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A Study on Thermal and Flow Characteristics by Solar Radiation for Single-Span Greenhouse by Computational Fluid Dynamics Simulation

Authors : Jonghyuk Yoon, Hyoungwoon Song

Abstract : Recently, there are lots of increasing interest in a smart farming that represents application of modern Information and Communication Technologies (ICT) into agriculture since it provides a methodology to optimize production efficiencies by managing growing conditions of crops automatically. In order to obtain high performance and stability for smart greenhouse, it is important to identify the effect of various working parameters such as capacity of ventilation fan, vent opening area and etc. In the present study, a 3-dimensional CFD (Computational Fluid Dynamics) simulation for single-span greenhouse was conducted using the commercial program, Ansys CFX 18.0. The numerical simulation for single-span greenhouse was implemented to figure out the internal thermal and flow characteristics. In order to numerically model solar radiation that spread over a wide range of wavelengths, the multiband model that discretizes the spectrum into finite bands of wavelength based on Wien's law is applied to the simulation. In addition, absorption coefficient of vinyl varied with the wavelength bands is also applied based on Beer-Lambert Law. To validate the numerical method applied herein, the numerical results of the temperature at specific monitoring points were compared with the experimental data. The average error rates (12.2~14.2%) between them was shown and numerical results of temperature distribution are in good agreement with the experimental data. The results of the present study can be useful information for the design of various greenhouses. This work was supported by Korea Institute of Planning and Evaluation for Technology in Food, Agriculture, Forestry and Fisheries (IPET) through Advanced Production Technology Development Program, funded by Ministry of Agriculture, Food and Rural Affairs (MAFRA)(315093-03).

Keywords : single-span greenhouse, CFD (computational fluid dynamics), solar radiation, multiband model, absorption coefficient

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