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Effect of Assumptions of Normal Shock Location on the Design of Supersonic Ejectors for Refrigeration

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Abstract : The complex oblique shock phenomenon can be simply assumed as a normal shock at the constant area section to simulate a sharp pressure increase and velocity decrease in 1-D thermodynamic models. The assumed normal shock location is one of the greatest sources of error in ejector thermodynamic models. Most researchers consider an arbitrary location without justifying it. Our study compares the effect of normal shock place on ejector dimensions in 1-D models. To this aim, two different ejector experimental test benches, a constant area-mixing ejector (CAM) and a constant pressure-mixing (CPM) are considered, with different known geometries, operating conditions and working fluids (R245fa, R141b). In the first step, in order to evaluate the real value of the efficiencies in the different ejector parts and critical back pressure, a CFD model was built and validated by experimental data for two types of ejectors. These reference data are then used as input to the 1D model to calculate the lengths and the diameters of the ejectors. Afterwards, the design output geometry calculated by the 1D model is compared directly with the corresponding experimental geometry. It was found that there is a good agreement between the ejector dimensions obtained by the 1D model, for both CAM and CPM, with experimental ejector data. Furthermore, it is shown that normal shock place affects only the constant area length as it is proven that the inlet normal shock assumption results in more accurate length. Taking into account previous 1D models, the results suggest the use of the assumed normal shock location at the inlet of the constant area duct to design the supersonic ejectors.

Keywords : 1D model, constant area-mixing, constant pressure-mixing, normal shock location, ejector dimensions
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