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Chemical Engineering

Effect of Aspect Ratio

Presence of Electrostatic Force

Highlights

Bleaching of Vegetable Oil

Hybrid Model and Optimization

Discovering Thoughts, Inventing Future

VOLUME 15 ISSUE 2 VERSION 1.0

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Chemical Engineering

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Bleaching of Vegetable Oil using Organic Acid Activated Fuller's Earth (Bentonite Clay)

By Atif Khan
University of Engineering and Technology, Pakistan

Abstract - Vegetable oil is one of the basic food items which is consumed by almost every human being in this universe. Therefore quality of vegetable oil should be good enough so that it accounts for healthy life. In vegetable oil manufacturing there are four major steps involved which are neutralization, degumming, bleaching and deodorization. Among these steps bleaching is the very important and critical step because it ensures the good color and odor of vegetable oil. The famous method of bleaching in Pakistan is adsorption by inorganic acid activated fuller's earth (bentonite clay). Treatment with inorganic acid (Sulfuric acid and hydrochloric acid) activated bentonite clay is very efficient and shows satisfactory results. But there is a major disadvantage associated with its use. Fumes of hydrochloric acid or sulfuric acid are very dangerous for both the equipment and labor involved in manufacturing of vegetable oil. Therefore the safety of the labor and equipment is compromised. The major purpose of this research work is to give the alternative method for activation procedure of bentonite clay and this method should be the safest method for both the labor and equipment used in vegetable oil industry.

Keywords: *bentonite clay; surface activation; organic acids; adsorption; fourier transform infrared spectroscopy (ft-ir).*

GJRE-C Classification : *FOR Code: 030599*

BLEACHINGOFVEGETABLEOILUSINGORGANICACIDACTIVATEDFULLERSEARTHBENTONITECLAY

Strictly as per the compliance and regulations of :

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Keywords: bentonite clay; surface activation; organic acids; adsorption; fourier transform infrared spectroscopy (ft-ir).

I. Introduction

Specific properties of clay minerals and its derivatives made them valuable for their application in various fields. One of the various applications of bentonite clay is its use as a bleaching agent in vegetable oil industry[1]. Vegetable oil production consists of various manufacturing steps and among these steps refining is the most important and critical step. Refining is based on several stages including neutralization, degumming, bleaching and deodorization. Among these four stages bleaching is very complicated step because quality of cooking oil is based on this step. Furthermore appearance, taste and color of vegetable oil are also depending upon this step. On commercial basis there are two types of fuller's earth, natural and activated[2]. Activated fuller's earth is preferred because of its performance due to higher adsorption capacity. Adsorption capacity of fuller's earth is enhanced by various treatment techniques. Among these techniques acid treatment is the most practiced technique in vegetable oil industries. Other techniques include alkali treatment and organic treatment, but these techniques are not effective enough for enhancing the adsorption capacity of fuller's earth at desired level[3].

In acid treatment normally sulfuric acid and hydrochloric acid is preferred but there are some issues related to it. Fumes of these acids are very dangerous for the labor and equipment involved and moreover some traces of hydrochloric acid remain in vegetable oil after treatment and when this vegetable oil is consumed by human beings it may be carcinogenic if consumed at some extent. It can cause liver and stomach disorders in old ages[4]. So for avoiding these serious issues, treatment with organic acid is introduced in this research paper. Organic acid treatment of fuller's earth is the safest mode of activation because it has no harm to labor, equipment as well as health of human being. Major motivation of this research is the safety of labor and equipment in vegetable oil industry. Average life of equipment is increased which ultimately increase the overall economics of the process[5].

Application of fuller's earth for the bleaching of vegetable oil involves certain issues like filtration, retention of oil and environmental hazards. These problems may arise if the amount of fuller's earth is used in excess amount i.e. more than its requirement[6]. Excessive amount of fuller's earth causes oil losses which ultimately cause oil retention and creates problem during filtration. Moreover the type of clay and their particle size is also an important factor in filtration efficiency. If particles are at large distance from each other than filtration will be easy and if particle size is compact the filtration will be difficult and take more time[7].

There is a lot literature on surface chemistry and modification techniques of fuller's earth. The basic information in the literature is mainly focused on fundamental structural unit and surface characteristics of bentonite clay and their application in process industries. Important parameters which affect the treatment techniques are acid concentration, treatment time, temperature effect, Solid/liquid ratio and moisture content[8].

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II. Material and Methods

a) Sample preparation

Fig.(1) shows the steps for methodology involved in this research.The fuller's earth for activation and analysis was taken from the "Good Earth" company in Sheikhupura (Pakistan) which manufactures the activated fuller's earth or bleaching earth for different vegetable oil processing industries[9]. 100 grams of weighed fuller's earth are taken separately for sample preparation. Each of these samples was ground to powder form. Then these samples were treated with four organic acids which are most suitable for activation according to the literature[10]. These four organic acids were oxalic acid, phosphoric acid, citric acid, acetic acid.These acids with different concentrations are used but 1N acid solution is optimum for treatment and showed satisfactory results so 1N acid solution is use for treatment[11].

b) Phosphoric acid treatment

Phosphoric acid is best recommended for the removal of aluminum ions. It reacts with aluminum and aluminum phosphate is formed, which settles down and easily removed. Literature shows that treatment of clay in Algeria with 70% acid dosage and 24 hours residence time, 66 % conversion of bleaching earth is achieved. Concentration of acid and residence time both highly depends upon the nature of the clay. When maximum conversion is achieved then bleaching earth is washed with water so that acid is completely removed. Then in next step it is dried in 200°C for almost complete removal of moisture. Then its adsorption capacity is tested by treating with edible oil[12].

c) Oxalic acid treatment

Second sample of fuller earth is then treated with oxalic acid. According to literature survey oxalic acid is good for removal of both aluminum and iron. Research on Brazilian clay reveals that 81% oxalic acid dosage and 24 hours residence time gives 74% conversion. In this research different dosages of oxalic acid are selected to obtain maximum conversion. After acid treatment it is washed with water and dried at 200°C for maximum removal of moisture. Finally adsorption capacity is tested by treating it with edible or vegetable oil[13].

d) Citric Acid Treatment

Citric acid bleaching is mostly recommended when soybean oil refining is required. Literature does not reveal conversion of bleaching earth using citric acid. Therefore different dosages of acid will be checked for maximum conversion of bleaching earth. When maximum conversion is achieved then same procedure of washing and drying is adopted as mentioned above and then finally its adsorption capacity is tested by oil treatment[14].

e) Acetic Acid treatment

Acetic acid is recommended when palm oil refining is required. According to literature 1N acetic acid with 0.5 hours' time give 66% conversion. Acetic acid is recommended for removal of magnesium. By varying its concentration and residence time conversion rate also changes. So that concentration will be selected at which maximum conversion occurs. After that same procedure of washing, drying and oil treatment is adopted for testing adsorption capacity[15].

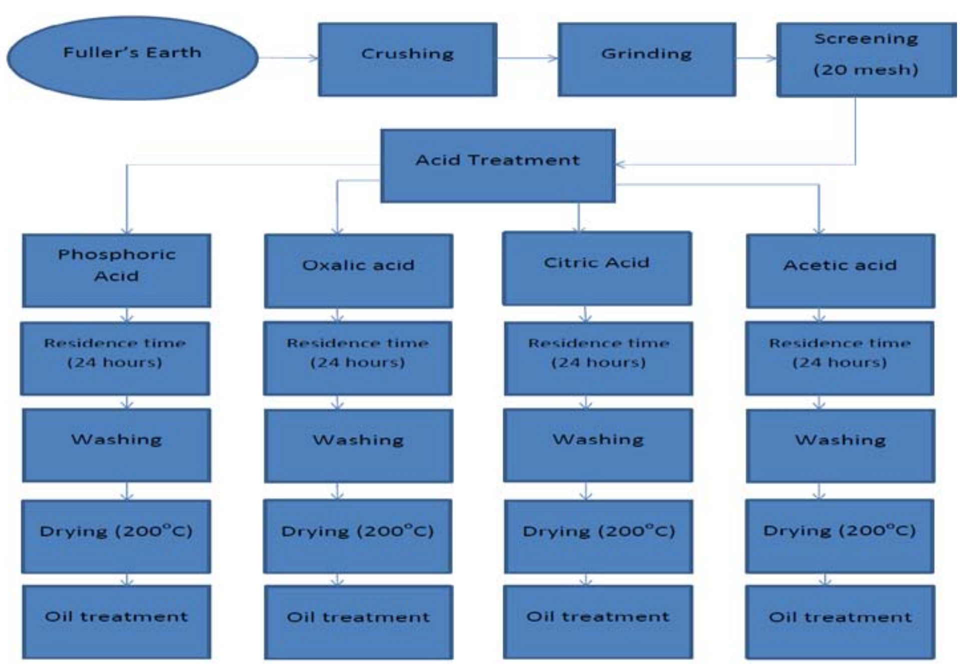

Fig.1 : Research methodology steps

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f) Method of Characterization

The analysis technique which is used for the characterization of both the untreated/treated clay is the Fourier's Transform Infrared Spectroscopy (FT-IR). The quality features of infrared spectroscopy are one of the most effective tools of this vast and advanced method for characterization[14]. For so many years, large research has been done in terms of the basic frequencies for absorption (also known as group frequencies) which is very important tool for understanding of the structure and spectral co-relation of the associated molecular vibrations. Application of this precious information at serves to be a combination of both art and science[16].

III. Results and Discussions

After making four samples of organo-clays, bleaching capability of these clays have been tested by their application on used vegetable oil. Four samples of 50 ml of used vegetable oil havemade and 2 gram of each organo-clay has been poured in it. After heating it at 200°C and 24 hours residence time the oil has been filtered and its results have been analyzed through FT-IR technique. Results of this oil have been compared with the un-used or new vegetable oil. For this purpose used and unused oil samples of SUFI vegetable oil has been taken. SUFI vegetable oil is a very popular and most consumed brand in Pakistan.

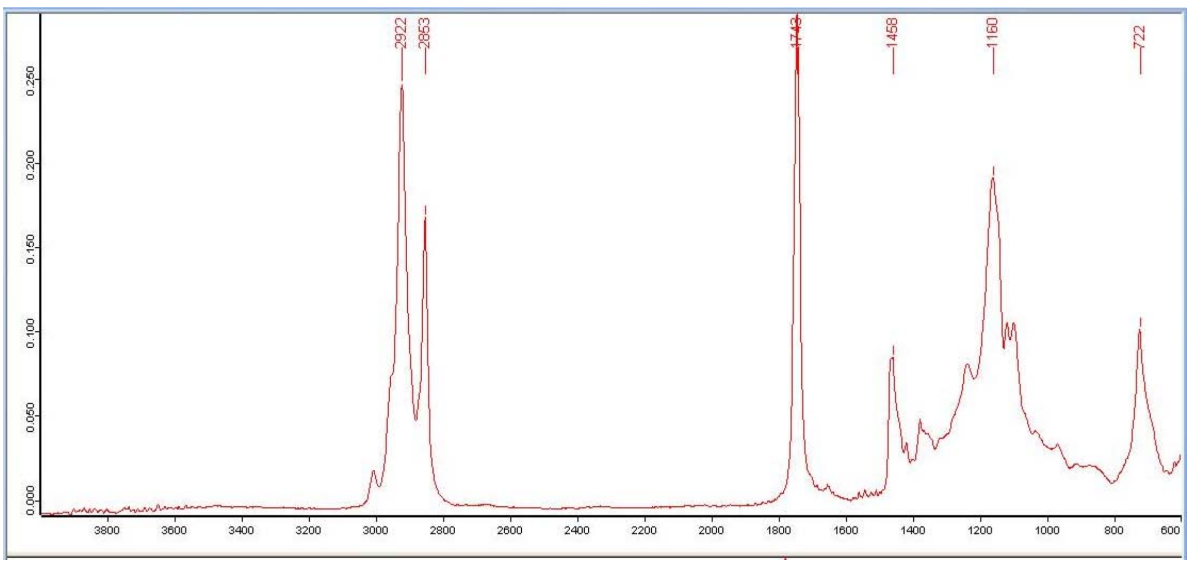

Fig. 2 : Analysis of used vegetable oil

Analyses of used vegetable oil (fig.2) before treatment shows that greater number of saturated hydrocarbons is present i.e. straight chain alkane, alkene and their respective derivatives. If we go from right to left sharper peaks mostly formed between the ranges (1000-2000 cm^{-1}), between 2000-2500 cm^{-1} no peaks are formed and after 2500 cm^{-1} some shaper peaks are formed showing straight chain methane-oxygen functional group and from 3000-3500 cm^{-1} no larger and sharper peaks are formed. If the analysis of used vegetable oil is compared with analysis of unused vegetable oil (fig.3) than it can be observed that peak pattern in the range up to 3000cm^{-1} is almost the same but after 3000 cm^{-1} although the sharper peaks are not formed in both cases but the intensity of spectrum is greater in used vegetable oil. In unused vegetable oil spectrum is lying approximately on x-axis line showing approximately zero intensity while the spectrum analysis of used vegetable oil shows little bit higher intensity of spectrum after 3000 cm^{-1}.

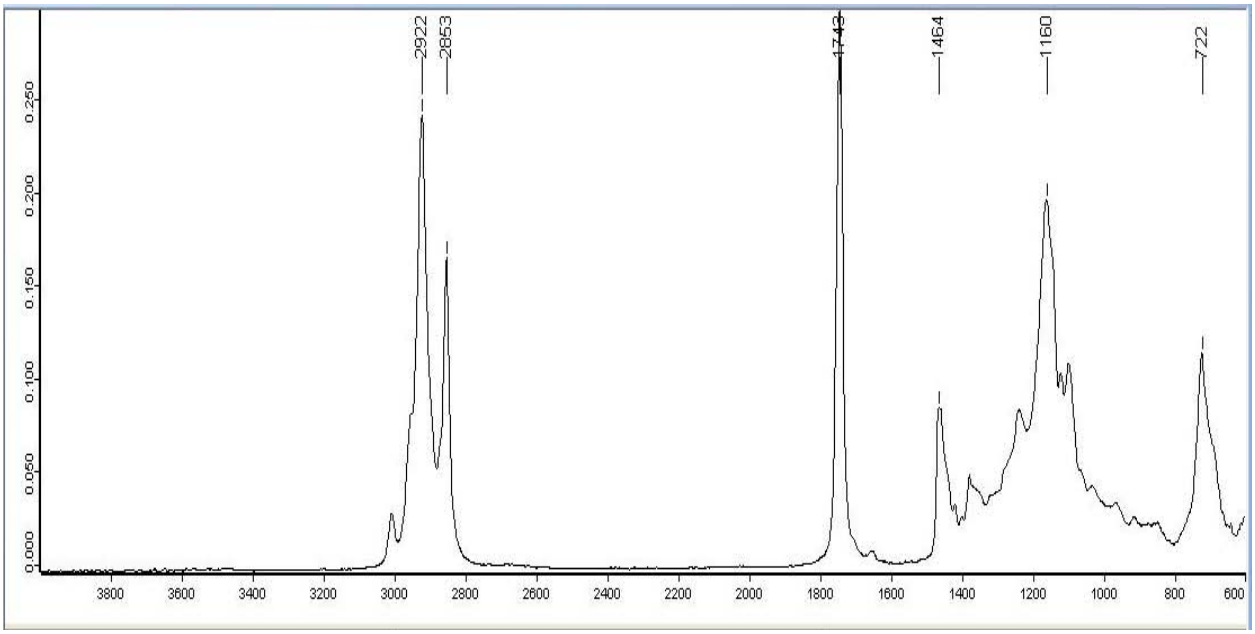

Fig. 3 : Analysis of pure vegetable oil

Analysis of acetic acid activated clay treatment of vegetable oil (fig.4) shows variation in peak pattern if compared with the result of pure vegetable oil analysis. Peak pattern obtained in the range up to 1500 cm^{-1} is almost the same as in pure vegetable oil. In the range between 1500 to 2000 cm^{-1} intensity is higher and then from 2000 to 3000 cm^{-1} spectrum pattern is almost the same as in pure vegetable oil. After 3000 cm^{-1} again intensity rises up to 3500cm^{-1} and starts declining afterwards, showing variation in adsorption spectrum in comparison with pure vegetable oil.

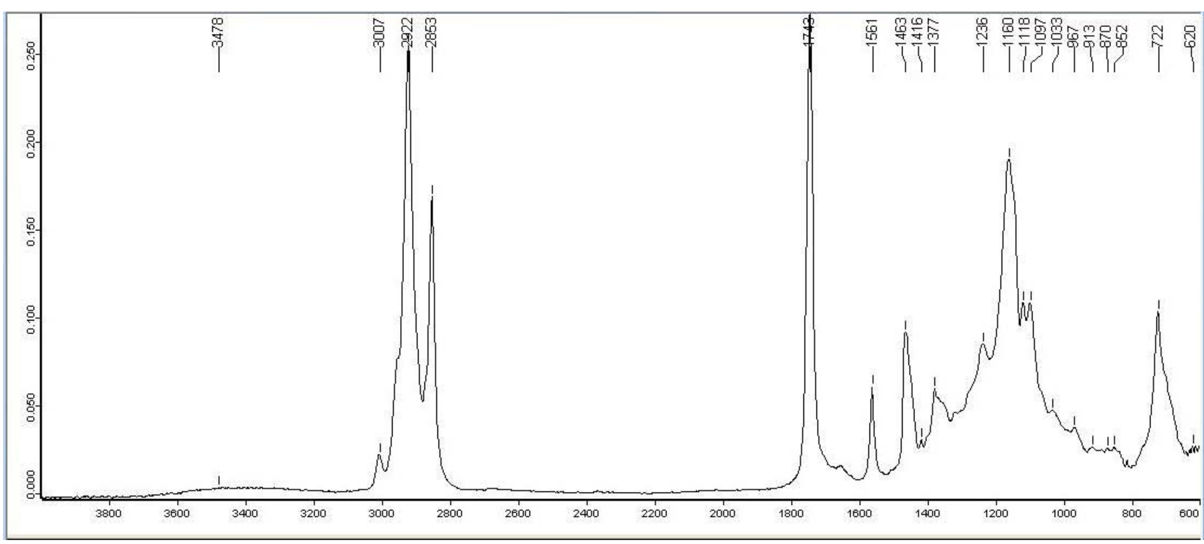

Fig. 4 : Analysis of Acetic acid clay treatment of used vegetable oil

Analysis of phosphoric acid activated clay treatment of used vegetable oil (fig.5) shows that intensity variation throughout the spectrum. At some regions intensity is same as in between 1500-2000 cm^{-1}. However in the beginning of the spectrum more peaks are formed showing greater number of straight chain hydrocarbon functional groups. Sharper peaks are formed mostly in the range 600-750 cm^{-1} and 1000 to 1100 cm^{-1}. In range 2600-2900 cm^{-1} intensity degree of sharpness of peaks is reduced if compared with pure vegetable oil sample and after 3000cm^{-1} spectrum intensity is little higher than pure vegetable oil sampled.

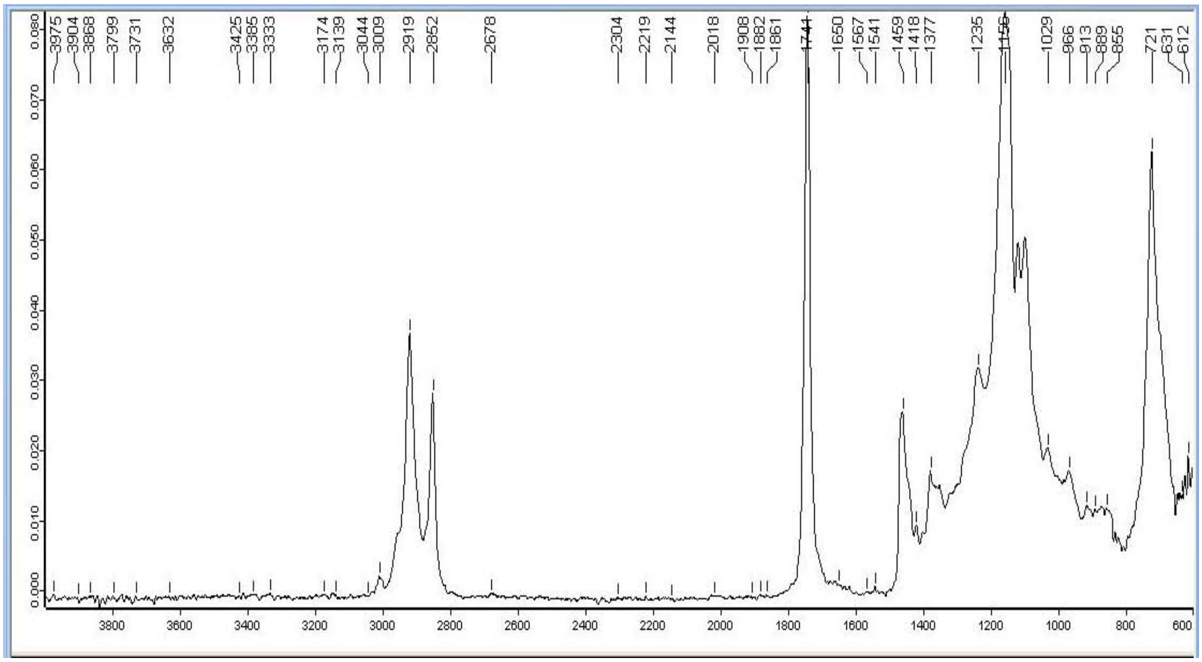

Fig. 5 : Analysis of phosphoric acid activated clay treatment of used vegetable oil

Analysis of citric acid activated clay treatment of used vegetable oil (fig.6) shows variation in spectrum intensity if compared with pure vegetable oil sample. Citric acid activated clay shows almost same results as in fig.5 except at some regions. At the beginning same peak pattern and intensity has been observed clearly as in phosphoric acid treatment but 1800 cm^{-1}intensity is higher up to 2400 cm^{-1} and after 2400 cm^{-1} it starts declining and after 2800 cm^{-1} same spectrum intensity is observed. In the range between 3000-3200 cm^{-1} intensity is approximately at zero level and almost same as in pure vegetable oil but after 3200 cm^{-1} spectrum intensity again starts increasing and till end intensity increases to much higher level as compared to previous samples showing large variation in spectrum intensity in this region. Large variation in this regions shows that power of bleaching of citric acid is more intensive than its requirement.

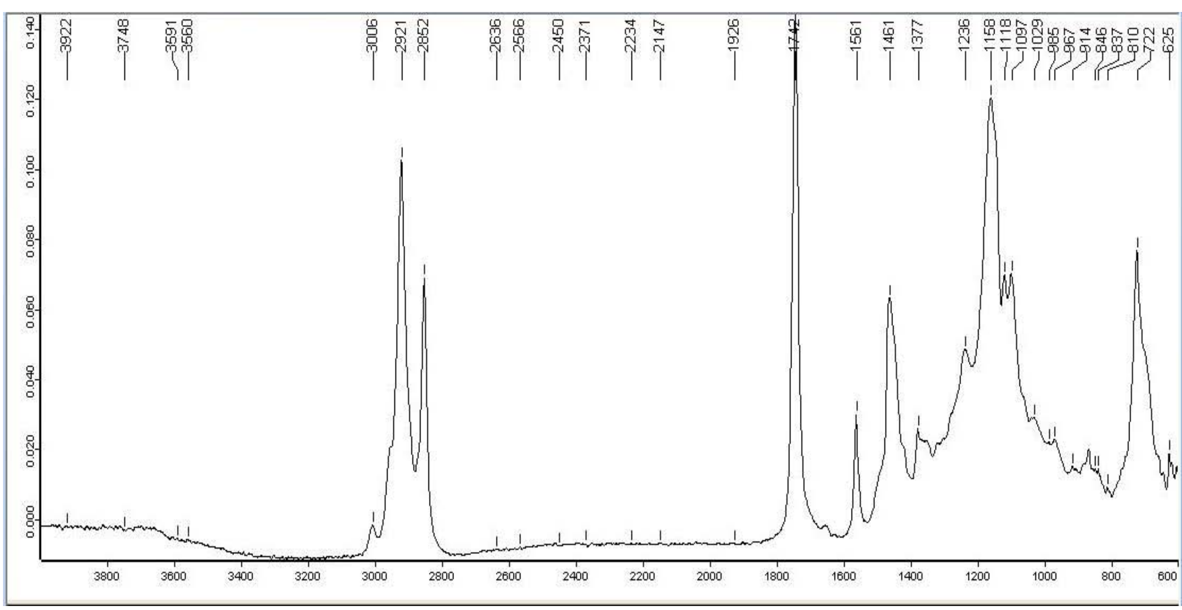

Fig. 6 : Analysis of citric acid activated clay treatment of used vegetable oil

If the oxalic acid activated clay treatment of used vegetable oil (fig.7) is compared with pure vegetable oil sample the it is clearly observed that the spectrum intensity from beginning to end and peaks formation and their intensity throughout the same. Hence oxalic acid activated purifies the used vegetable oil more effectively as compared to other three organo-clays.

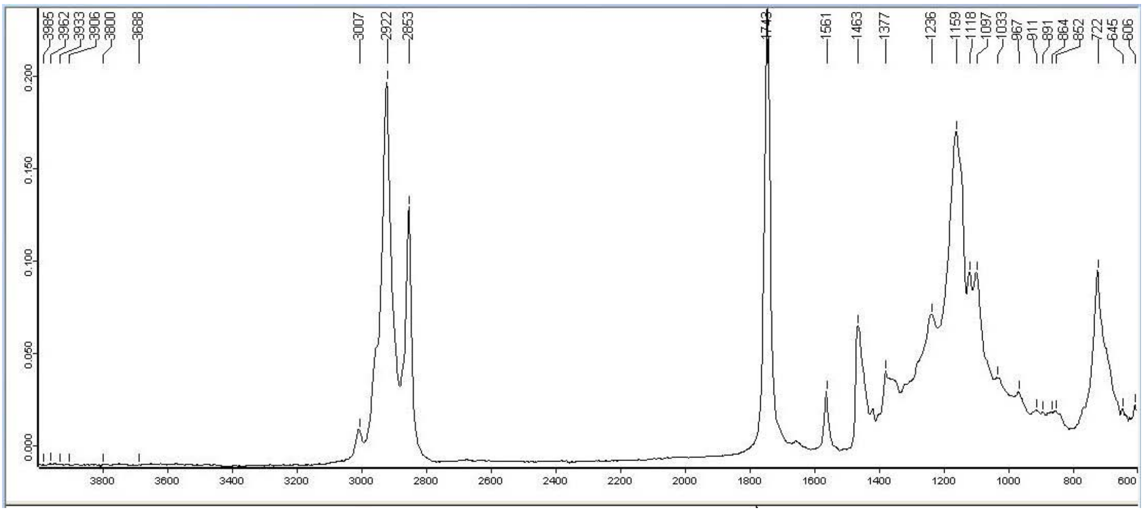

Fig. 7 : Analysis of oxalic acid activated clay treatment of used vegetable oil

IV. Conclusion and Recommendations

From the above discussion if four of these organo-clays are considered the best orano-clay which is suitable for the treatment of bleaching process in vegetable oil industry in Pakistan is Oxalic acid. Oxalic acid treated clay analysis shows that bleaching power of oxalic acid is effective enough that it can purify the used vegetable oil and convert it into approximately new vegetable oil. So if this clay is used in bleaching portion in vegetable oil manufacturing industry, it will show more satisfactory results in comparison with inorganic acid treated clay. If some further research work is carried out, these organo-clays can be used as an adsorbing agent in purification of used lube oils as well. Therefore more research is required in this regard.

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Hybrid Model and Optimization of Bioreactor of Wastewater

By Ghanim. M. Alwan
University of Technology Baghdad, Iraq

Abstract - This work deals with modeling and operation optimization of lab-scale continuous biochemical reactor. Wastewater is feeding to reactor contaminated with different concentration of glucose. The reactor is non-linear with stochastic changing in optimum operating conditions. Simulated model could develop the process and generate extra-confirmed data. The selected process variables are: dilution rate (D), feed substrate concentration (Si), pH and temperature (T). Simulated model could develop the process and generate extra-confirmed data. The effect of D was observed within Si of 20 g/L, while pH and T are affecting within Si of 60 g/L.Si has major effect on dynamic characteristics of the reactor. Reasonable agreement has been found when compared the simulated result with the previous work .Optimization technique helps the decision maker to select best operating conditions. This could reduce the risk of experimental runs and consumed cost for operating and design. Global Genetic algorithm (GA) has been found more reliable than deterministic search for the bioreactor. Optimization results are based on maximizing biomass growth. Optimal results indicate that maximum biomass concentration (X) is 80.57 g/L could be obtained at high value of Si (197.56 g/L) and low D (0.1hr-1).Si is sensitive variable for stochastic mutation of biomass growth.

Keywords: *biochemical reactor; stochastic optimization; simulation.*

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HYBRIDMODELANDOPTIMIZATIONOFBIOREACTOROFWASTEWATER

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Keywords: biochemical reactor; stochastic optimization; simulation.

I. Introduction

Lee [1] and Kapadia etal. [2] described the concept and applications of the biochemical reactors.The stirred-tank bioreactor is one of the most commonly used types for large scale production in industrial applications such as food, pharmaceuticals, various commodity and specialty chemicals .It is used mainly in two modes: the continuous mode and the fed-batch mode.In the continuous mode, the limiting substrates are constantly added to the reactor, while the output stream is simultaneously removed at the same rate, to keep the reactor volume constant. The continuous stirred biochemical reactor is widely used in the treatment of liquid wastes.Its process kinetic can be characterized by the following reaction scheme:

$$\text{Substrate} \rightarrow \text{Biomass} + \text{Gas}$$

Henson [3] explained that as compared to conventional chemical reactors, bioreactors present unique modeling and control challenges due to complexity of the underlying biochemical reactions.

Karadag and Puhakka [4] and Garhyan etal.[5] studied the bioreactor performance using mixed cultures influenced by several operational parameters which affect its static and dynamic behavior such as: dilution rate, feed substrate concentration pH, hydraulic retention time, organic loading rate and temperature. In particular, the role of pH seems the most important parameter in the regulation of enzymes pool production. Ruggeri etal. [6] indicated that the pH adjustments validated the dynamics of the system. Charoenchai, et al. [7] concluded that the temperature is a variable that directly affects the growth rate of organisms.

Annamalai and Doble [8] had found the mathematical modeling of fermentation process helps to; elucidate the mechanism of production process, estimate kinetic parameters such as specific growth rate of biomass and product formation rate develop the understanding between effects of operational conditions on production, and reduce laboratory experiments thereby saving time and resources.

Alhumaizi and Ajbar [9] and Shimizu [10] proved the biological processes are inherently very nonlinear and had frequently been changing optimum operating conditions. Many available mathematical models for biological reactions were not suitable for a control design since no accurate biological law had been proposed.

Kapadia etal.[11] proposed a novel robust controller for a continuous stirred biochemical reactor that controls the culture dilution rate into the reactor in order to maximize a cost function representing the biomass yield.

Genetic algorithm (GA) is global stochastic search based on mechanics of natural selection and natural genetics.GA is based on Darwin's theory of 'survival of the fittest'. There are several genetic operators. Such as; selection, crossover and mutation…etc. Gupta and Srivastova [12] concluded that the deterministic algorithms for function optimization are generally limited to convex regular functions. However, many functions are either not differentiable or needed a lot of difficult mathematical treatment: decomposition, sensitivity computing…etc.

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II. Scope of the Work

The objective of this work is to simulated hybrid model for lab-scale biochemical reactor. Study of effect of effective process variables on dynamic behavior of the reactor. The system is non-linear with stochastic mutations in operating conditions. Reasonable simulated model can generate confirmed data for formulating the optimization problem. Stochastic globe genetic algorithm search is implementing to select the best operating conditions.

III. Dynamic of Hybrid Model

Dynamic modeling for optimization and control requires models that describe the essential dynamic characteristics of the process under study. In the present work, the following assumptions have been adopted for the model:

1. Homogenous liquid-phase system.
2. Non-isothermal conditions.
3. Acidity of water is variable.
4. Pseudo first order irreversible reaction.
5. Constant hold-up.
6. Follow the Monod law.

The component material balances for biomass(X) and substrate(S) are:

$$dX/dt = r1-(F/V)\,X \qquad (1)$$

$$dS/dt = (F/V)\,Si - (F/V)\,S - r2 \qquad (2)$$

In addition, the reaction rate equations are:

$$r1 = \mu(s)\,X1 \qquad (3)$$

And, $$Y = r1/r2 \qquad (4)$$

For Monod law;

$$\mu(s) = (\mu max * S)/(Km+S) \qquad (5)$$

$$\mu max = -40.5+11.78pH-0.0691pH^2+1.65T+0.003T^2-0.468pH.T \qquad (6)$$

Equations (1&2) can be simplified to:

$$dX/dt = (\mu(s) - D)X \qquad (7)$$

$$dS/dt = D\,(Si - S) - (X/Y)\mu(s) \qquad (8)$$

Where D=F/V

Eq.6 was correlated depended on the experimental data of Lopez etal. [13].Eqs.6, 7 and 8 represent the hybrid model of reactor.

The simulated model will implement for the wastewater contains glucose with different concentrations from 6.0 to 200.0 gm/L. Temperature of water are varied from 20 to 30 C° and the acidity are from pH2 to pH4.The kinetic parameters of the biological reaction are; maximum specific growth rate coefficient (μmax=0.3 hr-1), saturation constant (Km=1.0 g/L) and yield (Y=0.4) depended on the results of Lopez etal.[13] ,Cutlip and Shacham[14].

IV. Results and Discussion

a) Optimal operating Conditions

The initial optimal operating conditions of the system (Table 1) were estimated by the nonlinear Levenberg-Marquardt method with the aid of the MATLAB computer program.

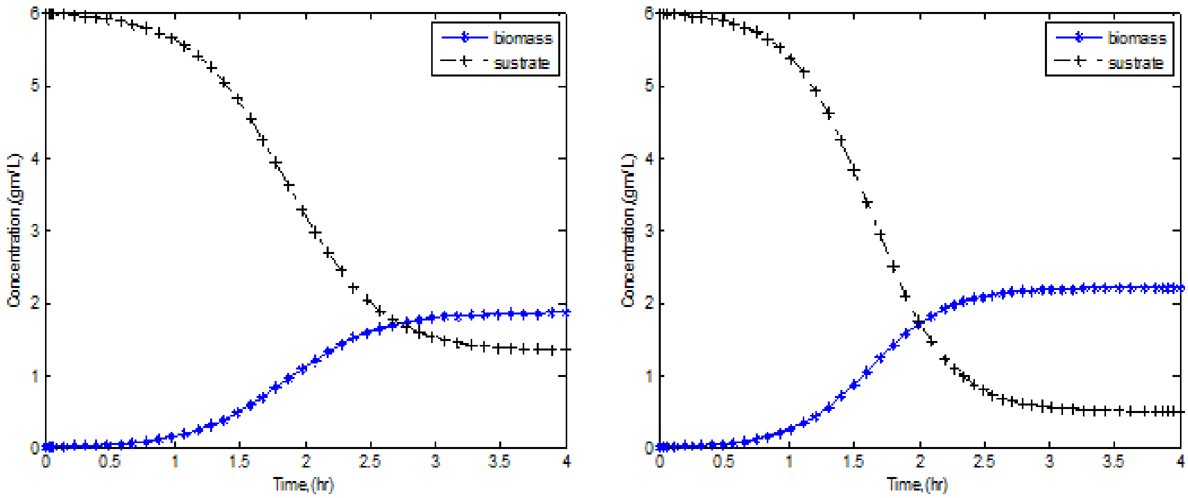
Table 1 : Optimum initial operating conditions

X(gm/l)	Si(gm/l)	D(hr^{-1})	Y(-)	μ(1/hr)
0.001	6.0	0.3	0.4	0.4

b) Unsteady State Conditions

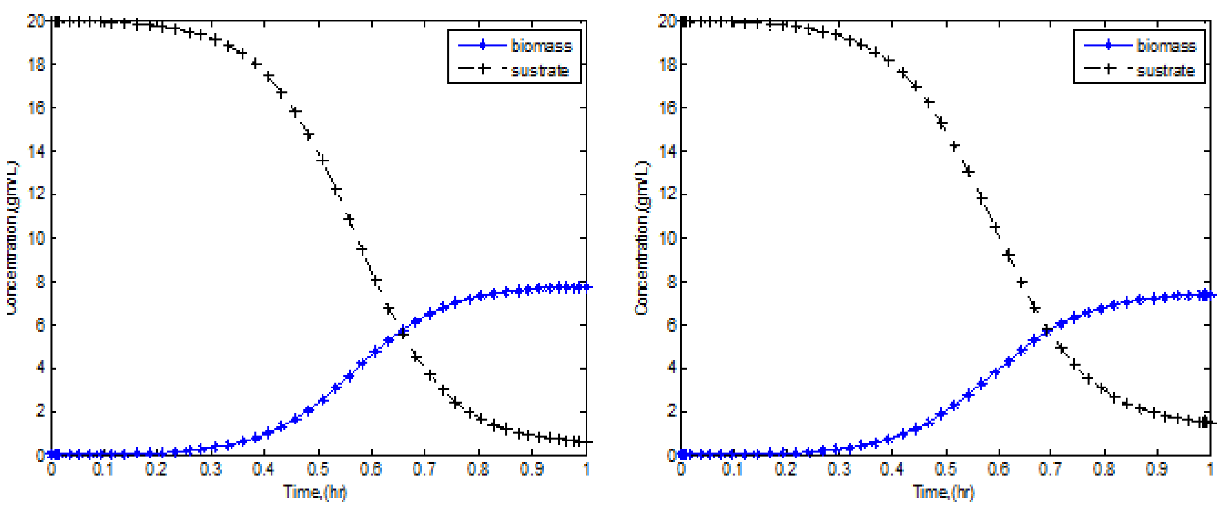
The present bioreactor can be viewed as nonlinear dynamic system and the simulation is very useful tool for model validation .The unsteady- state model (Eqs. 7 and 8) are solved numerically using 4th order Runge-Kutta method with the aid of the MATLAB program, starting from steady- state operating conditions (Table1). Figs. 1-7 explain the behaviors of the biochemical process under different operating conditions.

Dynamically, the system behaves as the first-order lag system. The dynamic model appears that the biomass concentration curves have S-shape and more sluggish when compared with the substrate curves, which have an exponential shape because of the rate of consumed substrate is more than the rate of biomass cell generation in the reactor. The response speed of the biomass and substrate curves increase with Si and decreases with D as shown in Figs.1,2 and 3.The intersection point between two curves indicates to the local optimal point of the system, where the concentration of the biomass equal to that of the substrate. These points are depending on the operating conditions.



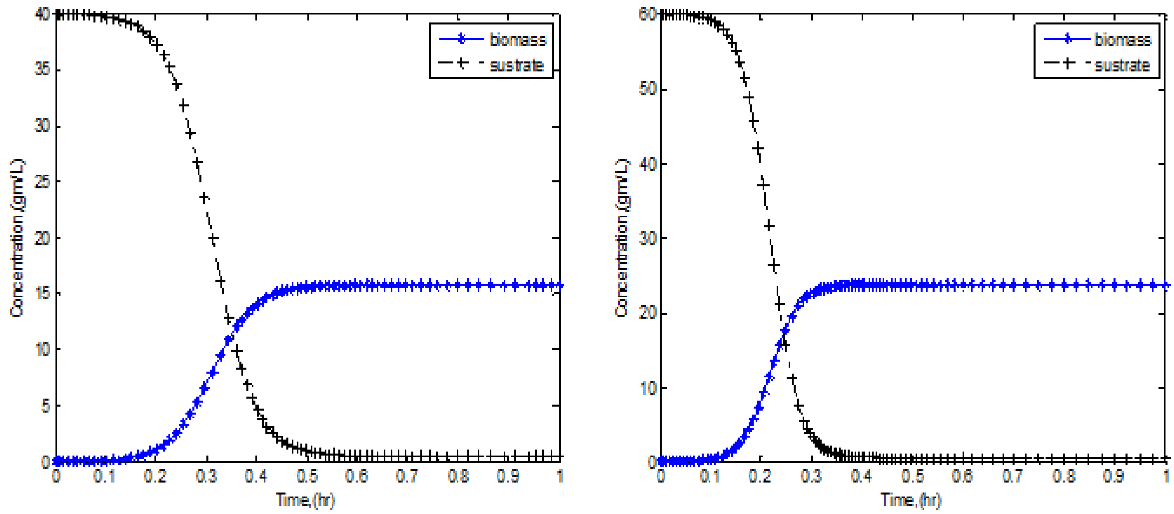
(a) (b)

Fig. 1 : Unsteady state concentration of biomass and substrate at Si=6 for :(a)D=0.3, (b) D=0.8



(a) (b)

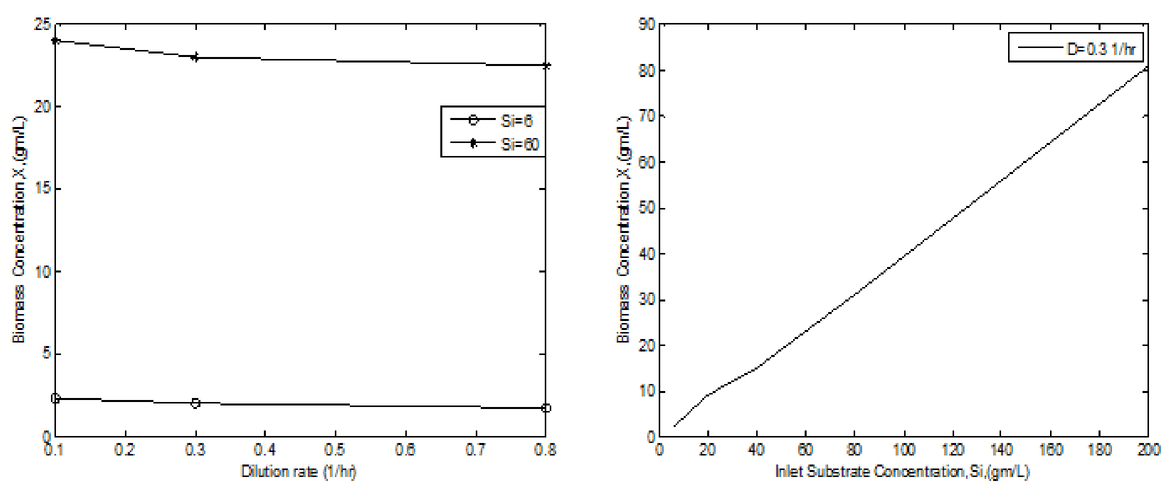
Fig. 2 : Unsteady state concentration of biomass and substrate at Si=20 for ;(a) D=0.3, (b) D=0.8



(a) (b)

Fig. 3 : Unsteady state concentration of biomass and substrate at D=0.3for; (a) Si=40, (b) Si=60

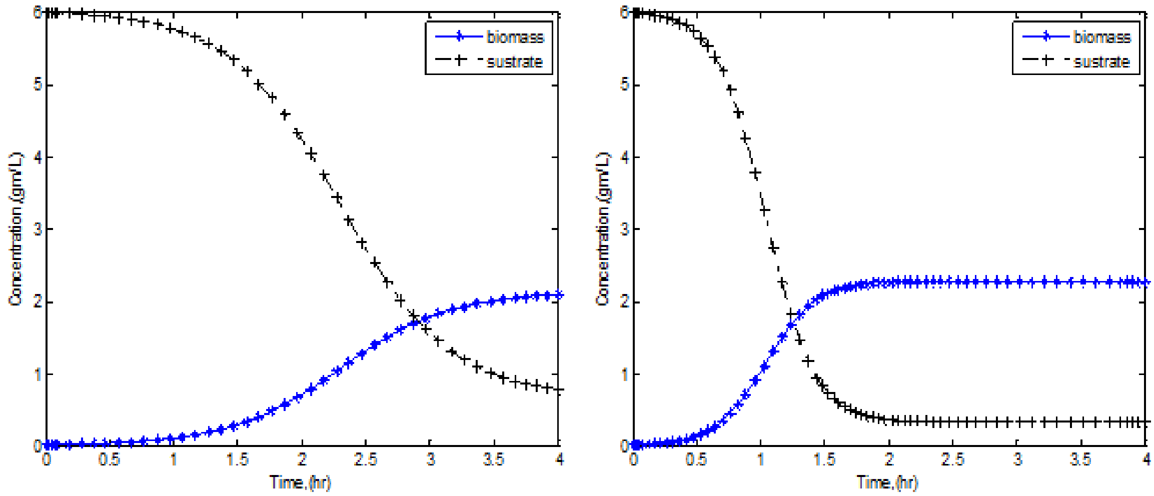
The concentration of the biomass in the reactor decreases with increasing D (Fig. 4a) for low and high Si. In the contrast, the increasing of Si increases the concentration of biomass in the reactor as shown in Fig. 4b.This is due to the fact; that Si has a positive effect on the specific growth rate constant (μ) regarding to the Monod law (Eq.5).While the increasing of D tends to increase the dilution of the substrate which could moderate the growth rate then reduces the concentration of the biomass in the biochemical reactor. The sensitivity of the process (steady- state gain) against Si (Fig. 4b) is more than that with D (Fig. 4a).The effect of Si is more pronounced at low D as shown in Figure 4. Jarzebski [15] also concluded these behaviors.



(a) (b)

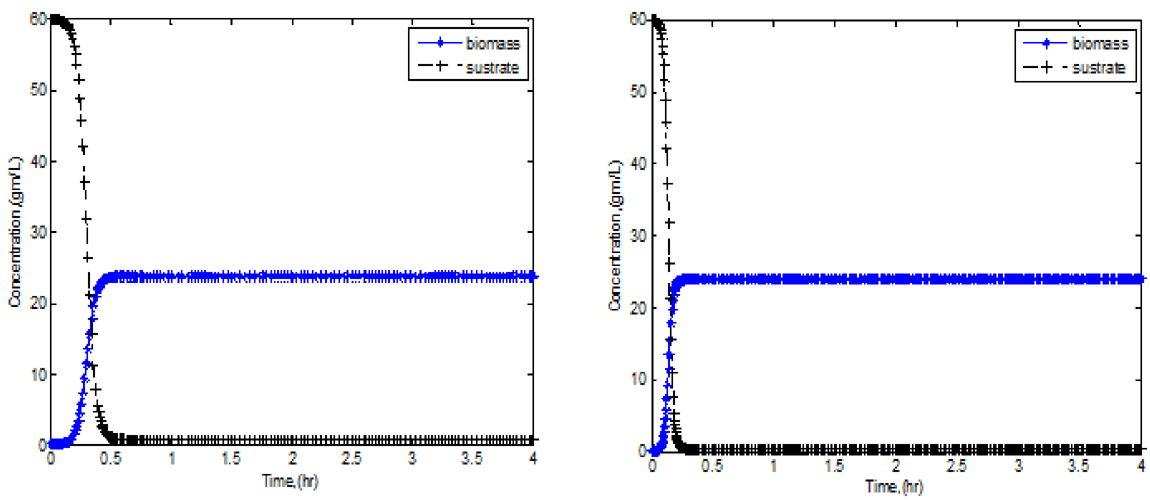
Fig. 4 : Biomass concentration as a function of (a) Dilution rate, (b) Inlet substrate concentration

The effect of temperature on the biomass growth rate appears in Figs.5 and 6 at temperature range from 15 to 30°C. The simulated results explain that increasing of temperature enhances the growth rate of the biomass at low and high Si. This increases the response speed of the biomass concentration. The steady- state value of the biomass concentration was unaffected with increasing of temperature as shown in Figs.5 and 6.



(a) (b)

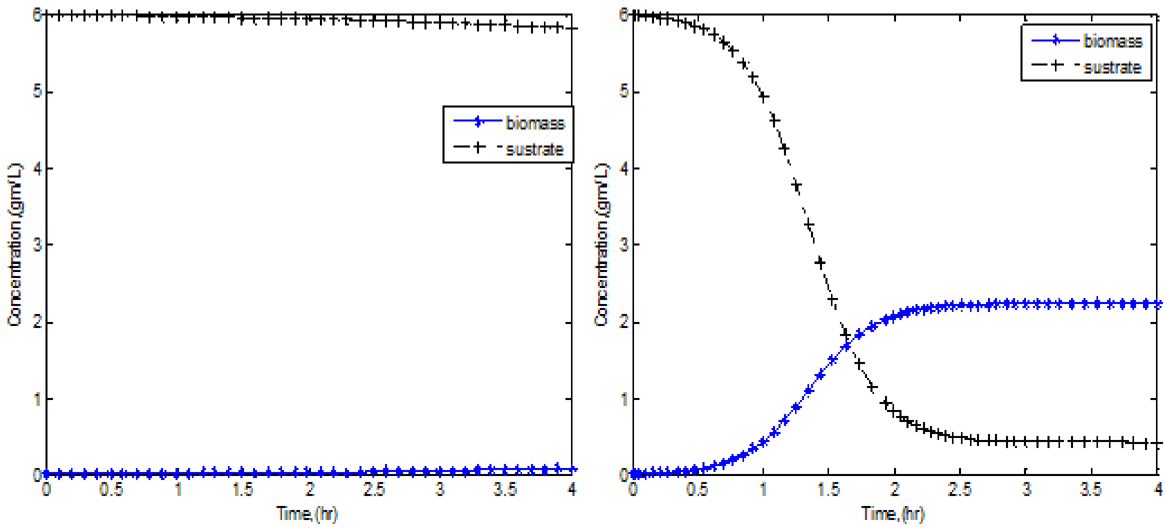
Fig. 5 : Effect of temperature on the process at D=0.3 and Si=6 for (a) T=20, (b) T=30



(a) (b)

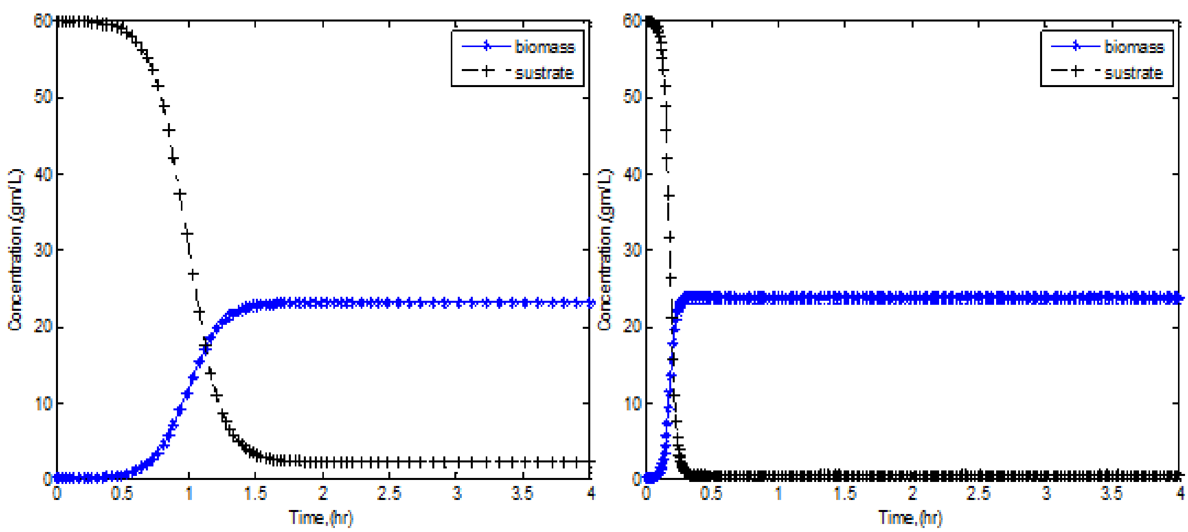
Fig. 6 : Effect of temperature on the process at D=0.3 and Si=60 for (a) T=20, (b) T=30

Figs.7 and 8 explain the effect of the water acidity (pH) on biomass growth. The effect was studied for the available data ranged between pH 2 to pH 4.The biomass growth is very slow at low acidity (pH 2) and increased with increasing to pH 4 as shown in Figs 7a and 7b.The concentration of the biomass in the reactor is very low with the lower feed substrate concentration(Si=6) and pH 2 of water as shown in the Fig. 7a.At high substrate feed concentration(Si=60) ,the growth of biomass cell would enhanced at low acidity(pH=2) when compared Fig. 7a with Fig. 8 a. Si regarding to the Monod law directly affects the growth rate coefficient (μ). The final steady- state concentration of biomass is unaffected by the increasing of pH at high Si as shown in Fig. 8.



(a) (b)

Fig. 7 : Effect of pH on the process at D=0.3 and Si=6 for; (a) pH=2, (b) pH=4.



(a) (b)

Fig. 8 : Effect of pH on the process at D=0.3 and Si=60 for; (a) pH=2, (b) pH=4

Reasonable result can observe when compared the simulated results with these obtained by Cutlip and Shacham [14] as shown in the Fig. 9 .The deviation is about 8%.This indicates that the proposed simulated model is agreed for the present biochemical reactor. Therefore, the reliable model could use to generate the desirable data for formulating the optimization equation.

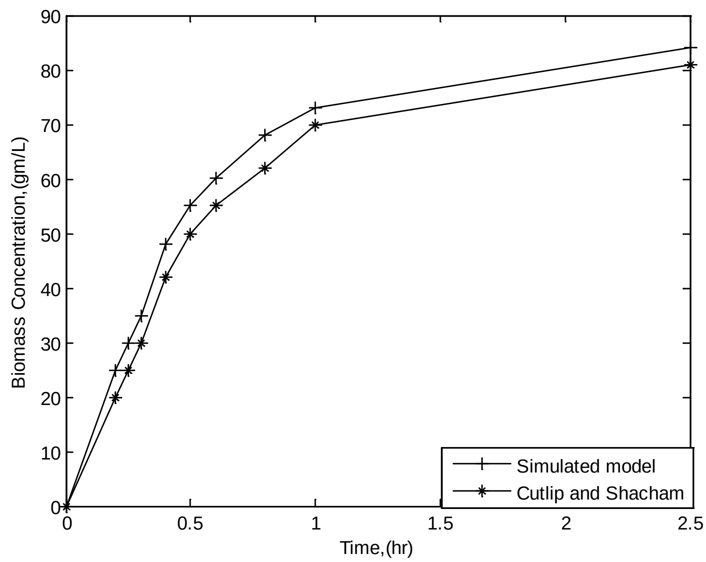


Fig. 9 : Comparison with previous work

c) Optimization problem

The available simulated data have been used to correlate the objective (concentration of biomass) with the decision variables to facilitate the optimization scheme. The selected effective decision variables are; dilution rate (D) and inlet concentration of substrate (Si). Nonlinear regression (Levenberg-Marquardt) method was implemented with the aid of the computer program (Statistica version10).

The optimization equation is:

$$X=0.409\ Si\ -0.575D-0.028DSi\ +0.02 \quad (9)$$

Subject to inequality constraints:

$$6.0\leq\ Si\ \leq\ 200 \quad (10)$$

$$0.1\leq\ D\ \leq 0.8$$

Eq.9 indicates that the dilution rate (D) has negative effect on the biomass concentration while the inlet concentration of substrate (Si) has positive effect.

d) Optimization Technique

The objective is to maximize the biomass concentration in the reactor. The optimization equation (Eq. 9) is interacted and nonlinear, so that the deterministic search is unsuccessful. GA has been found suitable for the present biochemical process. GA is stochastic global search based on mechanics of natural selection. Fig. 9 illustrates the results/solution of the algorithm scheme. The parameters of the GA were adapted, and the selected operators are suitable for solving the problem to obtain the best optimal values. Hybrid function implemented as the combined search between genetic algorithm and pattern search to refine the values of decision variables. 51 generations occurred regarding to the nonlinearity of the process. The adapted operators of GA are explained in the Table 2.

Table 2 : Adapted parameters of GA

Population type	Double vector
Population size	80
Creation function	Feasible population
Scaling function	Rank
Selection function	Roulette
Crossover function	Scattered
Crossover fraction	0.8
Mutation function	Adaptive feasible
Migration direction	Forward
Migration fraction	0.1
Hybrid function	Pattern search
Number of generation	51
Function tolerance	1.0E-6

Table 2 explains the best operators of the genetic algorithms. Fig.10 illustrates the outputs of the algorithms solutions/operators of genetic algorithm.GA is implemented with the pattern search by using the hybrid function as shown in Table 2 to refine the decision variables .The best fitness, best function and score histogram as shown in Figure 10 illustrate that the

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maximum biomass concentration is 80.57 g/L.The histogram of decision variables indicates that the optimal values are; Si=197.56 g/L (variable 1) and D=0.1hr-1 (variable 2), which are within the limit of inequality constraints (Eq.10). The histogram of the variables in Fig.10 indicate that Si (variable 1) is the effective variable on X. Due to the nonlinearity of the bioreactor process, the optimization equation(eq. 9) was solved by (51) generations as shown in Fig.10.

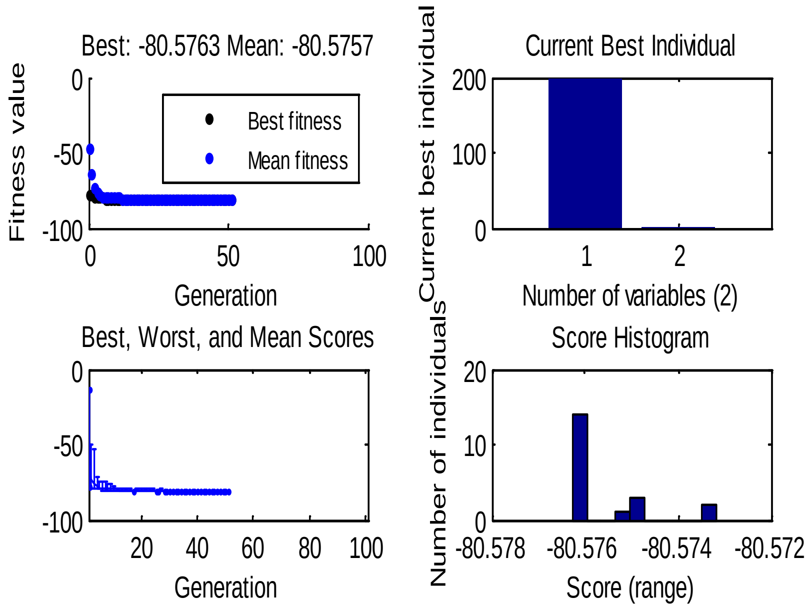
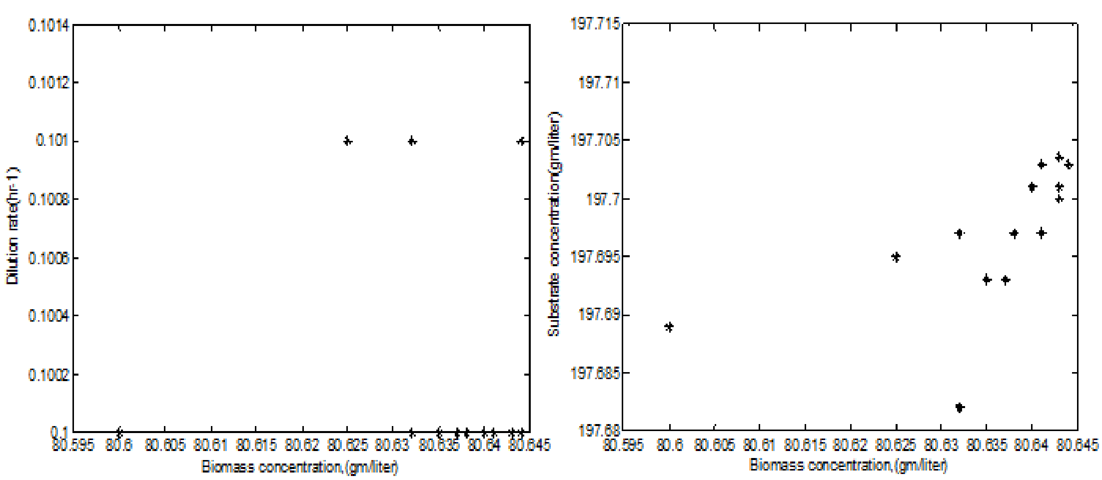


Fig. 10 : Results of GA search

The optimal sets of the decision variables are illustrated in Figs.11a and 11b corresponding to the objective X.The scattering and stochastic of the results are appeared in these figures as a results of natural selection by GA .It is found that the optimal values of the dilution rate (D) is approximately constant within its lower bound as explained in Fig.11a.Inlet substrate concentration (Si) is more sensitive to the optimal objective change(X) as shown in Fig. 11b .This is because of that Si is the effective variable on X as shown in Fig. 10.Si is changed within its upper bound (Fig.11b).These behaviors are because of Si has positive effect while D has negative effect on X as shown in the Eq. 9.This confirmed by Alwan[16] .Optimal values of the two decision variables are stayed within optimal value of X, which equal to 80.57 g/L as shown in Fig. 11.



(a) (b)

Fig. 11 : Stochastic mutation of decision variables corresponding to objective X

Optimization technique is a powerful tool to obtain the desired operating conditions that improves the performance of the reactor. This reduces the risk of experimental runs and consumed cost for design and operation. However, the reliability of the search depends on; the best selection of decision variables, formulation of objective function and the selection of the proper optimization technique. Palonen, etal. [16] was indicated to this conclusion.

V. Conclusions

Simulated model helps study of dynamic characteristics of the biochemical reactor. Reliable model could use to generate extra data in the case of unavailable experimental results. Effect of dilution rate was observed at low feed substrate concentration that is within 20 g/L. Effect of pH and temperatures were observed within concentration of 60 g/L. Feed substrate concentration has been found effective process variable on the growth rate of the biomass cell in the reactor. Maximum concentration of the biomass cell could be obtained at high concentration of substrate and low dilution rate. Feed substrate concentration is more sensitive to stochastic mutations of the biomass concentration. Reasonable agreement has been obtained when compared the simulated results with the previous work. Stochastic genetic algorithm has been found best global search for the nonlinear biochemical reactor process.

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Nomenclatures

D: Dilution rate, [1/hr]
F: Flow rate, [L/hr]
Km: Saturation constant, [g/L]

PH: Acidity [-]
r1: Rate of cell generation,[g/L.hr]
r2: Rate of substrate consumption,[g/L.hr]
S: Substrate concentration in the reactor,[g/L]
Si: Feed substrate concentration,[g/L]
T: Temperature, [C°].
t: Time, [hr]
V: Volume of the reactor,[L]
X: Biomass concentration in the reactor,[g/L]
Y: Yield, [-]
Greek Symbols
μmax: Maximum specific growth rate coefficient,[1/hr].
μ(s): Local specific growth rate coefficient, [1/hr].

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Effect of Aspect Ratio, Tubular Assembly and Materials on Minimum Fluidization Velocity in 3D-Atmospheric Fluidized Bed

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Abstract - Hydrodynamics of fluidized bed is a noteworthy factor in manipulating and analyzing the characteristics of fluidized bed. Minimum fluidization velocity is noteworthy parameter for analyzing the distinctiveness of fluidized bed. Comparison was being done on different Geldart's particles group B (local sand) and A (rice husk) materials having densities of 1490 kg/m^3 and 567 kg/m^3 and same particles sizes i-e 149 μm. In this study different height to diameter (aspect) ratios were used H/D= 0.8, 1, 1.1 along with different tubes banks of two geometries inline assembly and staggered assembly. Diameter of tubes considered to be 1.2" to understand the behavior of minimum fluidization velocity by using these tube banks inside the bed and hydrodynamic parameters were resolute for these three aspect ratios and tube banks assemblies by measuring pressure drop experimentally and theoretically by using Ergun equation. Minimum fluidization velocity reduces by using tubes inside the bed furthermore, fluidization velocity achieves earlier in triangular pitch arrangement of tubes than in square pitch.

Keywords: minimum fluidization velocity, minimum bubbling velocity tube bank, biomass, bed height.

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Effect of Aspect Ratio, Tubular Assembly and Materials on Minimum Fluidization Velocity in 3D-Atmospheric Fluidized Bed

Masooma Qizilbash [α] & S. R Malik [σ]

Abstract- Hydrodynamics of fluidized bed is a noteworthy factor in manipulating and analyzing the characteristics of fluidized bed. Minimum fluidization velocity is noteworthy parameter for analyzing the distinctiveness of fluidized bed. Comparison was being done on different Geldart's particles group B (local sand) and A (rice husk) materials having densities of 1490 kg/m^3 and 567 kg/m^3 and same particles sizes i-e 149 μm. In this study different height to diameter (aspect) ratios were used H/D= 0.8, 1, 1.1 along with different tubes banks of two geometries inline assembly and staggered assembly. Diameter of tubes considered to be 1.2" to understand the behavior of minimum fluidization velocity by using these tube banks inside the bed and hydrodynamic parameters were resolute for these three aspect ratios and tube banks assemblies by measuring pressure drop experimentally and theoretically by using Ergun equation. Minimum fluidization velocity reduces by using tubes inside the bed furthermore, fluidization velocity achieves earlier in triangular pitch arrangement of tubes than in square pitch. Minimum fluidization velocity remains unchanged by changing bed height for both the materials. However, pressure drop increases as aspect ratio is incremented.

Keywords: minimum fluidization velocity, minimum bubbling velocity tube bank, biomass, bed height.

I. Introduction

A trend by which fine solids are changed into a fluid-like state through contact with gas or liquid or by both gas and liquid is termed as Fluidization. It is a contacting technique, which has extensive industrial applications and several Investigations concerning range of aspects of fluidization is being carried out and numerous applications have been made based on these techniques like drying, adsorption and chemical processes such as combustion, carbonization, gasification and solid-catalyzed reaction. In order to keep vast variety of review and researches to rational proportion, it has been restricted to gas-solid systems. A number of outstanding reviews have been in print on measurement techniques for fluidized beds by several researchers.

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Cylindrical gas-solid fluidized beds have been working in process industries. Apart from the gas-solid advantages of fluidization in cylindrical beds, the efficiency and the quality in large diameter suffer seriously due to certain drawbacks such as channeling, bubbling and slugging behavior at gas velocity higher than the minimum fluidization velocity resulting in poor gas-solid contact. Hence studies have been done by the investigators to improve the quality of gas-solid fluidization. To overcome the above mentioned drawbacks quality techniques such as vibration and rotation of the bed, use of improved distributor and promoter [20] has been studied.

Consideration of non-cylindrical conduits, instead of a cylindrical one is considered to be an striking alternative technique for improved gas-solid fluidization by reference [9] The introduction of vibrational and rotational motion of the bed and distributors promotes turbulence in a gas-solid fluidized bed that increase the fluidization quality by minimizing bubbling, channeling and slugging but the relative demerits of the above technique is increase of pressure drop. The use of non-cylindrical conduits has been found to be more effective in controlling fluidization quality as compared to the other methods [12] Recently the use of non-cylindrical beds has begun to receive much attention for several applications because of a few advantages, like (i) the operation of the fluidizer over a wide range of superficial velocity, (ii) the possibility of fluidizing a wide range of particles of different sizes or densities, and (iii) intensive particle mixing.

Fluidized bed combustion initiated from a flame low grades of variety of fuels. One of the main rewards of fluidized bed is its ability to burn several fuels and is also characterized by following parameters i-e Sulphur removal and low Nox emissions without any particular designed DeSOx or DeNOx equipment [11]. To fluidize biomass is another complicated process Some studies have been done to determine the effect of particle size, shapes and densities of different biomass such as wood chips, mung beans, millets, corn stalks and cotton stalks on minimum fluidization velocity [2]. The effect of tubular assembly on minimum fluidization velocity has not been covered by majority of researchers and is being studied in current paper.

The purpose of this study is to determine minimum fluidization velocity for local sand and rice husk at different aspect ratios and to investigate the effect of minimum fluidization velocity in presence of tubular assembly of two different arrangements triangular pitch and square pitch having 1.2" diameter of tubes.

II. Experimental Setup

0.1211 m^2 Atmospheric Fluidized Bed has been fabricated in this study. A schematic diagram of apparatus is shown in Fig1. Rotameter is used to regulate the air flowrate having pressure of 100 psi. Spargers tubes were used as a distributor inserted beneath be for uniform mixing. Local Sand and rice husk has been used both exhibit same diameter of 149µm but different densities 1490 kg/m^3 and 567 kg/m^3 to be familiar with fluidization characteristics for materials having different densities. Tubes inserted having diameter of 1.2 inches and two different assemblies i-e triangular pitch and square pitch. Both arrangements were used on 6 inches above the distributor to keep away from trouble in air distribution.

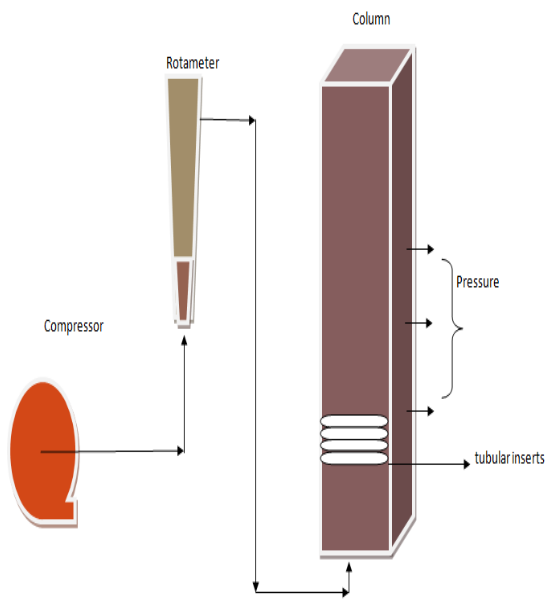

Fig.1 : schematic diagram of 0.348m*0.348m fluidized bed reactor

Table 1 : Properties of bed materials

Materials	Geldart group	dp (µm)	ρp (kg/m^3)	Φ	e
Sand	B	149	1490	$6*10^{-4}$	0.21
Rice husk	A	149	567	0.65	0.79

III. Experimental Procedure

Minimum fluidization velocity was examined experimentally by observing pressure drop across the bed of 0.348m*0.348m fluidized bed reactor. The bed was packed with both solid particles (sand and rice husk) one by one and then vigorously fluidized by introducing air at 100 psi and at particular initial air flow rate to split down the internal structures. Superficial air velocity was varied and at each increment pressure drop was recorded by means of manometer installed. 1.2" diameter tubular geometry (triangular pitch & square pitch) was assembled inside the bed and above the distributor. Pressure drop and minimum fluidization velocity was observed experimentally. Different aspect ratios such as 0.8, 1 and 1.1 then used and Pressure drop and minimum fluidization velocity then evaluated.

IV. Observations and Calculations

Density of local sand particle= ρ_s=1490kg/m^3
Density of rice husk=ρ_r=567 kg/m^3
Diameter of both materials=d_p=149μm
Voidage of sand e_s=1-(ρ_b / ρ_s)= 0.21
Voidage of rice husk e_r= 0.795 (taken from combustion and gasification in fluidized bed)
Sphericity of sand Φ_s= As/Ap= 0.00006 (taken from combustion and gasification in fluidized bed)
Sphericity of rice husk $\surd_\rho$= 0.65 (taken from combustion and gasification in fluidized bed)
Viscosity of inlet air at 27°C= 1.84*10^{-5}N.s/m^2

Density of inlet air at 27°C=ρa=1.16 kg/m^3
Diameter of tubes inserted=dt=1.2"
Materials of tubes inserted=PVC
Geometry of tubes inserted= triangular pitch and square pitch

Constants C_1 & C_2 for sand and biomass = 27.2 & 0.0408 (taken from Grace, Prabir Basu and used by Basu Paudel, B.t (2011) in experimental study of fluidization biomass, inert particles and biomass/sand mixtures)

a) Applied equations [9, 10]

$$\Delta P/L=\{150(1-e)^2/e^3(\mu U)/(\Phi dp)^2\}+\{1.75(1-e)/e^3(\rho g U^2)/(\Phi\ dp) \quad (1)$$

$$F_D=\Delta P=AL\ (1-e)(\rho_p-\rho_g)g \quad (2)$$

$$Ar= \rho_g\ (\rho_p-\rho_g)\ gdp^3/\mu \quad (3)$$

$$Re_{mf} = \{C_1^2+C_2Ar\}^{0.5}-C_1 \quad (4)$$

$$Re_{mf} = U_{mf}d_p\rho_g/\mu_g \quad (5)$$

$$U_{mf}= Re_{mf}\ (\mu_g)/d_p\rho_g \quad (6)$$

Table 2 : Experimental values of pressure drop of different materials at 0.33 m of initial bed height & 1.2''dia tubes

Sr No	Flowrate Q (l/min)	Velocity U (m/s)	Pressure drop ΔP (Cm of water) sand			Pressure drop ΔP (Cm of water) Rice husk		
			Without tubes	Square pitch tubes	Triangular pitch tubes	Without tubes	Square pitch tubes	Triangular pitch tubes
1	0	0	0	0	0	0	0	0
2	20	0.0027	8.2	8.5	8.3	2.5	2.8	2.7
3	40	0.0049	10	11.5	11	3.5	4.2	4
4	60	0.0082	14	15	13.8	4.3	5.8	4.5
5	80	0.0107	19	20	20	5	6	6
6	100	0.0132	22	23	22.5	5.8	4	6.5
7	120	0.0165	22.5	24	23	5	5	5
8	140	0.0189	24	20	23.5	6.1	5.1	5.1
9	160	0.021	25	19.5	18.4	5	5	4.3
10	180	0.024	19	18	20	5.5	5.3	5
11	200	0.027	18.2	20	19.5	5	5	5.5

Table 3 : Experimental values of pressure drop of different materials at 7.1 m of initial bed height & 1.2''dia tubes

Sr no	Flowrate Q (l/min)	Velocity U (m/s)	Pressure drop ΔP (Cm of water) sand			Pressure drop ΔP (Cm of water) Rice husk		
			Without tubes	Square pitch tubes	Triangular pitch tubes	Without tubes	Square pitch tubes	Triangular pitch tubes
1	0	0	0	0	0	0	0	0
2	20	0.0027	9	9.3	10	2.8	3.7	3
3	40	0.0049	11.5	14	12	3.9	4.3	4
4	60	0.0082	17	22.9	21	4.3	5	4.5
5	80	0.0107	22	24	24	5	5.7	5
6	100	0.0132	23	24.4	24.3	5.9	6	6
7	120	0.0165	24.1	18	24.9	6.8	7	7.1
8	140	0.0189	25.5	19.7	20	7	4.8	7.1
9	160	0.021	19.9	19	19	5	4	3.3
10	180	0.024	18.5	19	18.5	5.9	4.3	4
11	200	0.027	18	19.3	18	5.5	4	4.4

Table 4 : Experimental values of pressure drop of different materials at 6.1 m of initial bed height & 1.2''dia tc ubes

Sr no	Flowrate Q (l/min)	Velocity U (m/s)	Pressure drop ΔP (Cm of water) sand			Pressure drop ΔP (Cm of water) Rice husk		
			Without tubes	Square pitch tubes	Triangular pitch tubes	Without tubes	Square pitch tubes	Triangular pitch tubes
1	0	0	0	0	0	0	0	0
2	20	0.0027	10	11	10	3	4	3.8
3	40	0.0049	15	17	15.5	4	4.5	4
4	60	0.0082	20	20.5	20	5.5	6	5.7
5	80	0.0107	23	25	25	6	6.7	6
6	100	0.0132	23.8	26.5	25.3	6.9	7	7
7	120	0.0165	25.3	29	29	7.5	5	6.1
8	140	0.0189	26	20	30.2	4	5.1	5
9	160	0.021	26.5	20.2	19.3	2	5	4.3
10	180	0.024	20	19.9	20.1	2.5	5.3	5
11	200	0.027	22	19.9	20	3	5	5.5

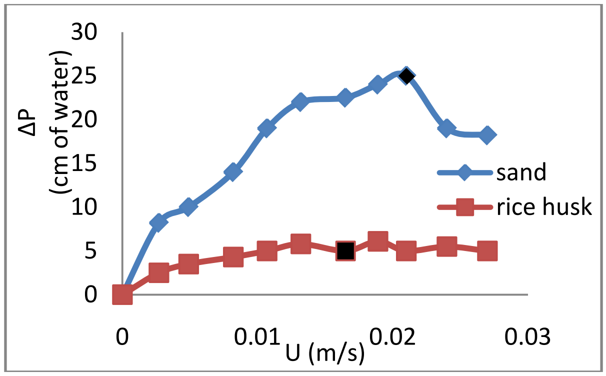

Fig. 2 : Comparison of U_{mf} for sand and rice husk at H/D=0.8 in absence of tubes

Fig 2 represents superficial air velocity as a function of pressure drop for two different particles local sand and rice husk as a bed material at an aspect ratio of 0.8 in the absence of tubular assembly to study the effect of superficial air velocity on pressure drop across the bed in tubes absence to make appropriate comparison with the bed having tubes inserted in it.

Fig 3 and 4 shows the effect of superficial air velocity on pressure drop of two different bed material i-e local sand particles and rice husk particles at an aspect ratio of 1 and 1.1 to estimate the pressure drop variation at different height in the absence of tubes

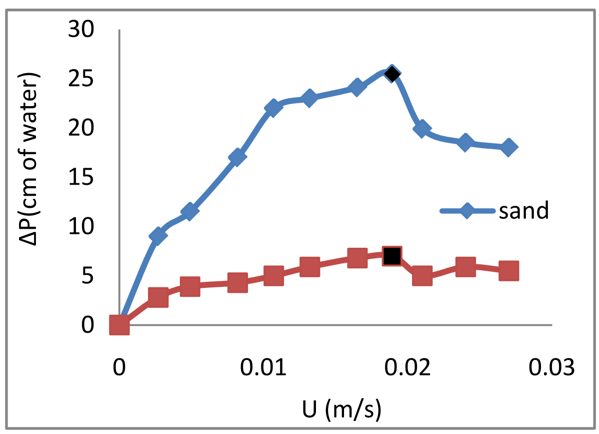

Fig. 3 : Assessment of U_{mf} of sand and rice husk at H/D=1 in absence of tubes

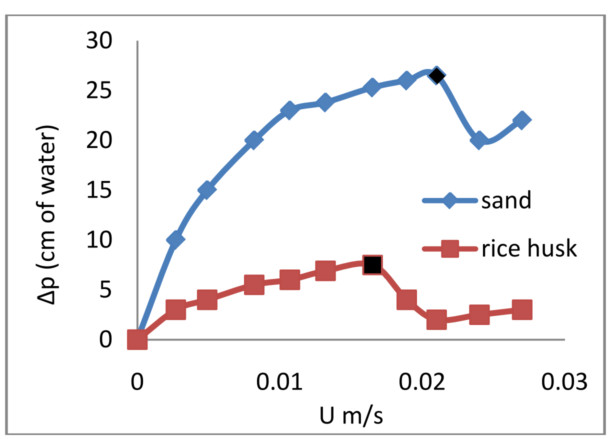

Fig. 4 : Evaluation of U_{mf} for sand and rice husk at H/D=1.1 in absence of tubes

V. Results and Discussion

a) Effect of materials and aspect ratios

Two materials having same diameters and different densities were being studied in the 0.348m*0.348m fluidized bed reactor as a bed material to understand the effect of densities on minimum fluidization velocities and it is observed that rice husk has lower density and so is the minimum fluidization velocity as compared to the local sand having higher density. As well as aspect ratio is concerned pressure drop increases on increasing bed height or aspect ratio but there is no effect of aspect ratio on minimum fluidization velocity hence minimum fluidization velocity for both the material are independent on aspect ratio. fig 5 represents the graph between minimum fluidization velocity for two different materials at three different aspect ratios.

Table 5 : Minimum fluidization velocities and bed weight on increasing height in absence of tubes

H/D	Sand		rice husk	
	U_{mf} (m/s)	Bed weight (kg)	U_{mf} (m/s)	Bed weight (kg)
0.8	0.021	59.6	0.016	22.6
1	0.018	62.5	0.018	23.8
1.1	0.021	68	0.018	26.

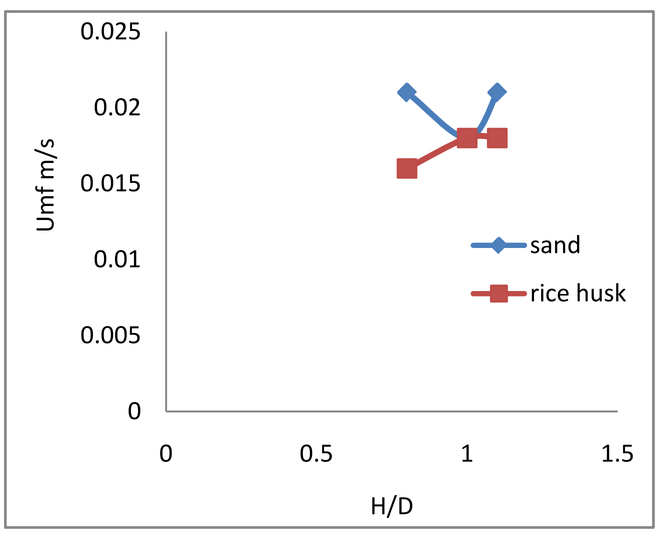

Fig. 5 : H/D vs U_{mf} of sand and rice husk

b) Effect of tubes inserted

1.2" diameter of tubes have been used in 3D Atmospheric Fluidized Bed reactor to determined the effect of tubular inserts on minimum fluidization velocity and different arrangements of tubes such as inline arrangement and staggered arrangement were studied to estimate the effect of square pitch arrangement and triangular pitch arrangement on minimum fluidization for both the materials i-e local sand particles and rice husk as observed from fig 6, 7 and 8 which is a comparison plot of superficial air velocity as a function of pressure drop for local sand particles as a bed material in presence of tubes of two different geometries inside the bed at different aspect ratios i-e 0.33 m, 0.35m and 0.38m

Tubes basically confine the air flow and trim down the cross sectional area of fluidized bed reactor, giving higher interestial gas velocity and therefore a lower minimum fluidization velocity U_{mf}

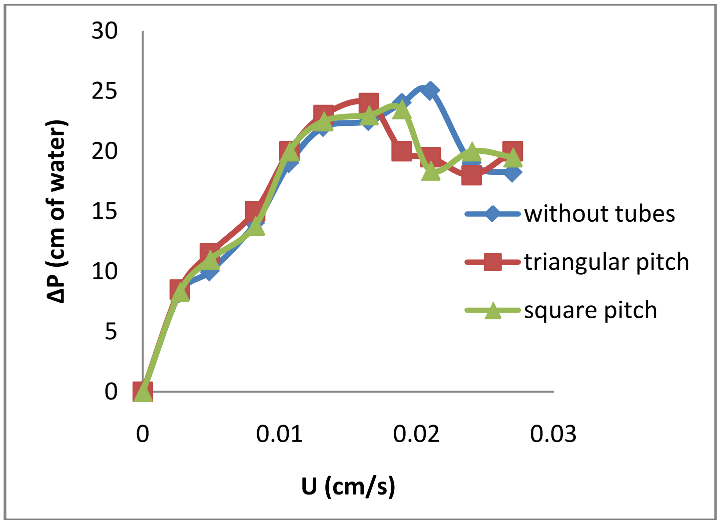

Fig. 6 : Plot between superficial air velocity and pressure drop having square pitch and triangular pitch arrangement of 1.2" tubes at 0.33m initial bed height of local sand particles

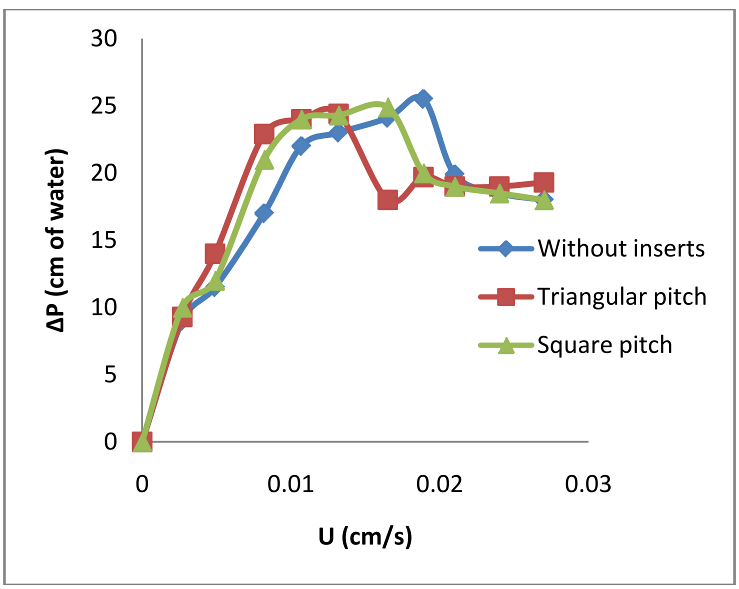

Fig. 7 : Plot between superficial air velocity and pressure drop having square pitch and triangular pitch arrangement of 1.2" tubes at 7.1m initial bed height of local sand particles

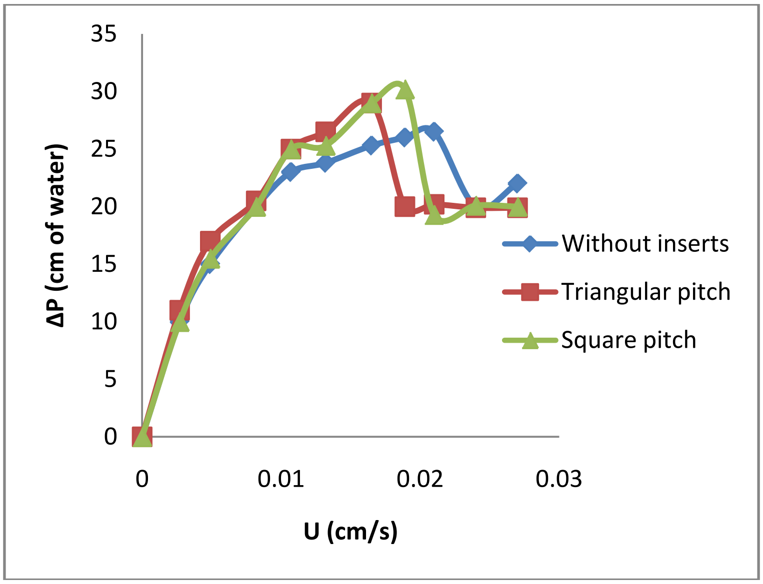

Fig. 8 : Plot between superficial air velocity and pressure drop having square pitch and triangular pitch arrangement of 1.2" tubes at 6.1m initial bed height of local sand particles

Fig 9, 10 and 11 represents the graph between superficial air velocity and pressure drop having square pitch arrangement and triangular pitch arrangement of 1.2" diameter tubes inside the reactor at initial bed heights i-e 0.33m, 0.35 and 0.38m. Minimum fluidization of rice husk particles was being studied by determining bed pressure drop experimentally and is being marked in plots.

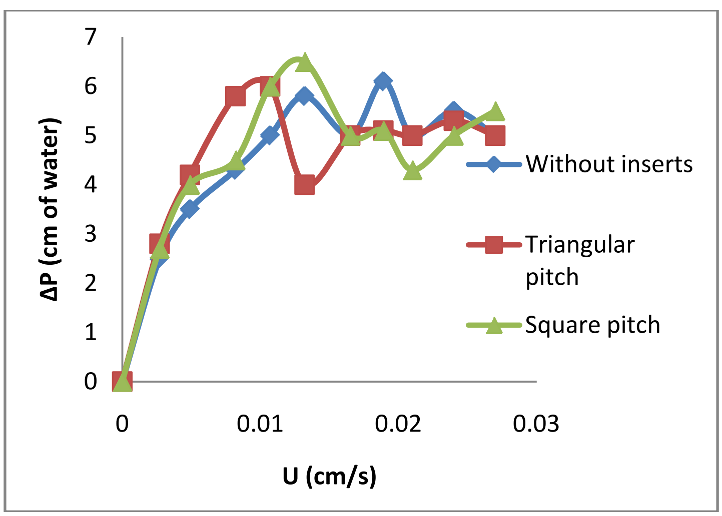

Fig. 9 : Plot between superficial air velocity and pressure drop having square pitch and triangular pitch arrangement of 1.2" tubes at 0.33m initial bed height of rice husk particles

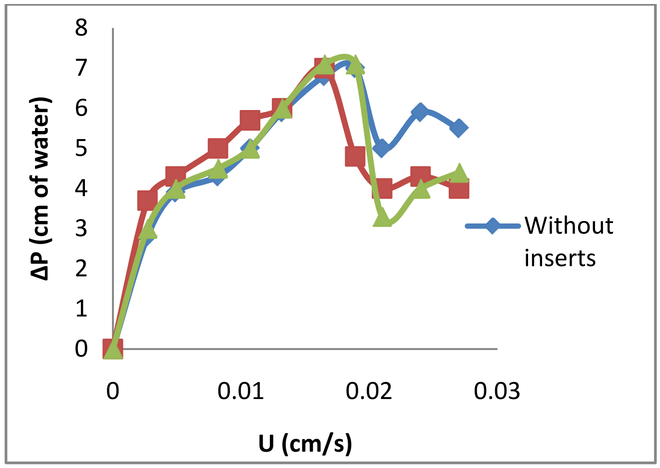

Fig. 10 : Plot between superficial air velocity and pressure drop having square pitch and triangular pitch arrangement of 1.2” tubes at 7.1 m initial bed height of rice husk particles

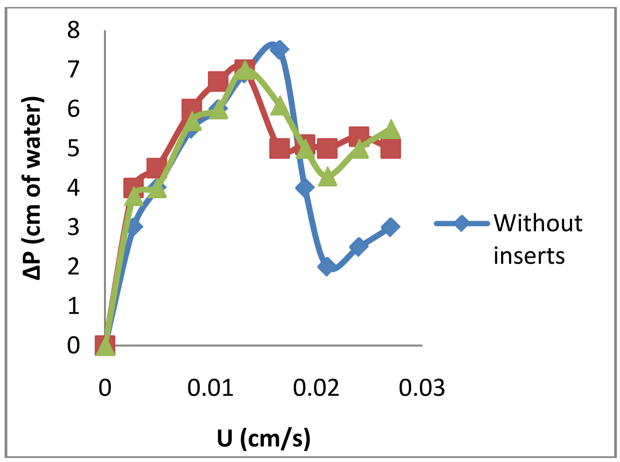

Fig. 11 : Plot between superficial air velocity and pressure drop having square pitch and triangular pitch arrangement of 1.2” tubes at 6.1m initial bed height of rice husk particles

Table 6 : Measured and Calculated Umf with Re_{mf} and Ar

Materials	Particle density ρ_p (kg/m^3)	U_{mf} (woi) (m/s)		Re_{mf}	Ar
		Exp	Pred.		
Sand	1490	0.021	0.015	0.12	165
Rice husk	567	0.018	0.004	0.04	62.07

The force balance in a bed for which the lower part of depth L_1 has no inserts and upper part has inserts of depth L_2

$$\Delta p_1 - \Delta p_2(1-a_t/a_b) = \prod/6 d_g^3(\rho_c - \rho)[(1-e_1)+(1-e_2)+(1-a_t/a_b)L_2]$$

e1=e2=e3 assumption

If mass of particles are constant then

$$M = \prod/6 d_g^3 \rho_c (1-e)[L_1 + L_2(1-a_1/a_b)]$$

Hence at Umf pressure drop is constant so to put side by side different beds with and without inserts one should plot this against true superficial velocity as shown in Fig 14. and showed that Umf is reduced when number of tubes inserted inside the bed.

$$\Delta P' = \Delta p\ [L_1/L_1 + L_2(1-a_1/a_b)]$$

$$U' = U[(L_1/L_1 + L_2) + (L_2/L_1 + L_2)(1/1-a_t/a_b)$$

Equations for true values obtained from reference [1]

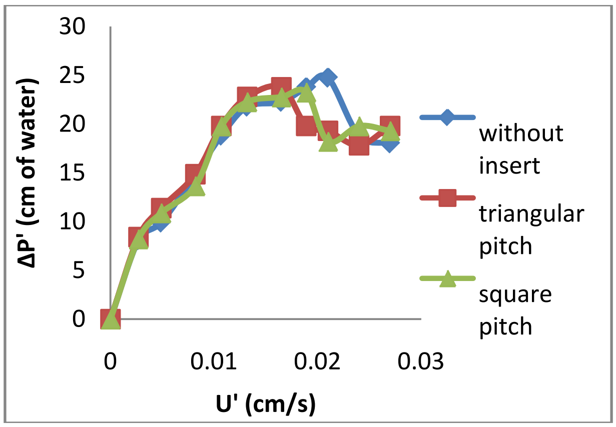

Fig 12 : Graph between true values of pressure drop and superficial air velocity for triangular and square pitch arrangements of tubes inside the bed for sand particles at 0.33m initial bed height

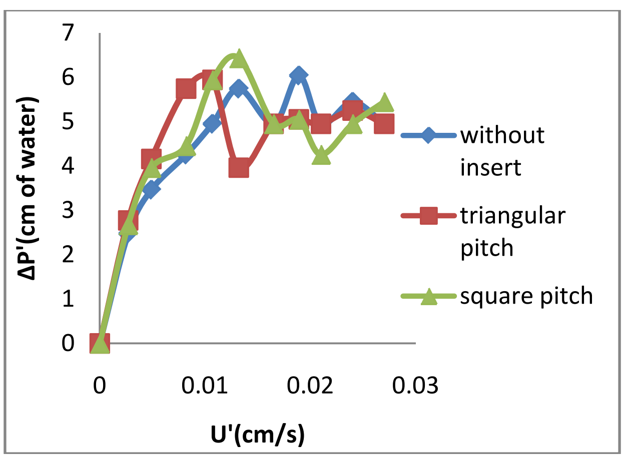

Fig 13 : Graph between true values of pressure drop and superficial air velocity for triangular and square pitch arrangements of tubes inside the bed for rice husk particles at 0.33m initial bed height

VI. Conclusions

- Minimum fluidization velocity studied in current research in 3D Atmospheric Fluidized Bed increased by increasing the density of the materials.
- The results obtained in current research shows that bed height is independent on minimum fluidization velocity for 0.348m*0.348m Atmospheric Fluidized Bed.
- Pressure drop increased as bed height incremented.
- By using tubes inside bed minimum fluidization velocity reduced.
- Triangular pitch arrangements of tubes enhance turbulence and decrement the fluidization velocity as compared with square pitch arrangements in bed.

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Symbols used
d_p=diameter of particles [μm]
H=height of bed [m]
D=diameter of fluidized bed [m]
H/D=height–to-diameter ratio [dimensionless]
U=superficial air velocity [m/s]
Umf=minimum fluidization velocity [m/s]
ΔP=pressure drop across the column [cm of H_2O]
Ar=Archimedes number [-]
ρg= density of gas [kg/m3]
ρp=density of particle [kg/m^3]
g=gravitational constant [m/s^2]
μg=viscosity of gas [Ns/m2]
Remf= Reynolds number [-]
es=voidage of sand[-]
er=voidage of rice husk[-]
Φs=sphericity of sand[-]
Φr=sphericity of rice husk[-]
U'=true velocity [m/s]
ΔP'=true pressure drop[-]
L_1=depth of bed with inserts[m]
L_2=depth of bed without inserts[m]
a_t=cross section area of tubes[m2]
a_b=cross section area of bed[m2]
woi= without inserts

VII. Acknowledgements

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Analytical Study on Motion Behavior of Non-Spherical Particles in Incompressible Fluid with Presence of Electrostatic Force

By A. Noorpoor & N. Shahrokhi-Shahraki
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Abstract - In this paper, the accelerated motion of non-spherical particles in an incompressible fluid in both the presence and the absence of electrostatic force was investigated. Differential transformation method (DTM) and a FORTRAN code was used to calculate the instantaneous velocity of particles. Regarding particles' instantaneous velocity in the absence of electrostatic force, DTM approach was resulted in a proper accordance with previous studies which utilized variational iteration method (VIM). In addition, a good agreement between DTM and VMT was seen as sphericity of particles was varied from 0.5 to 0.9. The results showed that falling velocity increased with increasing sphericity. Moreover, the presence of electrostatic force (by assuming the electrical load equal to 1 micro colon) was compared to the one with no electrostatic force. The results showed that the falling velocity was decreased by 23.33% under the effect of an additional resistant force.

Keywords: electrostatic, particles, acceleration motion, fluid, liquid.

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A. Noorpoor [α] & N. Shahrokhi-Shahraki [σ]

Abstract- In this paper, the accelerated motion of non-spherical particles in an incompressible fluid in both the presence and the absence of electrostatic force was investigated. Differential transformation method (DTM) and a FORTRAN code was used to calculate the instantaneous velocity of particles. Regarding particles' instantaneous velocity in the absence of electrostatic force, DTM approach was resulted in a proper accordance with previous studies which utilized variational iteration method (VIM). In addition, a good agreement between DTM and VMT was seen as sphericity of particles was varied from 0.5 to 0.9. The results showed that falling velocity increased with increasing sphericity. Moreover, the presence of electrostatic force (by assuming the electrical load equal to 1 micro colon) was compared to the one with no electrostatic force. The results showed that the falling velocity was decreased by 23.33% under the effect of an additional resistant force.

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I. Introduction

Sedimentation of solid or liquid particles in fluids occurs in the different natural and artificial phenomena. Different researches were studied the behavior of dispersed particles in an incompressible media, in which most of the mutilized Eulerian-Eulerian or Eulerian-Lagrangian approaches. When using an Eulerian-Lagrangian approach for two-phases fluids, the continuity and momentum balance equations must be derived from the hydrodynamics of the continuous phase. However, each encapsulated particle is considered as a main mass for which velocity and state are derived from Newton's second law as follows

$$m_i \ \frac{du_i}{dt} = F_i \ , \ \frac{dx_i}{dt} = u_i \qquad (1)$$

wherem_i is particle mass,$u$is velocity, $t$is time, x is original analytical function, andF_i is the resultant of forces that are appliedtothe particle, including gravity, buoyancy, drag, virtual mass force, the Basset force, and lift force.

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Equation (1) has been solved numerically in different studies by various methods, for example the finite difference method [1]. Some analytical methods which were applied for analysis of the acceleration of spherical and non-spherical particles motion in Newtonian fluids was addressed in[2-10]. Jalaal and Ganji[3]studied spherical and non-spherical particles motion in unsteady state at Newtonian media. They used friction coefficient governed by Chhabra and Ferreira's equations[11]for a range of Reynolds numbers by using the homotopy perturbation method (HPM). Jalaal et al. [6]studied non-spherical particles motion at the Newtonian media using the VIM and friction equations derived by Chien[12]. In another researches, Jalaal et al.[4] and Jalaal and Ganji[5]studied non-spherical particles by using the HPM.

Stokes [13]assigned following equation for drag coefficient of a sedimenting particle. The equation is derived for a flow field that is totally dominated by viscous diffusion as below

$$C_D = \frac{24}{Re} \qquad (2)$$

where C_D is drag coefficient and Re is Reynolds number. This equation denied the effect of inertia and is accepted for$Re < 0.4$. Therefore, Oseen[14], assuming the effect of inertia, completed the Stokes's equation as follow

$$C_D = \frac{24}{Re}\left(1 + \frac{3}{16} Re\right) \qquad (3)$$

Most of previous researches on spherical and non-spherical particles carried out experimentally and only a few of them were analytically investigated the solution of motion equations. In this regard, Proudman and Pearson [15]proposed$Re^2 \times \ln{(Re)}$ parameter to consider the behavior of drag coefficient for spherical particles and then Sano [16]completed aforementioned equation. Lovalenti and Brady [17] used the Kim and Karilla's equations [18]to solve directly the behavior of applied forces on particles and derived different parameters of time reduction, Includingt^{-1}, $t^{-5/2}$,e^{-t}, $t^{-2}.e^{-t}$,$t^{-1/2}$, and t^{-2}, depending on initial conditions. Ferreira and Chhabra[11]achieved the following equation for $0 \le Re \le 10^5$

$$C_D = \frac{24}{Re}\left(1 + \frac{1}{48} Re\right) \quad (4)$$

Equation (4) showed a suitable accordance with results of experimental researches. Also, in many cases, a linear equation can describe the drag force very well. In some cases, Reynolds number has an average value and the liner and exponential terms are used in[11, 12, 19-22].

Regarding non-spherical particles, Haider and Levenspiel[23]proposed an accurate equation in order to contemplate drag force taking into account of Reynolds number and sphericity. Rewriting the force balance and assuming $\rho << \rho_s$, the equation (1) can be implemented as

$$m\frac{du}{dt} = mg\left(1 - \frac{\rho}{\rho_s}\right) - \frac{1}{8}\pi D^2 \rho C_D u^2 - \frac{1}{12}\pi D^3 \rho \frac{du}{dt} \quad (5)$$

where$g$ is acceleration due to gravity, ρ is fluid density, ρ_s is particle density and D is particle's equivalent diameterThe main difficulty in solving equation (5) is the non-linear part appeared to express drag force.By insertingequation (4) in equation (5) and rewriting the equation (5), the equation (6) is derived as follow

$$a\frac{du}{dt} + bu + cu^2 - d = 0 \ , u(0) = 0 \quad (6)$$

Where a, b, c, and d are constants and depend on physical condition of the system.

Different methods were proposed in previous studies to solve equation (6). Among those, VIM, a technique based on repeated integration proposed by He [24], was used successfully to solve linear and non-linear equations by different authors. This method is based on the true function by a general Lagrangian multiplier. DTM is another method to solve the linear and non-linear terms proposed by Yaghoobi and Torabi[8]. Noorpoor and Nazari [25] used DTM to calculate the falling velocity of a particle in the acoustic field.

II. Materials and Methods

In this paper, equation (5) was solved by using the Yaghoobi and Torabi's equations[8]. The solving procedure included applying DTM by using a FORTRAN code.

By combining equation (5), Reynolds number ($Re = \frac{\rho u D}{\mu}$, μ is dynamic viscosity), and drag coefficient equation, the final equation of a falling acceleration of non-spherical particle motion in an incompressible fluid was written as follow

$$\left(m + \frac{1}{12}\pi D^3 \rho\right)\frac{du}{dt} + 3.75\pi D\mu u + \frac{67.289 e^{(-5.03\emptyset)}}{8}\pi D^2 \rho u^2 - mg\left(1 - \frac{\rho}{\rho_s}\right) = 0 \quad (7)$$

where $\emptyset$ is sphericity of particle. For simplicity, this equation's coefficients were assigned as a, b, c and d in further equations. First term of equation (7)is to describe the added mass to a falling non-spherical particle in an incompressible fluid. The second and third term show the resistant force of particle's linear and non-linear motion respectively, and the fourth shows the applied gravity and buoyancy forces on the falling non-spherical particle in an incompressible fluid.

$$a = \left(m + \frac{1}{12}\pi D^3 \rho\right) \quad (8)$$

$$b = 3.75\pi D\mu \quad (9)$$

$$c = \frac{67.289 e^{(-5.03\emptyset)}}{8}\pi D^2 \rho \quad (10)$$

$$d = mg\left(1 - \frac{\rho}{\rho_s}\right) \quad (11)$$

So, equation (7) was rewritten as follow

$$a\frac{du}{dt} + bu + cu^2 - d = 0, u(0) = 0 \quad (12)$$

According to DTM conversion functions, equation (12) is provided as following transformed equation

$$a(k+1)U(k+1) + bU(k) + c\left(\sum_{l=0}^{k} U(l)U(k-1)\right) - d \times \delta(k) = 0 \quad (13)$$

The value of $u(0)$ is equal to zero. Other value of $u(k)$ for k=1, 2, 3 … are governed by above equation and can be calculated as bellow.

$$U(1) = \frac{d}{a} \quad (14)$$

$$U(2) = -\frac{1}{2} \times \frac{bd}{a^2} \quad (15)$$

$$U(3) = \frac{1}{3!} \times \frac{d(b^2 - 2cd)}{a^3} \quad (16)$$

$$U(4) = -\frac{1}{4!} \times \frac{bd(b^2 - 8cd)}{a^4} \quad (17)$$

$$U(5) = \frac{1}{5!} \times \frac{d(b^4 - 22b^2cd + 16c^2d^2)}{a^5} \quad (18)$$

$$U(6) = -\frac{1}{6!} \times \frac{bd(b^4 - 52b^2cd + 136c^2d^2)}{a^6} \quad (19)$$

$$U(7) = \frac{1}{7!} \times \frac{d(b^6 - 114b^4cd + 720b^2c^2d^2 - 272c^3d^3)}{a^7} \quad (20)$$

$$U(8) = -\frac{1}{8!} \times \frac{bd(b^6 - 240b^4cd + 3072b^2c^2d^2 - 3968c^3d^3)}{a^8} \quad (21)$$

To calculate the velocity at each moment following equation is using

$$U_i(t) = \sum_{k=0}^{n}\left(\frac{t}{H_i}\right)^k U_i(k), \ 0 \le t \le H_i \quad (22)$$

By inserting equations (14) and (21) in equation (22), final equation of estimating the fall velocity of non-spherical particles in an incompressible fluid is derived as

$$U_i(t) = U(1)t + U(2)t^2 + U(3)t^3 + U(4)t^4 + \cdots \quad (23)$$

In order to study the impact of electrostatic force, Coulomb's lawis used as follow

$$F = \frac{Q^2}{4\times\pi\times\varepsilon_0\times r^2}, \varepsilon_0 = 8.85\times 10^{-12} \quad (24)$$

Where F is electrostatic force, Q is thesigned magnitude of the charges, r is the distance between the charges, and ε_0 is vacuum permittivity coefficient.

By inserting the above equation in equation (5), the equation (25) is derived.

$$\mathrm{m}\frac{du}{dt} = mg\left(1-\frac{\rho}{\rho_s}\right) - \frac{1}{8}\pi D^2\rho C_D u^2 - \frac{1}{12}\pi D^3\rho\frac{du}{dt} + \frac{Q^2}{4\times\pi\times\varepsilon_0\times r^2} \quad (25)$$

Assuming that all varieties of equation (24) are independent of time, following equation can be written by rewriting terms of equation (25) and inserting equation (7) in (11), and a non-linear deferential equation is formed:

$$a\frac{du}{dt} + bu + cu^2 - d - e = 0 \ , u(0) = 0 \quad (26)$$

By applying the DTM one quation (26) the following equation is derived.

$$a(k+1)U(k+1) + bU(k) + c\left(\sum_{l=0}^{k} U(l)U(k-1)\right) - (d+e)\times\delta(k) = 0 \quad (27)$$

By considering equations numbers from (13) to (27),the term (d+e) was replaced to (d) to calculate U(1) to U(8). As a result:

$$U(1) = \frac{(d+e)}{a} \quad (28)$$

$$U(2) = -\frac{1}{2}\times\frac{b(d+e)}{a^2} \quad (29)$$

$$U(3) = \frac{1}{3!}\times\frac{(d+e)(b^2-2c(d+e))}{a^3} \quad (30)$$

$$U(4) = -\frac{1}{4!}\times\frac{b(d+e)(b^2-8c(d+e))}{a^4} \quad (31)$$

$$U(5) = \frac{1}{5!}\times\frac{(d+e)(b^4-22b^2c(d+e)+16c^2(d+e)^2)}{a^5} \quad (32)$$

$$U(6) = -\frac{1}{6!}\times\frac{b(d+e)(b^4-52b^2c(d+e)+136c^2(d+e)^2)}{a^6} \quad (33)$$

$$U(7) = \frac{1}{7!}\times\frac{(d+e)(b^6-114b^4c(d+e)+720b^2c^2(d+e)^2-272c^3(d+e)^3)}{a^7} \quad (34)$$

$$U(8) = -\frac{1}{8!}\times\frac{b(d+e)(b^6-240b^4c(d+e)+3072b^2c^2(d+e)^2-3968c^3(d+e)^3)}{a^8} \quad (35)$$

Finally, using final derived equations described above, the equation (23)was solved as the general equation using a FORTRAN code.

III. Results and Discussion

The FORTRAN code is used for calculating instantaneous velocity,$U_i(t)$, by assuming sphericity, density and equivalent diameterof particle equal to 0.9, 2100$\frac{kg}{m^3}$ and 3mm respectively.

Figure 1 illustrated the changes in the instantaneous velocity for sphericity of 0.9 when the fluid was water and no electrical load was applied. The falling velocity increased with increasing time. This increasing approach followed the linear behavior at the beginning, until the velocity passed 0.1 m/sec point. However, as it can be seen, the value of velocity reached to a constant value of 0.16 m/sec after 0.07 sec.

Figure 1

Figure 2 and 3 compares instantaneous velocities in water and ethylene glycol as their densities differ. The same approach can be seen regarding the increasing of velocity with time. However, the rate of increase in values of velocity was higher for water as its density is lower than that of ethylene glycol. In addition, the rate in ethylene glycol's representative diagram was increased in nonlinear approach in contrast with the one of water's.

Figure 2

Figure 3

Figure 4 represents the changes of particle's velocity when its sphericity changes. As it can be seen, the increase in sphericity resulted in an increase in falling velocity. The trend of increasing velocity was approximately the same before the velocity hit 0.04 m/sec independent of particles' sphericity. After this velocity, however, this rate was higher for particles with higher sphericity.

Figure 4

Falling velocity of particles with lower sphericity reached a constant value in shorter times comparing the ones with lower sphericity. These results are consistent with Yaghoobi's and Torabi's [8] and Jalaal's and Ganji's [3]. An error analyzing was carried out in order to compare the results obtained in this study and Yaghoobi and Torabi's[8]; for particles with sphericity of 0.5 and in absence of electrostatic force assuming the water as the incompressible fluid used for both studies, the value of falling velocity differ 6.7%. Table 1 lists important points which can be taken form Figure 4 for falling velocities of particles with different sphericities and the trend they increased.

Table 1

In order to investigate the effects an electrostatic force on particles' sedimentation instantaneous velocity, an electrical load equal to 1 micro colon applied to a non-spherical particle with sphericity of 0.9 in water. The effects of electrostatic force in the motion behavior of particles in different distances between electric charges (0.5 m and 1.0 m) are shows in Figure 5. It can be found from this figure that applying electrostatic force reduced sedimentation velocity by 23.33% due to the formation of a resistant force between particles. This reduction was more pronounced for shorter distance between the charges compared to the one with longer distance. Also, it can be seen from Figure 5 that the effect of electrostatic force was approximately constant with time especially after 0.04 sec.

IV. Conclusion

The differential transformation method (DTM) was used for analytical investigation of non-spherical particles' falling velocity in an incompressible fluid in both the presence and the absence of electrostatic force. Results of this study indicated that, in general, the increasing curve of the sedimentation of non-spherical particles in incompressible fluids mostly behave nonlinear until it reaches the constant value. In addition, the effects of changing fluid's density in sedimentation behavior of particles was investigated. The results showed the falling velocity in water (the fluid with lower density) was higher than the one for ethylene glycol (the fluid with lower density).Moreover, when the sphericity increased, the sedimentation rate increased even though this rate differed for each sphericity. As results showed, particles with sphericity of 0.9 experienced the highest falling velocity and increasing rate followed by those with sphericity of 0.7 and 0.5 respectively. After applying an electric load of 1 micro colon in with distant between charges of 0.5 m and 1.0 m, the falling velocity decreased as a resistant force was created. This decrease was more noticeable for the distance of 0.5 with decreasing about 23% in value of falling velocity.

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Tables

Table 1 : Important points in increasing behavior of falling velocity of particles with different sphericities

Sphericity	Time of linear velocity sec	Maximum linear velocity m/sec	Start of constant velocity sec	Instantaneous velocity m/sec
∅=0.5	0.01	0.0306	0.03	0.06
∅=0.7	0.03	0.079	0.04	0.096
∅=0.9	0.06	0.146	0.08	0.16

Figures

Figure (1) – The changes of instantaneous velocity for sphericity of 0.9 with time in water and in absence of electrostatic force.

Figure (2) - The changes of instantaneous velocity for sphericity of 0.9 with time in water and ethylene glycol and in absence of electrostatic force.

Figure (3) - Positions of falling particle for sphericity of 0.9 in in water and ethylene glycol and in absence of electrostatic force.

Figure (4) - The changes of instantaneous velocity for sphericity of 0.9, 0.7 and 0.5 with time in water and in absence of electrostatic force.

Figure (5) – The changes of instantaneous velocity for sphericity of 0.9with time in water and in presence of electrostatic force with distance of charges of 1 m and 0.5 m.

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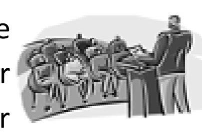

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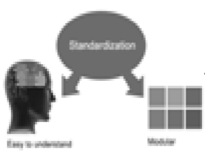

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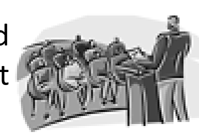

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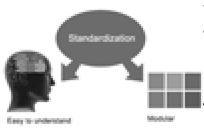

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All manuscripts submitted to Global Journals Inc. (US), ought to include:

Title: The title page must carry an instructive title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) wherever the work was carried out. The full postal address in addition with the e-mail address of related author must be given. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining and indexing.

Abstract, used in Original Papers and Reviews:

Optimizing Abstract for Search Engines

Many researchers searching for information online will use search engines such as Google, Yahoo or similar. By optimizing your paper for search engines, you will amplify the chance of someone finding it. This in turn will make it more likely to be viewed and/or cited in a further work. Global Journals Inc. (US) have compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Key Words

A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy and planning a list of possible keywords and phrases to try.

Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art.A few tips for deciding as strategically as possible about keyword search:

- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

The Editorial Board and Global Journals Inc. (US) recommend that, citation of online-published papers and other material should be done via a DOI (digital object identifier). If an author cites anything, which does not have a DOI, they run the risk of the cited material not being noticeable.

The Editorial Board and Global Journals Inc. (US) recommend the use of a tool such as Reference Manager for reference management and formatting.

Tables, Figures and Figure Legends

Tables: Tables should be few in number, cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g. Table 4, a self-explanatory caption and be on a separate sheet. Vertical lines should not be used.

Figures: Figures are supposed to be submitted as separate files. Always take in a citation in the text for each figure using Arabic numbers, e.g. Fig. 4. Artwork must be submitted online in electronic form by e-mailing them.

Preparation of Electronic Figures for Publication

Even though low quality images are sufficient for review purposes, print publication requires high quality images to prevent the final product being blurred or fuzzy. Submit (or e-mail) EPS (line art) or TIFF (halftone/photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Do not use pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings) in relation to the imitation size. Please give the data for figures in black and white or submit a Color Work Agreement Form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution (at final image size) ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs) : >350 dpi; figures containing both halftone and line images: >650 dpi.

Figure Legends: Self-explanatory legends of all figures should be incorporated separately under the heading 'Legends to Figures'. In the full-text online edition of the journal, figure legends may possibly be truncated in abbreviated links to the full screen version. Therefore, the first 100 characters of any legend should notify the reader, about the key aspects of the figure.

6. AFTER ACCEPTANCE

Upon approval of a paper for publication, the manuscript will be forwarded to the dean, who is responsible for the publication of the Global Journals Inc. (US).

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(Free of charge) from the following website:

www.adobe.com/products/acrobat/readstep2.html. This will facilitate the file to be opened, read on screen, and printed out in order for any corrections to be added. Further instructions will be sent with the proof.

Proofs must be returned to the dean at dean@globaljournals.org within three days of receipt.

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Before start writing a good quality Computer Science Research Paper, let us first understand what is Computer Science Research Paper? So, Computer Science Research Paper is the paper which is written by professionals or scientists who are associated to Computer Science and Information Technology, or doing research study in these areas. If you are novel to this field then you can consult about this field from your supervisor or guide.

TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

2. Evaluators are human: First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

3. Think Like Evaluators: If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

4. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

5. Ask your Guides: If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

6. Use of computer is recommended: As you are doing research in the field of Computer Science, then this point is quite obvious.

7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

8. Use the Internet for help: An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

9. Use and get big pictures: Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.

- Do not give permission to anyone else to "PROOFREAD" your manuscript.

- Methods to avoid Plagiarism is applied by us on every paper, if found guilty, you will be blacklisted by all of our collaborated research groups, your institution will be informed for this and strict legal actions will be taken immediately.)
- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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