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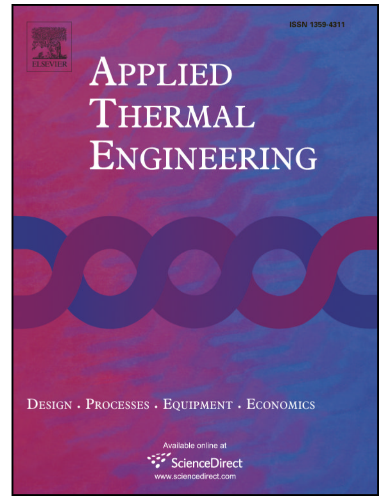

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Reduced Order Modelling of Flow and Mixing in an Automobile HVAC System Using Proper Orthogonal Decomposition

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Abstract

Proper Orthogonal Decomposition (POD) is applied for the development of a Reduced Order Model (ROM) of the mixing chamber of an automobile Heating, Ventilating, and Air-conditioning (HVAC) unit to accurately predict the enthalpy flows at the outlets for control purposes.

The proposed method collects snapshots of different parametric variations of the mixing chamber state to construct the POD subspace. The data is gathered from numerical simulations using the open source tool OpenFOAM. A generic demonstrator is modeled, which represents a simplified HVAC geometry and consists of a two-dimensional cavity, two inlets and three outlets. Two approaches to obtain the weighting coefficients for unknown operating conditions are compared with each other, namely the POD-Galerkin projection (POD-G) and a coupled POD and flow resistance (cPOD-FR) model. Within the cPOD-FR procedure, the weighting coefficients are estimated using the calculated airflow from the flow resistance model (FR). Subsequently, the approximated coefficients are applied to reconstruct the enthalpy flow rates.

It could be shown that the accuracy of the cPOD-FR procedure delivers most promising results for a ROM of the enthalpy flow rates. The procedure is capable to predict the integrated enthalpy flow rates at the outlets for 90 % of the evaluated test cases within an error margin of less than 5 %.

As a major outcome, the applicability of POD methods to generate ROMs is shown and a comprehensive comparison of weighting procedures for HVAC