

Performance and Analysis of Solar Operated Fuel Ethanol Distillation System using Insert's

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Abstract— The application of solar ethanol fuel making has energy savings also help in reducing the cost of Manufacturing. The solar ethanol fuel manufacturing also has environmental benefit and doesn't involve fossil fuel for process which emits large amount of emission. This also helps to reduce our dependency on foreign country and help us in improving country economy too Current study is covering two promising Renewable energy sources viz. solar energy as a renewable source for Manufacturing of Ethanol as bio-fuel. Both are the thrust area for study worldwide.The performance panel depends on the environmental factors, which is solar radiation and operating temperature. These environmental factors will be reduced the effectiveness of Flat plate solar panel due to increase in operating temperature of Flat plate solar panel. To improve the performance of Flat plate solar panel by using different types of augmentation technique are used which include active passive and combine technique.. In passive technique use twisted tape or wire coil different type of insert's which is placed in flowing fluid in tube then turbulence will create. Then laminar flows gets convert in to turbulent flow which result increases in heat transfer rate is used to overcome the problem of low efficiency of Flat plate solar panelthis mechanism is one way for maintaining a low operating temperature during its operation period. The experimental results mentioned that the decrement of operating temperature and increase the power output of the Ethanol Production. .

Index Terms— Distillation, renewable energy, ethanol, Bio fuel, eco-friendly, dehydration & Bi-product,Heat transfer, Insert.

I. INTRODUCTIONS

Ethanol (ethyl alcohol) as a liquid fuel for cooking and lighting is an attractive Renewable to kerosene in developing countries. Besides being a biomass-derived fuel and hence renewable, Ethanol can also be used in new types of cooking stoves and lanterns Ethanol. Has been traditionally produced from sugarcane, cereal grain etc. However with the debate on food vs. fuel, it is extremely attractive to use sweet sorghum, a multipurpose crop. It can provide grain from its ear heads for human consumption and ethanol from its stalk from the same piece of land Distillation takes up about 70-85% of total energy consumed in ethanol Manufacturing. Traditional fuels used have been biogases, charcoal and wood. Biogases are an excellent raw material for paper and hence it is a waste to use it as fuel. Solar distillation of ethanol does provide a solution for energy conservation in ethanol Manufacturing. This paper presents the data generated for a study of pilot solar distillation plant to produce ethanol (hereafter

referred to as alcohol) using sweet sorghum as the raw material. Distillation is an energy consuming process that is used for about 95% of all fluid separation in the chemical industry and accounts for an estimated 3% of the world energy consumption. Heat integration of distillation columns, where the condenser of one column is coupled with the re-boiler of another column, is used to reduce the energy consumption of distillation. Typically the reduction in energy consumption is 50%. It is very important that such heat integrated columns are operated correctly so that the plant is operational and the energy savings are achieved.

The economic competitiveness of ethanol has been heightened by concerns over prices and availability of crude oil as well as greenhouse gas emissions which have stimulated interest in Renewables to crude oil to provide for automotive power and also by the use of bio ethanol in the Manufacturing of hydrogen for fuel cells. Therefore, there is the need to explore ways of producing ethanol at competitive costs by the use of energy efficient processes. To cope with the high energy demand and improve the benefits from the process, the concept of poly generation and hydrothermal treatment especially when dealing with small scale ethanol plants is fast gaining interest. However, the analysis of the bio ethanol process shows that distillation is still the most widely used

II. OBJECTIVE

- To study the feasibility of solar energy powered fuel ethanol manufacturing process.
- To reduce the production cost of ethanol Manufacturing.
- To create new opportunities for small businesses in rural areas.
- To reduce the pollution due to distillation of ethanol
- To study the efficiency of solar Collector after using inserts.

This research work is carried out the conventional ethanol Manufacturing process consist of following steps-

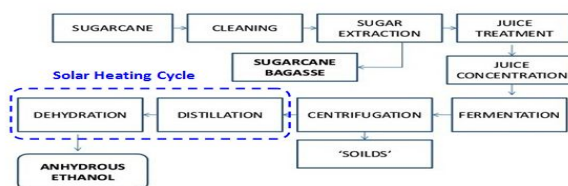


Figure 1: Processes involved in production of ethanol and solar heating cycle

The present research work focuses on “Distillation” steps of this process.

The modification and improvement shall be restricted to this part of this process only.

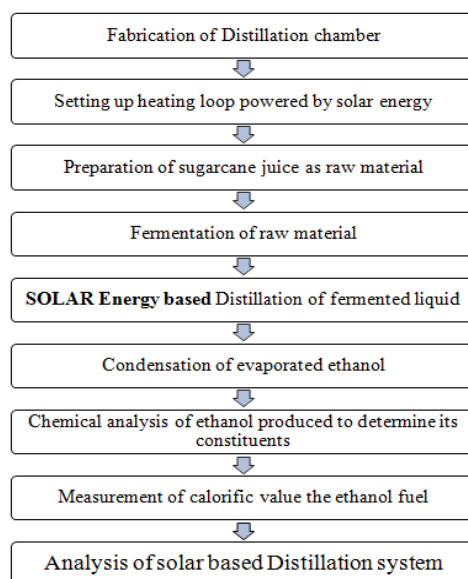
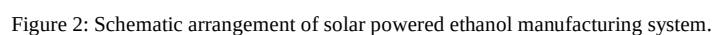


Figure 1: Flow diagram showing steps involved in Ethanol Manufacturing in present research work

This invention will now be described in relation to the accompanying drawing, in which figure 3 illustrates Line diagram of powered ethanol manufacturing system



The arrangement of solar powered ethanol manufacturing system is simple in construction and mainly it consists of some primary parts which may be considered as the working elements and various auxiliary parts for its proper functioning and for providing stability. Each unit (parts) has its own importance in the assembly of solar powered ethanol manufacturing system. The working of these units is to study the feasibility of solar energy powered fuel ethanol Manufacturing process and to reduce the pollution due to distillation of ethanol The assembly of solar powered ethanol Manufacturing system consist of following units:-

- 1) *Flat Plate solar panel*: This device absorbs the incoming solar radiation, converting it into heat at the absorbing surface, and transfers this heat to a fluid (usually air or water) flowing through the collector.
- 2) *Shell and tube Heat Exchanger*: Shell and tube heat exchanger is widely used in many industrial power generation plants as well as chemical, petrochemical, and petroleum industries.
- 3) *Tank*: Storage tank is container that hold liquid.
- 4) *Digital Temperature Indicator*: The digital temperature indicator is used for processing signals coming from temperature sensors. Depending on your specific needs, the digital indicator can be ordered with different inputs for thermocouples or resistance thermometers
- 5) *Copper Tube*: Copper is used for plumbing tube principally because of its corrosion resistance, machinability and high level of heat transfer.
- 6) *Twisted Tape Insert*: Inside the Copper tubes the twisted tape is inserted have been attached to every cylinder in order to create a flow of molasses from bottom cylinder to the top cylinder. The sizes of twisted tape are 8, 10, 12 mm width.
- 7) *Pipes*: A pipe is a tubular section or hollow cylinder, usually but not necessarily of circular cross section, used mainly to convey substances which can. Flow liquid and gases (Fluids), Slurries, Powder and masses of small

solids, it can also be used for structural applications hollow pipe is far stiffer far stiffer per unit weight than solid member flow liquids and gases (fluids), slurries, powders and masses of small solids. It can also be used for structural applications; hollow pipe is far stiffer per unit weight than solid members

- 8) *Thermo Couple*: A thermocouple is a sensor that measures temperature. It consists of two different types of metals, joined together at one end. When the junction of the two metals is heated or cooled, a voltage is created that can be correlated back to the temperature.

V. FIELD OF THE INVENTION

This invention related to design and fabrication of solar powered distillation system. The conventional distillation system for distillation consumes around 40-50 % of energy produced. To produce one fuel (Ethanol) another fuel is burned which result in consumption of lot of energy in Ethanol Manufacturing. Also consumption of conventional fuel result in large pollution to form and also will increase its cost. The proposed work would be able to produce Ethanol fuel without consumption of conventional fuel by using solar energy. The fabrication will have an arrangement of multistage distillation in single distillation column. The distillation column will have alternate arrangement of heating of fermented wash and condensation of vapors formed for more than 95 per of ethanol. The heating will be provided by water, heated by solar energy. Temperature sensors will be provided in distillation column at heating chambers which will allow heated water to flow at pre-determined temperature. After design and fabrication of the system experimentation will be carried out. The performance of the system and chemical analysis of ethanol will be carried out.

VI. EXPERIMENTAL DESIGN

In order to achieve the optimum results the design of this project has been broadly divided into 2 major sections followed by the sub-sections. The 2 major sections in this project are the Solar Heating Section & the Ethanol Distillation Unit.



Figure: 4. Solar water heating section

A. The Solar Heating Section:

The heating section is the area where complete heating of water takes place in order to maintain high temperature in the water jackets. The unit comprises of three major components.

1. Solar Tubes
2. Drum
3. Frame

1.Solar Tubes: In order to make our project as eco-friendly as possible we used solar water tubes as they are completely pollution free and requires next to zero maintenance cost.

2. Drum: We used Aluminum to make the drum in order to keep it light weight and durable. The capacity of the drum is approximately 20-25 liters.

3. Frame: The complete frame setup has been made up of Mild Steel material. The drum is attached on top of the frame at 3ft height of the ground in order to provide proper pressure head to the water to fill in the water jackets. Also a pipe is connected in between the heating section and the distillation unit to transfer the hot water.

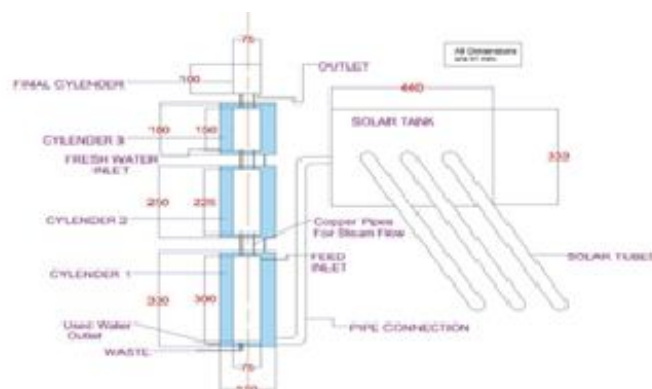


Figure 5 : Line diagram of the project



Figure 6: Distillation Unit

VII. ETHANOL DISTILLATION UNIT

The complete unit serves the purpose of distillation of Ethanol. It comprises of several small components which are connected in a sequential manner to get the best results.

1. Water Jackets.
2. Molasses Cylinders.
3. Copper Tubes.
4. Twisted Tape inset
5. Temperature Indicator.

6. Water, Waste, Feed, Ethanol Inlet & Outlet tube.

1. Water Jackets: A total of three water jackets have been created around the main 3 cylinders. The water jackets are made of Mild Steel and have also been completely insulated by using Glass wool in order to maintain the high temperature..

2. Molasses Cylinder: There are three cylinders made of copper placed inside the water jacket and the last one is kept open to the atmosphere. The fermented molasses is first poured in the bottom most cylinders and then by distillation the final product is obtained in the last cylinder.

3. Copper Tubes: Copper tubes have been attached to every cylinders in order to create a flow of molasses from bottom cylinder to the top cylinder..

4. Twisted Tape Insert: Inside the Copper tubes the twisted tape is inserted have been attached to every cylinder in order to create a flow of molasses from bottom cylinder to the top cylinder.

5. Temperature Indicator: A temperature indicator has been provided at the top water jacket. It is a necessary component to keep the water temperature in the last cylinder at around 77.5-79 deg Celsius.

6. Inlet & Outlet tubes for various purposes: Multiple small tubes have been provided to perform specific functions like Feed Inlet, Waste Extraction, Final product outlet etc.

Observation Table (With and without Insert's)

Table No IV:- Flat Plate Collector With Time (8mm Insert)

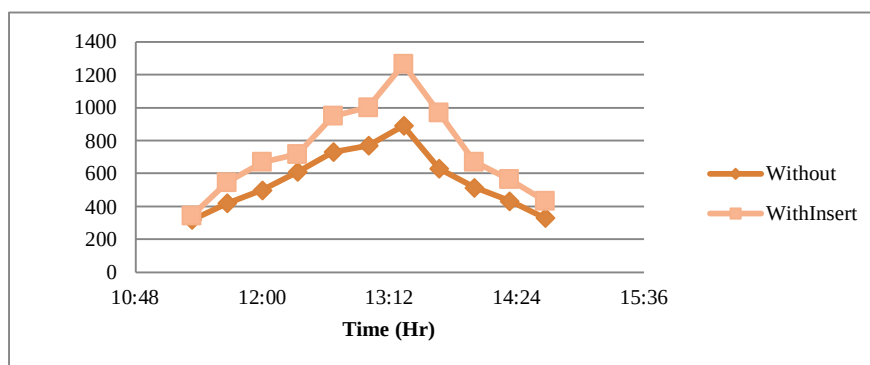
Table No V:- Flat Plate Collector 20 Liter Charge With Time (10mm Insert)

Table No VI:-Flat Plate Collector 30litter Charge With Time ((12mm Insert)

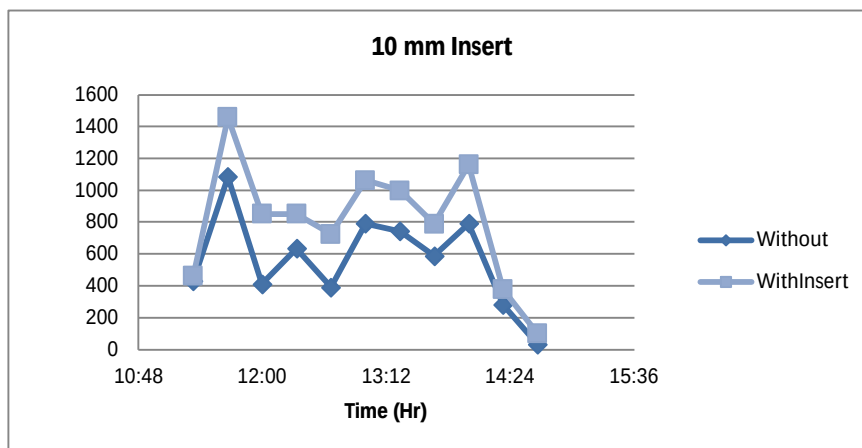
Table No. I			
Sr. No	Without	Insert	Time
1	320	345	11:20
2	420	546	11:40
3	500	668	12:00
4	610	717	12:20
5	730	949	12:40
6	770	1001	13:00
7	890	1263	13:20
8	630	968	13:40
9	515	670.5	14:00
10	433	563.3	14:20
11	330	433	14:40

Table No. II			
Sr. No	Without	Insert	Time
1	430	463	11:20
2	1086	1458	11:40
3	410	850	12:00
4	633	850	12:20
5	390	724	12:40
6	790	1061	13:00
7	743	998	13:20
8	587	788	13:40
9	790	1161	14:00
10	280	376	14:20
11	30	100	14:40

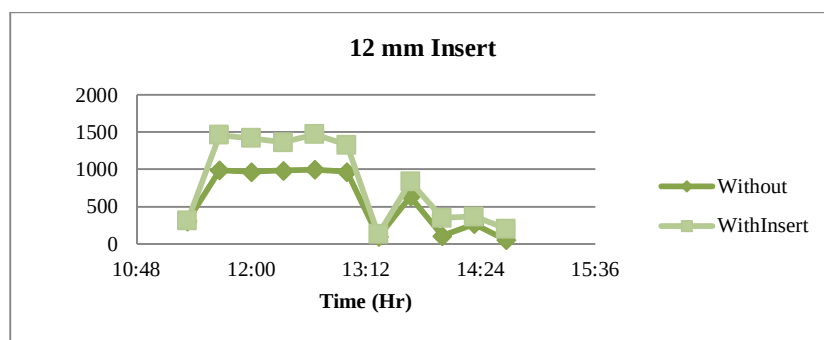
Table No III			
Sr. No	Without	Insert	Time
1	307	311	11:20
2	990	1459	11:40
3	967	1417	12:00
4	986	1363	12:20
5	997	1469	12:40
6	968	1329	13:00
7	98	134	13:20
8	637	833	13:40
9	110	351	14:00
10	267	366	14:20
11	54	205	14:40



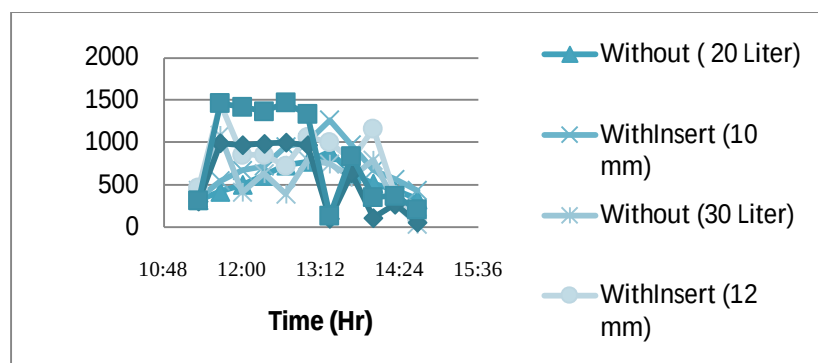
Graph 1: - Flat plate collector with Time (10 mm Insert)



Graph 2:-Flat plate collector 20 liter charge with time



Graph 3:-Flat plate collector 30 liter charge with time (12 mm)



Graph 4:-Flat plate collector Combine

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