Heat transfer from the evaporator outlet to the charge of thermostatic expansion valves

The bulb of a thermostatic expansion valve (TXV) is basically a temperature-pressure converter. It senses the temperature at the outlet of the evaporator, and the substance in the bulb (charge) generates the corresponding saturation pressure inside the bulb. The bulb is mounted on the evaporator outlet with a special mounting strap. The heat transfer is quite complex because it takes place both directly through the contact points between bulb and pipe and indirectly through the mounting strap. The TXV has to react to temperature changes at the evaporator outlet. Therefore, the dynamic behavior of the valve (and thereby the whole refrigeration system) depends greatly on the heat transfer between the evaporator outlet tube and the charge in the bulb. In this paper, a model for the overall heat transfer between the pipe and the charge is presented. Geometrical data and material properties have been kept as parameters in order to be able to see the effect of changes in those. Some of the parameters (e.g., thermal contact resistances) have been determined by a finite element model and a series of experiments. The model has been validated using test results obtained under different operating conditions and has been found to predict the time constant for the temperature development in the bulb within 1-10%. Furthermore, it has been found that approximately 20% of the heat transfer takes place through the mounting strap.

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