

Design, Fabrication and Analysis of Solar Powered Fuel Ethanol Distillation System

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Abstract— The implementation of solar ethanol fuel production has potential of energy savings also help in reducing the cost of production. The solar ethanol fuel production 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 Present study is covering two promising alternative energy sources viz. solar energy as a renewable source for production of Ethanol as bio-fuel. Both are the thrust area for study worldwide. Ethanol fuel production units may be setup as ancillary unit in far-flung areas having ample agricultural products. The fuel produced may be consumed by them or sold in market. Besides, the bi-product may be used as fertilizers. Wealth-from-waste, green and clean, abundant, inexhaustible and eco-friendly is the salient characteristics of such system. Production of fuel Ethanol is a reviving opportunity in rural areas, creating new opportunities for small businesses, developing new products, spawning new research, creating more good-paying jobs and more income for farm families would re-invigorate the economy of nation.

Keywords – alternative energy, ethanol, eco-friendly, distillation, dehydration & Bi-product.

I. INTRODUCTION

Ethanol (ethyl alcohol) as a liquid fuel for cooking and lighting is an attractive alternative 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 production 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 production. 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 reboiler 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 alternatives to crude oil to provide for automotive power and also by the use of bio ethanol in the production 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 production process.
- To reduce the cost of ethanol production.
- To create new opportunities for small businesses in rural areas.
- To reduce the pollution due to distillation of ethanol

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

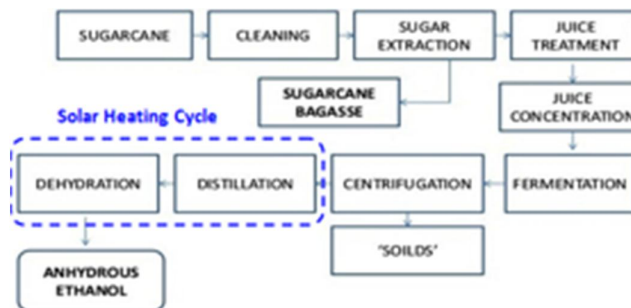


Figure 1: Processes involved in production of ethanol and solar heating cycle

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.

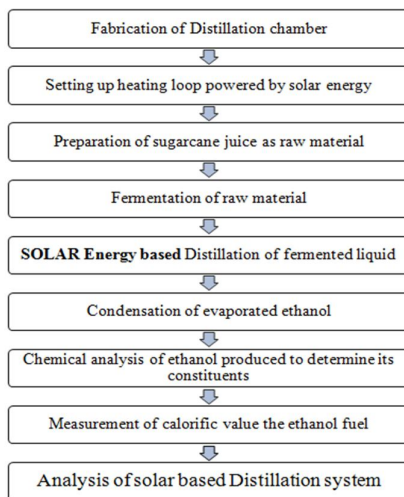


Figure 1: Flow diagram showing steps involved in Ethanol production in present research work

III. BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWING

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

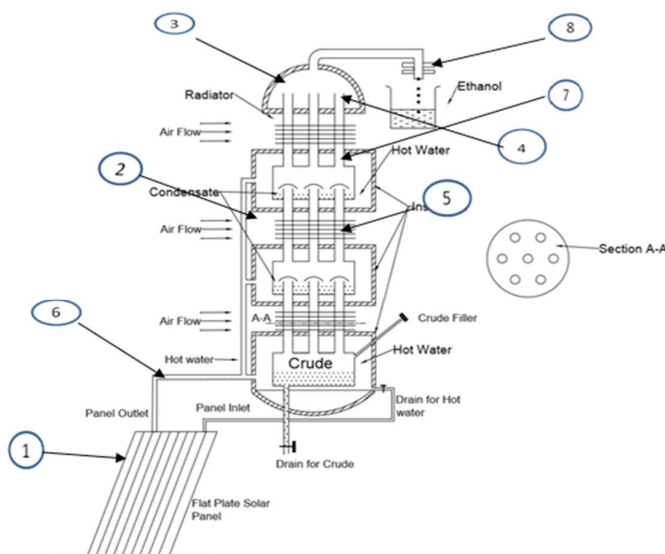


Figure 2: Schematic arrangement of solar powered ethanol production system.

IV. DETAILED DESCRIPTION OF THE ACCOMPANYING DRAWING

The arrangement of solar powered ethanol production 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 production system. The working of these units is to study the feasibility of solar energy powered fuel ethanol production process and to reduce the pollution due to distillation of ethanol. The assembly of solar powered ethanol production system consist of following units:-

- 1) Flat Plate solar panel
- 2) Shell and tube Heat Exchanger
- 3) Tank
- 4) Digital Temperature Indicator
- 5) Copper Tube
- 6) Pipes
- 7) Thermo Couple
- 8) Tap

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. The warmed fluid carries the heat either directly to the hot water or space conditioning equipment or to a storage subsystem from which can be drawn for use at night and on cloudy days.

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. There are effective parameters in shell and tube heat exchanger design such as tube diameter, tube arrangement, baffle spacing and baffle cut ratio.

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. 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 — 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.

7. *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. A thermocouple is a simple, robust and cost-effective temperature sensor used in a wide range of temperature measurement processes.

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 production. 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. For our project we used 2 solar tubes in order to meet our requirements.

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. The complete drum is surrounded by a thick layer of 'Glass Wool' material to create a good insulation effect to keep the temperature of water in the drum as high as possible. Also, there are two ports for inlet and outlet of water in the drum.

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. The frame is designed to firmly support the drum as well as the solar tubes without any fiddling or movement. Also a pipe is connected in between the heating section and the distillation unit to transfer the hot water.

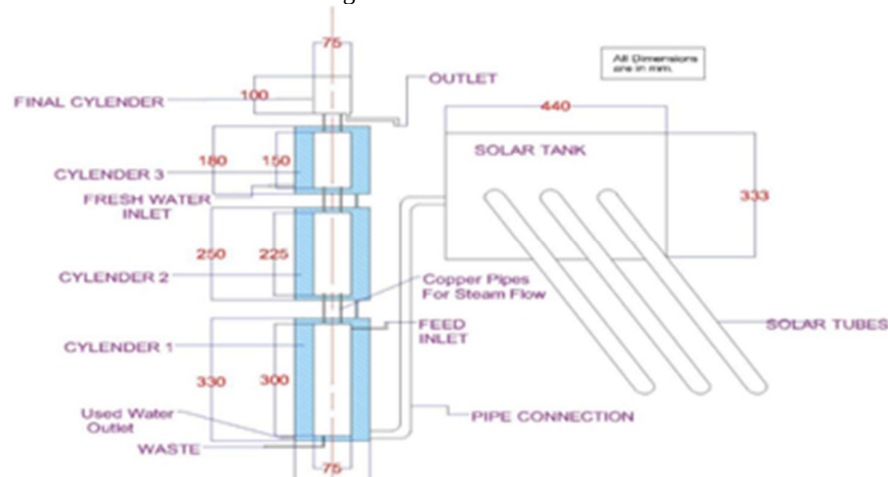


Figure 5: Line diagram of the project



Figure 6: Distillation Unit

B. 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. Temperature Indicator.
5. 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. The three cylinders are connected to each other by copper tubes for the flow of water from one cylinder to the other.

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. The capacity of each cylinder decreases respectively from bottom to top as the waste product remains in the bottom cylinder as the refined product moves forward.

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. The gap between two cylinders is connected by a set of 4 copper tubes each of diameter 5 mm and length of 5cm.

4. *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. A fresh water inlet has also been provided to bring down the temperature in case it exceeds the required temperature.

5. *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

TABLE NO. I		
Sr. No	ml	Time
1	320	7
2	420	8
3	500	9
4	610	10
5	730	11
6	770	12
7	890	13
8	630	14
9	515.78	15
10	433.38	16
11	330	17

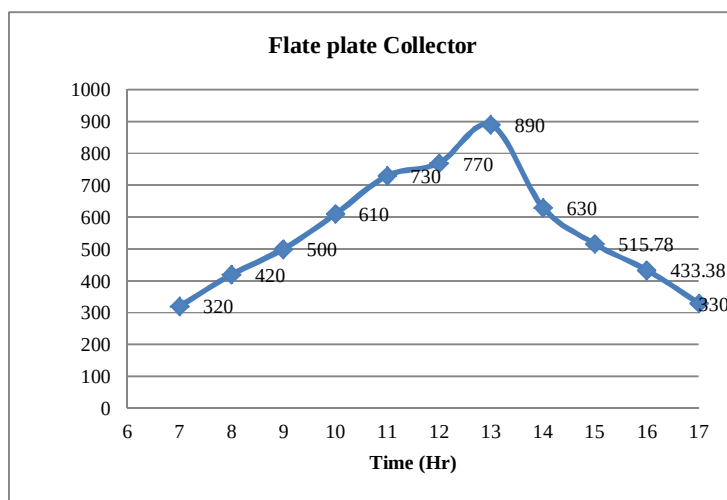
TABLE NO II		
Sr. No	ml	Time
1	307	11:20
2	990	11:40
3	967	12:00
4	986	12:20
5	997	12:40
6	968	13:00
7	98	13:20
8	637	13:40
9	110	14:00
10	267	14:20
11	54	14:40

TABLE NO III		
Sr. No	ml	Time
1	307	11:20
2	990	11:40
3	967	12:00
4	986	12:20
5	997	12:40
6	968	13:00
7	98	13:20
8	637	13:40
9	110	14:00
10	267	14:20
11	54	14:40

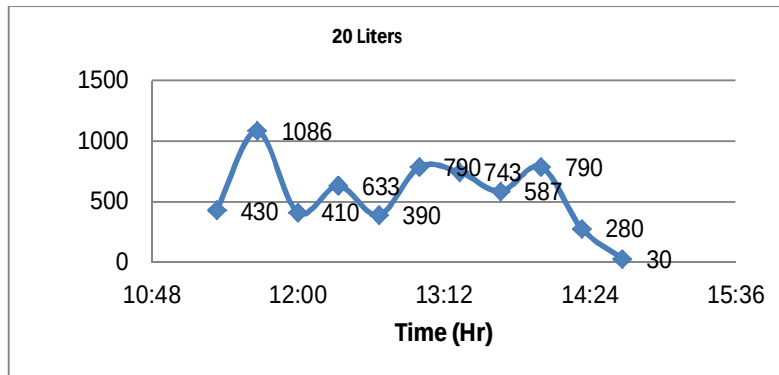
Table No I:- Flat plate collector with time

Table No II:- Flat plate collector 20 liter charge with time

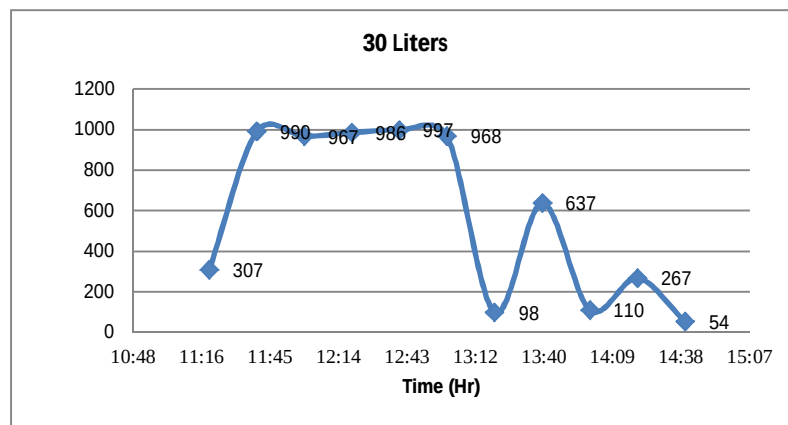
Table No III:-Flat plate collector 3



Graph 1: - Flat plate collector with Time



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



Graph 3:-Flat plate collector 30 liter charge with time

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