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SOLAR TUNNEL DRIER COMBINED WITH BIOGAS FOR COPRA DRYING

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Abstract - ***Today's world is digging more deep into the field of Non-Conventional energy resources and widening its spectrum inch by inch. Solar energy, one of Non-conventional source of energy, even though having a lot of merits in the sides of pollution, energy content. Every solar system should accompany a backup system, in order to serve its purpose consistently. A Solar tunnel dryer is designed for drying coconut, with a backup system using biogas burning for producing the heat required in the absence of proper and effective solar radiation. The system is based on indirect heating, in which air is heated and circulated to transfer the heat to effect the drying of the required product. It comprises of a flat plate solar collector with a Fan connected to circulate the heated air from the solar plate to the drying chamber. The heated air removes the moisture from the material to be dried. In days of lower solar radiations, the auxiliary heating unit is used. The unit consists of a burner to burn the biogas and also tube which carry air to the drying chamber. A blower which circulate the air through the tube, while the biogas is burnt inside the chamber. The hot air fed to drying chamber, remove the moisture and thus drying is done continuously.***

Key Words: *Solar tunnel Dryer, Biogas*

1. INTRODUCTION

The traditional method of dehydration is by open sun drying, which often results in food contamination and nutritional deterioration. Energy is required for mechanical drying of agricultural products in rural areas where grid electric supply is scarce. Selecting right drying technique is necessary in tropical regions where herbs and spices are harvested during winter and rainy season. Solar and biogas are two renewable sources of energy that may be used for drying of spices, herbs and agricultural products for commercial production at low cost.

Solar energy is effectively utilized for controlled drying of agricultural products to avoid food losses between harvesting and consumption. High moisture crops are prone to fungus infection, attack by insects and pests. Solar dryers remove moisture with no ingress of dust, and the product can be preserved for a longer period of time. The solar dryer can be seen as one of the solutions to the world's food and energy crises.

Solar dryers are a very useful device for agricultural crop drying, Food processing industries for dehydration of fruits and vegetables, Fish and meat drying, dairy industries for production of milk powder, Seasoning of wood and timber, textile industries for drying of textile materials, etc. Nevertheless, one disadvantage of solar drying is that the dehydration process is interrupted at night or under low insolation, resulting in a poor quality of the dried product. Hence, every solar drier should accompany a backup system, in order to serve its purpose consistently. Biogas burner is used as an auxiliary heating unit in the solar dryer during time of lower solar radiation.

Biogas is a renewable energy derived from organic wastes.it can be produced by digestion of animal, plant and human waste. Digestion is a biological process that takes place in a digester with anaerobic organism in absence of oxygen. It is a safe fuel for cooking and lighting.

2. SOLAR DRYERS

Solar energy dryers can broadly be classified into direct, indirect and hybrid solar dryers. The working principle of these dryers mainly depends upon the method of solar energy collection and its conversion to useful thermal energy for drying

2.1 Open Sun Drying

The crops are generally spread on the ground, mat, cement floor where they receive short wavelength solar energy during a major part of the day and also natural air circulation. A part of the energy is reflected back and the remaining is absorbed by the surface depending upon the color of the crops. The absorbed radiation is converted into thermal energy and the temperature of the material starts to increase. However there are losses like the long wavelength radiation loss from the surface of crop to ambient air through moist air and also convective heat loss due to the blowing wind through moist air over the crop surface. The process is independent of any other source of energy except sunlight and hence the cheapest method, however has a number of limitations. In general, the open sun drying method does not fulfill the required quality standards and sometimes the products cannot be sold in the international market. With the awareness of inadequacies involved in open sun drying, a more scientific method of solar-energy utilization for crop drying.

2.2 Direct Solar Drying

Direct solar drying is also called natural convection cabinet dryer. Direct solar dryers use only the natural movement of heated air. A part of incidence solar radiation on the glass cover is reflected back to atmosphere and remaining is transmitted inside cabin dryer. Further, a part of transmitted radiation is reflected back from the surface of the product. The remaining part is absorbed by the surface of the material. Due to the absorption of solar radiation, product temperature increase and the material starts emitting long wavelength radiation which is not allowed to escape to atmosphere due to presence of glass cover unlike open sun drying. Thus the temperature above the product inside chamber becomes higher. The glass cover server one more purpose of reducing direct convective losses to the ambient which further become beneficial for rise in product and chamber temperature respectively.

2.3 Direct Solar Drying

These differ from direct dryers with respect to heat transfer and vapor removal. The crops in these indirect solar dryers are located in trays or shelves inside an opaque drying cabinet and a separate unit termed as solar collector is used for heating of the entering air into the cabinet. The heated air is allowed to flow through/over the wet crop that provides the heat for moisture evaporation by convective heat transfer between the hot air and the wet crop. Drying takes place due to the difference in moisture concentration between the drying air and the air in the vicinity of crop surface.

The advantages of indirect solar drying are they offers a better control over drying and the product obtained is of better quality than sun drying, caramelization and localized heat damage do not occur as the crops are protected and opaque to direct radiation, Can be operated at higher temperature, recommended for deep layer drying, highly recommended for photo-sensitive crops.

2.4 Hybrid Solar Drying

The hybrid solar dryers combine the features of the direct and indirect type solar- energy dryers. Here the combined action of incident direct solar radiation on the product to be dried and air pre-heated in a solar collector

3. BIOGAS PRODUCTION

Biogas is produced from bio degradable wastes through a process called anaerobic digestion. Anaerobic digestion is a naturally occurring process through which organic matter such as manure, feed spills, meat processing wastes and crop residues are stabilized by microorganisms strictly in the absence of air. During this process, some organic compounds are converted to methane (CH_4) and carbon dioxide (CO_2) gases. This mixture of gases is known as biogas. The composition of biogas is 50 to 75 per cent CH_4 and 25 to 45 per cent CO_2. This mixture of gases is known as biogas. Like natural gas, biogas can also be used as a fuel in power generators, engines, boilers and burners.

In practice, specially designed and insulated tanks are used to facilitate the anaerobic digestion process under a controlled atmosphere. These tanks are known as anaerobic digesters or bio digesters. The effluent coming out from the digester after the completion of the digestion process is known as digestate. Digestate has nutrient value and can be applied on land like manure. Digestate also has much less odor compared to stored manure.

3.1 Operating Parameters

Most anaerobic digesters are operated in the temperature range of 15 to 45°C. The pH of the slurry in the digester is maintained between 6.5 and 7.5. The typical retention time of organic matter in the anaerobic digesters varies from 2 days to 60 days, depending on the type of digester and the concentration of organic matter processed.

4. BIOGAS PRODUCTION

Biogas plants are broadly classified into 3 types. They are

Fixed dome plants
Floating drum Plants
Balloon Plants

4.1 Fixed Dome Plants

A fixed-dome plant consists of a digester with a fixed, non-movable gas holder, which sits on top of the digester. When gas production starts, the slurry is displaced into the compensation tank. Gas pressure increases with the volume of gas stored and the height difference between the slurry level in the digester and the slurry level in the compensation tank. The costs of a fixed-dome biogas plant are relatively low. It is simple as no moving parts exist. There are also no rusting steel parts and hence a long life of the plant can be expected. The plant is constructed underground, protecting it from physical damage and saving space. While the underground digester is protected from low temperatures at night and during cold seasons, sunshine and warm seasons take longer to heat up the digester. No day/night fluctuations of temperature in the digester positively influence the bacteriological processes. The construction of fixed dome plants is labor-intensive, thus creating local employment. Fixed-dome plants are not easy to build. They should only be built where construction can be supervised by experienced biogas technicians. Otherwise plants may not be gas-tight.

4.2 Floating Drum Plants

Floating-drum plants consist of an underground digester and a moving gas-holder. The gas-holder floats either directly on the fermentation slurry or in a water jacket of its own. The gas is collected in the gas drum, which rises or moves down, according to the amount of gas stored. The gas drum is prevented from tilting by a guiding frame. If the drum floats in a water jacket, it cannot get stuck, even in substrate with high solid content.

4.3 Balloon Plants

A balloon plant consists of a heat-sealed plastic or rubber bag (balloon), combining digester and gas-holder. The gas is stored in the upper part of the balloon. The inlet and outlet are attached directly to the skin of the balloon. Gas pressure can be increased by placing weights on the balloon. If the gas pressure exceeds a limit that the balloon can withstand, it may damage the skin. Therefore, safety valves are required. If higher gas pressures are needed, a gas pump is required. Since, the material has to be weather and UV resistant, specially stabilized, reinforced plastic or synthetic caoutchouc is given preference. The useful life-span does usually not exceed 2-5 years.

5. EXPERIMENTAL SETUP

The experimental set up comprises of a flat plate solar collector with a fan connected and an auxiliary heating unit using biogas. Flat plate solar collector is used to collect the solar energy. Fan is used to circulate the heated air from the solar plate to the drying chamber. The dry heated air removes the moisture from the material to be dried .In days of lower solar radiations; the auxiliary heating unit is used. This auxiliary unit consists of a burner to burn the biogas and also tube which carry air to the drying chamber. Biogas is produced in a bio digester using organic wastes and is supplied to the burner using pipes. A blower is used to circulate the air through the tube. The hot air fed to drying chamber to remove the moisture and thus drying is done continuously.

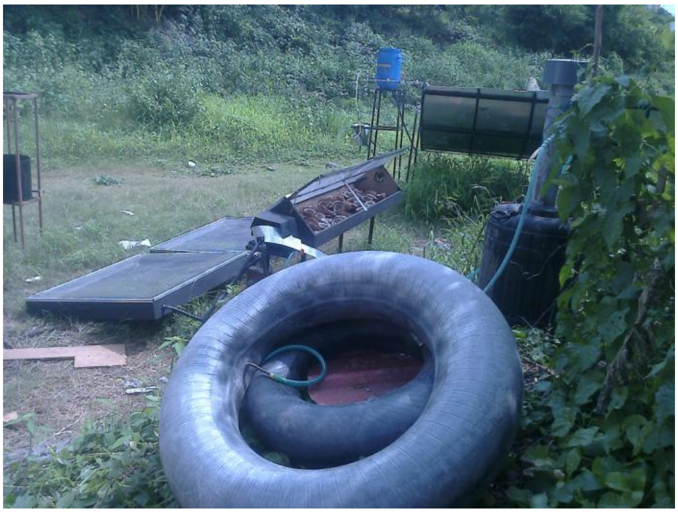

Fig -1: Experimental Setup

The parameters measured were solar intensity, dryer temperature and outside temperature. Solar intensity is measured using pyranometer and temperatures were measured using temperature gauge.

6. CONCLUSIONS

The aim of this project was to analyze the effect of solar tunnel drier combined with biogas for copra drying. The effect of temperature rise inside the dryer helped in drying the copra at a much better rate. It has taken 34 hours for the copra to dry in open sun, whereas when dried in solar drier it took just 20 hours. On the other hand, when solar tunnel drier combined with biogas we can able to dry copra even in time of lower solar radiation. The temperature of standard solar tunnel dryer increased simultaneously with increase in temperature of collector. Biogas is burned using a biogas burner which heats a G.I pipe and this hot air is blown to the drying chamber using a blower. In solar tunnel dryer combined with biogas grey gravel is placed in the mouth of the tube which blows hot air in to the drier, which helps to store heat for some more time.

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