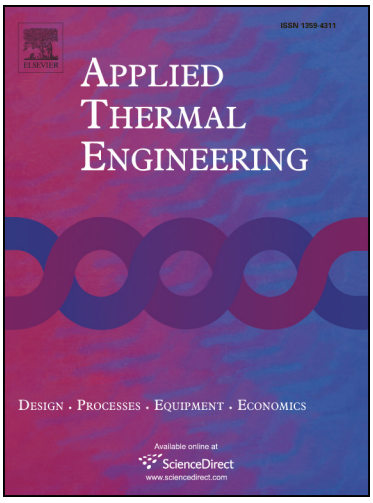

1D/3D Transient HVAC Thermal Modeling of an Off-Highway Machinery Cabin using CFD-ANN Hybrid Method

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Abstract

A comprehensive thermal model of a combine harvester air conditioning system is developed to study the transient cool-down phenomena in the cabin. The proposed simulation framework encompasses a 3D computational fluid dynamics (CFD) model that relies on an artificial neural network (ANN) which actively receives data on the performance of the refrigeration cycle in order to update the thermal state of the cabin. The refrigeration cycle is modeled using a 1D methodology to predict the heat absorption capacity of the evaporator at a wide range of operating conditions. The data generated by the 1D model is then utilized to train the ANN model with airflow, relative humidity (*RH*) and air temperature as input parameters and evaporator heat absorption as the output. The trained ANN model is integrated with the CFD model of the cabin allowing a realistic transient response of the evaporator based on the instantaneous thermal state of the cabin air. The proposed simulation framework exploits the versatility of ANN to simplify the overall complexity of the model and removes the necessity of 1D/3D co-simulation being the conventional method for this type of problems. The predicted transient thermal state of the cabin air is validated against experimental data and a substantial coherence of the numerical and experimental results is demonstrated.

Keywords: Artificial neural network (ANN), Computational fluid dynamics (CFD), Automotive air conditioning (AAC), refrigeration cycle, transient cool down.