Project 1: Christoph Wagner

Investigation of the Evaporator Design to increase the Evaporation Temperature in Refrigerated Display Cabinets for Ejector supported R744 Parallel Systems

Abstract

Facing the challenges of the greenhouse effect, it is not only important to produce power and heat from renewable energy sources, it is also necessary to reduce the energy consumption. This is valid for all sectors of energy usage, from large industry applications to smaller housing solutions as well as for refrigeration technology. For example, contributes the refrigeration technology 50 % of the total annual energy usage in supermarkets.[1] Furthermore, it is important to apply 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.

With the elevation of the evaporation temperature in refrigerated display cabinets a large amount of energy can be saved in supermarkets. In Figure 1 the basic components of a refrigerated display cabinet are shown.

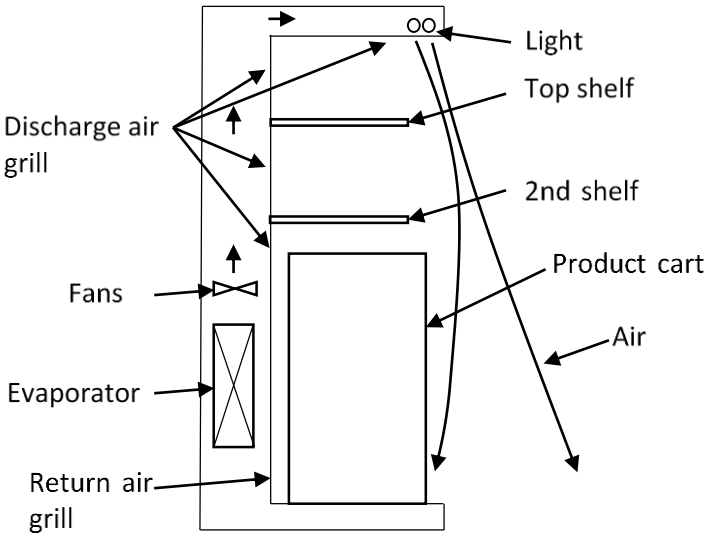

Figure 1: Main components of refrigerated display cabinets

In this report the design of the evaporator in refrigerated display cabinets is investigated to increase the evaporation temperature. The investigation is carried out

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

with the simulation tool HXSIM for a closed refrigerated display cabinet and an open refrigerated display cabinet. For the validation of the simulation tool experimental research was carried out. The research took place in the laboratory of Sintef Energy Research with an ejector supported R744 parallel compression test rig. Two cabinets for each construction design were investigated strongly based on the ISO 23953-2:2015.

In HXSIM a standard evaporator was implemented for each cabinet type in accordance to the requested cooling capacity. For each of these evaporators different design possibilities and geometries were applied to improve the cooling capacity so that the evaporation temperature could be elevated from – 8 °C to – 2 °C. For the open refrigerated display cabinet, the evaporator has to be enlarged by 50 % in horizontal direction and 37,5 % in vertical direction. Additionally, the circuiting concept was changed from uniform to staggered up to provide the requested cooling capacity at – 2 °C. The evaporator for the closed refrigerated display cabinet was also changed in the circuiting concept and enlarged. Mainly the enlargement of the evaporators was done in vertical direction so that the space for the product remains the same. For the closed refrigerated display cabinet evaporator, it was not possible to provide the target cooling capacity at – 2 °C. For this cabinet type new investigations have to be carried out.