

Fuzzy Control of Thermally Isolated Greenhouse Building by Utilizing Underground Heat Exchanger and Outside Weather Conditions

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Abstract : A traditional greenhouse is a metal frame agricultural building used for cultivation plants in a controlled environment isolated from external climatic changes. Using greenhouses in agriculture is an efficient way to reduce the water consumption, where agriculture field is considered the biggest water consumer world widely. Controlling greenhouse environment yields better productivity of plants but demands an increase of electric power. Although various control approaches have been used towards greenhouse automation, most of them are applied to traditional greenhouses with ventilation fans and/or evaporation cooling system. Such approaches are still demanding high energy and water consumption. The aim of this research is to develop a fuzzy control system that minimizes water and energy consumption by utilizing outside weather conditions and underground heat exchanger to maintain the optimum climate of the greenhouse. The proposed control system is implemented on an experimental model of thermally isolated greenhouse structure with dimensions of 6x5x2.8 meters. It uses fans for extracting heat from the ground heat exchanger system, motors for automatic open/close of the greenhouse windows and LED as lighting system. The controller is integrated also with environmental condition sensors. It was found that using the air-to-air horizontal ground heat exchanger with 90 mm diameter and 2 mm thickness placed 2.5 m below the ground surface results in decreasing the greenhouse temperature of 3.28 °C which saves around 3 kW of consumed energy. It also eliminated the water consumption needed in evaporation cooling systems which are traditionally used for cooling the greenhouse environment.

Keywords : automation, earth-to-air heat exchangers, fuzzy control, greenhouse, sustainable buildings

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