CHAPTER I

INTRODUCTION

Rationale for the Study

Majority of ASEAN countries are major producers, users and increasingly exporters of dried food products such as vegetables, fruits, marine goods. And these are popular in both fresh and dried. Naresuan University is one of the universities in Thailand, which promoting the application of solar energy to the drying industry as an alternative energy source. In 1989-1991, the National Research Council of Thailand (NRCT) funded the development of a solar fruit dryer with 36 m^2 of collector area capable of drying about 500 kg of fruit. In 1992-1995, a banana dryer factory with 156 m^2 of collector area and a drying capacity of 5-6 tons which supported by the ASEAN-Canada project was installed. Solar energy is potentially a good energy source for the drying industry where the usual operating temperature is generally lower than 100^0C. Previous works of Solar Energy Research and Training Center involved the design and development of a conventional solar dryer with an auxiliary energy source (hot air produced by an heat exchanger and a boiler) resulted in saving of equivalent electrical energy of around 40-70%.

The proposed system integrated the solar dryer with the infrastructure and production system of the existing factory in Thailand. This enables the use of the surplus steam from breweries, canning factories and other factories that use steam in their production process to heat the air for drying processes as an auxiliary heat source for the solar dryer. Such a system provides the following advantages:

1. No extra investment for the auxiliary heat source is needed since the surplus steam is already available. The surplus steam can be utilized in the existing factory to produce dried products resulted in increasing revenues.

2. Many factories in Thailand usually shutdown their boilers during the dry season in summer and winter. But factories fitted with steam-connected solar dryer can continue to operate and produce products.

3. No extra space is needed for the dryer since the area under the solar collector can be used as the processing area for production.

4. The hybrid solar dryer system is easy to operate and maintain.

5. Maintenance cost for this system is also cheap.

6. This system is beneficial to the environment in the long term since solar energy is free and clean compared to conventional energy.

7. Considerable energy cost saving can be achieved in the long term using steam-connected solar dryer compared with electric or oil-fired dryer. For Kho Kor Agro-Industry Factory, the annual energy saving for this system is 36,812 kWh (equivalent to 13,071 liters of fuel oil).

However, the system with surplus steam also has some disadvantages as following:

1. The drying temperature was not high enough when solar radiation was used as the only energy source in the system.

2. Drying time is longer when using the solar energy alone than using the combined system.

3. There is a limitation in location site of the dryer. Mountainous and site map are influenced the quantity of solar energy collected through out the year.

4. The boiler that was used in this system consumed fuel oil, which comes from fossil fuel. The cost of fuel oil varies with the market price. In order to save money, old energy source or energy source that available in the same location as system location such as LPG or other renewable energy that easy to control, should be selected to be auxiliary energy source in combination with solar dryer system.

Considering the advantages and the disadvantages of the hybrid solar dryer system indicates that the system may be improved in auxiliary energy part by replacing the auxiliary energy such biomass fuel. A gasifier is a device, which converts biomass

materials such as wood chips and other agricultural wastes into a combustible gas. This gas is a mixture of hydrogen, carbon monoxide, methane and traces of other hydrocarbons, which is formed under incomplete combustion at high temperatures. Thermal energy of the order of 4.5 to 5.0 MJ is realized, by burning 1 M^3 of biomass gas in the burner. It can be retrofitted to the conventional system as a supplementary source of energy. In addition, utilization of biomass as a fuel has drawn attention from the worldwide in respect to carbon dioxide mitigation, especially for using as fossil fuel replacement. While availability and costs influence the selection of energy resources for drying, the important management factors to be considered in the operation of a dryer include drying equipment costs, specific energy consumption and cost, drying time and drying cost.

Nowadays, solar dryers are used in several areas in Thailand as well as direct combustion and indirect combustion of biomass. Particularly, biomass gasifier can be used for high temperature (300^{o}C) to produce ceramic. Generally, there are many of wastes obtain from agricultural product drying system. These wastes can be use as a gasifier fuel for drying system. So it will be efficient if the solar drying system is combined with the biomass gasifier. Differently in combining these 2 systems is controlling the drying temperature. The new technique of combining the biomass/solar hybrid drying system should be developed in order to control the important drying parameters. This system would be the prototype of thermal renewable energy using completely. And it will be useful for the small and large scale drying system. The optimum drying condition and the product quality should be investigated to obtain the efficient drying procedure.

Purpose of the study

1. To develop sorption isotherm of chillies.
2. To evaluate the efficiency of the biomass/solar dryer system for chillies.
3. To establish the drying model of dried chillies.

Significance of the study

1. The drying model can be used for dryer system design.
2. An appropriate chillies drying methodology by using biomass/solar dryer system will be known in order to get good quality of dried chillies.
3. An isotherm curve of chillies can be used to control the drying system automatically.
4. Research results can be scaled up to industrial scale.
5. Research results can be used for promotion of renewable energy application in order to decrease fossil fuel energy.

Scope of the study

1. Corncob will be used as biomass fuel in a biomass gasifier.
2. Dawn draft gasifier will be used in this research.
3. Red Chillies pepper will be used as drying material.
4. The quality of dried product will be investigated in term of moisture content and color.
5. The testing condition will be investigated by varying air drying temperature.