（第３号様式）(Form No. 3)

学 位 論 文 要 旨
Dissertation Abstract

氏名：　Md. Parvez Islam
Name

学位論文題目：　Development of a zero energy cool storage system
Title of Dissertation　(ゼロエネルギー低温貯蔵庫の開発)

学位論文要旨：
Dissertation Abstract

This research work carried out a study into the developing of the zero energy cool storage system. This system doesn’t require any electric energy and made from locally available materials that is noiseless, simple in structure, easy to operate and low maintenance cost. Temperature inside the zero energy cool storage system can be reduced through the process of an evaporative cooling mechanism. The zero energy cool storage system consists outside wall made of porous volcanic lava stone and inside wall made of solid clay brick, one sand-zeolite-gravel stone based evaporative medium, and one detachable clay water tank inside the storage area. The temperature inside the zero energy cool storage was 15°C lower than the outside air temperature, while the inside relative humidity was 20% higher than the outside relative humidity. This lower inside temperature and higher relative humidity increased the shelf life of stored tomato and eggplant from 7 to 19 days and 4 to 9 days, respectively. Later an intelligent optimization technique combined with neural networks and genetic algorithms was applied to minimize the inside temperature of the zero energy cool storage system. A three-layered neural network with a time-delay operator was useful for identifying this dynamic system. Then, the genetic algorithm was used for searching for the optimal 8-step ON–OFF intervals of watering which minimize the inside temperature of the zero energy cool storage system through simulation of the identified neural-network model. The optimal intervals obtained for the watering schedule were ON = 35 min (T_1, T_3, T_5, T_7, T_9, T_{11}, T_{13}, T_{15}) and OFF = 55 min (T_2, T_4, T_6, T_8, T_{10}, T_{12}, T_{14}, T_{16}). The shelf-life

of the tomatoes during storage in the optimized zero energy cool storage system was extended from 7 to 16 days. Thus, it is concluded that the zero energy cool storage system optimized with an intelligent optimization technique combining with the neural network and genetic algorithm achieves a minimum inside temperature. Finally a new zero energy cool storage system with two types of cooling system, a solar-driven adsorption refrigerator and an evaporative cooling system, was developed. The solar-driven adsorption refrigerator produced about 3.5 kg of ice per day with a solar COP of 0.071. The ice was then stored in the ice box and cooled the storage space well throughout the following day. The inside temperature during the diurnal change was reduced to 10.1 °C by applying the solar-driven adsorption refrigerator, while the ambient outside temperature was 32.0 °C and the shelf life of tomatoes was extended from 7 to 23 days. Later, an ANN models are developed based on the nonlinear autoregressive with exogenous input NARX model and are implemented using the MATLAB® tools including the Neural Network Toolbox™ to predict the thermal performance of the solar collector of the solar adsorption refrigerator. The neural network predictions agreed well with experimental values with mean squared error which are near 0 and the best fit between outputs and targets (R) are very close to 1. These results showed that NARX models (1–12–1 with d1 = 10, d2 = 9 and 35 epochs) can successfully be used to predict thermal performance of the adsorber tube. Therefore, NARX-based ANN can successfully be used for the prediction of thermal performance of a solar adsorber tube by reducing time in testing of prototype for longer duration.

Thus, the new zero energy cool storage system proposed here is very effective in lowering the storage temperature and expanding the shelf life of fruit and vegetables in an area without electricity. The effectiveness of this new system could be improved by finding new light weight, low-cost, high heat conducting, and environmental friendly materials for collector, condenser and evaporator.