Chapter 17
Greenhouse Solar Thermal Application

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ABSTRACT

This chapter includes brief description of different solar thermal applications of greenhouse structure based on the different research work done in this area. It provides the basic knowledge of the use of solar energy to increase the production of different agricultural products using greenhouse system, e.g., crop production and drying of agricultural products. The chapter includes the introduction of greenhouse system, the definition, the concept, and the importance of greenhouse technology. The uses of various solar thermal applications in different greenhouse systems such as flat plate collector in greenhouse fish pond system and application of photovoltaic system in greenhouse drying are covered in this chapter.

INTRODUCTION

Greenhouse structures are used to provide the ideal condition required for the growth of agricultural crops throughout the year. The objective of this chapter is to provide a platform to disseminate the fundamental knowledge of greenhouse structure with various solar thermal applications, which includes:

- Fundamentals of greenhouse technology
- Different design of greenhouse structures with different solar thermal applications
- Basic working principles and energy balance
- Thermal analysis

The aim of this chapter is to provide an insight in the subject. We have drawn materials from different journals and books related to the subject.

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According to EncyclopediaC2000 (Anon, 2000) the greenhouse effect for environment is defined as: “Greenhouse Effect, term for the role the atmosphere plays in insulating and warming the earth’s surface. The atmosphere is largely transparent to incoming solar radiation. When this radiation strikes the earth’s surface, some of it is absorbed, there by warming earth’s surface. The surface of the earth emits some of this energy back out in the form of infrared radiation. As this infrared radiation travels through the atmosphere, much of it is absorbed by atmospheric gases such as carbon-dioxide, methane, nitrous oxide and water vapor. These gases then re-emit infrared radiation, some of which strikes and is absorbed by earth. The absorption of infrared energy by atmosphere and earth, called the greenhouse effect, maintains a temperature range on earth that is hospitable to life. Without the greenhouse effect, the earth would be frozen planet with an average temperature of about –18°C (about 0°F)”. Similarly this phenomenon accomplishes at the micro level, for a house having the transparent walls and roofs (glass, Perspex or polyethylene film), when the solar (short wave length) radiation passes through the transparent walls and roofs it is absorbed by some object inside and then warming up the object. The warm object emits heat in the form infrared (long wave length) radiation, which cannot be re-radiated back outside due to glass cover, resulting in increase in temperature. This house is thus called greenhouse. Today greenhouse is mainly used for the maximized the production of crops mainly during the off season, because inside greenhouse the favorable condition for the optimum growth of the agricultural crops is possible. Greenhouse is used to maintain the favorable condition required for increase the productivity of the crop. The environment such as light, air composition, temperature and nature of the root media has significant effect in the production of agricultural crop (Tiwari, 2003).

CLASSIFICATION OF GREENHOUSE SYSTEMS

On the basis of working principal applications, greenhouse may be broadly classified in the three categories:

1. Greenhouse for crop cultivation,
2. Greenhouse for crop drying
3. Greenhouse as the solar energy collector

The detailed classification on this basis is shown in Figure 1.

BACKGROUND

Greenhouse pond system (GPS) can provide a good alternative for maintaining water temperature in aquaculture facilities (Zhu et.al, 1998). One of the most important factors influencing fish growth is the water temperature (Brett and Groves, 1979; Corey et al., 1983). Many of the most popular fish species have optimum growth temperature between 25° and 32°C, thus making their culture applicable only during the warmer months (Stickney, 1979). Growth rate increases with increasing water temperature, but when the temperature is above the optimum, it has a negative instead of a stimulatory influence (Jobling, 1993). In low temperature regions, the metabolic activity of fish is greatly reduced, which affects the growth-rate of the fish (Halver, 1972). A few reports are available on greenhouse or plastic shelter pond that could achieve a 2.8 – 4.4 °C increase in water temperature for each month of the year when compared with an open–air pond (Klemetson and Rogers, 1985). A Rise of 9°C in water temperature was achieved (Brooks and Kimball, 1987) in January in Phoenix, USA in a solar heated aquaculture pond. Again rise of 4.13- 6.92 °C water temperature was achieved for greenhouse pond connected with two numbers of collectors and in case of without collector it was...