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Research on A New Technology Integrated Low-cost, Near-zero-energy Solar Greenhouse

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Abstract

This investigation was performed to improve the traditional greenhouse from the high costs, poor performance of heat preservation, low efficiency of solar collection, additional heating, brick structure, damages on farmland to low cost and high performance in Heilongjiang Province, China. The main objective of this researcg is to develope a more adoptable greenhouse with the outstanding economic, efficient and suitable advantages.
Researchers has designed and developed this new solar greenhouse. The main technical measures include internal and external insulation envelope using reflective aluminum knitting film; the ecological water circulation system for solar heat storage and collection, and geothermal energy utilization. In addition, the other technologies such as the assembled arch structure of broken line, the roof air vents for ideal condition of carbon dioxide, air temperature and humidity both in summer and winter are also applied on the rhe greenhouse.
Benefited from technology integration above, the experimental greenhouses and demonstration projects showed that they can realize 13 ℃ of minimum Indoor temperatures and 16 ℃ of ground temperature while -30 ℃ of outdoor temperature in winter. It was concluded that the new solar greenhouse without artificial heating can achieve nearly zero net energy besides a few energy consumption for water circulation and ventilation, which is very suitable for the Low-income farmers to engage the cultivation of mushroom, vegetable and fruit, animal husbandry in the severe cold region of China.

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Keywords: technology integration; low-cost, near-zero-energy Solar Greenhouse; ecological water circulation system; reflective insulation envelope.

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1 Significance of greenhouse in the cold area

Typically, greenhouses are used for indoor cultivation or breeding of vegetables, flowers, trees and other agricultural plants, and so on in low season. Especially in the cold region in China, greenhouse applications are very necessary to save energy, reduce air pollution from heating building, meanwhile to supply more fresh fruits and vegetables, especially expensive, specialties in the the low cost, environmentally friendly way, which could reduce the dependence to external fruit and vegetable, and to save shipping costs, reduce losses of them. Meanwhile greenhouse application can also help farmers generate income in the economically underdeveloped areas, speed up the wealth, reduce winter fallow. Self- picking fruits in greenhouse could create a short day trip to adapt to the demand of agricultural tourism in city outskirts, and stimulate local economy. But in the past, in Heilongjiang Province, the most important grain base of China, located in the cold region of latitude 45 degrees, the greenhouse has not been widely promoted. According to a survey, the various existing Unused greenhouse takes up to 50% of the whole. The main problems include the high cost of traditional greenhouse, high operating costs, poor performance of heat preservation, low efficiency of solar collectors and additional heating on them. And the construction and demolition of traditional brick structured greenhouse usually lead serious damage to farmland.

The ordinary farmers can not afford to build such greenhouse, the high cost of which lead to higher prices of the fruit and vegetable planted in it, even than the purchased products. Thus many people mistakenly believe that greenhouse not suitable for such a cold region like Heilongjiang. Here introduces a new developed solar greenhouse, named Camery Greenhouse ,which could overcome all the shortages above.

Greenhouses can be divided in glass greenhouse, plastic greenhouse according to the translucent materials used. The envilope of greenhouse should has good sealing, insulation performance, and ventilation of greenhuose is also very important especially for summer cooling. Modern greenhouse should install the control equipments of temperature, humidity, light and ventilation for high performance.

According to the purpose, greenhouse can be divided in production greenhouse, test (education) greenhouse and commercial greenhouse. Production greenhouse includes vegetable cultivation greenhouse and floriculture greenhouse; commercial greenhouse includes a variety of ornamental greenhouses, retail greenhouses and wholesale greenhouses. The Camry greenhouse introduced here is a modern greenhouses of production and commerce.

2 The common structures of greenhouse

The common structures of greenhouse in Heilongjiang include masonry structure, light steel structure and lightweight concrete structure and so on.

(1) Greenhouse of masonry structure

The largest number of Traditional greenhouses in the region are brick structured (Figure 1), with the glass wall or a plastic film on the south side of greenhouse, brick masonry back wall and side walls. Thier advantages are easy construction, simple structure, better heat storage capacity. The disadvantages include slow construction, high cost, serious damage to farmland, unremovable, low utilization of solar energy, poor overall efficiency, which lead it difficult to promote.

Figure 1 brick structured greenhouses in construction

(2) Greenhouse of light steel structure

With the arch shaped steel structure and whole plastic film envilope as solar collector(Figure 2), light steel conservatory is also more popular here, the advantages are low cost, quick construction, simple disassembly. Its disadvantage is that it only relies on daytime solar collection and its heat capacity is relatively poor, resulting in the

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