot-cycle based devices.

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A Review on Effect of Flat Plate Collector Design on Solar Water Heater Performance

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Abstract— Solar water heaters of different types are studied with the aim of collecting the maximum amount of solar energy at the minimum cost. A large number of these studies dealt with glazed solar collectors using one or more covers and have been reported by scholars. The present paper includes literature on performance characteristics of solar flat plate collector with different selective surface coatings. Flat plate collector is one of the important solar energy trapping device which uses air or water as working fluid. Out of the many solar collector design presently being developed, the relative simple flat plate solar collector has found vast application so far. This paper also reviews use of mathematical formulas for the development of solar water heater. This review is useful to enhance performance of flat plate collectors in solar water heating system.

Keywords—flat plate collector, performance of SWH , solar water heater, surface coating

I. INTRODUCTION

Solar energy is the primary source of energy for our planet. Solar energy is very large, inexhaustible and clean source of energy. The power from the sun intercepted by the earth is many thousands of times larger than the present consumption rate on the earth of all commercial sources. Increased utilization of solar energy in India could result in all around benefits, both in terms of cleaner environment and monetary gain.[1] The solar thermal energy is collected in a device called solar collector. It consists of a dark surface called absorber, fluid flow passage and suitable provisions for heat loss reduction. When exposed to the sun, the absorber absorbs the solar radiation and transfers a part of it to the fluid flowing over/under it. This is known as solar water heating. Solar water heaters play a vital role in low temperature applications especially in domestic area. Solar collector absorbs the incoming solar radiation, converting it into thermal energy at the absorbing surface, and transferring the energy to a fluid flowing through the collector. The fluid may be used for various purposes such as to heat the building and to dry the agricultural products etc. The solar energy has two main factors in its favor. Firstly, unlike fossil fuel and nuclear power it is environmentally clean source of energy. Secondly, it is free and available in adequate quantities in almost all parts of the world where people live. However there are many problems associated with the use of solar energy. The solar radiation flux available in the hottest regions on earth rarely exceeds 1 kW/sq-m; these are low values from the point of view of technological utilization. Hence large collecting areas are required. The second problem is that its availability varies widely with time, because of the day night cycle and also seasonally because of earth's orbit around the sun.

The flat plate collector forms the heart of any solar energy collection system designed for operation in the low temperature range, from ambient to 60^0C, or the medium temperature range, from ambient to 100^0C. The present study is concerned with the flat plate collectors parameter. Parameters that were essential to get the efficiency were emittance of plate and glass, insulation and plate thermal conductivity, insulation thickness (back and edge), collector's length, breadth and thickness, transmissibility and absorptivity of plate, tube spacing, tube outer and inner diameter and plate thermal conductivity.

The domestic sector consumes approximately 13 % form the total electrical load and about 40% of it is associated with electric water heating. A well-implemented solar water heating strategy may well reduce up to 70% of domestic electric water heating costs. However, this enormous environmentally friendly and sustainable energy potential is hardly used due to various reasons

linked to the financially-related, market-related, legislation-related, technical and awareness barriers imposed towards the spreading of SWH technology.

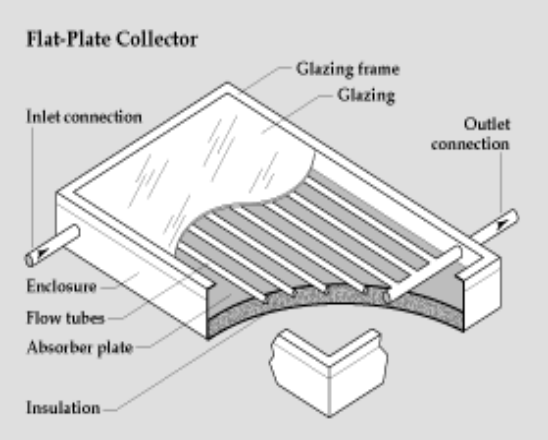

Fig. 1 Solar flat plate collector [10]

The method for testing a flat plate collector operating under natural circulation mode of heat transfer and the present procedure for the system performance characterization as per the code IS 13929 is complex in nature and are difficult to use. The method proposed a simple method for testing of a solar flat plate collector operating under natural circulation mode in general and that of a domestic water heating system in particular with minimum instrumentation and provides absolute performance index [4]. Performance of the solar collectors can be determined using developed empirical correlation to understand logically the effect of parameters like tube length, tube diameter and fluid flow characteristics for buoyancy induced flow through pipes. This analysis is simple for the forced convection situation, where the flow rate is artificially maintained constant to a desired value. The heat transfer coefficient is found to be weak function of the tube inclination and independent of tube length. The Nusselt number (heat transfer coefficient) tends to increase with the increase in the diameter of the test section and is proportional to 2nd power of the tube diameter. The mass flow rate increases with the heat supplied and the variation is parabolic. The mass flow rate is strongly influenced by heat flux [5]. Concepts of a theoretical and experimental study of laminar natural- convective flow in heated vertical duct are discussed. The ducts are open ended and circular in cross section and their internal surfaces dissipate heat uniformly. Temperature and velocity fields and the relationship between Nusselt and Rayleigh numbers were obtained by solving the governing equations by a step-by-step numerical technique. Two Rayleigh numbers were introduced on expressed in terms of the uniform heat flux and the other in terms of the mean wall temperature. The influence that the prandlt numbers has on the relationship between the Nusselt and Rayleigh numbers was discussed. Three inlet conditions were examined which give the same Nusselt relationship at small Rayleigh numbers and the differences between the Nusselt relationships obtained at large Rayleigh number were only small [6]. The thermal performance of latest heat storage in two phase thermo-siphon solar water heater, which utilizes the superior heat transfer characteristics and eliminates drawbacks found in the conventional solar water heater. This study also examines the functions of charge and discharge thermal behaviours in a two phase thermo-siphon solar water heater [7]. To determine the design space for synthesis, analysis and optimization of solar water heating system. The proposed methodology incorporates different design constraints to identify all possible designs or a design space on a collector area vs. Storage volume diagram. It has been observed that there exists a minimum as well as a maximum storage volume for a given solar fraction and collector area. Similarly existence of a minimum and a maximum collector area is also observed for a fix solar fraction and storage volume. The concept of design space approach for synthesis, analysis and optimization of solar thermal system is presented in this paper. Employment of the design space approach for optimization and parametric analysis of solar thermal system may reduce the labour, expertise and expense involved. The methodology is simple, flexible and does not need any special computational setup, thus offering a prospect of application in domestic as well as industrial configurations.

II. METHODOLOGY

A. Surface Coating

Flat-plate collectors are in wide use for domestic household hot-water heating and for space heating, where the demand temperature is low. Many excellent models of flat-plate collectors are available commercially to the solar designer. Flat-plate collectors fall into two basic categories: liquid and air. In a liquid collector, solar energy heats a liquid as it flows through tubes which are adjacent to the absorber plate. An energy efficient solar collector should absorb incident solar radiation, convert it to thermal energy and deliver the thermal energy to a heat transfer medium with minimum losses at each step. Two types of special surfaces, of great importance in solar collector

system are selective and reflective surfaces. Selective surfaces combine a high absorptance for radiation with a low emittance for the temperature range in which the surface emits radiation. This combination of surface characteristics is possible because 98 per cent of the energy in incoming solar radiation is contained within wavelengths below 3μm, whereas 99 per cent of the radiation emitted by black or gray surfaces at 400 K is at wavelengths longer than 3 μm. Almost all black selective surfaces are generally applied on the metal base which provides low emittance for thermal radiation and simultaneously good heat transfer characteristics for photo thermal applications. where most of the energy is absorbed and a small amount of energy reflected and radiated by the surface. Such a surface is called good selective surface. A surface that has a high absorptance and is a good absorber of solar radiation usually has a high infrared emittance as well and is a good radiator of heat. A flat-black paint that absorbs 96% of the incoming solar energy will also reradiate much of the energy as heat, the exact amount depending on the temperature of the absorber plate and the glazing. The surface coating has the ability to absorb the heat and this quality leads to increase in the temperature of fluid. Selective coating of the heating panel has been suggested to increase the energy absorbing properties. By way of example, a solar heating panel may be coated with black paint which is expensive and absorbs a great amount of solar energy. However, it has been found that paint flakes, chips, and it is not very durable. Black paint also enables much of the absorbed energy to be lost by emittance. Selective surface coatings can be prepared by using the following techniques:

1. Vacuum evaporation
2. Vacuum sputtering
3. Ion exchange
4. Chemical vapour disposition
5. Chemical oxidation
6. Dipping in chemical baths
7. Electroplating
8. Spraying
9. Screen printing, and
10. Brass painting method, etc. [2]

B. Performance Analysis of Flat Plate Collector

An energy balance on the absorber plate yields the following equation for steady state: (1) where, qu = useful heat gain, i.e., the rate of heat transfer to the working fluid; S = incident solar flux absorbed in the absorber plate; Ap = area of the absorber plate and

$$q_u = A_p S - q_l$$

q_1= rate of heat loss. by the absorber. In order to determine the flux 'S' absorbed by the absorber a term called the transmitivity, absorptivity product (τα)which is defined as the ratio of the flux absorbed in the absorber plate to the flux incident on the cover system, is evaluated and is given by 'S'.

$$S = I_b r_b (\tau\alpha) + I_d r_d + (I_b + I_d) r_r$$

Where
τ = transmistivity of glass cover system.
α = absorptivity of absorber plate.
(τα)b = transmitivity absorptivity product for the beam radiation falling on the collector.
(τα)d = transmitivity absorptivity product for the diffuse radiation falling on the collector.

Now, rate of the heat loss is given by,

$$q_l = U_l A_p (T_{pm} - T_a)$$

Where,
U_i = overall loss coefficient
A_p= area of absorber plate.
T_{pm}= average temperature of the absorber plate, and
T_a = temperature of surrounding air.
The heat loss from the collector is the sum of the heat loss from the top, the bottom and the sides.

Where,

$$q_t = U_t A_p (T_{pm} - T_a)$$
$$q_S = U_s A_p (T_{pm} - T_a)$$
$$q_b = U_b A_p (T_{pm} - T_a)$$
$$U_l = U_t + U_b + U_s$$

Here, U_t , U_b and U_s are the top, the bottom and the side loss co-efficient respectively.

C. Different Parameter and Guidelines for Optimum Performance.

The Parameters that were essential to get the efficiency were emittance of plate and glass, insulation and plate thermal conductivity, insulation thickness (back and edge), collector's length, breadth and thickness, transmissivity and absorptivity of plate, tube spacing, tube outer and inner diameter and plate thermal conductivity. To improve the performance these parameters can be formulates as follows.
The top loss coefficient, which accounts for the heat loss due to convection and radiation from the top surface, is calculated from:

$$U_t = \left\{ \frac{N}{\frac{C}{T_{pm}}\left[\frac{(T_{pm}-T_a)}{(N+f)}\right]^e} + \frac{1}{h_w} \right\}^{-1} + \frac{\sigma(T_{pm}+T_a)(T_{pm}^2+T_a^2)}{(\varepsilon_p + 0.00591Nh_w)^{-1} + \frac{2N+f-1+0.133\varepsilon_p}{\varepsilon_g} - N}$$

Where,

$$f = (1+0.089h_w - 0.1166h_w\varepsilon_p)(1+0.07866N)$$

$$C = 520(1-0.000051\beta^2)$$

for 0^o<_<70^o. For 70^o<_<90^o, use _=70^o
e = 0.430(1-100/ T_{pm})

The bottom loss coefficient, which accounts for heat loss due to conduction through the back of the solar collector, is calculated from:
U_b =k/L

The collector overall loss coefficient is calculated from:
$U_L = U_t + U_b + U_e$
• The collector efficiency factor which represents the ratio of the actual energy gain to the useful gain that would result if the collector absorbing surface had been at local fluid temperature is represented by:

$$F' = \frac{1/U_L}{W\left[\frac{1}{U_L[D+(W-D)F]} + \frac{1}{C_b} + \frac{1}{\pi D_i h_{fi}}\right]}$$

Where

$$F = \frac{\tanh[m(W-D)/2]}{m(W-D)/2}$$

$$m = (U_L/k\delta)^{0.5}$$

The collector heat removal factor, which relates the actual useful energy gain of a collector to the useful gain if the whole collector surface were at the fluid inlet temperature, is expressed as:

$$F_R = \frac{\dot{m}C_p}{A_c U_L}\left[1-\exp\left(-\frac{A_c U_L F'}{\dot{m}C_p}\right)\right]$$

The instantaneous efficiency of flat plate collector isestimated as:

$$\eta_i = F_R\left[(\tau\alpha) - \frac{U_L(T_i-T_a)}{G}\right]$$

The design of a solar water heating system requires precise knowledge regarding the availability of global solar radiation and its components at the location of interest. Since the solar radiation reaching the earth's surface depends on climatic conditions of the place, a study of solar radiation under local climatic conditions is essential. [11]
The first empirical correlation using the idea of employing sunshine hours for the estimation of global solar radiation was proposed by Angström (1924). The Angström correlation was modified by Prescott (1940) and Page (1961). The simplest model used to estimate the monthly average daily solar radiation on the horizontal surface from the monthly average daily sunshine duration (Fig. 2) is the well-known Angström equation (Angström 1924) [11]:

$$\frac{\bar{H}}{\bar{H}_O} = a + b\frac{\bar{n}_s}{\bar{N}_s}.$$

The regression parameters *a* and *b* can be determined from:

$$a = -0.110 + 0.235\cos\phi + 0.323\frac{\bar{n}_s}{\bar{N}_s},$$

$$b = 1.449 - 0.533\cos\phi - 0.694\frac{\bar{n}_s}{\bar{N}_s}.$$

The physical meaning of the regression constants is that '*a*' represents the case of overall atmospheric transmission for an overcast sky condition i.e. $\bar{n}_s/\bar{N}_s = 0$whereas '*b*' is the rate of increase in $\bar{H}/\bar{H}_o$ with$\bar{n}_s/\bar{N}_s = 0$. The sum of *a* and *b* (*a* + *b*) Significantly represents the overall transmission under clear sky condition or clear sky index.

$$\bar{H}_o = \left[\frac{24*3600}{\pi}I_{sc}\right]\left[1.0+0.033\cos\left(\frac{360N}{365}\right)\right]\left[\cos\phi\cos\delta\sin\varpi_s + \frac{\pi}{180}\varpi_s\sin\delta\sin\phi\right],$$

$$\bar{N}_s = \left(\frac{2}{15}\right)\varpi_s,$$

$$\varpi_s = \cos^{-1}(-\tan\phi\tan\delta),$$

$$\delta = 23.45\sin\left[\frac{360}{365}(284+N)\right].$$

D. Literature Review
N.Ghimire et.al. work explain the selection and performance of flat plate solar water heater and this can be understand from the following graphs which explain the experiements. Fig. 1 shows that with increase of the number of glass cover, efficiency increases. But it is applicable only in higher temperature as convective heat loss is reduced but in lower temperature efficiency decreases due to added absorption and reflectance of covers.

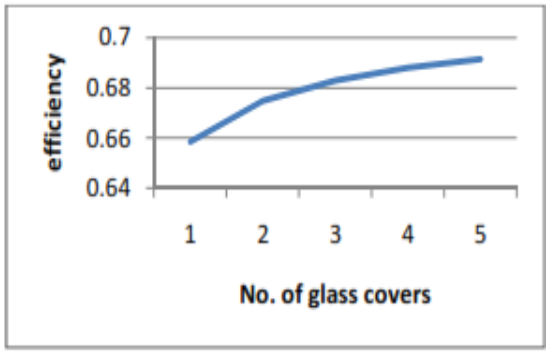

Fig. 2: Efficiency of collector with respect to number of glass Covers [2]

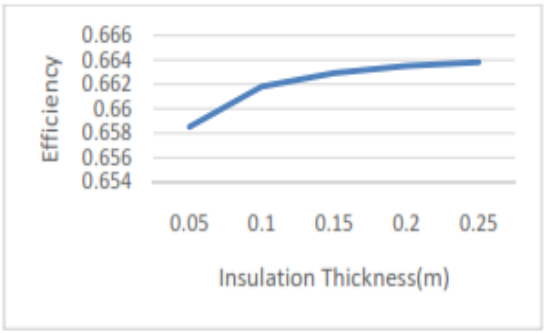

Fig. 3: Efficiency of collector with respect to mass flow rate [2]

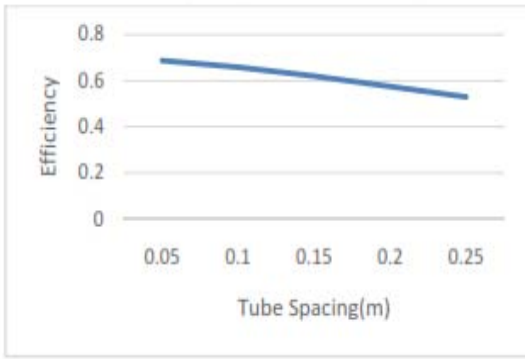

Fig. 4: Efficiency of collector with respect to tube spacing [2]

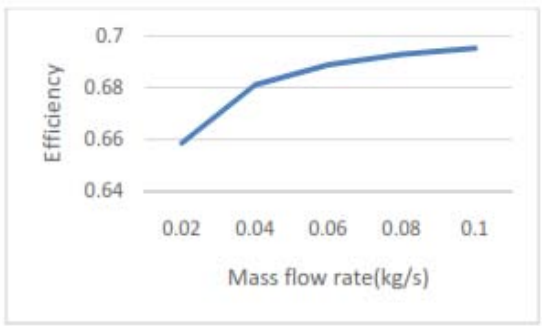

Fig. 5: Efficiency of collector with respect to insulation thickness[2]

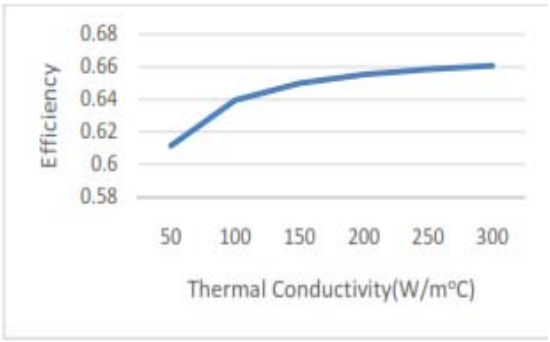

Fig. 6: Efficiency of collector with respect to thermal conductivity of plate [2]

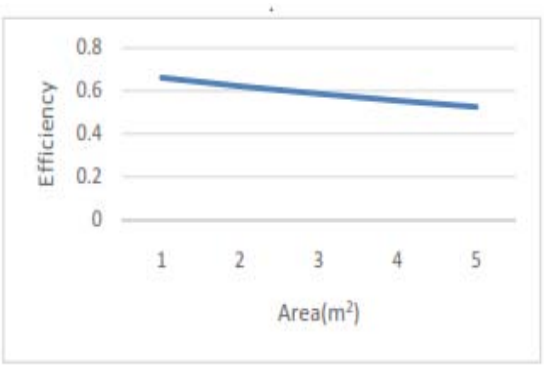

Fig. 7: Efficiency of collector with respect to area of collector□ □ □ □ □

N. Ghimire explained Graphs as follows. fig. 3 shows the results predicted for the variation of water flow rate with efficiency. Collector efficiency increases with the increase in water flow rate due to absorption of heat energy with high velocity of flow rate and less radiation losses. Fig. 4 show that with the increase of tube spacing, overall efficiency of the collector decreases. As the spacing is higher, heat transfer from fin will reduce causing less temperature rise. So any spacing between 0.05 and 1 will be efficient for higher efficiency. From the Fig. 5, we can see that with the increase of insulation thickness, efficiency increases as the heat loss is reduced from the collector. Here 0.1 m looks to be the best as efficiency increase after 0.1 m thick insulation is not steep. Fig. 6 clearly shows that with the selection of plate of higher thermal conductivity, efficiency increases. Most common plate is of aluminium (250) used in Local collectors as it is cost efficient and some manufacturers even used copper(385) which is corrosion resistive. Fig. 8 shows the effect of variation of efficiency with area of absorber plate. Here it is observed that as the area of plate increases the efficiency decreases due to more losses occurred when the area of collector is increased and if the area of the plate is decreased the efficiency increases [2].

III. CONCLUSION

This paper deals with different methods and parameters for performance analysis of solar water heater and it is observed that by increasing the absorptive power of plate and different surface coating would give maximum temperature of hot water in the storage tank. The performance of solar thermal absorber could be improved by change of absorber materials and coating thickness. The mathematical formulations are useful in design and development of solar water heater for better efficiency. The Collector efficiency increases with the increase in water-flow rate due to absorption of heat energy with high velocity and less radiation losses. Collector efficiency decreases with the increase in area of the absorber plate due to increased surface area leading higher rate of heat losses.

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Effect of Liquefied Petroleum Gas as a Fuel on Spark Ignition Engine Performance: A Critical Review

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ABSTRACT: Liquefied petroleum gas (LPG) as an alternative fuel demonstrate advantage in low CO_2 emission as compare to petrol because of propane and butane are the main constituents of LPG. In addition LPG is suitable for Spark Ignition (S.I.) engines due to its higher octane number. In the recent years, LPG vehicle have been widely use as an alternative to the petrol vehicle all over the world, since it is economical than petrol. This paper presents an exhaustive review about LPG as an alternative fuel for S.I. engine and its effect on frictional losses, volumetric efficiency due to sudden pressure rise in the cylinder, the heat loss and friction loss are more compared to gasoline resulting in lower mechanical efficiency. The frictional losses are very significant in small engines and to overcome this problem the tribological considerations in the design of engine piston-cylinder that is, piston skirt, piston ring and cylinder liner should be focused for its performance enhancement.

KEYWORDS: performance characteristics, friction, exhaust emission, liquefied petroleum gas, Spark Ignition Engine

(I) INTRODUCTION

Applications of Internal Combustion engine are popular in automotive industries. There are basically two types of Internal Combustion Ignition Engine, those needs spark plug are spark ignition engine and those needs fuel injection system are compression ignition Engine.

Considering the energy crises and pollution problems today, research and development have been concentrated on decreasing fuel consumption by using alternative fuel and reducing a toxic component in combustion products. Number of liquid and gaseous fuels and are among the potential fuel alternatives, like ethanol, methanol, compressed natural gas, liquid petroleum gas, bio diesel, etc. Since the major contributors in environmental pollution are automobiles and the changes for petrol engine generally have undergone the last 20-25 years has been due to control from emission standards and the fuel economy requirement becoming essential. Increasing the focus on liquid petroleum gas (LPG) as clean, relatively low in cost and abundant source of energy to provide affordable fuel-efficient transportation, increases the research for the optimum amount approach to manage of fuel, air, and combustion to achieve the best result in vehicle power, fuel efficiency and low gaseous and waste product. LPG is a gas product of petroleum refining majorly consisting of propane and somewhat butane some propylene and other like hydrocarbon LPG become more popular since mid of 1950 when the wide spread take up of dual fuel engine technology came to transport. Duel fuel vehicle have to separate fuel system with only being used at a time, this allowed LPG to be used in it parallel with other fuels.

Now a days the gaseous fuel as a LPG has been widely used throughout the world in S.I. Engine as a impact of Green house emission losses than any other fossil fuels a large no. of studies are carried out on LPG fuel S.I. Engine and it is found at the use of LPG has a significant effect on emission control and engine performance. CO, HC and CO_2 level are on lower side but the concentration of NOx for the same output has higher for LPG than Gasoline. S.I. engine fuel with LPG resulted in a decrease in power output and volumetric efficiency as compared to gasoline. The rubbing friction mainly divided as a crank shaft friction, accessory friction, valve train friction and piston assembly friction. A part form rubbing friction, rubbing friction also part of loss of work reduced by engine which is also known as flow friction. Both rubbing and flow friction together used engine losses which are undesirable to causes the wear of part and increases the losses which reduces the efficiency of the engine

Future Scenario for LPG vehicles:

Cost saving ,longer life of the engine and less emission will attract the public for making use of LPG run vehicles. Future of LPG vehicles is bright, provided the foiling improvements in the system are made.

i) At present in many countries LPG cylinders are used in the vehicles. The weight of the cylinders is a disadvantage. Some amount of power is wasted in carrying these cylinders along with the vehicles. However in developed countries most LPG cars use tanks. The tank is usually the same size of wheel. Such LPG tanks instead of cylinders, should be used in cars running on LPG.

ii) Effort must be made to have more LPG filling stations at convenient locations, so that LPG tanks can be filled in the gas pipes.

iii) Safety devices are to be introduced to prevent accident due to explosion of gas cylinders or leakage in the gas pipes.

LPG fuel feed system :

Propane has been tested in fleet vehicles for a number of years. It is a good high octane SI engine fuel and produces less emission than gasoline about 60% less CO, 30% less HC, and 20% less NO_x Propane is stored as a liquid under pressure and delivered through a high pressure line to the engine, where it is vaporized Hence, proper and sufficient precaution are to be taken before fitting the vehicle with the fuel feed system. Otherwise, there is every possibility for gas leakages causing fire hazards. Being a gaseous fuel, it has the disadvantage of lower engine volumetric efficiency

(II) COMPONENTS OF ENGINE FRICTION:

The useful power at the output of an internal combustion engine is lower than the power produced at the piston. This difference between the powers is due to friction. This frictional loss is a collective contribution from different components present in an engine for example, piston assembly, crankshaft bearing etc. Figure 1 shows the distribution of the input fuel energy in an engine.

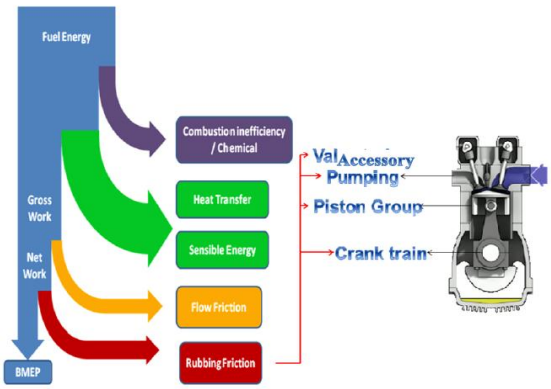

Fig. 1 Energy distribution in an IC engine[4]

Engine friction is mainly divided into four parts as shown in the figure. Apart from the rubbing friction, pumping friction is also part of the lost work produced by the engine, it is also known as the Flow friction. Pumping friction is a combination of throttling and valve flow work A detailed description of the rubbing friction is given below.

Rubbing Friction:

The total engine rubbing friction is the combination of friction from all the sub-assemblies and accessories of the engine. There are different assemblies of the engine which contribute to the total frictional losses are given below:

1. Crankshaft friction
2. Accessory friction
3. Valve Train friction
4. Piston Assembly friction

Generally the trends show, that piston ring assembly contributes approximately 50% of the total and accessory rubbing friction [4].

Crankshaft friction:

The friction contribution of the crankshaft is mainly due to the bearings and the bearing seals. Bearings operate in the hydrodynamic range, some amount turbulent dissipation is also present due to the flow of the lubricant through the bearing restrictions. The frictional force can be calculated by the product of bearing area and the mean velocity gradient. This particular term is derived from a simple problem of fluid between two rotating cylinders. A linear velocity profile for the fluid was considered in this case.
The various forces are shown below.

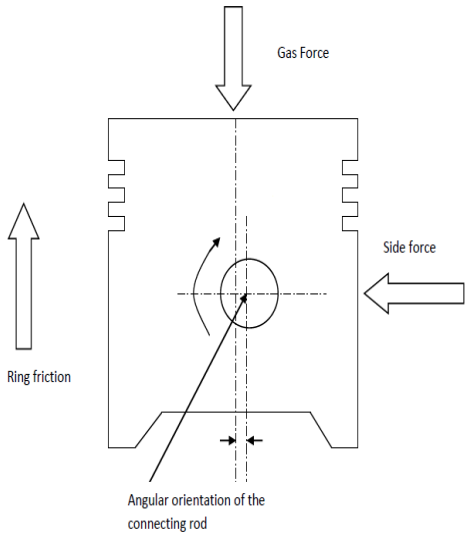

Fig.2 Piston forces

Accessory friction:

Accessory losses are the losses associated with built in parts like the oil pump, fuel pump etc. These losses contribute up to 20% of the total frictional losses. These losses are generally assumed to a function of speed.

Valve train friction:

A valve train mainly consists of camshaft, follower, rocker arm, spring, retainer etc. There are two main forces which provide frictional loading during the operation of a valve train. The first is the spring force, this force is significant only at low speeds. The second is the inertial force. The inertial forces become more significant at high speeds. Different approaches for reducing the valve train friction are: reduced loading of the spring and reduction in mass of the valve, usage of tappet roller cam followers and use of needle bearings for rocker arm. Roller cam followers greatly reduce the valve train friction; they can be used to reduce the friction to almost half its original value.

(III) PERFORMANCE MEASURSRMENT:

[A] Frictional Horsepower:

The friction horsepower can be measured by the following techniques.

a) Measurement of FMEP from IMEP.
b) Break down motoring test.
c) Willians line method
d) Morse test.

The difference between indicated power and the brake power output of an engine is the friction power.

• The frictional losses are ultimately dissipated to the cooling system (and exhaust) as they appear in the form of frictional heat and this influences the cooling capacity required. Moreover, lower friction means availability of more brake power; hence brake specific fuel consumption is lower.

• The *bsfc* rises with an increase in speed. The level of friction decides the maximum output of the engine which can be obtained economically. In the design and testing of an engine; measurement of friction power is important for getting an insight into the methods by which the output of an engine can be increased. In the evaluation of *IP* and mechanical efficiency measured friction power is also used.

If the mean effective pressure is based on bp it is called the brake mean effective pressure (and if based on IHP it is called indicated mean effective pressure (imep). Similarly, the friction mean effective pressure (fmep) can be defined as,

fmep = imep - bmep

The torque is related to mean effective pressure by the relation,

$$bp = \frac{2\pi NT}{60}$$

$$iP = \frac{Pim\ LANk}{60}$$

[B] Exhaust Emission: Variables affecting performance characteristics

i) Combustion Rate and Spark Timing
ii) Air fuel Ratio
iii) Compression Ratio
iv) Engine Speed
v) Mass of inducted Charge
vi) Heat Losses

Major exhaust emissions are

i) Unburnt hydrocarbons, (HC)
ii) Oxides of carbon, (CO and CO_2)
iii) Oxides of nitrogen, (NO and NO_2)
iv) Oxides of sulphure, (SO_2 and SO_3)
v) Particulates soot and smoke.

Hydrocarbon emission:

The causes for hydrocarbon emission from SI engine are-

i) Incomplete combustion.
ii) Crevice volumes and flow in crevices
iii) Leakage past the exhaust valve

(IV) LITERATURE REVIEW

1. **C.C. Danials & M.J. Braun [19]** are experimentally determine the friction behavior of individual engine component assembly over range of operating temperature for 20-85°C. They are experimentally determine the friction

behavior and they suggested that the piston & piston connecting rod assembly including oil ring, two compression ring, connecting rod, wrist pin bearing and connecting rod main bearing contributed the most friction mean effective pressure to the total engine losses.

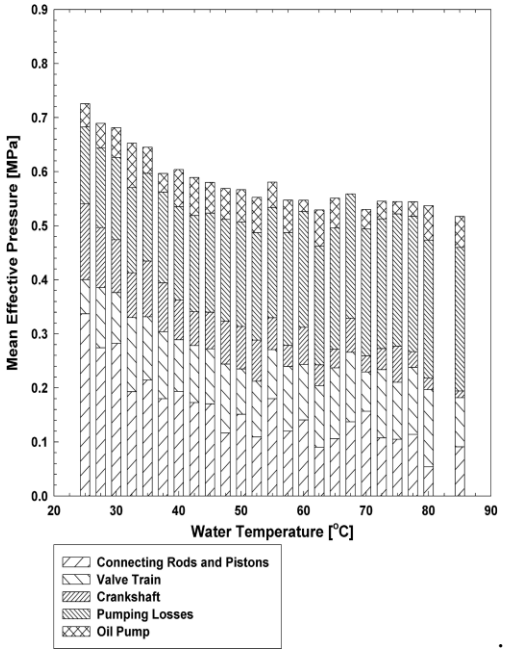

Fig.3—Comparison of mean effective

Pressure contribution of individual component.

The valve train assembly friction contribution of the FMEP was far smaller .

2. **Dhiraj karla, Dr. Viresh BabuA. Vijay Kumar [13]** reviewed the previous studies on LPG fuel S.I. engines power output volumetric efficiency from LPG found to be decreasing but advancing the ignition timing & increasing the compression ratio has on adverse effect on NOx & brake thermal efficiency was found to be increased with LPG fueled S.I. engine also emission characteristics are also improved as HC, CO & CO_2 showed reduction in concentration with LPG.
3. **Patton K., Nitschke R. & Heywood J. (5)** predicted the friction mean effective pressure (FMEP) for S.I. engine & include prediction of rubbing losses from the crank shaft, reciprocating & valve train component.
5. **E. Abu Nada, I Al. Hinti, A. Al. Shaikh, & B. Akash [18]** A parametric study has been performed covering wide range of dependant variable such as engine speed by considering piston friction combined with temperature dependent specific heat & heat losses from the cylinder. Their study evaluated the contribution of piston skirt & ring on overall cycle efficiency. The contribution of ring friction become more significant of low oil temperature high engine speed.
6. **H.R. Mistry & D.V. Bhatt [6]** concluded that frictional power loss contribution by individual piston ring varies under different speed. The nature of the curve power consumption of P.R.A. system with is in line with stribeck in nature.
7. **M.K. Dubey & R. Randa [3]** are experimentally found out brake specific fuel consumption (B.S.F.C.) is comparatively lower for LPG & also brake thermal efficiency for LPG are more than petrol fuel for the same load.
8. **M. Gumes [7]** suggested that the volumetric efficiency decrease considerably of the use of 25% LPG level, as for 50%, 75% & 100% LPG uses level, air fuel ratio are also decreases with increasing LPG uses level.
9. **Sulaiman M.Y., Ayub M.R. & Meran I. [11]** are found experimentally that application of LPG in petrol engine generally suffers a slight output reduction & due to the lower volumetric efficiencies & unaltered ignition timing at the engine.
10. **Thirumal Mamidi and Dr. J.G. Suryawnshi [16]** carried out the experimental investigation to evaluate the performance of a single cylinder four stroke SI engine fueled with LPG at variable loads and at various compression ratios the result obtained showed an increase in mass of fuel consumption for LPG at both the compression ratios when compared to gasoline. It was evaluated that Brake specific energy consumption (BSEC) for LPG values slightly higher than gasoline due to high calorific value but the brake thermal efficiency values slightly higher for gasoline than LPG at both the compression ratios. While the concentration levels of CO, CO_2 and unburnt HC were found to be lower than gasoline.
11. **Ali M. Pourkhesalian, Amir H. Shamekhi and Farhad Salimi [17]** investigated the performance of a four stroke, four cylinder SI engine fueled with different alternative fuels. It was evaluated that the engine fueled with gaseous fuels resulted in and decrease in volumetric efficiency and power output, as gaseous fuels have low density as compared to gasoline. BSFC for gaseous fuels was found to be lowered because they have high heating value as compared to gasoline.

Volumetric efficiency and power:

Power and torque mainly depend on an engine's in-cylinder mixture mass. Therefore volumetric efficiency plays one of the most important role among the engine parameter.

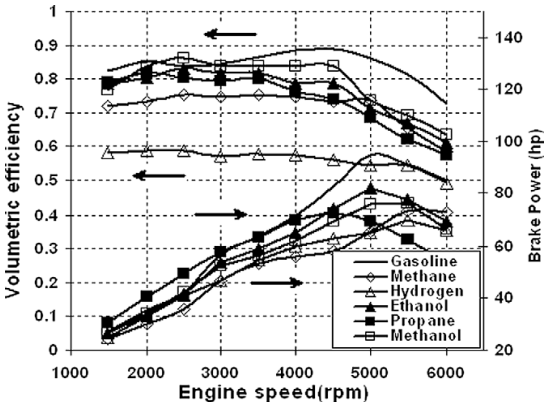

Fig. 4. Variation of volumetric efficiency versus engine speed

In Fig. 4, engine volumetric efficiency and brake power are shown for different fuels. Near the engine speed of 4500 rpm, volumetric efficiency reaches to its maximum peak and then decreases because of high pressure loss and choking in high engine speeds. As liquid fuels have latent heat of vaporization, they produce a cooling effect on intake charge during vaporization. Therefore, there will be an increase in intake mixture density and consequently in volumetric efficiency, but gaseous fuels which are vapor in ambient temperature, not only have no cooling effect, but also cause a decrease in volumetric efficiency, due to larger volume of fuel in inlet mixture. The engine operating on methane, methanol, hydrogen, propane and ethanol will experience an average reduction in volumetric efficiency by 12%, 5%, 28%, 10% and 8% comparing to gasoline, respectively. It can be seen that engine produce less power when operating on methane and hydrogen. The power produced by methane, methanol, hydrogen, propane and ethanol is less of gasoline by 20%, 13%, 19%, 10% and 10%, respectively. As the engine is designed for operating on gasoline, more power is obtained when gasoline is applied. All the other fuels have a higher octane number than gasoline, so engine compression ratio could be higher if the engine was dedicated to those fuels, and therefore engine performance could be improved.

Break mean effective pressure:

Following Fig. 5 presents a comparison between brake mean effective pressures (BMEP) of different fuels. For naturally aspirated spark ignition engines, maximum values for BMEP are in the range 850–1050 KPa at the engine speed where maximum torque is obtained .At the speed where maximum power occurred, BMEP values are 10–15% lower. The variation of BMEP and brake power is primarily due to the variation in volumetric efficiency [1]

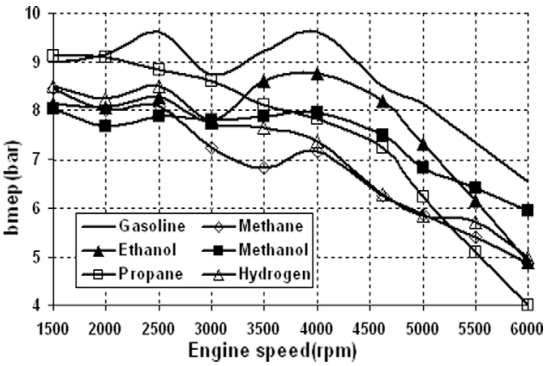

Fig.5 Variation of BMEP Versus engine speed from figure, it can be seen that the shape of BMEP curve follows the volumetric efficiency curve. The reduction in BMEP with methane operation is seen through out the speed range. Part of this BMEP loss is due to longer ignition delay and lower flame speed of methane. In more spark advance, combustion starts earlier with respect to TDC and there is a greater amount of negative work done on the piston before TDC compared to gasoline.

12. **Mufti and Priest [14]** have measured the piston assembly friction losses under fired condition on a single cylinder Ricardo Hydra Gasoline car engine using the IMEP method and found that piston assembly friction found approximately double during power stroke and compression stroke in comparison to suction and exhaust stroke in an engine cycle at different all speeds. Also, they observed that power loss by first compression ring is always found approximately 33% higher than that of second ring at different operating conditions and piston assembly friction losses by both rings also observed about 30-35% of total power losses at all different operating speeds
13. **Hamatake et. al.[15]** studied the frictional behaviour of piston ring assembly by varying no. of piston rings and concluded that to reduce the friction losses, decrease the number of rings.

(v) CONCLUSION

In this paper various consideration like performance variable, friction behavior and emission characteristics of S.I engine that the power output and volumetric efficiency are decreasing with LPG but the brake thermal

efficiency was found to be increased using LPG. The emission characteristics are also improved. Approximately 17 to 25% of fuel energy is wasted for maximum utilization in the form of frictional losses as direct losses like piston rings, main bearing, and cam shaft bearing etc. using LPG fuel in S.I. Engine. These losses are excess than S.I. Engine fuel as petrol. So it very important to reduce frictional losses using both types of fuels and overcome wears of various parts and by applying proper lubrication optimum utilization of the fuel energy, which is otherwise going to be wasted must be utilized in such a way that it should not affect the engine performance adversely. Also the power output and volumetric efficiency of engine would be improved for LGP as a S.I. engine fuel.

VI. ACKNOWLEDGEMENT

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Flow Evaluation of Ball Valve for Performance Enhancement Using CFD Software

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Abstract: Ball valves are commonly used as flow control device, in applications where the discharge pressure required from the valves are relatively low. It is observed that design the valve in such a way that it will give best performance and optimum efficiency would be achieved in hydraulic power plants. Owing to fast progress in the development of flow visualization and numerical technique availability, it is possible to observe the flow around a valve and to estimate the performance of a valve. In this study the flow evaluation through 1 ½" CPVC Ball valve is carried out using computational Fluid Dynamics (CFD) software. Modeling of the valve is done using CATIA V5 R20 software and for analysis ICEM CFD 12 is used. Valve parameters including flow coefficient and head loss coefficient have been considered using CFX 12. The fluid is taken as incompressible fluid for design and analysis of valve. Magnitude of head loss coefficient calculated from numerical analysis is compared with the experimental data and the results are found satisfactory.

Keywords: CPVC Ball Valves, Optimum Performance, ICEM CFD, CATIA V5 R20

I. **Introduction:** Ball valve is high quality; economical quarter-turn shutoff valve designed for irrigation, pool and spa, and general purpose applications**.** It has simple mechanical meeting and small flow resistance in a totally open function, It provide a surprisingly excessive flow capacity. They're most suited for exceptionally low pressure with the flow. Usually, the fluid friction coefficient is low and additionally the increase is normally minimal because of the Ball valve is operated with a quarter turn. Manual operation may be through lever or tools provided with it. The primary try at gathering and collating the published statistics regarding Ball valves was likely made via Cohn in 1951. Experimental studies on Ball valve go with the flow traits are performed by way of Addy et al in 1985. The outcomes of numerical simulation of go with the flow characteristics inclusive of each velocity and pressure calculations are offered in literature. Examine on hydrodynamic torque of the Ball valve are conducted by means of Morris and Dutton in 1989.

Ball valves are required to have excessive performance characteristics and higher precision as they are used as close off valves. The characteristics of a valve i.e. head loss characteristic, torque traits and force characteristics of Ball valve is decided conventionally through tests. If take a look at valve is of large size, scale version of valve is examined to decide its traits. Evaluation of flow feature experimentally is a hectic and is not very precise work. Exact theoretical evaluation of flow through complex geometry may be very hard with using high velocity computers, and the numerical techniques, the flow evaluation can be made the use of CFD. So flow analysis is to be performed using simulation software. Goal of this research work is to find amount of water leakage from ball valve at closed condition. At present nearly each enterprise is using software for evaluation. Ball valves are used in various power plants and it has extensive scope. So this study will be beneficial for all fields where Ball valves are used. Computational fluid dynamics is a tool to perform numerical solution with the flow simulation for predicting the float behavior within a particular domain via numerical answer of governing equations to ideal accuracy. Computational fluid dynamics is becoming very beneficial approach for engineering layout and analysis due to improved numerical method and at the same time, it saves time and power of experimental setups.

II. Literature Review

A series of numerical CFD simulations of the flow through ball check valve of an ABS control valves are performed, with and without inclusion of a cavitation model, under similar conditions of pressure difference between inlet and outlet ports by Jose R. Valdes. [1] And concludes that the correlation between measurements and CFD predictions is excellent in both cases, thus validating the accuracy of simulations and cavitation model for valve flow prediction. The significant difference between cavitating and non-

cavitating conditions shows importance by taken into account the cavitation effects in prediction of the flow rate.

A methodology for the parametric modeling of flow in different types of hydraulic valves is developed by Jose M. Rodriguez. [2] This methodologies based on derivation of a generalized parametric function for modeling of the discharge coefficient of valve restrictions. This function has a square root form and two parameters that are characteristic of the restriction geometry and that can be derived from numerical CFD simulations. Once the flow coefficient functions are characterized, the calculation of flow rate is done by means of either a second order equation or a simple iterative procedure, in which input data are fluid properties and main geometrical dimensions. The methodology is demonstrated by applying it into two completely different hydraulic valve systems i.e. a brake master cylinder and HCU valves. The results of flow rate calculated with parametric model. And it is compared with those obtained from CFD simulations on initial design and on designs with same topology but different dimensions obtaining in every case. The coefficients of critical restrictions of a particular valve are used to determine the flow for other valves of similar topology but different dimensions. If the geometry is severely changed, critical restrictions must be identified and the parameters must be calculated again. The flow rate can be calculated using iterative or non-iterative methods.

In order to examine the performance characteristics of the parts of high-pressure, cryogenic ball valves, numerical analyses of the strength and thermal shock were conducted and the seat structure was investigated and tested by Dong-Soo Kim.[3] The conclusions are obtained as the design of the constituent parts of the ball valve, including the body, seat, bonnet, ball and spring, were optimized. In this study, a high-pressure, cryogenic ball valve that can achieve zero leakage was designed.

Thus, CFD analysis of symmetric disc valve has been carried out by G. Tamizharasi [4] and conclusions was drawn are at smaller opening angle the pressure loss is comparatively less. The total pressure variation and intensity of turbulence increase at downstream when opening angle increases. Force concentration is observed for 40^0 valve opening position. Increased wall shear are observed for 40^0 and 60^0 opening positions.

The paper of Ana Pereira[5] shows utility of the CFD numerical simulations as a tool for design and optimization of hydropower performance and flow behavior through hydro mechanical devices or hydraulic structures of intake and outlet types. Experimental tests not always are viable because they are very expensive and it is much more difficult to analyze different scenarios and boundaries. The flow of a real fluid in contact with a boundary implies velocity variations, pressures gradients and shear stress development, from which energy losses result, as important factors to take into account in the concept, design, construction, operation and maintenance of hydropower plants or any other type of hydraulic conveyance system.

The results of CFX simulation generated by Xue guan Song [6] agreed with the experimental data very well. However, at some peculiar position, especially at the valve opening degree smaller than 20^0, it didn't agree well. This may be due to disadvantage of the k-ε turbulent model of its own. It's suggested to use another turbulent model which is good at treatment of near-wall such as k-ω model and SST turbulent model. The simulation by CFX was very sensitive to the degree of valve opening near to fully closed condition, where the flow near the valve is highly turbulent. So small subdivision is recommended near this region, and results are used with the comparison of the test values.

In general, the result obtained by using commercial code ANSYS CFX 10.0 agrees with the experimental result very well. However, it is recognized that all CFD based predictions are never possible to be 100% reliable. Hence further investigation must be performed before the computational simulations are used directly in the industry.

III. CFD Analysis and theory Approach

CFD provides numerical approximation to the equations that govern fluid motion. Application of the CFD to analyze a fluid problem requires certain steps. First, the mathematical equations describing fluid flow are written. CFX is a commercial Computational Fluid Dynamics (CFD) program, used to simulate fluid flow in a variety of applications. The ANSYS CFX product allows engineers to test systems in a virtual environment. The scalable program is applied to simulation of water flowing past ship hulls, gas turbine engines (including compressors, combustion chamber, turbines and afterburners), aircraft aerodynamics, pumps, fans, HVAC systems, mixing vessels, hydro cyclones, vacuum cleaners etc.

This is the initial step in analysis process. The primary purpose of geometry creation is to generate a solid that defines region for fluid flow. This section describes creation of geometry. Dimensions and geometry details of existing model are collected. Model is created using

CATIA V5R20 software and exported in IGES format. The model of valve shape in shown in the following figures the step defines creation of regions and geometry. 2D region is created for defining inlet and outlet. Creation of regions facilitates to assign boundary condition for inlet, outlet and other defined regions. The model of Ball valve is shown in fig. 1 and its exploded view as shown in fig. 2.

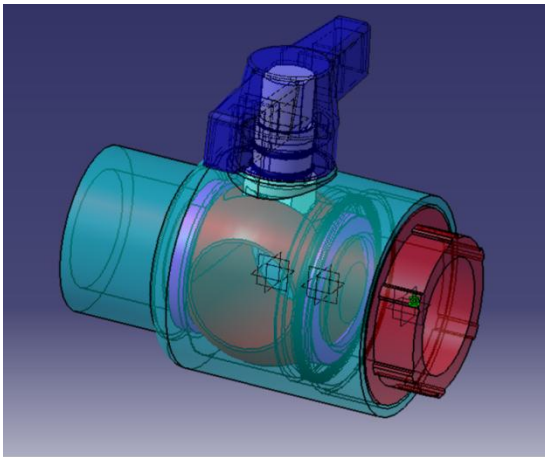

Figure 1. Typical Ball Valve model in Catia V5

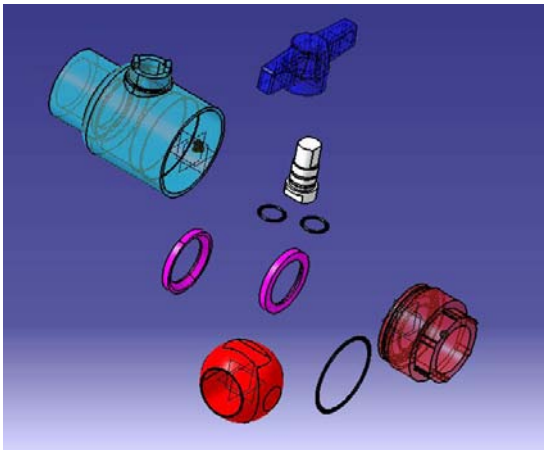

Figure 2. Ball Valve with Exploded view

Flow coefficient (C_V)

The flow coefficient is used to relate to the pressure loss of a valve to discharge of the valve at a giving valve opening angle. Today, CV is the most widely used value for valve size and pipe system. By using the CV, a proper valve size can be accurately determined for most applications. The most common form used by valve industry is Equation (1):

$$Cv_{ISA} = \frac{Q_{gpm}}{\sqrt{\Delta P_{ISA} / S_g}}$$

Where the pressure drop ΔP_{ISA} can be measured from static wall taps located 2 pipe diameters upstream and pipe diameters downstream of the valve.

ΔP is the pressure drop in units of psi, Q_{gpm} is in units of gpm, and Sg is the specific gravity of the fluid (1 for water).

Flow Pattern

The fluid, which was modeled as water, is given a uniform velocity of 3m/s at the inlet and zero reference pressure at the outlet. Through rough calculation, the range of Reynolds Number of flow in this study is larger than 105, hence the effect of the Reynolds Number is so small that it can be neglected [5].

Numerical Method

Incompressible and viscous fluid (water) flows through the Ball valve. The flow pattern reveals that flow studied is turbulence flow. To deal with turbulence modeling, the eldest approach, Reynolds-averaged Navier-Stokes Equations(RANS), is utilized. Its common form can be written as Equation (2)

$$\overline{u}_j \frac{\partial \overline{u}_i}{\partial x_j} = g_j - \frac{1}{\rho}\frac{\partial \overline{p}}{\partial x_i} - \frac{\partial \overline{u_i' u_j'}}{\partial x_j} + \nu \frac{\partial \overline{u}_i}{\partial x_j^2} \qquad (2)$$

Dynamic flow coefficient (Ct)

Hydrodynamic torque T(α) is valve shaft produced by the flow passing through valve at a given valve opening angle α. The hydrodynamic torque coefficient Ct is a factor, which is independent of the size of valve. For a given valve and valve opening, it is easy to calculate hydrodynamic flow torque by using Ct times the different pressure drop, Equation (3) shows the relation between Ct, T, pressure drop and valve diameter.

$$C_T = \frac{T(\alpha)}{\Delta P_{net} \cdot d^3} \qquad (3)$$

IV. Visual Inspection Techniques

This is one of the best performance prediction techniques for Ball valve. The valve material is CPVC and as per the ASTM D:2846 for valve material sustainable pressure ratings are passing water at 82^0 C with 36 kg/cm^2 pressure for six minute and water at 82^0 C with pressure of 26 kg/cm^2 for two hours.

The valve performance is visually inspected as shown in fig. 3. The visual inspection

shows that the valve meets the standard criteria with large amplitude. That is the valve passes water of temperature 82^0 C at pressure of 36 kg/cm^2 for 6 minutes and 26 kg/cm^2 for four hours satisfactorily.

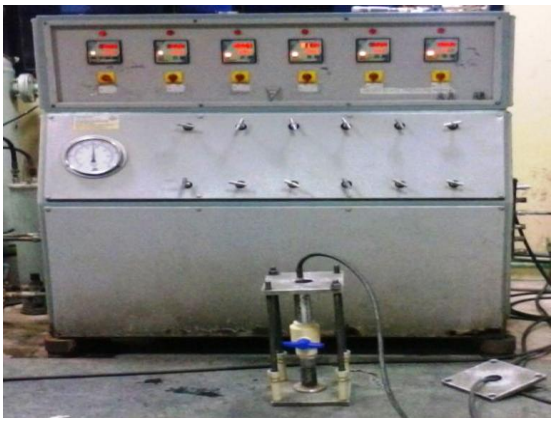

Figure 3. Test setup for testing of ball valve

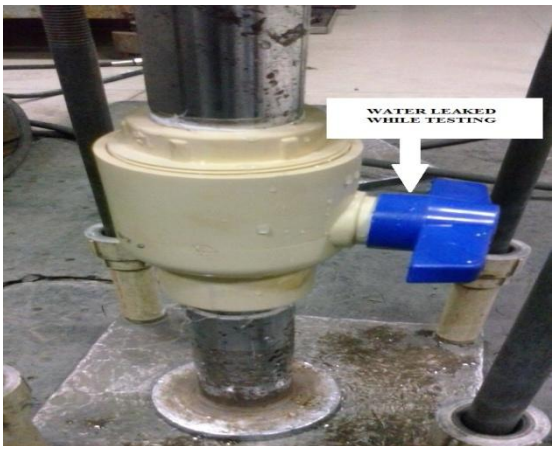

Figure 4. Ball Valve leaked from its spindle

V. Results and discussions

In this section experimental results for the performance testing of ball valve are discussed. The experimental setup for the testing of ball valve is as shown in figure.3 in which the inlet water is allowed to pass through ball valve at different pressure from one side and other side is blocked. Then the test results obtained are as shown in figures below;

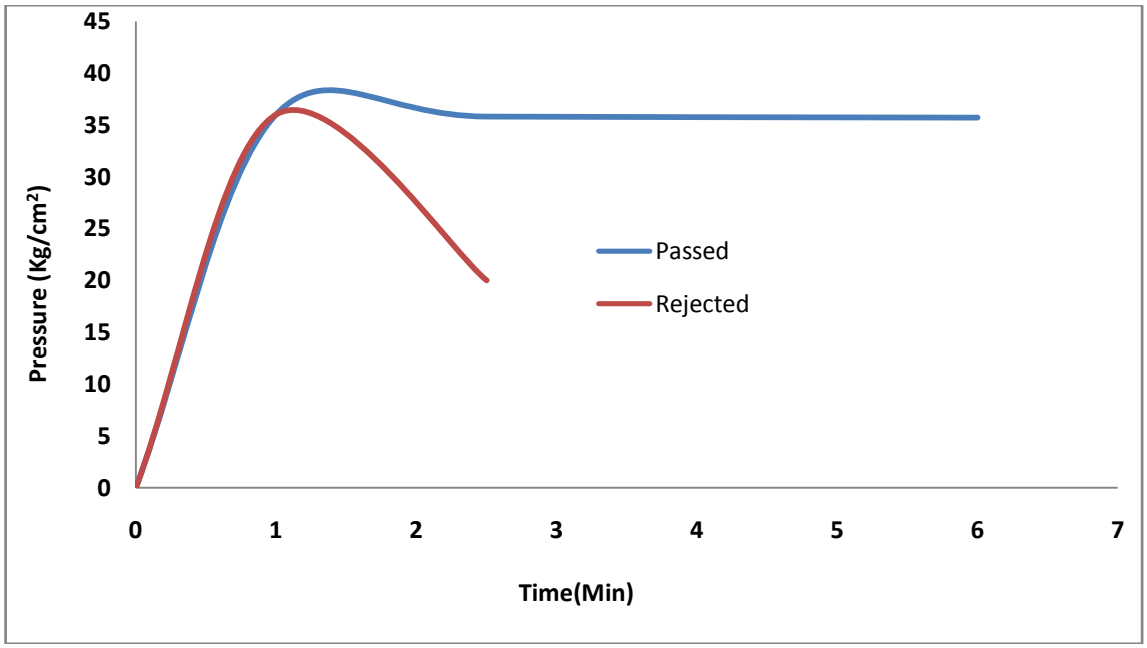

Figure 5. Test result at 36 Kg/cm^2 for 6 min.

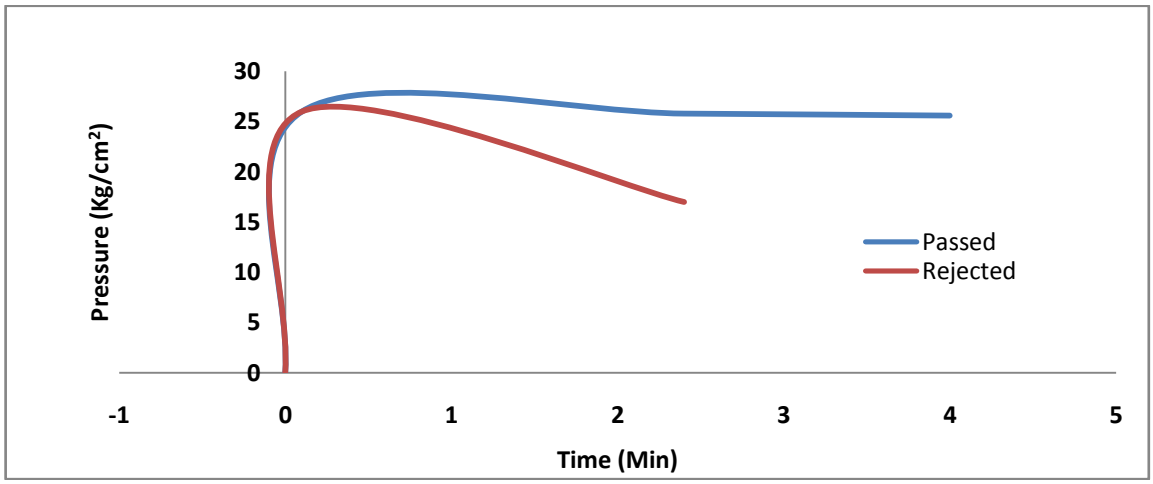

Figure 6. Test result at 26 Kg/cm^2 for 4 hours

The fig.5 & fig. 6 shows the result at two different pressures and periods in which as the pressure drop occurs during the testing and also visualizing the water droplets on ball valve then it is said that the piece failed in testing and it is rejected. And if there is no any pressure loss during the testing then it is passes the test and that ball valve piece is accepted.

VI. Conclusion

In this paper, basics of CFD and experimental testing of ball valve has been discussed. Visual inspection shows the valve meets standard criteria as per ASTM D2846 for valves, so the design of valve is tested and validated. It is observed that CFD software method gives similar results matching to visual inspection. As per experimental testing following conclusions about causes for leakage problem are observed; i) Owing to shrinkage in material of spindle, ball or main body of ball valve during moulding process, ii) Owing to improper size and dimensions of small `O `rings which are placed on spindle of ball valve, iii) As there is small bending in spindle during manufacturing then it also causes the leakage and iv) As the fitting of ball valve nut is improper, it may also put the clearance in ball valve which causes the leakage problem.

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A Review on Effect of Air Induction Pressure Variation on Compression Ignition Engine Performance

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ABSTRACT: Owing to Concern of environmental pollution and energy crisis all over the world, research interest on reduction of diesel engine exhaust emissions and saving of energy is increasing. Because of Better fuel economy and higher power with lower maintenance cost, the popularity of diesel engine vehicles has been increased. Diesel engines are more economical than any other source in this range for bulk movement of goods, powering stationary/mobile equipment, and to generate electricity. The air induction system plays important role in combustion process by providing necessary air charge in case of Compression Ignition (C.I.) engine. Pressure drop across air intake manifold has significant effect on the indicated power of C.I. engine. To improve the volumetric efficiency, majority car manufacturers place air grill at the front of a vehicle. In this Paper, the causes and effect of air induction pressure variation on performance of compression Ignition engine is studied. It is observed that due to increased inlet air pressure results in better mechanical efficiency, volumetric efficiency, scavenging and reduced exhaust temperature at the engine exhaust thereby reduced oxides of Nitrogen.

Keywords: - Exhaust Emissions, Volumetric Efficiency, Air Induction Pressure, Air Intake Manifold

1. Introduction

Engine performance is responsive to induction depression particularly for Internal Combustion (IC) engines running without turbocharger or supercharger. The majority of engine intake systems has dirty duct, air box, air cleaner, clean duct, intake manifold plenum, and intake manifold runner. The classic length of the air intake system (AIS) can be up to 1 meter. The air path through this manifold presents a pressure drop challenge to the designer of air induction system. The pressure drop across the air intake system is known to have a significant influence on the indicated power of the IC engine. In the case of natural aspirated engine, the downward movement of piston generates the suction which creates pressure drop. The fall in pressure along the intake system is relia on engine speed and load, the flow resistance of different elements in the system, the cross sectional area through which the fresh charge moves, and the charge density. Standard steady flow test bed can be use to measure pressure drop along the air intake system. These measurements are carried out on complete air intake system together with cylinder head and ports. For direct injection engines where the port is shaped to generate the required degree of swirl within the cylinder, measurement of pressure drop is mainly important. Hence, to study of the effect of air intake pressure drop on a diesel engine is very essential. This paper intends to study the effect of air pressure on the combustion quality as well as emissions on diesel engine.

Rizalman Mamat et al. [1] studied effect of the pressure drop in the inlet manifold, on the engine performance and exhaust emission system of v6 diesel engine. The fuel used in this v6 diesel engine is Rapeseed Methy Ester (RME) and a comparison between (RME) fuel and ultra low sulphure diesel (ULSD) was conducted and a steady state test for both fuels were carried at BMEP 3.1 and 4.7 bar. The effect of air intake pressure drop on the engine performance and emissions of a V6 diesel engine has been investigated. Harshraj Dangar et al. [2] conducted experiment in a four stroke direct injection water cooled constant speed diesel engine typically used in agricultural farm machinery with pressurize inlet air attachment and EGR system. EGR was applied to the experimental engine separately and also with varying pressure of inlet air. Compressor was used to pressurize the inlet air. The combine

effect of increasing inlet air pressure and EGR system on engine performance and emission like brake thermal efficiency, brake specific fuel consumption, NOx, CO, CO2 and HC was measured.

Meisam Ahmadi Ghadikolaei [3] investigated the effect of cylinder air pressure and fuel injection pressure on combustion characteristics of direct injection (DI) diesel engine. The combustion characteristics in this experimental study were measured in terms of ignition delay, combustion duration and injection duration at varying cylinder air pressure (10-15-20 and 25 bar) and fuel injection pressure (100-200 and 300 bar) based on diesel and gasoline. Shah et al. [4] reviewed on how the design and orientation of the intake manifold influence the Performance and Emissions characteristics of diesel engine. And concluded that varying the orientation of the Intake Manifold, cylinder flow field structure is greatly influenced which will directly affect the performance and emission of the engine. To enhance performance with least emissions certain orientation of the intake manifold can be optimized.

Hosseinzadeh et al. [5] studied pressure drop against 0%, 26%, 52%, 66% and 74% of air filter hole's masking for different mass flow rates using computational fluid dynamics. The effect of masking on altitude and performance at different revolutions per minute of the engine is investigated using GT-Power software which is one-dimensional computational fluid dynamics software. Also, an experimental and computational fluid dynamics study was carried out to predict altitude against different proportions of air filter hole's masking at 1000 rpm. Thiyagarajan et al. [6] predicted Dust distribution and pressure drop for a constant flow rate of air using commercial CFD code Fluent. They consider the deposition of dust on the filter and the resulting changes in the filter medium properties, which lead to increasing pressure loss across air filter.

Krishna et al. [7] investigated the in-cylinder flow pattern around the intake valve of a single-cylinder internal combustion engine using Particle Image Velocimetry (PIV) at different intake air flow rates. Yerrennagoudaru et al. [8] Optimized airflow performance during intake valve process. Analyses were done in CFD simulation and experimental using a test rig single cylinder 4 stroke direct injection diesel engine. GOUD et al. [9] studied the effects of air filters performance. The analysis is carried out with different simulation results in the form of numerical simulation of flow particles captured by air filters. George et al. [10] considered flow through the inlet manifold for a four cylinder turbocharger diesel engine at low and high rpm. At lower rpm at around 1500 the turbocharger boost pressure will negligible, thus the engine will be in natural aspiration. At this normal running condition the mass flow to engine drops considerably with altitude. Adem Guleryuz [11] focused on optimum required air need through turbocharger for local diesel engine. While researching actual need, new turbocharger filter were designed and manufactured for engine manufacturer. Dan Adamek [12] Discussed about Methods for Diesel Engine Air Intake and Filtration System Size Reductions.

2. 1 Effects of Air Induction Pressure on Engine Performance:-

2.1.1 Effects on Brake thermal efficiency:-

Trends of Brake thermal efficiency for different load condition are shown in fig. 1 and 2. Brake Thermal Efficiency is defined as break power of heat engine as a function of the thermal input from the fuel. It is used to evaluate an engine performance of converting fuel energy to mechanical energy.

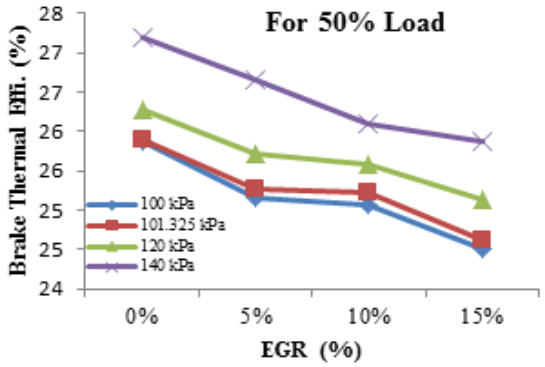

Figure No.1: Effects of Air Induction Pressure on Brake thermal efficiency for EGR rate at 50% load [2]

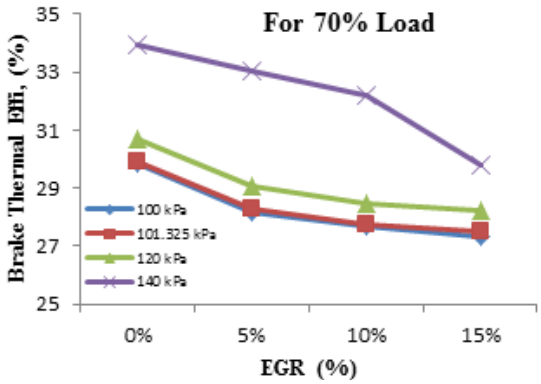

Figure No.2: Effects of Air Induction Pressure on Brake thermal efficiency for EGR rate at 70% load [2]

From figure 1 & 2, it is observed that brake thermal efficiency is increasing with increasing air induction pressure. With increasing inlet air

pressure along with EGR it increases oxygen availability and significantly burning of fuel is occurred.

2.1.2 Effects on Brake specific fuel consumption:-

Fig. 3 and 4 represents comparison of BSFC for all datasets using EGR with inlet air pressure for 50% and 70% load condition. The BSFC is clearly a function of AFR as discussed in details by Heywood [13]. The discharge air increases when air induction pressure increases.

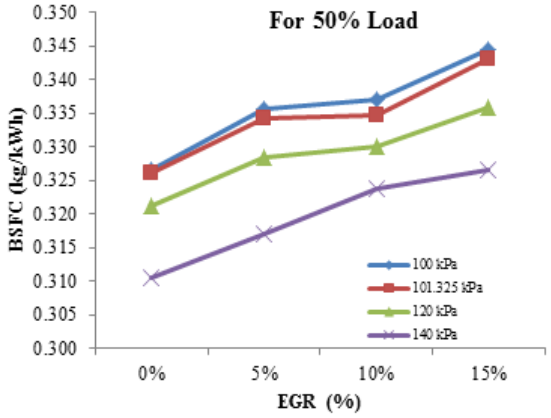

Figure No.3: Effects of Air Induction Pressure on Brake specific fuel consumption for EGR rate at 50% load [2]

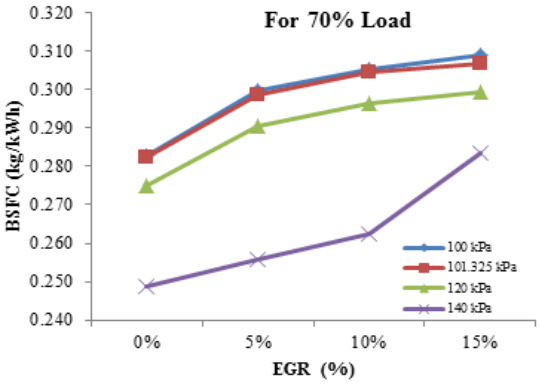

Figure No.4: Effects of Air Induction Pressure on Brake specific fuel consumption for EGR rate at 70% load [2]

From figure No. 3 & 4, it is observed that Brake specific fuel consumption is decreased with increasing inlet air pressure. It is due to by supplying pressurized inlet air, density of air increased and thus more oxygen available for combustion.

2.1.3 Effects on Exhaust gas temperature:-

Fig. 5 and 6 shows the exhaust gas temperature for increasing inlet air pressure and EGR rate at 50% and 70% load condition. The exhaust gas temperature decreases more by increasing inlet air pressure. Exhaust gas temperature also decreases with increase in inlet air pressure since advanced injection timing at higher inlet air pressure caused low-temperature reaction. In other words, as the inlet air pressure is increased further, cylinder gas temperatures are decreased, allowing more advanced injection timing. Thus by increasing inlet air pressure with EGR system lowered more exhaust gas temperature than individual EGR system.

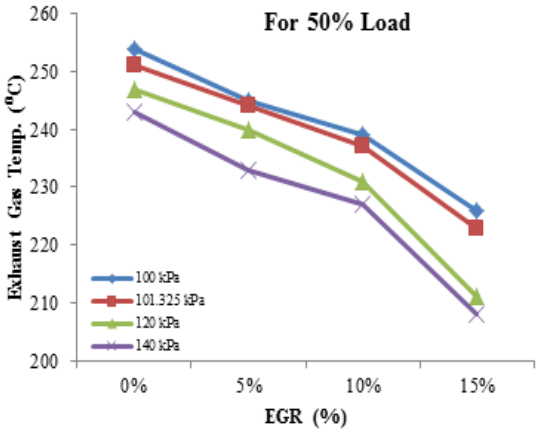

Figure No.5: Effects of Air Induction Pressure on Exhaust gas temperature for EGR rate at 50% load [2]

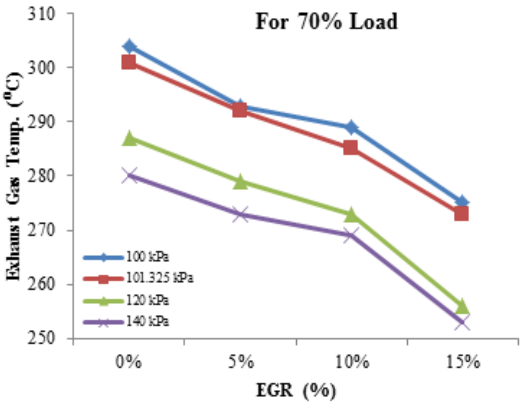

Figure No.6: Effects of Air Induction Pressure on Exhaust gas temperature for EGR rate at 70% load [2]

Conclusion

It is observed that, different methods of increasing air induction pressure are very effective to improve engine performance and emission control of Compression Ignition engine. It shows that increase in air induction pressure increases brake thermal efficiency, decreases exhaust gas temperature and decrease in Brake specific fuel consumption. Also

increasing inlet air pressure reduces NO_x emission and increases HC, CO and CO_2 emission. Increase in CO, HC, and CO_2 emissions can be reduced by using exhaust after-treatment techniques, such as diesel oxidation catalysts (DOCs) and soot traps.

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A Review on Mild Steel Drilling Process Parameters for Quality Enhancement

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Abstract: The objective of this study is to illustrate procedure adopted in Taguchi method for sheet metal processing on a drilling machine. The orthogonal array, signal-to-noise ratio and the analysis of variance are employed to study the performance characteristics in drilling operation. In this analysis, three factors namely speed; feed and depth of cut are considered. This paper deals with optimization of Drilling machine process parameter to provide good surface finish as well as high surface removal rate used as quality attributes and are considered to be directly related to productivity. Taguchi method is a statistical approach to optimize the process parameters and improve the quality of components that are to be manufactured.

Keyword: Drilling machine, Surface roughness, Material Removal Rate, Taguchi method, ANNOVA

1] INTRODUCTION

Taguchi's parameter design offers a systematic approach for optimization of various parameters with regard to performance quality and cost. The quality and cost is one of the prime requirements of customers for machined parts productivity is also necessary to fulfill the customers demand. For this purpose quality of a product and productivity should be high and cost should be low. Design optimization for quality was carried out and single to noise ratio and analysis of variance (ANOVA) were employed using experiment result to confirm effectiveness of this approach. The signal to noise ratio in Taguchi methodology was used to find optimal parameter for material removal rate and surface roughness in drilling operation based experimental results done on mild steel work piece and high speed steel tool. The personnel industry as well as in research and development is required maintain surface roughness and MRR. Mild steel and is extensive used us a main engineering material in various industry such as air craft and aerospace industry impact of drilling parameter such as speed in rpm. Feed rate mm/min depth of cut in mm. the drilling tool diameter is constant. The tool angle is fixed 118º .the Taguchi optimization methodologies to optimize the drilling parameter in drilling machining age hardened mild steel and tool is high speed steel. Authors analyzed the data using ANOVA with the help of commercial software package minitab-15. A series of experiment based on the Taguchi L9 orthogonal array is utilized for experimental planning for CNC drilling machining.[1]

2] LITERATURE REVIEW:

Tygi et al. [2] used Taguchi Method and investigate the effect of machining parameter i.e., spindal speed, feed rate, depth of cut on surface roughness (SR) of Drilling machine tool mainly affect the SR. Koklu [3] investigated the effect of the mechanical properties of mild steel and feed rate, cutting speed And drill diameter on burr height and surface roughness of drilling, using the Taguchi method.

The result of statically analysis shows that cutting speed and feed rate minimize significantly both the height of exit burrs and the surface roughness. To sun [4] worked on statically analysis of process parameter for surface roughness in drilling of mild steel and alloy steel metal matrix composite. The experimental study are conducted under varying feed rate, spindle speed drill type, point angle of drill, and heat treatment. The determined significant factor was the feed rate and tool type.

Kilickap et al. [5] focused on the influence machining parameter i.e. cutting speed feed rate and cutting environment on the surface roughness obtain in a drilling of mild steel and alloy steel. Thiren G. Pokar, Prof. V. D. Patel [6] used grey based taguchi method to determine the optimum micro drilling process parameters.B.Shivapragash,K.Chandrasekaran,C .Parthasarathy,M.Samuel [7] have tried to optimize the drilling process involving metal matrix composites(MMC) in order to minimize the damage done to it during the process by using taguchi and grey rational analysis. The input parameter is spindle speed, depth of cut and feed rate whereas the output parameters are MRR and surface roughness.

Taguchi method is a powerful tool for the design of high-quality systems. It provides a simple, efficient and systematic approach to optimize the designs for performance, quality, and cost. The methodology is valuable when the design parameters are qualitative and discrete. Taguchi parameter design can optimize the performance characteristics through the settings of the design parameters and reduce the sensitivity of the system performance to sources of variation. In recent years, the rapid growth of interest in the Taguchi method has led to numerous applications of the method in a world-wide range of industries and countries.

Basically, experimental design methods were developed originally Fisher. However, classical experimental design methods are too complex and not easy to use. Furthermore, a large number of experiments have to be carried out when the number of the process parameters increases, to solve this problem, the Taguchi method uses a special design of orthogonal arrays to study the entire parameter space with a small number of experiments only. The experimental results are then transformed into a signal – to – noise (S/N) ratio [8][9] to measure the quality characteristics deviating from the desired values. Usually, there are three categories of quality characteristics in the analysis of the S/N ratio, i.e., the – lower – better, the – higher – better, and the – nominal – better. The S/N ratio for each level of process parameter is compared based on the S/N analysis. Regardless of the category of the quality characteristic, a greater S/N ratio corresponds to better quality characteristics. Therefore, the optimal level of the process parameters is the level with the greatest S/N ratio. Furthermore, a statistically significant with the S/N and ANOVA analyses, the optimal combination of the process parameters can be predicted. Finally, a confirmation experiment is conducted to verify the optimal process parameters obtained from the parameter design.

There are 3 Signal-to-Noise ratios [10][11] of common interest for optimization of Static Problems. The formulae for signal to noise ratio are designed so that an experimenter can always select the largest factor level setting to optimize the quality characteristic of an experiment. Therefore a method of calculating the Signal-To-Noise ratio we had gone for quality characteristic. They are

- Smaller-The-Better,
- Larger-The-Better,
- Nominal-The-Best

3.1 General steps involved in the Taguchi Method are as follows:

1. Define the process objective, or more specifically, a target value for a performance measure of the process. This may be a flow rate, temperature, etc. The target of a process may also be a minimum or maximum; for example, the goal may be to maximize the output flow rate. The deviation in the performance characteristic from the target value is used to define the loss function for the process.
2. Determine the design parameters affecting the process. Parameters are variables within the process that affect the performance measure such as temperatures, pressures, etc. that can be easily controlled. The number of levels that the parameters should be varied at must be specified. For example, a temperature might be varied to a low and high value of 40 C and 80 C. increasing the number of levels to vary a parameter at increases the number of experiments to be conducted.
3. Create orthogonal arrays for the parameter design indicating the number of and conditions for each experiment. The selection of orthogonal arrays is based on the number of parameters and the levels of variation for each parameter, and will be expounded below.
4. Conduct the experiments indicated in the completed array to collect data on the effect on the performance measure.
5. Complete data analysis to determine the effect of the different parameters on the performance measure.[12]

3.2 Signal to Noise Ratio (S/N Ratio) Consideration:

Taguchi found out empirically that S/N ratios give the (near) optimal combination of the factor levels, where the variance is minimum, while keeping the mean close to the target value, without using any kind of model. For that purpose, the experimental results should be transformed into the S/N ratios. There are three categories of the S/N ratio

(a) Smaller-the-better :- S/N (η)= -10logi2} i=1,2,3...
(b) Larger-the-better :- S/N (η)= -10logi2} i=1,2,3...r
(c) Nominal-the-best :- S/N (η)= 10log {R2/S2}

Where Ri is value of surface roughness for the i th trial in r number of tests. The levels of each design parameters have been identified, analysis of the influence of machining parameters on response parameters.

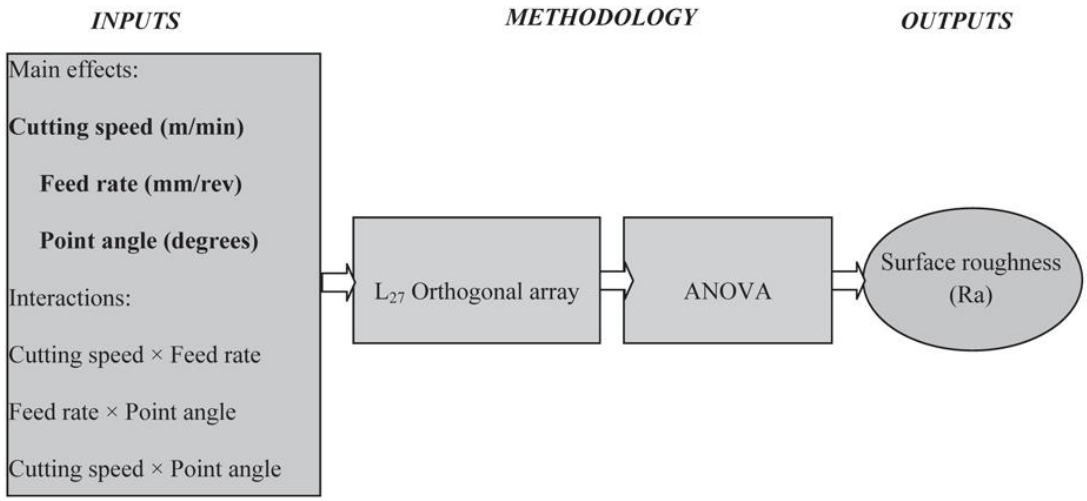

Figure 3. Flow diagram of methodology for analysis of surface roughness (Ra) in drilling [13]

3.3 Analysis of Variance (ANOVA) :

Analysis of variance (ANOVA) is a collection of statistical models, and their associated procedures, in which the observed variance in a particular variable is partitioned into components attributable to different sources of variation. In its simplest form, ANOVA provides a statistical test of whether or not the means of several groups are all equal, and therefore generalizes *t*-test to more than two groups.

ANOVA is used in the analysis of comparative experiments, those in which only the difference in outcomes is of interest. The statistical significance of the experiment is determined by a ratio of two variances. This ratio is independent of several possible alterations to the experimental observations: Adding a constant to all observations does not alter significance. Multiplying all observations by a constant does not alter significance. So ANOVA statistical significance results are independent of constant bias and scaling errors as well as the units used in expressing observations.

3.4 High Speed Steel

One of our tools for the drilling operation will be the high speed steel. High speed steel (HSS)are used for making drilling tools, we used tool diameter 10mm in the drilling machine and point angle is118º This property allows HSS to drilling faster than high carbon steel, hence the name high speed steel. At room temperature, in their generally recommended heat treatment, HSS grades generally display high hardness The composition of high speed steel are carbon (0.6%to0.75%) tungsten (14%to20%),Chromium (3%to5%) vanadium (1%to1.5%), Cobalt (5%to10%) and remaining is iron.

4] MACHINING PROCESS:

Calculating mass of each plate by the high precision digital balance meter before machining operation and before machine process for particular tool path of using various levels of spindle speed, feed rate and, depth of cut. in Experiments were performed using Manually operate drilling machine. After that calculating mass of each work piece plate again by the digital balance meter. The MRR values were measured three times of each specimen and then, the material removal rate Values were average. The Ra values also measured three times on each specimen and the surface roughness (Ra) is measured with a mitutoyo surftest SJ-201 series 178 portable surface roughness tester instrument. Machining experiments for determining the optimal machining parameter were carried out by setting of spindle speed in the range of 1000-2000 rpm, feed in the range of 0.5-1.5 mm/min, depth of cut in the range of 3-7 mm and

Essential parameter of the experiment are given in table1.[1]

Table :- 1 Drilling machining condition

Work Condition	Description
Work piece	Mild steel ,Rectangular shape
Spindle SeedFeed	1000 to 3000 rpm
Depth of Cut	0.5 to 0.15 mm/min
	3 to 7 mm

5] DESIGN CONSIDERATIONS:

The experimental layout for the machining parameters using the L9 orthogonal array (OA) and Signal to noise ratio is done. The machine was used for the drilling operation in this study. The surface roughness are two essential part of a product in any drilling machining operation the theoretical surface roughness is generally dependent on many parameters such as the tool geometry, tool material and work piece material. This array having a three control parameters and three levels as shown in table2.This method, more essentials all of the observed values are calculated based on 'the Higher the better' and 'the smaller the better'. In the present study spindle speed (N, rpm) Feed rate (f, mm/min) and depth of cut (D, mm) have been selected as design factor. while other parameter have been assumed to be constant over the Experimental domain This Experiment focuses the observed values of SR were set to maximum, intermediate and minimum respectively. Each experimental trial was performed with three simple replications at each set value. Next, Signal to noise ratio is used to optimize the observed values.

Table 2: Design scheme of experimenters of parameter and level [1]

Control Parameter	Level			Observed Value
	1	2	3	
	Minimum	Intermediate	Maximum	
Spindle Speed's(rpm)	1000	1500	2000	Surface Roughness(Ra)
Feed Rate (mm/min)	0.5	1	1.5	Material Removal rate
Depth of Cut(mm)	3	5	7	

Table 3 : L_9 table and observed values [1] [

No of Trail	Control parameter(level)			Result/ Observe Value					
	Spindal Speed (rpm)	Feed rate (mm/rev)	Depth of cut (mm)	MRR (cm^2 / min) × 10^ -3			SR (Ra)		
				1	2	3	1	2	3
1	1000(1)	0.5(1)	0.5(1)	1.37	1.50	1.44	3.26	3.22	3.27
2	1000(1)	01(2)	01(2)	1.36	1.33	1.41	3.22	3.28	3.21
3	1000(1)	1.5(3)	1.5(3)	1.40	1.44	1.39	3.31	3.27	3.22
4	1500(2)	0.5(1)	0.5(1)	1.43	1.49	1.44	3.61	3.41	3.42
5	1500(2)	01(2)	01(2)	1.39	1.39	1.42	2.97	2.93	2.99
6	1500(2)	1.5(3)	1.5(3)	1.40	1.41	1.40	3.12	3.21	3.22
7	2000(3)	0.5(1)	0.5(1)	1.49	1.44	1.45	3.96	3.99	3.92
8	2000(3)	01(2)	01(2)	1.44	1.43	1.44	3.93	3.91	3.85
9	2000(3)	1.5(3)	1.5(3)	1.33	1.33	1.36	3.33	3.20	2.20

Table 4: Analysis of variance and F test for MMR

Parameter (z)	DOF (fz)	Sum of Square (Sz)	Variance (Vz)	F-ratio (Fz)	Percent
S	2	0.013	0.0065	65*	23.5
F	2	0.022	0.011	110**	39.3
D	2	0.020	0.010	100*	35.4
E	20		0.005		1.5855

** significant parameter, * Sub significance parameter

Table 5: : Analysis of variance and F test for MMR

Parameter (z)	DOF (fz)	Sum of Square(Sz)	Variance (Vz)	F-ratio (Fz)	Percent
S	2	1.414	0.707	366.67**	51.908
F	2	0.732	0.366	174.285*	26.628
D	2	0.510	0.255	121.428*	18.400
E	20	0.042	0.002		1.048

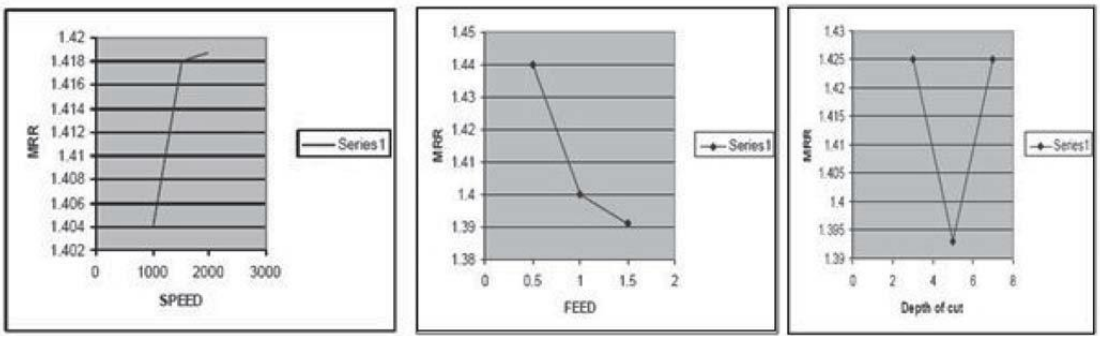

Figure 1. Effects of parameters on MRR [1]

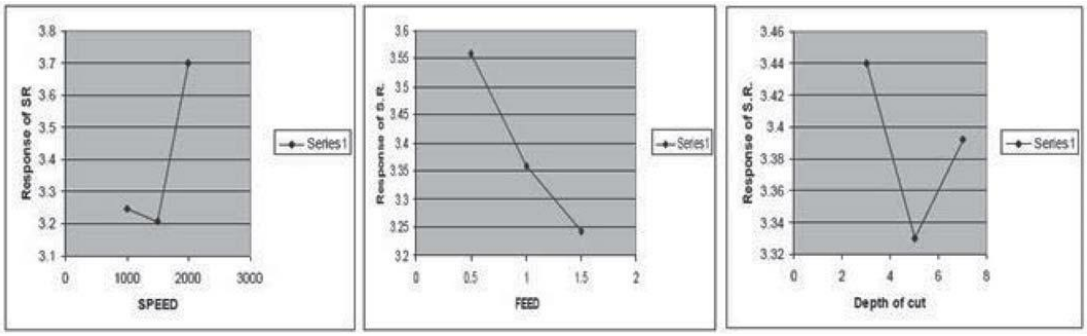

Figure 2. Effects of parameters on surface roughness [1]

6] FINDINGS FROM LITERATURE REVIEW:

The purpose of this study is to investigate the influence of cutting parameters, such as cutting speed and feed rate, and point angle on surface roughness produced when drilling Mild steel. design method, was performed drilling with cutting parameters in Mild steel (see Fig. 3). The orthogonal array, signal-to-noise ratio, and analysis of variance (ANOVA) were employed to investigate the optimal drilling parameters of Mild steel. From the analysis of means and ANOVA, the optimal combination levels and the significant drilling parameters on surface roughness were obtained. The optimization results showed that the combination of low cutting speed, low feed rate, and medium point angle is necessary to minimize surface roughness. The effect of parameters such as Cutting speed, feed rate and point angle and some of their interactions were evaluated using ANOVA analysis with the help of MINITAB 15 @ software. The purpose of the ANOVA was to identify the important parameters in prediction of Surface roughness. After the analysis of the results in ANOVA table no (4), cutting speed is found to be the most significant factor (F-value 366.67) & its contribution to Surface roughness is 51.908% followed by feed rate (F-value174.285) the factor that sub significantly affected the surface roughness which had contribution of 26.628% respectively.

After the analysis of the results in ANOVA table (5), cutting speed of material removal rate is found to be the most significant factor (F-value 110) & its contribution to MRR is 39.5% followed by feed rate (F-value 100) the factor that sub significantly affected the surface roughness which had contribution of 35.4 % respectively.

Figure 1 shows the main effect of MRR of each factor for various level condition it was increase in spindle speed then increase in the material removable rate and, the increase in the feed rate then decrease the decrease the MRR and

depth of cut increase beginning in machining process in decrease MRR and after some process increase Depth of cut and slightly increase MRR**.** According to predicted optimal parameter setting we have conducted the confirmation test and found MRR 1.46 cm3/min which shows the successful implementation of this approach.

Figure 2 shows the main effects of SR of each factor for various level conditions. According to predicted optimal parameters setting we have conducted the confirmation test and found surface roughness 2.12 (Ra) which shows the successful implementation of this approach in case of drilling machine optimization of mild steel work piece

7] CONCLUSION:

The following conclusions can be drawn from this analysis on drilling processes:

1. Taguchi method has been used to determine the main effects, significant factors and optimum machining conditions to obtain better performance characteristics.
2. Multiple performance characteristics such as tool life, cutting force, surface roughness and the overall productivity can be improved by using Taguchi method.
3. The optimum speed for a particular setup is affected by many factors, including Composition, hardness & thermal conductivity (k) of material, Depth of hole, efficiency of cutting fluid type, operating condition and stiffness of drilling machines, Stiffness of work piece, fixture and tooling (shorter is better), Quality of holes desired, life of tool before regrind or replacement.
4. Surface roughness is determined by several factors which include cutting parameters such as cutting speed, feed, depth of cut, Tool geometry, The material of the cutting tool, Machining condition etc.
5. This paper shows vast feasibility of machining mild Steel on drilling machine with HSS tool.
6. Signal to noise ratio has been used to determine optimum machining operating parameters to improve quality of drilling hole in mild steel.
7. The Spindle speed of drilling machine Tool mainly affects the Surface roughness.
8. Feed Rate largely affects the Material removal rate.

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A Review on Management of Banana Processing for Effective Utilization

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ABSTRACT: Fruits are excellent food supplements; their agricultural production is specific to meteorological conditions and soil type. Fruit processing is a boon of science and technology with multiple benefits. Recent fruit preservation technique has made it possible to transport the fruit overseas in the form of by-products. It has made banana by-products available in all season. Apart from this banana processing is a potential source of employment generation. For developing countries like India fruit processing has bright prospects. Banana is major fruit of India having world`s largest production. However only around 2% of banana produced is processed. It is observed from the review that there is a tremendous scope for enhancing its processing. In fact Banana processing can play vital role in Indian economy. As banana is perishable in nature and it must be utilized at the earliest. The present paper highlights major products of banana processing and global marketing potentials.

Key words: Banana, Fruit processing, Economy

INTRODUCTION

In modern days food preservation has become of a science based on latest developments in science and technology and food processing is a growing industry in many countries including India.

Fruits and vegetables are important supplements to the human diet as they provide the essential minerals and vitamins and fiber required for maintaining health. India ranks first in production of fruits and second in production of vegetable in the world. However, this abundance of production is not fully utilized and about 25-30% of wastages occur at various stages of fruit handling and distribution (Patil et al 2009). India produced about 62.86 million tons of fruits and 122.25 million tons of vegetables in 2006-07 (UNCTAD 2010; Narayana et al 2007).

Though India is the largest producer of fruits and vegetables in the world, only less then 2% of the total production is processed. In other countries the percentage of processed fruits are very high. Thailand processes (30%), Brazil and USA (70%). Philippines (78%) and Malaysia (83) (www.ikisan.com).

There is a tremendous scope for export of processed value added products of fruits and vegetables. During 2006-07, around 797481.55 MTS various processed fruits and vegetables valued at Rs. 2502 crores were exported from India (Babhulkar N N 2009). The prime position of India in the production of fruits and vegetables provides us an unlimited potential to capture the vast export market of the world in the processed fruits and vegetables. The enormous Indian population also constitutes the potential consumers of processed foods (Roy et al 2000). With increasing urbanization, rise is middle class purchasing power, change in food habits and dying out of the practice of making preserves and pickles in homes, there is an increasing demand for factory made jams, jellies, fruit beverages, dehydrated foods, pickles etc. in the domestic market.

Therefore, it is needless to say that food processing sector in general and fruit processing industry in particular is still a sunrise area which holds tremendous potential both for revenue generation and for employment opportunity (Tripahti et al 2000).

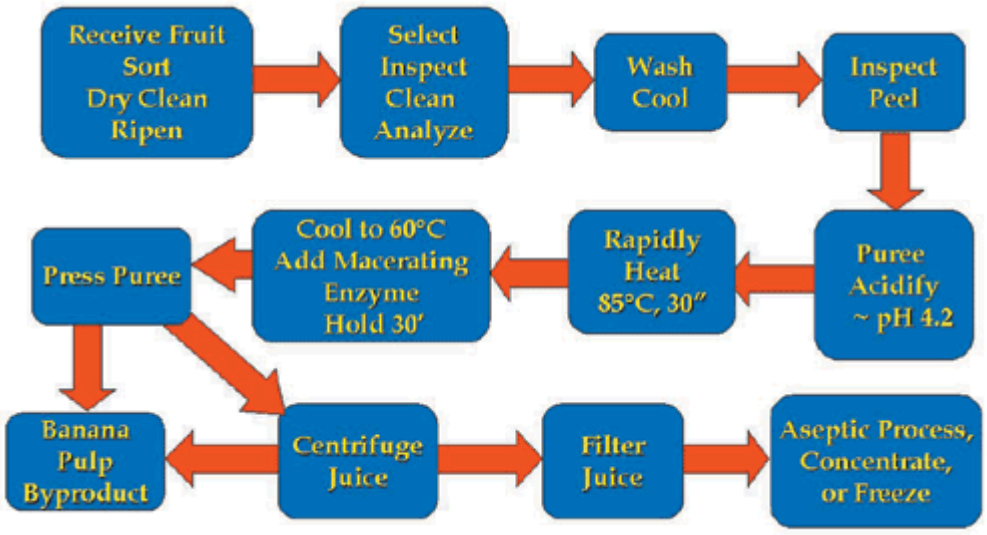

Figure:1 General Layout for banana processing in Industry

India is the largest producer of banana in the world with a production of approximately 20.86 million tons from an area of 6.00 lakh hectares (www.ikisan.com). Out of this amount only 3-4% of banana is processed. The most popular processed product is Nendran chips, which is still in cottage scale while some bigger manufactures are processed banana puree for export. However, there is scope for converting banana into several other processed products like figs, jam, jelly, powder, Flour, baby food, health drink, RTS beverages, wine, alcohol, sauce, pickles, chutneys, animal feed, fiber etc. several processing technologies for value added banana products have been developed at National Research Center for Banana, Trichy. Some of the common banana products are discussed below (Rethinam 2008):

Properties of Banana:-

- Banana is the fruit of a palm tree that comes from southest Asia
- Nutritious fruit which provides energy of its carbohydrates
- Rich in potassium, suitable for athletes and stress.
- Digestive food, recommended for the stomach
- Suitable for digestive ulcers and gastritis

Products of Banana:- Major products developed from banana processing are given below/

1. Chips/Crisps:

Nendran fruits of approximately 80% maturity are harvested and demanded. The fingers are peeled, treated with 0.1% potassium metabisulphite and cut into slices of 1.2-0.8 mm thickness and deep fried in suitable cooking oil, preferably coconut oil. Upon frying this will yield crisp, yellow coloured chips, which are sprinkled with common salt and packed in polyethylene bags.

Figure 2:- Banana Chips

Generally they have a storage life of 30-35 days under ambient conditions. Packing the chips in laminates with nitrogen gas can extend its life up to 4 months. Several other verities of banana chips like flavored, sweet, sweet and sour, tomato flavored, with pepper, etc. are also catching up in the market.

2. Banana Fruit Candy/Stem Candy:

Banana fruit candy made from nendran with jaggery and ginger are widely sold in market in Kerala state. Banana stem (true stem) can also be made into candy through osmotic dehydration process followed by sun drying.

3. Banana Fig:

Banana figs are dried or dehydrated banana fruits with sticky consistency and very sweet taste. Fully ripe banana fruits of variety 'Karpuravalli' or 'Dwarf Cavendish' are peeled, treated with 0.1% potassium metabisulphite solution and dried either in sun or oven at 50^{o}C. These figs are packed in polyethylene bags or any other suitable containers. They have a shelf life of about 3-4 months under ambient conditions.

Figure 3:- Banana Fig

4. Banana Flour:

Banana flour is prepared from mature green bananas, which have a high starch content. It can be used as nutritious adjuvant in several food preparations like bread, cakes, biscuits, health drink and baby food formulations.

Figure 4:- Banana flour

It can also be blended with other cereal flours for making chapaties and roties. It has some medicinal property to cure ulcers. Under cool and dry conditions it can be stored up to one year without any adverse change in their composition.

5. Banana Powder:

Banana powder is prepared from fully ripe banana fruits either through drum drying or spray drying process. The moisture content of final product should be around 2-4%. This product has got high market value as it is extensively used in confectionary industry, ice cream preparations and baby food making. When suitably packed banana power will have shelf life of more than 6 months.

Figure 5:- Banana powder

6. Banana RTS juice:

Since banana puree is very thick, juice cannot be directly obtained from it. Therefore, the puree is treated with pectolytic enzyme and clear juice is obtained through filtration or centrifugation. After pasteurization and bottling it can have a shelf life of a minimum of 6 months under ambient conditions.

7. Banana Fruit Bar:

Banana Fruit Bar is confectionary item prepared from ripe banana fruit of any variety. It is made by homogenizing banana pulp, sugar, citric acid and pectin in suitable proportions and dehydrating the mass in a ghee coated ray at 70^{o} C in an oven till sets into a sheet. It is then cut into suitable size and packed in polyethylene pouches.

Figure 6:- Banana Fruit Bar

8. Banana Biscuits:

Banana biscuits are made by mixing 60% banana flour and 30% maida. The dough is made using flour mixture and suitable proportions of sugar, saturated fat, baking powder, milk powder and essence. These biscuits are very tasty and highly nutritious.

Figure 7:- Banana biscuits

Figure 9:- Banana wine

9. Banana Jam & Jelly:

Banana jam is made by cooking the fruit pulp with sugar along with pectin and citric acid in right proportions till gives a good set. Several varieties of banana are suitable for making jam. This is product, which has good commercial value and good market.

Figure 8:- Banana Jam

Banana jelly is a semi solid product prepared by boiling clear strained fruit extract free from pulp after addition of required amount of sugar, citric acid and pectin. A perfect jelly should be transparent, attractive and sparkling in colour with strong flavour of fruit.

10. Banana Wine:

Banana wine is produced by fermenting the enzyme treated clear banana juice with wine yeast viz . Saccharomyces cerevisae var. ellipaoiswua. The fermentation is carried out for about 3 weeks followed by filtration, clarification, and bottling. The pasteurized wine is stored in bottles for aging. The alcohol content of banana varies from 9-12%.

11. Health drinks and Baby food:

A highly nutritious and tasty health drink formulations and baby food formula has been developed by NRCB using banana flour/powder after supplementing with suitable natural source of proteins ,minerals ,vitamins and fat . it has got a shelf life of about 6 months and suitable is for children and adults.

12. Banana fiber:

Banana fiber is extracted from the pseoudostem, peduncles and dried petioles and of banana plant.

Figure 10:- Banana fiber

The banana fibre can be used for manufacture special kind of papers, ropes, threads, baskets, toys and several fancy items. The yarn made form banana fiber is much in demand for making textiles.

CONCLUSIONS

It is quite obvious from the review that there is a vast scope for value addition and processing of banana if properly planned, since it is perishable. The post globalization world economy is giving more weightage on processing and value addition. Banana processing industry can play a vital role in

the economic uplifting of the country specially the agricultural section. In fact this is going to be the second phase of green revolution and new employment generation.

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A Review on Techniques of Ethanol Production from Damaged Sorghum and Corn Grains

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Abstract : Ethanol production from starchy raw materials specifically damaged corn and sorghum grains by direct bioconversion are potential source for non-edible option. Ethanol production from damaged corn and sorghum starch requires the use of amylase and amyloglucosidase for the pre-treatment starch before fermentation. Preparation of damaged corn and sorghum grains for ethanol production is concentrated by study of separation for damaged grains to removing waste part and constituents reducing bio-ethanol conversion. This paper reveals the fermentation process for ethanol production from damaged corn and sorghum grains, for early detection of poor fermentation performance. Owing to rapid depletion of fossil fuel reserves, alternative energy sources that are renewable, sustainable, efficient, cheaper and eco-friendly options this work would be helpful in improvement of ethanol production. It is observed that Process of Ethanol production from damaged Sorghum and Corn grains is having vast potential and it would be very useful source of renewable energy.

Keywords: ***Kinetic parameter, mathematical model, Ethanol, Fermentation, pre-treatment***

1. Introduction

Owing to global environmental problems associated with fossil energy, concern of fuel sustainability is growing which results in rapid increase ethanol production. Use of Maize as biofuels is not socially feasible because it is major source of caloric intake. Agricultural wastes and Insect, fungi and sprout-damaged kernels which are not fit for human consumption or industrial processing are still other options to produce biofuels. Some qualitative and quantitative losses are occurring in the postharvest system of cereals. Overall postharvest losses in maize are mainly during drying in the field and storage, and can predominantly be attributed to biotic factors such as insects, molds, rodents and sprouting. According to FAO (1993), the range of worldwide postharvest losses is between 10 and 37%.

Insects are the most important biotic factor related to postharvest losses. In addition to insect damage, fungal infections are also a major postharvest problem causing unwanted effects such as discoloration, off-odors, loss of germination capacity and contamination with harmful mycotoxins. In tropical areas, field and storage sprouting also causes direct and indirect losses due to the activation of degrading intrinsic enzymes that break down proteins, carbohydrates and lipids into simpler forms. The use of insect, fungi and sprout-damaged grain for human consumption is not always possible and its utilization in other industrial processes could reduce, at least to some extent, the producer losses.

Types of grain damages:-

A) Broken/Cracked Kernels

A broken or cracked kernel is a one of the most common form of grain damage. This type of damage occurs during handling process and moving grain anytime from one place to another. During further handling, deterioration of the grain more quickly through accelerated insect and fungal infestation and a faster propensity to breaking because of cracks in kernel. The increase in mechanical damage decreases the allowable of storage time.

(a) Broken/Cracked Kernels (b) Fungal and Insect Infestation (c) Heat Damage

Figure No 1:- Corn and Sorghum grain damages types. [2]

Stress cracks can form within the kernel, in addition to exterior cracks. Combination of thermal and mechanical handling processes like drying usually causes the stress cracks in the grain. Kernels can break more rapidly during further handling because of internal stress cracks which have greater breakage vulnerability. Percentage losses also turn into large quantities of useless grains by contaminating them with their droppings, webs and odors apart from damage due to insect pests. Quantitative as well as qualitative losses in grains take place significantly during storage [3].

B) Fungal and Insect Infestation

Dry matter losses may be because of Fungal and insect infestations make the grain less valuable. Grain damage as well as loss the actual weight of the grain result due to grain Insect infestations.
An insect infestation is able to reduce the chemical or nutritional value of the grain which is very important for the end use. Moisture, mechanical damage, storage temperature, and other factors can be trigger mold growth. Weight or quality losses because of insect during storage are not accurately measured though it is estimated around 35% of total production [2].

C) **Heat Damage**

Heat damage mostly arises from drying of grain. USDA recognized heat damage as new type of damage though it is a sub type of damage including broken or cracked kernels. Heat damaged kernels may have seed coats which are peeling off or have a discolored, wrinkled, and blistered, be puffed and/or swollen. It is undesirable effects due to elevated temperatures used to eliminate moisture by drying process. Breakage/cracks, discoloration, and shrinkage are the most common signs of heat damage. Interior and exterior stress cracks on the kernels are caused because of temperature and moisture gradients in the grain during the drying process. Grain qualities problems arise due to cracks are listed in the two earlier grain damage types. Brown et al. explained that for multiple types of drying, the percentage of stress-cracked kernels increases as moisture content increases [2].

Ethanol Production from Damaged Sorghum and Corn Grains:-

Ethanol production from damaged corn and sorghum grain is obtained by separation method for removal of damaged portion. Mechanical damaged corn and sorghum grains can be directly separated by using filters. Mechanically damaged food grains are prone for other damages because of breakage of protective grain shield. Sprouted damaged food grains can be processed to produce ethanol during early stage. Damaged portion can be removed by washing using water and then drying for further processing.

The ethanol production from damaged sorghum and corn grains mainly includes the following steps
1) Sample Preparation:-
In this process the damaged part from the grain is removed from it and it is used for further process.

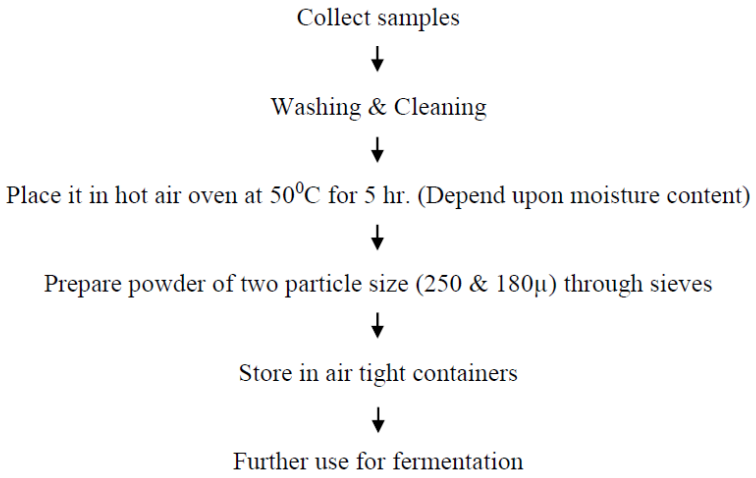

Figure No: - 2 Sample Preparation [3]

2) Simultaneous Saccharification and Fermentation (SSF)

The prepared sample from damaged grain is further used for Simultaneous Saccharification and Fermentation (SSF) to extract alcohol from it.

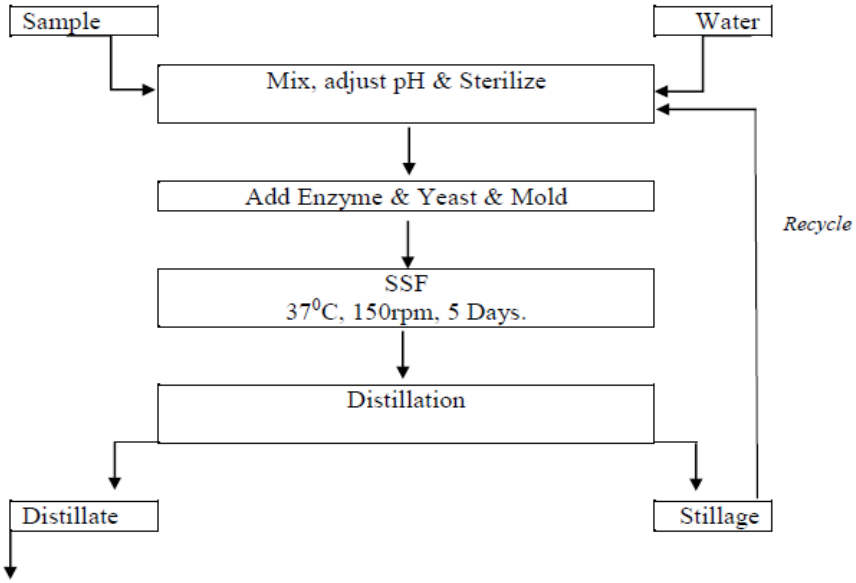

Figure No: - 3 Simultaneous Saccharification and Fermentation (SSF)

Grain damaged by sprouting may not affect ethanol production and final ethanol yield negatively but may lose value for food applications. Ethanol yield from field-sprouted corn and sorghum grain is slightly higher than that from the non-sprouted control grain. High ethanol yield indicates the positive effect of cell-wall-degrading intrinsic enzymes generated during sprouting. The fermentation process for sprouted grain could be much shorter than that required for normal grain.

Table No. 2 Ethanol yield from damaged corn and sorghum grain [4]

Samples		Type of Damaged Grain	Ethanol Yield (L/ton starch)
Corn	Controlled Damaged	Mold Damaged Grain	479.40 $\pm$ 23.71
		Insect Damaged Grain	470.47 $\pm$ 10.10
		Sprouted Damaged Grain	550.48 $\pm$ 6.59
Sorghum	Controlled Damaged	Mold Damaged Grain	505.95 $\pm$ 41.10
		Insect Damaged Grain	486.67 $\pm$ 7.91
		Sprouted Damaged Grain	555.78 $\pm$ 50.55

In all treatments, an increase of Fungal infected is observed because of the reduction of density due to endosperm damage or starch consumption or degradation. Insect damage and sprouting is more detrimental in corn compared to sorghum. After 72 h fermentation, all the glucose was metabolized by the fermenting yeast. This indicates a complete and high efficient fermentation and the effectiveness of the liquefaction step that rendered dextrins highly susceptible to amyloglucosidase and pullulanase. Therefore, the presence of S. zeamais and intrinsic enzymes did not affect yeast and a-amylase or amyloglucosidase/ pullulanase activities. For insect damaged kernels, a reduction in yield is indeed observed. These findings are crucial in geographic regions where S. zeamais is the principal infesting agent and indicates the robustness of sorghum against this particular insect. The negative impact of the use of insect or mold-damaged kernels is mainly due to dry matter losses incurred during storage and stresses the importance of first-rate storage practices. However, this study clearly demonstrates the use of already damaged kernels is possible. These kernels can be acquired at a discount price by biorefineries and subsequently converted into bioethanol with similar efficiencies.

Salient findings from review:

Findings from scholars work for the use of damaged food grains is summarized here in brief. Main causes of grain damages are mechanical damages during harvesting and handling grain size reduces due to breakage. Moisture content and due to insecticides deterioration of grain occurs heavily. Measurements of grain quality for determination of grain damage are also briefly discussed in this paper. After identification of sorghum and corn grain in damaged condition, that is these grains are not usable as food or feed. The next best option for its utilization is as fuel energy production [2].

Owing to rapid depletion of fossil fuel reserves, alternative energy sources need to be renewable, sustainable, efficient, cheaper and eco-friendly. A worldwide interest in the utilization of bio-ethanol as the future transportation fuel has stimulated studies on the cost and efficiency of industrial process for ethanol production. Keeping this in view, improvements in the ethanol fermentation have been focused. Generally, economic restrictions force industrial processes to work in a very small range of operating conditions. For some batch processes which have long operating times in each cycle and depend strongly on the operating variables. It is very important to define the optimum conditions to achieve sufficient profitability. From the review of literature it is observed that kinetic models describing the behavior of microbiological systems are very useful tool and it would reduce testing for elimination of possibilities. Mathematical models are effective tool for analyzing biological process and microbial growth phenomenon. The studied model shows more insight into the environmental conditions that is surrounding bio-process and can be used for further development and optimization of bio-processes. This paper reviews the various process options and kinetic models adopted towards resolving the technological challenges to develop a low-cost commercial process [16].

Bioethanol produced from renewable biomass, such as sugar, starch, or lignocellulosic materials. Bioethanol is one of the alternative energy resources; this is both renewable and environmentally friendly. Although, the priority in global future ethanol production is put on lignocellulosic processing, which is considered as one of the most promising second-generation bio-fuel technologies, cereal grains for fuel ethanol is still underutilized. Sugar-based that is molasses, sugar cane, sugar beet and starch-based that is corn, wheat, triticale, potato, rice, etc., feed stocks are still currently predominant at the industrial level. They are, so far, economically favourable compared to lignocelluloses. Currently, approximately 80 % of total world ethanol production is obtained from the fermentation of simple sugars by yeast. In this paper, a review of the state of the art in bio ethanol production and availability is discussed. Pointing out the progress possibilities on starch-based production are discussed, in the respect of feedstock choice, pre-treatment, optimization of fermentation and process integration. It is observed that utilization of cereal grains for bioethanol production is the best option after food application [3].

The result of this study shows that simultaneous saccharification and fermentation of damaged sorghum grain as a substrate is feasible. The starch content in damaged grains is inferior when compared with fresh sorghum grains. But as these damaged grains are cheaper than fresh grains further production of ethanol is possible by using damaged sorghum grains at low cost. It equally revealed the fact that optimization of culture condition could enhance ethanol production from damaged grains using co-culture technique, thereby increasing the economy. It also showed that increasing temperature, pH, and agitation rate increases ethanol yield up to a certain level. But further increase in these parameters beyond certain level neither increase ethanol yield nor cell dry weight [15].

Conclusion

Damaged corn and sorghum grains has immense potential source for non-edible option due to removal waste part as well as constituents reducing bio-ethanol conversion from it. Use of techniques available for separation of damaged portion would further enhanced ethanol production yield from corn and sorghum starch. Complete process optimization from damaged corn and sorghum grains is possible by the study of each step involve during conversion from damaged grains to ethanol. So, more stress is given on study of bifurcation useful and nonproductive material in this work which is not specifically focused earlier.

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A Review on Utilization of Chitosan Nano-composite for Bio-medical Application

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ABSTRACT: The research and development in recent polymer nano-composites materials utilization has significantly impacted its bio-medical application. Particularly, polymers that are biodegradable gives considerable benefit of being capable to be busted down and removed after it has served the function. Degradable polymers have broad range of clinical applications such as surgical sutures and implants. It is observed from the review of literature materials with desired biological, physical, chemical, degradation properties and biomechanical should be selected to fulfill the functional demand. To fulfill new challenges in biomedical applications with new materials, a large range of natural and synthetic degradable polymers have been continuously searched by scholars. In this paper the use of Chitosan Nano-composite for bio-medical application such as drug delivery, tissue regeneration, and wound healing is discussed. The biomedical activity of chitin and chitosan compounds is affected by their physicochemical nature which is robustly linked to conditions of chitin and chitosan production process as its source.

INTRODUCTION

Any natural or artificial substance engineered to interact with biological systems in order to direct medical treatment is known as biomaterial. Biomaterials should be biocompatible which means they carry out their role with a suitable host reaction. Materials composed of everything from metals and ceramics to glasses and polymers have been researched to meet the requirements of the biomedical community. Polymers acquire considerable potential because of flexibility in chemistry gives rise to materials with large physical and mechanical property diversity. Degradable polymers are of greatest interest as these biomaterials are able to be busted down and excreted or resorbed without removal or surgical revision. [1]

After cellulose, Chitin is one of the most abundant polysaccharide. Chitin and chitosan are an significant family of linear polysaccharides consisting of changeable amounts of β-(1→4)-linked 2-acetamido-2-deoxy- β -D-glucopyranose (GlcNAc) and 2- amino-2-deoxy- β -D-glucopyranose (GlcN) units. Chitin samples are insoluble in water and common organic solvents because they contain a high content of GlcNAc units. On the other hand, they dissolve only in solvents such as N, N-dimethylacetamide, hexafluoroacetone or hexafluoro-2-propanol. The term “chitosan” represents a group of fully and partially deacetylated chitins; however a rigid nomenclature with respect to the degree of Ndeacetylation between chitin and chitosan has not been established. Chitin and chitosan must be classified on the basis of their insolubility and solubility in 0.1 M acetic acid in which the insoluble material is called chitin, whereas the soluble one is Chitosan. Figure 1 shows the structures of ideal chitosan, ideal chitin, and the real structures of these compounds [2].

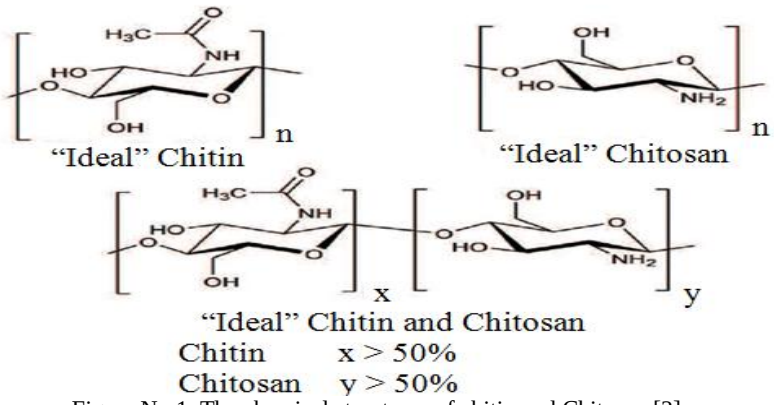

Figure No 1. The chemical structures of chitin and Chitosan [2]

Owing to versatile biological activities of Chitin and Chitosan such as biocompatibility, biodegradability, non-toxicity and adsorptive abilities and chemical applications, mainly in the medical and pharmaceutical fields, they have immense economic value. The biological properties of these compounds depend closely on their physicochemical parameters, particularly their solubility in water and other generally used solvents. Chitin has far fewer applications though they are highly insoluble and chemically somewhat unreactive material than compared to Chitosan. For increasing their range of biomedical applications, Solubility chitin and Chitosan in water and organic solvents can be improved by chemically modifying free hydroxyl and the primary amino groups of them. Chitin or chitosan based materials with different structures demonstrate dissimilar biological activities, and not all the biological activities were found in one kind of chitin or Chitosan material. Therefore for an understanding of the structure–property–activity relationships and special emphasis in this respect should be placed on the chitosans and chitin used in biomedical applications, Knowledge of the microstructure of chitosan and chitin samples is essential. Chitin and chitosan possess very interesting biological properties (Figure 2); thus, they have been used in lots of applications, mainly in the medical and pharmaceutical fields [3]

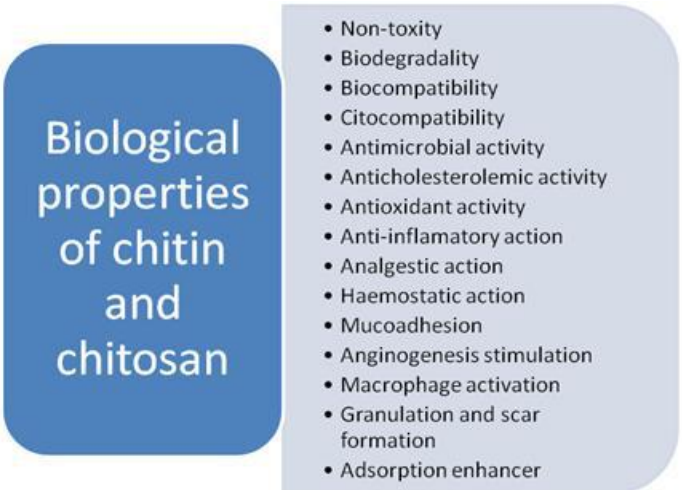

Figure No 2.Biological properties of chitin and chitosan [3]

Salient finding from review:

Ulery et al. [1] summarizes the modern advances in the field over the past 4 years, specially highlighting new and interesting discoveries in drug delivery applications and tissue engineering. A wide range of degradable polymers that hold potential as biomaterials are currently exists. With advancements in polymer synthesis techniques, the paradigm of utilizing a few well characterized polymers (e.g. PLGA and collagen) for all biomedical applications has shifted to using polymers, both heavily researched and newly developed, that can fit certain niches (e.g. DNA and RNA association with phosphoesters and

inherent bioactivity of chitosan). The field of degradable polymeric biomaterials will only continue to progress if the recent creation of strong collaboration teams composed of chemists, biologists, material scientists, engineers and clinicians is encouraged. Kumirska et al. [2] concluded that Chitin and chitosan are natural aminopolysaccharides with unique structures, multidimensional properties, highly sophisticated functions and wide ranging applications, especially in the biomedical and pharmaceutical fields. The chemical modification of these polymers improves their solubility in water or organic solvents, which in turn enhances their biological activities and raises the number of potential biomedical applications.

Kumirska et al. [3] concluded that (1) Chemical methods of modification can generate completely new chitin/chitosan-based biofunctional materials. (2) The biological properties of chitin/chitosan materials used directly in biomedical applications (e.g., antimicrobial effects) could be different that observed for materials obtained after preparation of nanoparticles, microspheres, hydrogels, films, fibers or tablets, (3) Chitin/chitosan properties are interrelated and many times they could influence the bioactivity in a conflicting manner. Sonia et al. [4] comprehensively integrate the recent applications of chitosan nano/microparticles in oral and/or buccal delivery, stomach-specific drug delivery, intestinal delivery, colon-specific drug delivery, and gene delivery, giving special emphasis to oral drug delivery. Honarkar et al. [5] explained that Chitosan and its derivatives are suitable for tissue engineering applications. Various type of chitosan derivatives have been used in skin, bone cartilage, liver, nerve, and blood vessels. This material is also a good candidate for use as a carrier of drugs for controlled release and other pharmaceutical applications. This polysaccharide has shown high potential for absorption of dyes, metal ions, and proteins. So, it might also be a good candidate for removing pollutants from water and wastewater.

Dash et al. [6] summarized the chemical structure and relevant biological properties of chitosan for regenerative medicine. Also the methods for the preparation of controlled drug release devices and their applications. Aiman Omar Mahmoud Abbas [7] researched on modifying and optimizing chitosan for applications in gene delivery, enzyme immobilization and tissue engineering Chen et al. [8] focuses on the versatile modifications of chitosan matrices (ionic or chemical crosslinking) and the most modern research activities in drug-eluting devices, including vascular stents, artificial skin, bone grafts, and nerve guidance conduits. Yuan et al. [9] studied the potential application of this hybrid nanocomposite carrier in biomedical applications, including tissue engineering and controlled drug delivery Anitha et al. [10] focuses on the diverse applications of CT and CS membranes and scaffolds for drug delivery, tissue engineering and targeted regenerative medicine.

Cai et al. [11] investigated the morphological and compositional properties of composites. As well as studied the interaction between the organic matrix and the inorganic crystallite and the formation mechanism of the rod-like nanoparticles. Hule et al. [12] discusses current efforts and key research challenges in the development of these materials for use in potential biomedical applications. Jayakumar et al. [13] emphasized recent research on different aspects of chitin and chitosan based nanomaterials, including the preparation and applications of chitin and chitosan based nanofibers, nanoparticles and nanocomposite scaffolds for tissue engineering, wound dressing, drug delivery and cancer diagnosis. Jayakumar et al. [14] reviewed the recent reports on the preparation, properties and biomedical applications of chitin and chitosan based nanofibers in detail Jayakumar et al. [15] took a closer look on the wound dressing applications of biomaterials based on chitin, chitosan and their derivatives in various forms in detail

Khor et al. [16] surveyed to demonstrate the utility of chitin and chitosan as potential materials for various implant applications and some of the challenges in demonstrating biocompatibility as well as sterility that must be addressed. The eventual realization of real implants awaits the take-up of these materials on a more commercial basis that would see the introduction of chitin-based implantable devices. Venkatesan et al. [17] discussed the preparation, mechanical properties, chemical interactions and in vitro activity of chitosan composites for bone tissue engineering.
Peter et al. [18] prepared Nanocomposite scaffolds using nBGC disseminated chitosan matrix by lyophilization technique. The prepared composite scaffolds were characterized using FT-IR, SEM, XRD and EDS studies. In addition, swelling, density, degradation, bioactivity, cytotoxicity and cell attachment studies of the composite scaffolds were also performed.

Singh et al. [19] successfully synthesized monodispersed α-Fe2O3 nanoparticles through a simple hydrothermal method and dispersed it in chitosan (CH) solution using glycolic acid as organic surfactant to fabricate nanocomposite film.

The methods and magnetic nanoparticles described in the paper have provided a novel approach for the preparation of CH based nanocomposite films which may be applied to the magnetic field assisted drug delivery systems, cell/enzyme immobilization, biosensors, magnetic resonance imaging (MRI), tissue engineering and many other industrial processes. Shelma et al. [20] suggested that the tensile strength of the chitosan films can be increased up to a significant level by incorporating chitin nanofibres without appreciable change in water vapor permeability. However, the percentage swelling of the composite chitosan films decreased with increase in chitin whisker content. Tamura et al. [21] presented the preparation and biomedical applications of novel chitin membranes and scaffolds prepared from chitin hydrogel.

Bio-Medical applications of Chitosan Nano-composite:-

Owing to its unique physicochemical properties, chitosan has great potential in a range of biomedical applications, including drug delivery, tissue regeneration, wound healing, blood coagulation, and immune-stimulation.

1. Drug Delivery Perspective: Biopolymers are capable materials in the delivery of protein drugs due to their compatibility, degradation behavior, and nontoxic nature on administration. On appropriate chemical modification, these polymers can provide better materials for drug delivery systems. Owing to favorable biological properties, Chitosan is extensively used for dental, colon-specific, buccal, gastrointestinal, and gene delivery applications. It is used in the form of tablets, gels etc. Figure 3 shows the different types of chitosan-based drug delivery systems [4]

In recent years, significant effort has been devoted to the development of biodegradable materials for drug delivery systems. Among the various biodegradable polymers used for the progress of controlled-release formulations, chitosan has been reported to be advantageous since it is a natural, nontoxic, biocompatible product with the potential for biodegradability. A type of amphiphilic derivatives of chitosan has been synthesized by incorporating (2-hydroxypropyl-3-butoxy) propyl into succinyl–Chitosan. The N-chitosan-derivative-based ophthalmic drug delivery systems can be easily and capably used for patients. Self-aggregated nanoparticles from methoxypoly(ethylene glycol)-grafted chitosan (mPEG-g-Ch) have been synthesized by a formaldehyde linking method. These nanoparticles were chosen as a transporter for badly water soluble methotrexate (MTx), an anticancer drug. MTx is a folate antimetabolite and has been used in the treatment of various malignancies. However, it may cause adverse effects such as bone marrow suppression, interstitial pneumonitis, chronic hepatotoxicity, acute, and chronic interstitial obstructive pulmonary disease. So, it is essential to decrease its toxicity and side-effects. Therefore, mPEG-g-Ch self-aggregated nanoparticles have been used as a transporter for MTx to sustain its release, prolong its circulation time, increase its therapeutic index, and reduce its toxic effects. The obtained outcome show continuous release of more than 50% MTx in 48 h from MPEG-g-Ch.

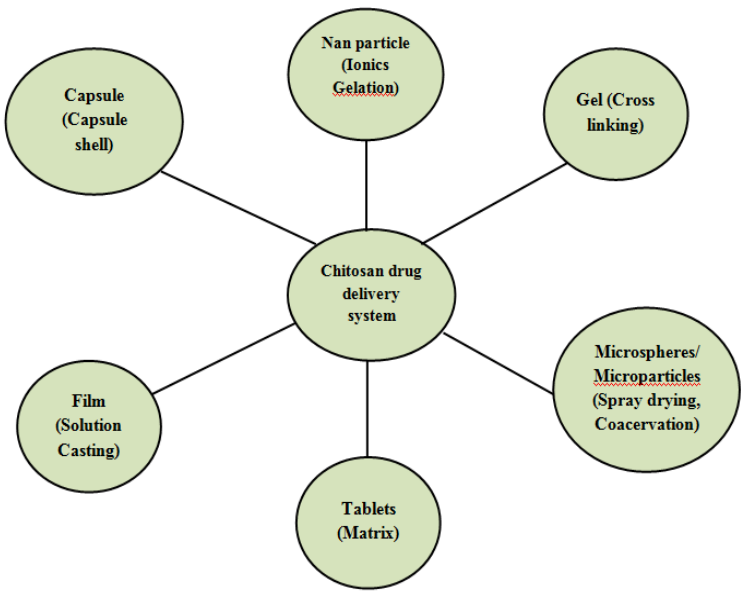

Figure No 3: - Different types of chitosan-based drug delivery systems [4]

In a new study, dry powders were prepared by spraydrying of aqueous ethanol solution of chitosan (drug release modifier), leucine (aerosolization enhancer), and terbutaline sulfate (model drug). A new combination coating material of HPMC and ChA has potential for use in colonic drug delivery. The system is enzyme controlled due to the degradation of ChA by the colonic enzyme. Also, Chitosan acetate may interact with the acidic drug but has no effect on the drug release in this system. Preparation of enteric-coated chitosan-prednisolone conjugate microspheres (Ch-SP-MS) and in vitro evaluation of their potential as a colonic delivery system have been studied. Sonication was utilized to prepare finer Ch-SP-MS and the addition ratio of eudragit was reduced to obtain eudragit-coated Ch-SP-MS with higher drug content. The eudragit coating can protect Ch-SP-MS morphology at gastric pH of 1.2 and allow almost complete regeneration of Ch-SP-MS at intestinal pH of 6.8 a few hours after exposure at this pH. Drug release is also suppressed at gastric pH and raised at intestinal pH. Recently, water-soluble N-(c-bromopropanoyl amino acid)–chitosan derivatives have been synthesized.

Nanocomposite films from chitosan/organic rectorite (chitosan/OREC) have been synthesized by a casting solvent- evaporation method Addition of OREC to pure chitosan film enhances many of the properties related to the amount and interlayer distance of the layered silicate in the chitosan/OREC. In vitro drug controlled-release studies show a slower and more continuous release for the nanocomposite films in comparison with pure chitosan film, and the drug delivery cumulative release is proportional to the amount and interlayer distance of OREC. [5]

2. Tissue Engineering; There is also a special place for chitin or chitosan in the field of tissue engineering. The mechanical properties of chitosan membranes deteriorated when the molecular weight of chitosan increased, whereas it is precisely the high molecular weight of chitosan that gives the chitosan scaffold its better mechanical strength. The reduced proliferation of human skin fibroblast cells on a collagen/chitosan scaffold with increasing chitosan molecular weight was observed, while the MW of chitin and chitosan samples had no appreciable influence on the proliferation of tissue fibroblasts or on keratinocytes [2].

Chitosan scaffolds are promising materials for the design of tissue engineered systems owing to their low immunogenic activity, controlled biodegradability and porous structure. The influence of DA on the structural and biological properties of chitosan scaffolds for cell culture and tissue engineering was studied. The mechanical strength of chitosan was better with lower DA and that chitosan with lower DA favored cell adhesion. Also observed that chitosan scaffolds with DA (15-25%) displayed a more regular structure in comparison to scaffolds with very low DA (<15%). Moreover, the lateral pore connectivity was much lower for chitosans DA 15-25% than for scaffolds with DA <15%. Both observations were very important, because it is very well known that the microstructure of the matrix has an important influence on cell intrusion, proliferation and functioning in tissue engineering. Freier et al. prepared and characterized chitin and chitosan tubes for nerve regeneration. The compressive strength of these tubes was found to increase with decreasing of DA [2].

3. Wound-healing applications: An ideal dressing should protect the wound from bacterial infection as well as promote healing in wound-healing. Chitosan-based materials which are produced in varying formulations have been used in a number of wound healing applications. Chitosan induces wound-healing on its own and produces fewer scarring. It seems to enhance vascularization and the supply of chito-oligomers at the lesion site, which have been implicated in better collagen fibril incorporation into the extracellular matrix. While different material dressings have been used to improve endothelial cell proliferation, the delivery of growth factors involved in the wound-healing process can enhance that process. In addition to the reparative nature of the chitosan hydrogels, they can also deliver a therapeutic payload to the local wound, for example, fibroblast growth factor-2 (FGF-2) which stimulates angiogenesis by activating capillary endothelial cells and fibroblasts. To sustain FGF-2 residence at the wound site, FGF-2 was incorporated into a high molecular weight chitosan hydrogel, formed by UV-initiated cross linking. A chitosan hydrogel scaffold impregnated with-FGF loaded microspheres were developed by Park et al. that accelerates wound closure in the treatment of chronic ulcers. Films of chitosan, in combination were found to promote accelerated healing of incisional wounds in a rat model. The wounds closed within 14 days and mature epidermal architecture observed histological with keratinized surface of normal thickness and a subsided inflammation in the dermis. [6]

CONCLUSION: In this exhaustive review it is found that vast scope exists in application of Chitosan nano-composite in biomedical field. Biomedical applications such as drug delivery, tissue engineering, and wound healing are

discussed in this paper. Chitosan is used as a biomaterial for its biodegradability and biocompatibility properties. Chitosan has an immense potential in variety of biomedical applications. Chitosan's physicochemical and mechanical properties are utilized in fabricating particles and films it can be modulated for specific purposes. The chemical modification of chitosan polymers improves their solubility in water or organic solvents, which in turn enhances their biological activities and increases number of potential biomedical applications. Chitin and chitosan has an intrinsic structural and physicochemical variability due to its natural origin and manufacturing process. Furthermore, the poor physicochemical characterization of the chitin and chitosan-based products used in biomedical experiments makes it very difficult to compare results and set up relationships between the physiological behavior of these compounds and its properties.

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