Abstract

Thesis Title: Studies on transcritical CO_2 based cooling and heating systems with ejector

Abstract: Past two decades have witnessed a renewed interest in carbon dioxide as refrigerant for a wide variety of heating and cooling applications. However as carbon dioxide has relatively low critical temperature (≈ 31°C), for applications that involve high temperature heat sinks, the conventional refrigeration cycle has to be modified when carbon dioxide is used as a refrigerant. Since carbon dioxide cannot condense when heat sink temperature is high, heat rejection takes place in the supercritical region without any change of phase, with the conventional condenser getting replaced by a gas cooler. The system thus becomes a transcritical cycle. The high pressure operation with carbon dioxide is expected to give rise to a very compact system with efficient heat exchangers and compressors. Transcritical operation also offers new opportunities for optimal system capacity control and possibility of obtaining cooling and useful heating simultaneously. Since the throttling losses are generally very high in CO_2 based systems, an ejector can be used in place of the throttling valve to improve the system performance. Internal heat exchanger may also be used in both conventional system and the system with an ejector. The large temperature glide seen in CO_2 systems during heat rejection process, makes the system extremely suitable in applications where both cooling and heating (e.g. milk pasteurization) are required simultaneously. Taking all these features into account the objectives of this thesis have been fixed as:

- Detailed thermodynamic analyses of CO_2 transcritical systems.
- Development of model of the two-phase ejector.
- Studies on application of the proposed system for milk pasteurization.
- Experimental studies on CO_2 transcritical system with throttle valve and ejector.

From the studies it is concluded that transcritical CO_2 based systems are highly suited to applications such as milk pasteurization. Use of ejector in place of throttle valve improves performance under all conditions. The correlations developed for systems with and without ejector are useful in the selection of optimum operating conditions. The simple ejector with variable geometry can be used to control the system performance efficiently.