ABSTRACT

The expansion device is an important component in refrigerating systems. A rather simple solution is an orifice tube. It is robust and reliable, easy to install and to replace, but it cannot be controlled since the throttle's cross section is fixed. An example for a controlled expansion device is a needle valve which can be adjusted with a step motor for instance.

For the refrigerant CO_2 the control strategy of the expansion device is of special interest since the

high pressure, which has a significant influence on both the cooling capacity and the efficiency, can be varied using the expansion valve. The impact of the high pressure on the system can be investigated either by experiments or by means of simulations. The latter requires a reliable equation for the determination of the mass flow through the throttle and the pressure respectively.

This paper presents experimental data and a model for predicting the CO_2 flow rate through a short tube orifice and a needle valve to be used as expansion device in refrigerant cycles. For this, besides the needle valve several orifices with different tube geometries have been studied, i.e. different tube lengths and bore diameters. The data were analyzed for operating conditions which typically occur in automotive air-conditioning systems: The inlet pressure was varied in a range of 75 to 130 bar and the temperature in a range of 25 to 40°C, i.e. all inlet conditions were single-phase. These investigations have shown that the mass flow rate is strongly depending on the inlet pressure. Of course, the mass flow rate increases with increasing upstream pressure. The

inlet temperature plays an important role for the mass flow which increases with decreasing temperature (at constant inlet pressure).

Based on the experimental investigations a semi-empirical model with three independent variables for predicting the mass flow rate has been developed. The model was "designed" to cover flow with single-phase inlet and two-phase outlet for the refrigerant CO_2.