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A CFD BASED INVESTIGATION OF THE INFLUENCE OF MEDIUM PARAMETERS ON THE TRANSCRITICAL R774 EJECTOR

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The main aim of the study is to investigate numerically thermodynamic processes occurring during an operation of a transcritical ejector working as a part of the heat pump system. Especially, this work concentrates on the estimation of performance characteristics of ejector with respect to thermodynamic parameters of flowing medium. To achieve this goal, a three-dimensional mathematical model of transcritical R774 (CO_2) flow through ejector was built using a commercial CFD code Fluent. However, the software is not capable of solving so complex problem as three-dimensional transcritical two-phase flow of a real fluid. Therefore, based on the commercial code platform an enthalpy based two-phase formulation was developed using the User Defined Function capabilities. In this modelling approach two-phase flow is assumed to be homogeneous mixture of both phases at the thermodynamic equilibrium. The presence of each phase is distinguished based on the thermodynamic parameters. This methodology was widely validated against experimental data recorded on the heat pump experimental setup equipped with ejector [3]. In the analysed problem very important issue is calculation of physical properties of the working medium (CO_2). Since the ejector working region is close to the saturation line and critical point CO_2 needs to be treated as a real fluid. One of the most recent and accurate real gas models are provided by the REFPROP libraries [2]. However, utilisation of these libraries in the CFD model appeared very time consuming, especially in case of determination of the ejector performance characteristics. Therefore, based on the REFPROP libraries in-house fast approximation of the physical properties of CO_2 in one and two-phase region was developed.

Ejector performance was assessed based on its isentropic efficiency defined as [1]:

$$\eta = \frac{\dot{m}_{suc}}{\dot{m}_{mot}} \frac{h_{suc,in} - h_{s,suc,in}}{h_{mot,in} - h_{s,mot,in}} \tag{1}$$

where $\dot{m}_{suc}$ and $\dot{m}_{mot}$ are suction and motive mass flow rates, $h_{suc,in} - h_{s,suc,in}$ refers to isentropic increase of specific enthalpy of suction flow and $h_{mot,in} - h_{s,mot,in}$ stands for isentropic drop of specific enthalpy of motive flow. Figure 1 below presents influence of suction and outlet pressure on the ejector efficiency. It can be noticed that there exist optimal suction pressure for each outlet pressure. Moreover, the working region moves to higher pressures as outlet pressure is increased.

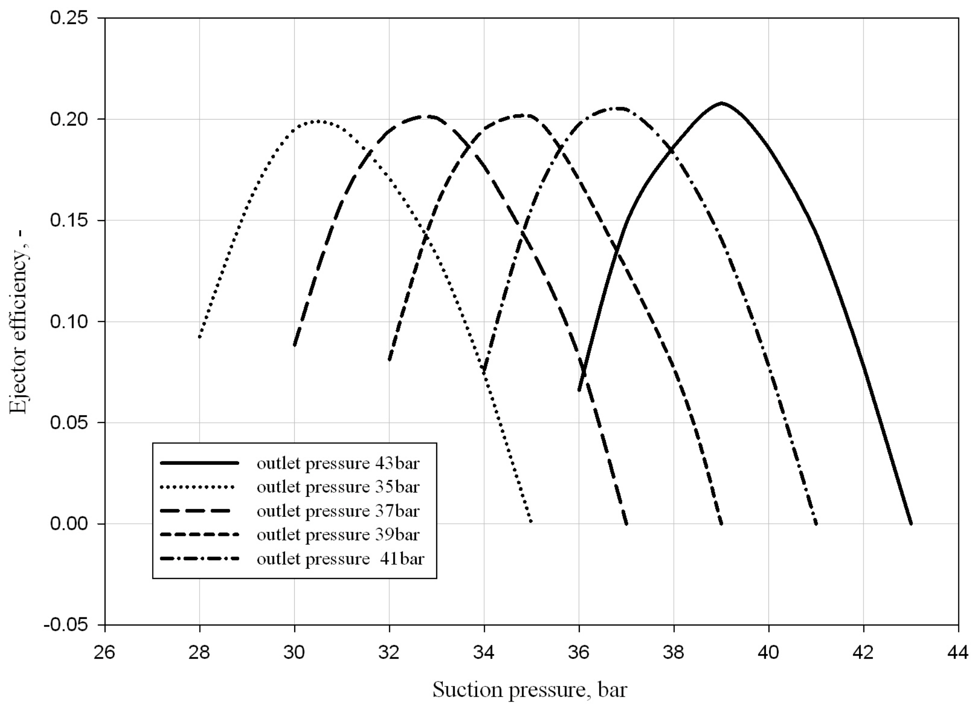

Figure 1: Influence of suction and outlet ejector pressure on its efficiency.

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