Using Novel Nano-Porous Triple-Bore Hollow Fiber Membranes for Air Dehumidification in Greenhouses

Alfaddagh, Noorah

Plant cultivation in Saudi Arabia's coastal areas is implemented mainly in greenhouses, which are located in humid environments. The ideal humidity for most plants typically ranges between 50% and 70%, which is much lower than the humidity levels in these areas in Saudi Arabia, which can reach up to 95%. Methods such as silica absorption, heating, and venting are used to treat high humidity, but test results show that they consume very high amounts of energy. In this study, membranes were used in combination with a liquid desiccant for energy efficient air dehumidification in greenhouses while increasing water flux. Nano-structured porous polyvinylidene fluoride (PVDF) hollow fiber membranes were fabricated using a triple-bore spinneret at 14-15% concentrations by phase inversion methods. 13 hollow fibers were characterized using scanning electron microscopy and water flux testing. Calcium chloride was used as a liquid desiccant to be pumped into the hollow fibers in a closed environment similar to greenhouse conditions with controlled temperature and humidity (35°C±3°C, 70%±5%) to absorb water vapor from humid air. Water flux and absorption rates were directly proportional to flow rates during the experiment. The liquid desiccant absorbed water vapor efficiently (2.53 g/h) and higher flow rates (2.5 ml/min) increased water absorption rates. In conclusion, the experiments showed that using triple-bore hollow fiber membranes with liquid desiccants can efficiently decrease humidity levels in closed chambers. This project provides a valuable leading indicator for a suitable plant growth environment while conserving energy in comparison to current venting or heating applications.

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