Thermodynamic and economic analysis of an ejector-driven high-temperature vapor compression heat pump

Introduction:

High-temperature vapor compression heat pumps are versatile and efficient systems suitable for industrial heating purposes. In these systems, a circulating refrigerant is used as a working medium that absorbs low-grade waste heat from the industrial process and upgrades it using a compressor for re-use in the process. After the rejection of heat from the condenser, the working fluid is at high pressure and it is passed through an expansion valve to reduce its pressure. However, during the expansion process, a significant amount of energy is lost and consequently, the overall performance of the pump deteriorates. To overcome this issue, an additional component ejector could be added to a typical heat pump cycle (Fig. 1). Ejector is a mechanical device that uses a high-pressure (motive) fluid to entrain a low-pressure (suction) fluid by momentum transfer phenomena. Ejector is a relatively new technology and is being widely explored and used in refrigeration and heat pumps for expansion work recovery. The main reason for ejector integration is its minor contribution to the cost of the heat pump. The objective is to develop a cost-effective heat pump with a superior performance in comparison to the existing systems. To elevate the performance, choosing an appropriate refrigerant is a crucial step. One way of doing this would be to test various refrigerants and perform a thermodynamic analysis of the system to compare their performance. However, the choice of refrigerants depends on multiple factors, including the overall impact they have on the environment. The target is to analyze multiple refrigerants that have negligible Global warming Potential (GWP) and Ozone Depletion Potential (ODP) and evaluate their performance to make the entire system highly sustainable.

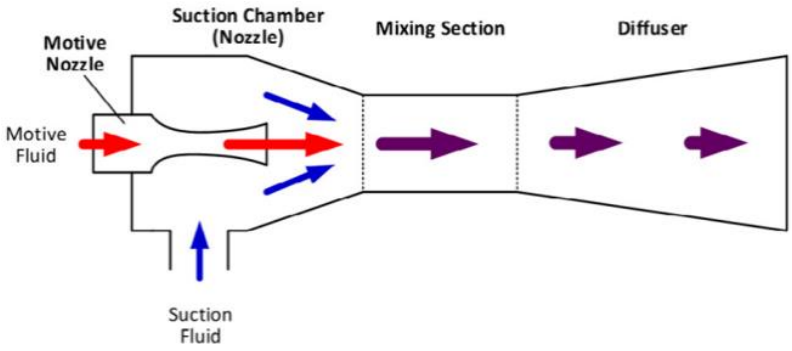

Fig.1 Schematic of ejector working

Assignment:

This assignment focuses on performing a thermodynamic analysis of the heat pump utilizing carbon dioxide as a refrigerant. Other than this, certain binary fluids will also be analyzed and their performance will be compared. During the next phase of this assignment, the economic analysis of the heat pump will be performed. This assignment is part of a larger project Kick Start and the student is supposed to work with an EngD student to accomplish the goals of the assignment. The final assignment tasks will be defined after consultation with the student.

Your background: We are looking for an excellent master's student with a Mechanical Engineering or Sustainable Energy Technology background. The candidate must be familiar with (or willing to learn) Engineering Equation Solver (EES) software.

Contact: Er. Bhupesh Jain (b.jain@utwente.nl), Dr. A.K. Singh (a.k.singh@utwente.nl)