Project 2: Christoph Wagner

Development and Investigation of the behaviour of an Ejector supported R744 System in Modelica

Abstract

Refrigeration system in supermarkets are contributing 50 % of the total annual energy usage.[1] Therefore, it is important to build efficient refrigeration systems which are applying natural refrigerants as Ammonia or Carbon Dioxide to decrease the greenhouse effect. CO_2 is a good choice to replace synthetic refrigerants because of his favourable properties.

Especially ejector supported R744 system designs are demonstrating a large potential in all climate conditions and as a natural refrigerant CO_2 is an environment friendly solution. To get a better understanding of these system behaviour an ejector supported R744 system was modelled in this report. The system was simulated in Dymola with the help of the TIL-library in the Modelica program language.

The system design is according to a test rig in the laboratories at Sintef Energi AS and the NTNU (Norwegian University of Sciences and Technology) in Trondheim, shown in Figure 1. The system consists of one base compressor and two parallel compressors (at the right side) as well as two ejectors (liquid and gas). The used medias are water (blue cycles), air (orange cycle) and green (VLE fluids).

Also a refrigerated display cabinet model was developed for the simulation model which is located at the right side. The model of the display cabinet simulates different heat losses as door opening, defrost periods and heat losses to the ambient so that the behaviour can be modelled.

[1] M. Ducoulombier, A. Teyssedou, M. Sorin, A model for energy analysis in supermarkets, Energy and Buildings 38 (2006) 349–356.

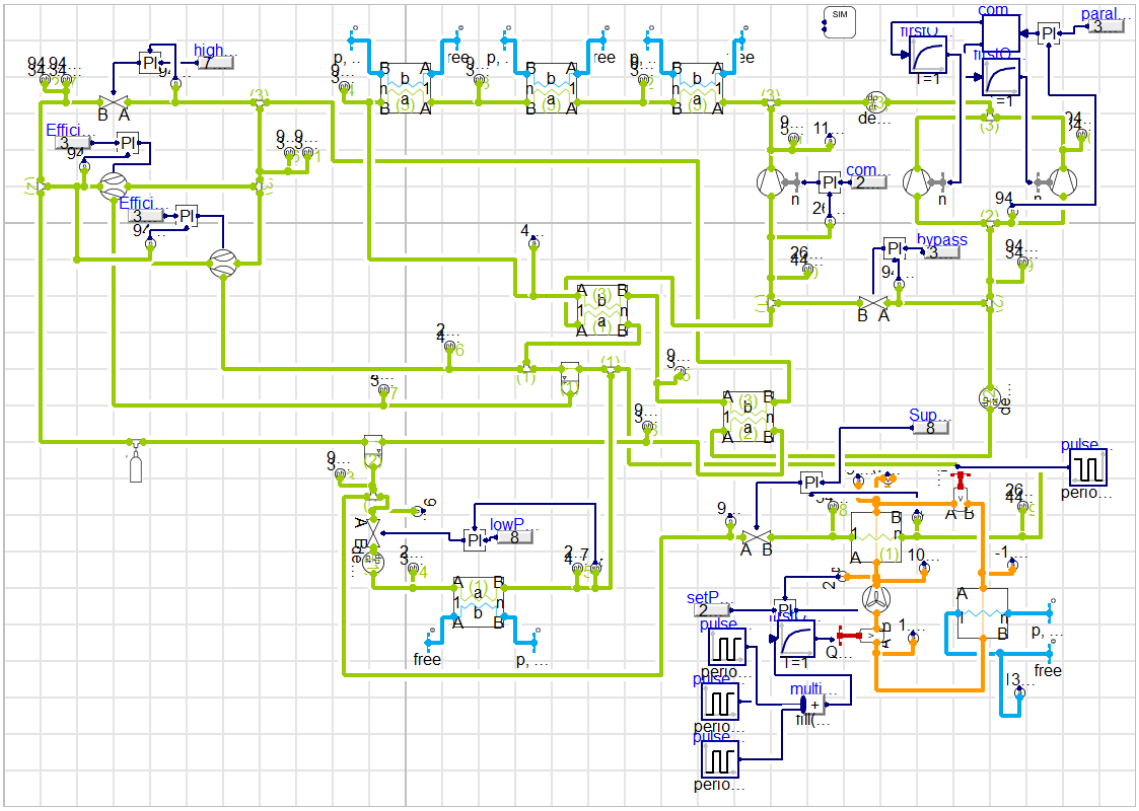

Figure 1: R744 parallel compression system with a refrigerated display cabinet modelled with TIL-library

To evaluate the model a cooling curve was measured in the laboratories and compared to simulation data. It is proved, that the simulation model is precise and it can be used for further investigation. Furthermore, this demonstrates that refrigeration systems and especially systems for the usage in supermarkets can be simulated and their behaviour can be modelled.

However, the simulation shows that there is still a large potential considering the model design of the refrigerated display cabinet. Especially the interaction with the ambient could be more investigated and pressure losses could be considered in the refrigeration system as well as in the air cycle in the cabinet.

Yet, the presented cabinet model is a representative model and can be applied in future simulations. With the created knowledge new investigations will be performed and new models can be created and simulated by the NTNU.