Modeling and Analysis Of Down Draft Gasifier

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Abstract

Gasification is a robust alternative technology to produce either electrical or thermal energy using renewable energy resources like biomass. Biomass is considered to be one of the most assurance imperishable energy sources in the present scenarios. Due to strict policy on reduction of emission, biomass has become one of the centers of attention worldwide as a source of green energy. The technology of gasification is considered now to be in an advanced stage of development. Hence there is high expectation from the user industry for its various applications. Now a day, because of increasing the interest in biomass gasification, many different kinds of models and methods are to be suggested in order to describe the analysis and to recognize these intricate procedures, and the model designs, optimization, simulations, and procedure investigations of gasifier has been executed. In this work the combustion and reduction zones average temperatures were recorded at 8380C and 7540C respectively, with this also Total heat flux during 1second is 1.135e003w/m2; Directional heat flux is 1.0942e006w/m2. After this continuing the simulation up to 9000Secs then observed some changes in the results that is max temp is 841.360C, max total heat flux is 2.3672e006w/m2, and for directional heat flux is 7.9383e005w/m2 .The results obtained by simulation model analysis were validated with the experimental results, graphs from literature, for this reason a downdraft gasifier model is designed using verifiable data's in SOLID WORKS software. This work reveals that temperature distribution, heat flux and directional heat flux in a steady state and transient heat transfer in front the chamber of downdraft gasification process has been investigated by applying ANSYS 16.0 Work bench software.

Keywords: CO2- Carbon Dioxide, CO- Carbon Monoxide, H2-Hydrogen, CH_4-Methane

1. Introduction

A gasifier system is a reactor that transforms biomass into clear gaseous fuel called producing gas (which is having CV in the order of 1000–1200 kilocalories per normalized cubic meter). Biomass gasifying system naturally utilizes biomass for power production. It contains a downdraught gasifier, a gas-cleaning engine and train. The development modification provides users with the opinions of multi-fuel operations. The diesel genset exists could start on both producer gas and diesel, either of starts only on diesel fuel. The producing gas is used into the diesel engine to start the engine operates in a multi-fuel system, thereby decreasing diesel consumption by extra than 70%. The producing of gas generating (producer gas) known as gasifying process is half portion firing of solid fuels (bio fuel) and taking place at temperature range of 10000C. The reactors are known as a gasifying process. The firing materials from fully burning of bio fuels energy normally contain a water vapors, nitrogen, carbon dioxide and excess of oxygen. In gasification process however, where there is a many materials of solid fuels (not complete and complete burning, firing) the combustion of products are able to catch gases such as Carbon monoxide (CO), Hydrogen (H2) and detects of Methane's and not useful for materials such as dust and tar. The generations of these gas contents are by reactions of vapors based water and carbon related dioxides from a existing layers of charcoal. Hence the main point to gasifying system models is to make circumferences like that a) bio fuel is decreased to charcoals and, b) charcoals is transferred at available temperatures to producing Carbon monoxide and Hydrogen[1].

The process of Gasification is a thermo and chemical procedure by which carbon contained (hydrocarbon) materials (petroleum coke, biomass, coal, etc.) can be transferred to a made by gas (like syngas) or producing gas by means of half of the oxidation with air, oxygen, or steam content. The system which does this work is called as gasifier. The Gasifier process is a chemical reaction where many types of savior physical and chemical processes taking place. A hydrocarbon raw materials (biomass) are used into a more-pressure, more-temperature chemical reactions (gasifier) contains steam and a limiting quantity of oxygen. As biomass comes through the reactors it becomes dried, paralyzed, heated, partially oxidized and generated. By using these kinds of “reducing” terms, the bonds of chemical in the raw materials are severed by the higher pressure, heat and producing gases are existed. The important mixtures of producing gas are carbon monoxide (CO) and hydrogen (H2). In short, the performance of gasifier is to pyrolysed in the biomass to produce volatile contents, carbon, gas and to transfers the volatile component into fixed gases, CO, H2 and CH4 [1]. Biomass is the organic component, which includes system material from like grasses, trees and agriculture based crops. The mixture of chemical biomass energy movements amongst various living organisms, because normally contains of more, but variables in moisture part, a fibrous design consists of sugar or carbohydrate, lignin and ashes. The energy of Bio fuel is very heterogeneous in this normal stage and belonging to a heating amount smaller than that of coals. The process of Gasifying is a higher than centenary old technique, which cherished during an earlier than the Second World War. This technology disappeared sonly after the 2nd World War, when that liquidious based fuel (petrol based) becomes effortlessly available. Before the 20th century, the gasifying process reused irregular and can liberating feelings amongst the investigators. However, now a day with hiking price of fossil fuels and reducing environment based taking into account, this development has again uses of attractions and have been achieved as a latest, durable techniques.

The procedure of transformation of solidaceous carbon based fuel into combustion of gases of small amount of firing called as gasifying process. The finale gases called as producing gas (mixture of carbon monoxide 15-20%, Hydrogen 10-15%, Methane up to 4%, Nitrogen 45-55%, Carbon dioxide 8-12%), is stronger in the uses after new and real solid bio fuel. A component using for this gasifying system procedure is called as gasifier. Gasifying process is basically a thermal and chemically transformation of biological components at deviated temp against small amount oxygen. In gasifying process, the biomass strength or any other biological material is transferred to combustion of the gas (mixtures of CO, CH4 and H2), also water, chars and combustible as normal products.At the beginning, in the beginning stage known as pyrolysed zone, the biological component is decomposes by high temp into gas based content and liquidious volatiles components and partially burned (which is mostly a nonvolatiled materials, consists of more CO2 based mixture). In the 2nd stage, the hot partially burned components reacting with the gases (mainly H2O, CO2), leads to product gases namely, CH4 and CO, H2. Mixing against air, the cleaning producing gases can be using in a gaseous turbine (in larger scaled plants), gasolines or diesel used engines, gas engines [1].Congratulations! Your paper has been accepted for journal publication. Please follow the steps outlined below when submitting your final draft to the IJAMTES Press. These guidelines include complete descriptions of the fonts, spacing, and related information for producing your proceedings manuscripts. Please follow them and if you have any questions, direct them to the production editor in charge of your journal at the IJAMTES.

1.1 Gasification Process:

Gasifier has four distinct processes –

1. Drying:-This zone contains, moistured contents of the bio fuels is consistently decreased to be 5 to 35%.In this dried zone, temp is ranges from 100-2000C.

2. Pyrolysis:-This is the 1st step in the burning, or gasifying of bio fuel. When the non appearance of air, biomass is heated in the range of 350-6000C, this forms burned wastes, gases and tar vapor. Bio fuel + temp → solids, liquid,
Gases components (H_2, H_2O, CO, CO_2)
3. Combustion: - In combustion process the reaction between oxygen in the air and solid carbonized biomass, this result in formations of CO_2. H_2 exists in the bio fuels is also oxidize to produce water. High quantity of temp is released with the oxidations of carbon and H_2. $C + O_2 \rightarrow CO_2$
4. Reduction: - In this zone the absence of O_2, so many decreased re-actions occurs in the heat which has the limits of about 600-10000C.These kind of reactions are mostly endothermic [1].

2.METHODOLOGY

Solid works:

Various bodies (part) ware the nominal constructing blocks in the SOLIDWORKS operating system. Many assemblages contain materials or other assembled parts, known sub assemblies. SOLID WORKS designed model contains of 3D geometries that explains its corners, surfaces, faces. The SOLID WORKS software starts you construct the models quickly and accurately. SOLID2 WORKS models are Explained by 3D designs., Components based.
SOLIDWORKS using design 3Dimensional methodologies. Similarly we designing parts, from those beginning drawing of the last output, we made a 3Dimensinal drawing. From this model, we could make 2Dimensional drawings or mating assemblies comprising about parts alternately subassemblies will make 3Dimensional parts. We could likewise make 2Dimensional designs about 3Dimensional assemblies. At planning a design utilizing a SOLIDWORKS, we can analyze in 3D, this kind of lifestyle the model5exists when it will be made. SOLIDWORKS employments a 3D configuration approaches. Similarly a1s we outline a part, starting with the introductory sketch of the last result, we make a 3Dimensional design. Starting with this design, we can be in 2Dimensional designs separately making segments comprising of sub assemble or its parts will make 3Dimensional assemblies. We could likewise make 2Dimensional models of 3Dimensional parts.
When manufacturing a system utilizing a SOLIDWORKS, we might visualizing it previously, 3D for the best approach the design approaches when this may be used

2.1.1 Finite element method

"Finite element method (FEM) is a numerical method for resolving the integral and differential equations". It has function to the different physical problems, where leading the differential equations are available. The practice fundamentally consists of accommodating the piece wise reliable capability for arrangement and to get the parameters of the capacities in a way that diminishes the fall in the arrangement. In this article, a short introduction to finite element method is given. The technique is defined with the assistance of the plane stretch and plane strain definition. The "finite element analysis" this is the arithmetical procedure for extracting the functions of engineering and mathematics, physics related problems. It is need full for the critical with complex geometrical, material characteristics and loadings where analytical results cannot be occurred.

2.2 ANSYS workbench capabilities

ANSYS is integrated analysis of design tool based on FEM development by ANSYS, Inc. in this study, ANSYS workbench is used for finite element modeling. ANSYS provides a particular choice for the static, buckling and modal analysis. To achieve this analysis, the methodology is briefly explained below.

2.3 METHODOLOGY

Define the material Properties

⇩

Modeling of the Gasifier

⇩

Meshing

⇩

Apply boundary conditions

⇩

Result analysis

Fig.2.3 Methodology utilized for analysis

3 1. Defining of material properties:

The material used for the present case study is steel, below table describes their mechanical and thermal properties.

2.3.2 Properties of steel

Density	$7850kg * m^{-3}$
Coefficients of Thermally Expansions	$1.2 * e^{-005-1} * C^{-1}$
Specific of Heat	$434JKg^{-1} * C^{-1}$
Thermally Conductivity	$43Wm^{-1} * C^{-1}$
Material resistivity	$1.7 * e^{-005}$ Ohm*m

3 Modeling:

SOLID WORKS which gives the 3D modeling for creating and editing geometries. The model of SOLID WORKS is having 3Dimensinal geometry defines that its edge, surface and faces.

4. Meshing: Various complex geometries can be easily meshed with the help of ANSYS which contains the different 2D and 3D and hybrid meshes.

5. Boundary conditions: Applying corresponding boundary conditions to given model, after completion of mesh.

6. Results: The results which are obtained by finite element method is analyzed and validated.

2.4.1 Static analysis

A static structural analysis helps to determination of displacement stresses, displacements, strain, and forces in the components or structure which is ca1used by loads that do not influence the major inertia1 and its damping actions. A strong loads and retort rules can be suspected, that is the loading and structure's responses are supposed to varies slow with related to time. By using ANSYS and SAMCE solver, we can perform the static structural analysis. Types of loadings are to be considered in constant analyses; includes:

From outside area considered pressure and force is considered. Constant condition inertial force (just like gravitational or rotational velocity) , Inflict (not zero) movements.,Temperature considerations (thermally strain). A "static structural analysis" is to be either non linear or linear.

2.4.2 Thermal analysis

The Several physics of ANSYS, ANSYS functions of mechanical, and ANSYS occupational components guides, help the constant state heat related examinations. The heat related effects of steady state thermally supported loads, temperatures are applied on system or components can be calculated by steady state thermal analysis. Engineer/analyst regularly performs a slow motion related detailed examination during perfuming a transiently heat related detailed examination, to support modification the starting condition. Constant stage of thermal analysis is to be the final stage of transient's heat examination, which does the action next every transiental effect, has decreased.

To examine the heat related effects, thermal based gradient, thermal or heat flowing rates and temperature fluxes in a component, we can use steady state thermal analysis.

Those are because of the heat related loadings that does not change with final time. Likewise loads including the followings: Convection, Radiation, Flowing rate of Heat, during heating flux (flowing per unit area of heat), Generating heat per rate (per unit volumes of heat flow).

A constant stage heat related detailed examinations may be steady state, with components characteristics is constant or irregular, with components characteristics that depends on variations of the heat. Heat related characteristics of most materials varies against temperatures, hence generally examination is unsteady. It includes radiations effect can does examinations; in a non linear manner.

2.4.3 Temperature application on various zones

The following conditions show that temperature distribution in a Transient and Steady state Heat transfer. The main fundamental aim of these finite elemental examinations can be determined how component or group of materials responding to some loaded condition. And identifying appropriate loaded terms is main step in the examinations. To define a problem that results in that results in a single solutions, we must give the information on dependent variables at demine boundaries. The boundary conditions involving recognize the location of boundaries and giving suitable information at the boundary. Here we can study the loads and boundary conditions for thermal analysis.

2.4.4 TRANSIENT STATE THERMAL ANALYSIS

2.4.5 Steady state thermal heat transfer analysis

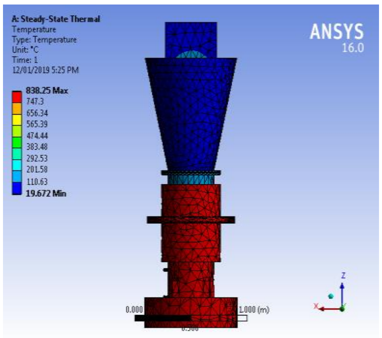


Fig.2.4.4Temperature distribution

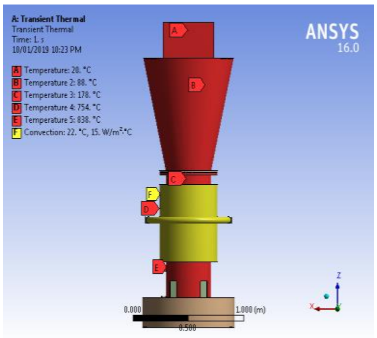


Fig2.4.5: Steady state temperature Distribution.

2.4.6 Graphical representations of temperature Distribution

Time [s]	Maxi [°C]
1.e-002	972.8
2.e-002	872.9
3.866e-002	916.82
8.015e-002	889.44
0.14912	839.78
0.24912	877.71
0.34912	904.38
0.44912	907.55
0.54912	902.79
0.64912	895.88
0.74912	888.86
0.84912	882.43
0.94912	877.29
1.	876.06

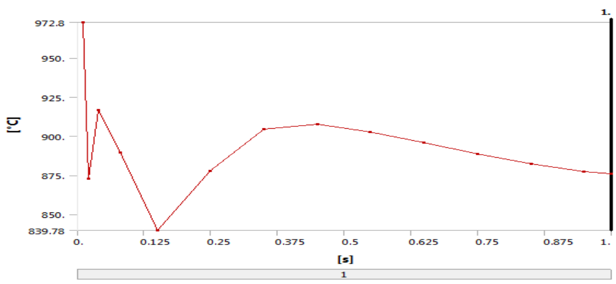
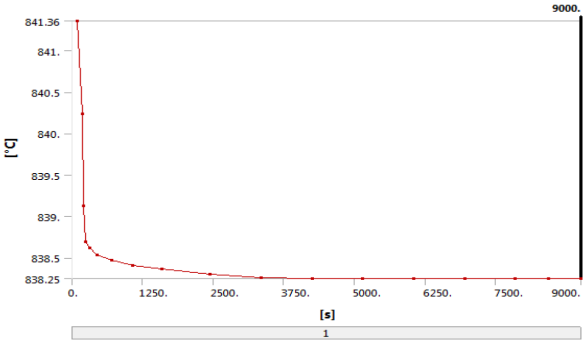


Fig 2.4.5 Transient Fig. Thermal> Solution (A6) > Temperature

2.4.6 Graphical representations of temperature Distribution

Model (A4) > Transient Thermal (A5) > Solution (A6) > Solution Information > Temperature - Global Maximum

Time [s]	Min [°C]	Max [°C]
90.	8.7049	841.36
180.	19.942	840.24
210.	19.937	839.13
240.	19.936	838.69
307.73	19.938	838.61
446.72	19.943	838.54
704.52	19.951	838.47
1072.3	19.957	838.41
1586.2	19.961	838.36
2443.6	19.965	838.31
3343.6	19.966	838.26
4243.6	19.967	838.25
5143.6	19.967	838.25
6043.6	19.967	838.25
6943.6	19.967	838.25
7843.6	19.967	838.25
8421.8	19.967	838.25
9000.	19.967	838.25



2.5. Temperature distribution in different sectors

2.5.1 Pyrolysis sector and drying sector

For the toper bisection of reactors, the average of the temperature were 880C & 1780C during drying stage (T1) and pyrolysed (T2) stages with standard variations of 200C & 680C, represented (Figures 2.4.4). In the zones of pyrolysis and drying zones, the temperatures of each exact copy showed towards tends over the movements. It can be examined that the external air heat has a sufficient actions on the reactors start ups and operations. For external temp less of -100C, the ignited flame required to be kept constant for lengthy durations of time insides of the ignited ports to confirm initiation. In extra or supplementary, the conditions of the bed which influences the upwards tends to temperatures. Cold pyrolysis components lefts in the main part of the reactors from a preceding function occurs relatives to solid mass of components existed each other. This flow ability of the mass is reduced in the biomass reactors and deviated down side the ignited processes. A small charcoal related bed is covered by recently made by biomass assisted to begins, which existed in a high quickly tends to temperature [1]. Heat transferred from the burning stages to topper level influences the temperatures trend of the pyrolysis and drying stages. Temperature transfers usually depend on kinetics of the reaction and conducting ability of component. The existence of gaseous content internal of raw material less than the temperature conducing ability of raw material influences on the temperatures in the pyrolysis and drying stages.

As early as possible the flame was away off from the ignited side, the temperature preceding ahead a downside trend towards initial temp means that not sufficient temperature is established in burning stage (zones) to maintaining the gasified process. Fewer heat in the pyrolysis and drying stages implies the less temperature established in burning (combusting) zones, means that's the gasifying is not occurs correctly in reduction or combustion zones.

As it is to be seems in Figure 2.4.4 & 2.4.5, there are few important difference exists between the separate movements. Whenever, a group of every run is similar. Each of the environment related parameter that should trouble free influences initiation of processes of the gasification ware the initial air temperatures. This initiation varying ability ware obviously, whenever the some tests was performing before two varieties positions, especially in what the external heat is mainly varies. More than this, cleanings-up stages between runs was one more influenced factor on the heat profiles of the operation, as more caked on component made lesser temperature transferred. For this because, the avg of all the ways is explained to make it simple to observes the trend before the gasifying processes [1].

2.5.2. Combustion and Reduction sector

The intensity of the zones in combustions (T3) and reductions (T4) zones in the below portion of the reactors, varies a important results along avg temp of 8380C and 7540C of the reduction and combustion zones. The avg amount of reactions A, B and C are 8180C, 8670C and 8310C, finally. However, all the reactions following same fields of maximizing at the initial then other remains a constant with others less variations (Figure 2.4.4 & 2.4.5). When the firing heat is raised to nearly 8000C (occurs in the first fewer seconds), then temperature becomes constant for the left over time of the further operations. The reduction zone temperature showed more constant behavior comparing to the combustion zones in all similar systems (Figure 1 & 2.1). The avg amounts in the reduction stage for similar operations. A, B and C were 6150C, 8470C and 8000C, occurred. This less stable ability in the reduction stages is important because of, to in stabile of air flowing in those stages. Furthermore, many of the responses in the burning stages are energy release and providing the essential heat for these responses. Before the tests, the reducing stage visible many temp variations with a accurate fluctuations of 2480C comparing to the burning stages (zones) which had a accurate fluctuations of 1650C. As seen in Figure 1 & 2.1, the temperatures of the reducing stages increasing instantly after start ups the burning in all reactions avoids. Experiment A which takes surrounds few additional second. The slowdown should be causes of initiation condition, particularly external oxygen temp where influences the Starting-ups times. As the burning stabilizes in reducing Stages, this keeps the temp amongst 7000C to 12000C.

The temperature is developed from an energy releasing in the firing stages and synthetic gases follows in a downside directions because of the air pressures existed through the progress. Gasifying reactions are especially endothermic; hence there were so many exothermic reactions to helps to initiating the endothermic reaction. Similarly, the reactions of oxygen with carbon and H2 are energy releasing processes. The downside half of the reactors achieved a more temp than the topper side of the gasifying system.

The temperature different throughout the operations of the gasifying system are drawn in Figure 1. The reducing stage of the temp was examined to completely a more biofuel carbonaceous transmission and maintains a less tar mixture. The less reaction temp (minimum of 7500C) can increases the points and mixtures of tar developed.

Figure 2.4.4 describes the estimated avged temperatured profile of the various sections of the gasifying before steady stage limits. The graph is represents the based on the worldwide constant conditions of the systems behind, begins the operations. Evidently, the begins time and links sequences ware not expected sequences of gasifying through this graphical indication and these outcomes in the structure movements through constant declaration to transiental and unsteady present terms [1].

2.6 Transient thermal Total heat flux

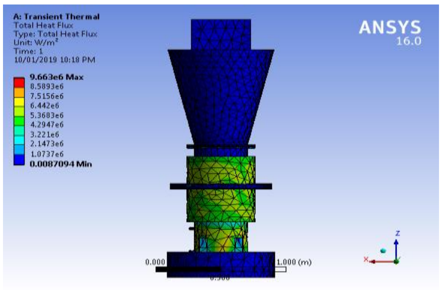


Figure 2.6 Total Heat flux

In the fig 2.6 shows the temperature distribution in different zones of downdraft gasifier. The figure shows also shows that total heat flux in various zones. Minimum and maximum heat flux has been shown in the figure with the color indications.

2.7Transient thermal heat transfer with a directional heat flux

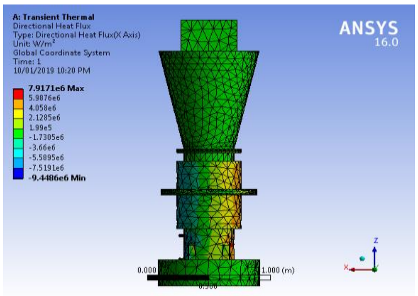


Figure 2.7 Directional heat fluxes

In the above figure shows that transient thermal heat transfer with a directional heat flux in different zones of downdraft gasifier. Minimum and maximum directional heat flux given in the above shown diagram in which clearly described how the heat fluxes is to be transmitted with directional indications. Introduction you can mention the introduction about your research

3. RESULTS AND DISCUSSION

3.1 Temperature distribution within the gasifier

Figure 2.4.4 shows the temperature profiles produced in the different positions along the gasifier as function of time. At the beginning of the experiment, all temperatures are constantly raising. This experimental time corresponds to a transient period. After some time, temperatures within the combustion and reduction zones (T1, T2 and T3) achieved a more temperature extent around 8000C and vary slightly in an identified limited level. This is to be considered as a steady or pseudo steady state regime. Figure 2.4.4 shows also that a longer time is needed for the temperatures in the drying and pyrolysis zones to increase. After some time, they reach the pseudo steady state regime.

This delay could be explained by two reasons: the first is that heat transfer is very limited in the uppermost directions. As expected, the original biomass has a low thermal conductivity and contains some moisture. The warmed layers near to the combustion zone are without stopping supplied to the below sided stages which reduces the heat promotes in the upward movements. The second one is the thermally inertial of the gasifier. Initially, the heat is absorbed by the gasifier body, and when the thermal inertia is overcome, the biomasses in the pyrolysis and drying stages starts to be temperature rising up. We can come to an end that the four stages or layer in the gasifying system (namely pyrolysis, drying, reduction and combustion) it becomes modified and clearly seemed after their final time or ending hour. So the gasifying performances have to be studied and examined after this initial starting duration.

3.2 Total heat flux and Directional heat flux

The definition of heat flux is described as the quantity of temperature transfers every unit areas per elemental time from or to surfaces. In normal efforts it is a defined amount since it involves, in rules, two numbers viz. the amount of heat transferred per unit time and the area from/to which this heat transfers taking place. In practice, the heat transfer is measured by the changes in temperature kept about by its effects on a device of sensor of known areas. The heat flux fluctuations before temperature sharing time shows in the Fig 2.6 & 2.7.The occurrence of heat flux may setting either a slower state temperature places or a transient temp fields in between the sensor. The temp field setting up may be either right angles to the directions of heat flux or parallel to the directions of heat flux shows diagrametically in the Fig 2.6 &2 .7.

3.3 modeling results:

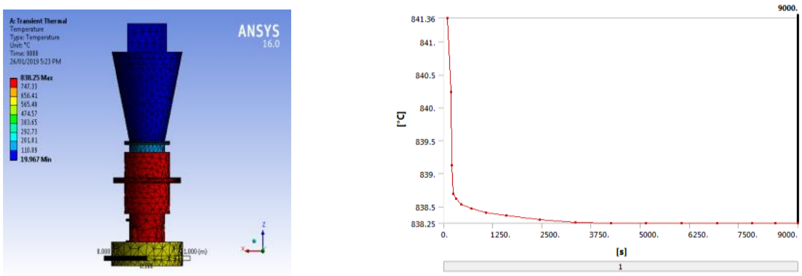


Fig.3.3 (a) Transient state Time during 9000s

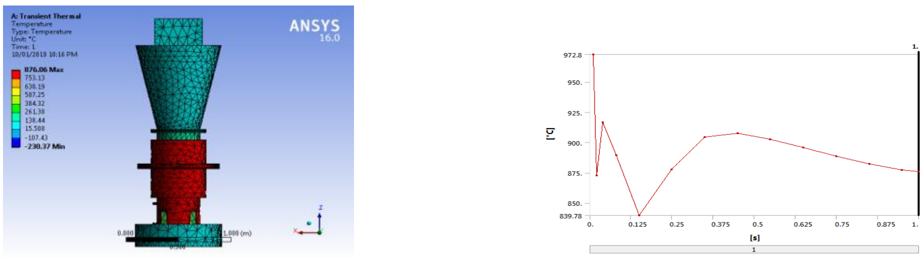


Fig 3.3(b) Transient state during 1Sec

3.4 Validation with literature paper.

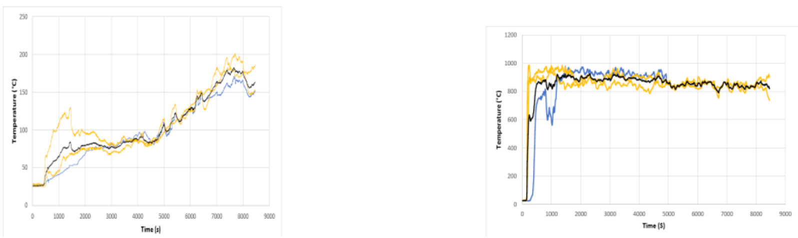


Fig 3.4(a) Plotted results from literature [3]

Accuracy of the ANSYS design was executed compares the temperature sharing along the various stages of the down draft gasifies with predicted and analyzed values referring with the graphs 3.3(a) and 3.3(b) & 3.5(a). A difference between the expected and analyzed temperatures values views was made. For these plots, predicted temperature profile was plotted with the help of graph. The ANSYS model diverges from the investigational data’s, but comparison considerably decreases, at when some time changes in the input simultaneously. When low input rate is applied, the design expects with perfection in temperature values, but deviation noticeable for temperature fixed in between T4 and T5. On the other side the more air flowing rate enhance the perfection of the expected temperature distributions. Distinction between the importances's on the same place decreases. These comparisons on the temperature profiles can be attributes to the energy preservations design applied. Here average temperature of the combustions and reducing zones were observed (recorded) at 8380C and 7540C, during 9000seconds in a conduction of the experiment respectively. Further variations of the data's are dependency on the temperature.

4. CONCLUSIONS

The process of gasifier has an outstanding capacity for generating power and heat whenever experimental variable studies with accurately. Heat flux and temperature are two major points for gasifying processes that have been examined in this investigation. Direct impact of the temperature has transmission performance in the gasification and production of tar. Before the biomass gasifying process, the richest temp observed (recorded) was 8380C reaches in the combusting zones where the biomasses raw materials is partly oxidation occurs. Before steady state and transient state highest temperature observed is 8380C and total heat flux is during 1second is 1.135e003w/m2, Directional heat flux is 1.0942e006w/m2. After this continuing up to 9000secs then observed some changes in the results that are max temp is 841.36oC, max total heat flux is 2.3672e006w/m2, and for directional heat flux is 7.9383e005w/m2. Before all three reactions, pressure drop were observable in the lesser relational parts when comparing to the topper part. This change in the pressure was evaluated to be because to the raw materials fixing in the reactors which prevents the movement of the raw materials inner side the reactors.Depends on the great size, fixation (bridge) can influences the times of the gasifying processes and lastly it should stops the operation. Therefore, the word of “degree of bridging” is mainly dependent on temperature and other factors. The experimental variables in gasifying processes had lesser comparisons in between reactions but almost all behaviors is every time is similar. The huge degree of compactness of components is also a important points affects the conversional operations in a downdraft gasifier. After the above consideration points it may be finally considering the points(conclusions) that, without examination of gasifies in Ansys software, it is complicated to examine design variables such as size and other variations and its affects. So this type of evaluations is a fine device to replacing costlier and time consumable experimental study. Hence it is implemented more favorable in uncomplicated ways

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