Solar Energy Based Steam Cooking System

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***Abstract*- Solar cooking can be another appliance for cooking in which we use solar energy to produce steam for cooking as well as there is no smoke, no soot. This cooking system having interesting feature such as cooking in indoor and outdoor possibility. Components which are used in this type of system are over head storage tank, evacuated tube collector, steam boiler, guage thermometer and pressure guage. Thus solar cooking system have a very relevant place in the present fuel consumption pattern. Various design of solar cooking system developed in our country.**

Index Terms- Evacuated Tube Collector, Renewable Energy, Solar Energy, Fire Tube Boiler

I. INTRODUCTION

Solar cooking system is a device which uses solar energy as a primary source or energy resource. Natural sunlight as a source is not enough for cooking of food because it doesn't provide required heat for cooking purpose so, in solar cooking system a solar collector is provided for this applications. However, two main components of solar cooking system are reflected solar collectors and a cooking unit. As it uses no fuel and electricity, it makes whole system as a renewable type of product. It also uses wood such as babool for lighting up the flames to increase the temperature for steam generation. Steam generation are the main source and a final product of a solar energy system to cook food. Generally its applications are in hotels, guest houses, mess, etc. Now a days this steam cooking system are acquired in domestic way to reduce the cost in consumption of fuel. It is a best application where huge amount of food is prepared. Its setup cost is high but it reduces fuel consumption, cost, no use of electricity in cooking field.

II. WORKING

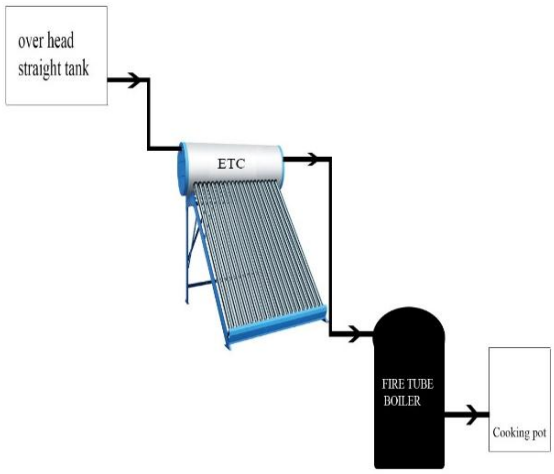

Fig. 2.1 Working of Steam cooking system

Overhead Tank consist of water at room temperature 25°C which flows through pipeline to ETC where evacuated solar collector tube increases the temperature of water approx. 60°C . From ETC water flows to the fire tube boiler where temperature of water is increased to double as of ETC approx. 120°C. At 120°C generation of steam takes place which is utilized in cooking pot for cooking of food.

III. COMPONENTS OF STEAM COOKING SYSTEM

(a) Over Head Storage Tank- Overhead tank is a water reservoir tank which stores water at atmospheric temperature.

(b) Evacuated Tube Collectors (ETC) based Solar Water Heaters- Solar water heater raise temperature of water which is flowing through the pipelines of overhead storage tank. It is installed where sunlight is available basically at terrace. This Heated water is then stored in insulated storage tank.

Fig. 3.1 Evacuated Tube Collectors (ETC) based Solar Water Heaters

(c) Fire Tube Boiler- Fire tube is a type of a boiler which uses hot gases to pass through one or more tubes. This tubes consist of flowing water. The walls of tubes are heated by surrounding of hot gases which heat the water to 120°C . At 120°C water converts to steam which is utilized for cooking purpose.

IV. CALCULATIONS BASED ON SOLAR COLLECTOR

1. Amount of energy required to cook 5 kg of rice:
m= 5 Kg
Specific heat of rice= 1.8 KJ/Kg ^{o}C
T1= 25^{o}C
T2= 100^{o}C

T1= Initial temperature of rice
T2= Final temperature of rice

Required energy:
Q1 = m x Cp x ΔT
=5 x 1.8 x (100-25)
= 675 KJ

2. Energy required to boil 5.5 kg of water:
m= 5.5 kg
Specific heat of water= 4.187 KJ/Kg ^{o}C
T1= 25^{o}C
T2= 100^{o}C
Required energy:
Q2 = m x Cp x ΔT
= 5.5 x 4.187 x 75
=1727.1 KJ

3. Amount of energy required for cooking pot:
m= 2 Kg
Specific heat of stainless steel: 0.510 KJ/ Kg ^{o}C
T1= 25^{o}C
T2= 100^{o}C

Required energy:
Q3 = m x Cp x (T2 -T1)
= 2 x 0.510 x 75
= 76.5 KJ

4. Energy required for vaporization:
m= 5.5 kg
h_{fg}= 2260 KJ/Kg
h_{fg}= Latent heat of vaporization of water
Q4 = m x h_{fg}
= 5.5 x 2260
= 12,430 KJ

Total energy:
Q = Q1 + Q2 + Q3+ Q4
= 675 + 1727.1 + 76.5 + 12,430
= 14,908.6 KJ

Assuming Loss, QL = 1/3 x Q
= 1/3 x 14,908.6 KJ
= 4,969.6 KJ
Total design and energy required for cooking of 5 kg rice:
QD = Q + QL
= 14,908.6 + 4969.6
= 19,605.2 KJ

VII. CONCLUSION

In this experiment, we have found out how a steam cooking system works as well as detailed study of components with calculations. The maintenance cost is minimum and fuel cost is low as it is type of renewable type of system.

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