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A Review on Solar Thermal Powered Egg Incubator with Thermal Energy Storage Systems

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***Abstract*: The continuous increase in level of greenhouse gases and increase in fuel prices and demand are the main driving forces behind the utilization of renewable sources. Here one of the renewable energy is the solar energy which is very easily available in nature. This review paper is about the effective utilization of the solar energy, by incubating the poultry eggs using the solar collector. And, hence the thermal energy storage system is needed during the night time and overcast periods. Now here are some journal papers reviewed below that are related to this processes.**

***Keywords*: Incubator, Thermal energy, solar collector**

1. Introduction

The incubation of poultry eggs using solar collector can be concluded from the below discussed journals. In this type of solar incubator, the water acts as a heat transfer medium. The heated air from the hot water is passed to the eggs inside the incubating chamber. In order to store the heated water during night time and overcast periods the thermal energy storage system is used. The optimum temperature of 37 degrees Celsius is maintained throughout hatching period. Hence the incubation of eggs using the solar collector is discussed in the below journal.

A. Performance of incubator

Kelleh Gbawuru Mansaray carried out, Fabrication and performance of solar power egg incubator, the solar photovoltaic powered chicken egg incubator was designed, fabricated and tested to evaluate its performance [31]. The major components are incubating unit, temperature device and solar PV system. The incubating unit was generally maintained throughout the incubating temperature range of 36.8-37.9 degree Celsius and an average relativity humidity of 67.3%.

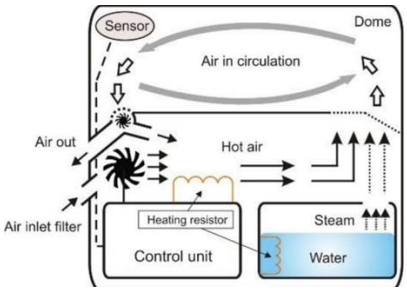

Fig. 1. Performance of incubator

The results show the percentage facility and hatchability of eggs were 43.3 % and 23.1% respectively. The low hatchability rate could have resulted from many factors including an overcast weather, poor storage of eggs, time and energy wasted in turning of eggs, faulty eggs etc. Engineering equations involving heat and mass balance of incubator components.

2. Study on solar collector

S. Thongsan and et-al analyzed, Development of solar collector combined with thermoelectric module for solar drying technology has been successfully developed and seebeck effect is applied [32]. It means that the heat energy is converted directly into electricity. The objective of this research is focused on development of a solar drying technology using a solar collector combined with thermoelectric generator module (TEG). Solar collector can be operator and produced hot air temperature about 70-80 degree celcius.

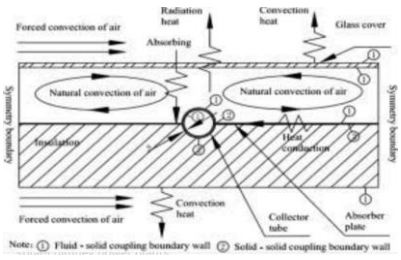

Fig. 2. Solar collector

The average back side temperature of collector 45.4 degree Celsius, were ambient temperature was 35.8 degree Celsius. In areas with snow or no sunshine, lots of cloud or tree corner, dusty forals etc… photovoltaic system were implemented for producing the heat and that heat is converted into electricity by certain system. Sun energy comes through radiation and concentrated for heating purpose. Here, solar collector has been studied.

3. Energy load for traditional incubator

Diduo Liu and et-al experimented, Research on energy load during incubation and energy saving potential of traditional incubator [28], the cooling and heating load of a single incubator unit is examined, with a capacity of 38400 eggs

incubated at same incubation temperature. According to the fact that in large-scale incubation plants the incubators ever work in the form of modules. A module constituted of 15 egg incubation boxes and 3 egg hatching boxes is again studied and analyzed the energy demands. The result of theoretical load calculation shows that in one incubator box, there is a conversion from heating load to cooling load during the incubation time period and both of heating load and cooling load exist at the common time in hatching process of the egg incubator module. The energy-saving potential of traditional incubator is analyzed, the possibility of using other high efficiency methods is also studied to substitute the electric heater in the poultry incubation components and achieve the aim of energy conservation. The characteristic of heating and cooling load has been studied in both the single incubator and the incubation module. For one single egg incubator of capacity 38400 eggs, there is a changing point from heating load to cooling load during the whole incubation time period of 21days, which is experienced by the eggs, heat production, the components heat dissipation, the external atmosphere, and the free air flow. And the peak of heating load only exists in Day 1, while a steady heating load, about 1.5kw, lasts for few days. During the metabolism period, the cooling demand of the incubator is keep on increasing, reaching 9.7kw at Day 18. For incubation module, both of heating load and cooling load exist at the common time in the incubation process, although the former, about 14 on average, is much less than the latter, about 75kw on average. It has been widely accepted that electric heater in old incubators has a large energy waste. Theoretically, heat pump has ability to increase the efficiency of heat supply, the heat recovery technique and the water-loop heat pump could balance the gradual heating and cooling load in theory, which are recommended to be used in incubator's energy-saving reconstruction. More practical measurement studies are needed to examine all the theoretical results, as well as the applicability and stability of all kinds of the energy-saving techniques that has been studied and mentioned.

4. Thermal energy storage system

A. Mawire and et-al analyzed, simulated performance of storage materials for pebble bed thermal energy storage systems [29]. A Simplified one dimensional single phase model for an oil pebble thermal energy storage systems is used to study the performance of three thermal solid sensible heat pebble materials. The materials are fused silica gas, stainless steel and alumina. The model is evaluated with reasonable agreement and practical results is achieved between simulation and experiment. With these materials, the thermal performance is evaluated in terms of axial temperature distribution. Also the energy storage, the total exergy stored and the transient charging efficiency has been evaluated. The results show that the amount of exergy stored and degree of thermal stratification should be considered and also the value of the total amount of energy stored important for the thermal performance of oil – pebble –bed systems are considered. A high ratio of the total exergy to the total energy stored is stated as the good thermal performance of pebble material. A valid simple single phase model for an oil pebble TES system has been used to investigate the thermal performance of three solid sensible heat pebble materials (fused silica, alumina and stainless steel). The thermal performance was expressed in terms of the axial temperature distribution, the total energy stored in storage system, the exergy stored and the transient charging efficiency.

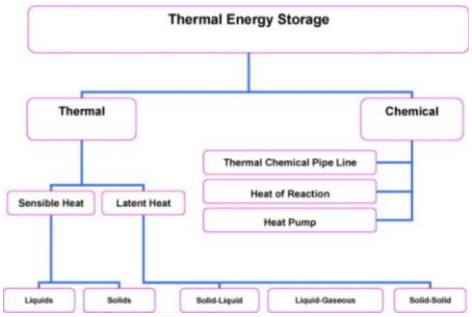

Fig. 3. Thermal energy storage system

The result of the various simulation indicate that the total exergy stored and thermal stratification is important than a value of the total amount of energy stored for the thermal performance of oil /pebble-bed systems. High ratio of total exergy to the total energy stored was fixed as a good value of thermal performance. From the simulations, it is concluded that fused silica has the good thermal stratification performance while stainless steel attains the highest total energy stored at the expense of greater decrease from the peak value as charging progresses. On the other hand, alumina has the fastest energy storage rate and also had the best exergy to energy ratio variation during the process of charging. It was compared with fused silica at the end of charging process. The only condition in the designing efficient oil bed pebble system solar applications of low to medium temperature (100 to 300degree celcius) relatively. Thus it should look at all the aspects studied above instead of only looking at conventional methods of energy validation and thermal stratificated evaluation. Normally, these are applicable to solar hot water thermal energy storage systems operating generally at low temperatures. These simulation concludes that the designers of solid liquid thermal energy storage systems to highly prefer solid pebble material based on a joining of the thermal parameters studied. These study on simulation proved to be effectively used tool in evaluating various storage materials and could be used to completely substitute experimentation that is detailed. By this paper thermal energy storage system has been studied.

5. Photovoltaic solar poultry incubator

Nithin T Abraham et-all experimented, Design and implementation solar PV poultry incubator, [33] Incubation of poultry chick eggs is most important in recent days. As the

demand for chicken increases day by day. But the process of hatching eggs by the traditional method is very complicated as well as it consumes more power. In short traditional method of egg hatching requires continuous supply of electric power. In this paper a solar poultry incubator design is suggested as new method, which could be used for hatching eggs from solar photovoltaic and hence it reduces the usage of electric power and can increase the usage of solar power which is a renewable form of energy. On introducing this method of solar poultry incubator we are able to decrease the power usage of the incubator by 75% and the cost involved in this design also yields gain and hence brings out the revolution in this sector. A solar poultry incubator design is discussed in this paper which can make a revolution in the area of poultry agriculture mainly in undeveloped areas and it can bring the electricity usage down made from traditional method and is substituted by renewable energy based sources and is found to be economical than the traditional poultry chick incubator.

6. Combined materials for thermal storage system

Shivam Yadav and et-al analyzed, Application of combined materials for a baby incubator, [34] Incorporation of phase change materials for the development of the thermal energy system to store the latent heat corresponds to the most functional technology to store thermal energy with familiarity of the storage process being isothermal in nature and high availability of high-energy storage density. The concept of maintaining the temperature appropriate for the babies to incubate at constant temperature and therefore controlling the fundamentals properties needed with the help of phase change materials is the main aim of this research. The aim of the creation of microenvironment for babies is attained by the combination of PCMs, thermal energy storage equipment and thermal insulators. Thus, the growth of PCM into Nano-HVAC devices develop the phase change thermal energy storage baby incubator. Phase Change Materials exhibits applications in the storage of thermal latent heat systems for the use in thermal applications of space crafts, solar engineering and heat pumps. The main aim of this research is manufacturing of a cost economic and portable baby incubator to make the babies to live in adverse environmental factors especially in the tribal regions where medicines and hospital and health care facilities are unavailable at the vicinity. This paper results the correct selection of material combination to be used for the production of portable type baby incubator. The parameters of the material were analyzed the appropriate concentration of the thermal storage and phase change materials were studied. This paper also expresses the importance of this incubator in the rural areas, which was explained with help of the case study of the Raigad district. The construction of the portable baby incubator was described along with its components materials to use in this paper. This paper provides optimum research for the production of portable type baby incubator along with important parameters of being cost economic, material of construction is available easily. Its ability to withstand large temperature variations makes it a key point of importance in this research. The future aim of this project elaborate on decreasing the cost of the incubator by selecting the composite mixture as well as perform optimization to reduce the time delay in maintaining constant temperature inside incubator by selecting high performance and correct concentration mixture.

7. Solar incubator operated with solar collector

S. I. Kuye and et-al experimented, Design and Construction of Solar incubator [30], the cost of production is continuously increasing due to the energy demand that is experienced globally. This results in the hike of price of chicken production and unaffordable to a common man. In order to encourage a middle class farmer to go into bird's production as the supplement for him and family. It is mandatory to look at other ways of producing energy for egg incubation. Here, solar energy is adopted because it is free and abundant. Here solar incubator consists of solar collector which is used to heat the water, that water heats an incubating unit. It is designed to work for 24hours by using its inbuilt heat storage system, during the absence of solar energy. The experimental setup made, is used for increasing chicken production by incubating the eggs using solar energy.

8. Conclusion

Thus the incubation of poultry eggs can be made using the solar collector by studying the above journal papers. The incubation of eggs can be done by reducing the usage of electric power in order to save electricity.

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