A CFD study of the fluid flow through air distribution hoses in a greenhouse

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ABSTRACT

The indoor climate of a greenhouse provides the plants with favorable growing conditions that can result in faster growth and higher yields. Important parameters to control in a greenhouse are the temperature, the humidity, and the level of CO_2 concentrations. In southern Europe, both heating and cooling are required to control the greenhouse temperatures throughout the year. Especially, with increasingly hot summers, the need for energy-efficient greenhouse cooling and humidity control has become more and more important. In this study we employ CFD (Computational Fluid Dynamics) simulations to study the fluid flow through air distribution hoses (ADHs) in a research greenhouse in Bucharest, Romania. The ADHs are part of a novel, energy-efficient concept at the greenhouse, comprised of an integrated heat pump system, air handling units (AHUs), dry coolers, and borehole thermal energy storage (BTES). The heat pump system provides both heating and cooling, while the greenhouse humidity is controlled by the AHUs. CO_2-enrichment to the greenhouse is provided from installed CO_2 tanks. The CO_2-enriched air is circulated from the AHUs to the ADHs, which have a series of punctuated holes along their lengths. In the simulations, different configurations of the punctuated holes are simulated to optimize the mixing of the climate-controlled air with the greenhouse air. Both the diameters and locations of the holes are varied to study the flow rates out of the holes, the air throw, the dispersion of CO_2, and the pressure drops along the ADHs. The CFD simulations provide suitable design criteria for the installation of ADHs in a greenhouse environment.