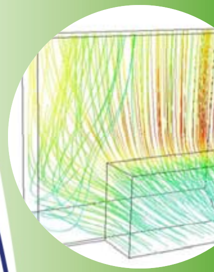
Refrigeration Developments and Testing Ltd

RD&T Case Study

Using CFD to improve the performance of a retail display cabinet

Company: Pastorfrigor



Background

Maintaining food temperatures below critical values is the key to maximising the high quality display life of chilled foods. Computational fluid dynamic (CFD) modelling can be a valuable tool to rapidly identify changes to improve the performance of retail display cabinets.

When Pastorfrigor wanted to develop a retail display cabinet that maintained food at low temperatures they approached Alan Foster and Judith Evans to help them with this task. The Pastorfrigor MV 200TP integral cabinet originally operated to meet the M2 (-1 to 7°C) temperature classification. It was therefore a challenging task to reduce maximum temperatures in the cabinet by 3°C to meet the M0 (-1 to 4°C) temperature classification.

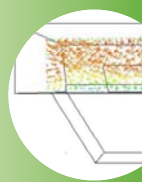
Testing work

The cabinet was initially tested prior to any modifications. The temperature of all test packs was above –1°C and below 7°C, confirming that the cabinet complied with the M2 classification. However, only 42 test packs (out of 54) spent the entire test period between -1 and 4°C. The energy consumed by the refrigeration system, fans and cabinet lights throughout the 24 hour test was on average 1.37 kW. The refrigeration compressor ran for 77% of the test period.

Airflows within the cabinet were examined using smoke as a tracer. On all shelves a vortex was created above the packs that caused air to circulate within each shelf. Further investigation of the cabinet revealed that the evaporator did not extend over the full width of the rear duct and this prevented good air flows to the cabinet well.

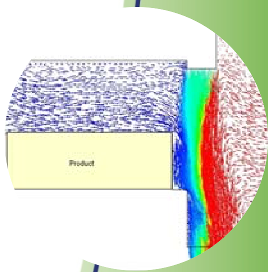
CFD work

CFD modelling concentrated on two features of the cabinet that were most likely to be responsible for high temperatures:



1. The flow of air as it left the evaporator and travelled up the rear duct at the corners of the cabinet.
2. The flow of air as it left the discharge air grille and the rear grille and its interaction with product on the top shelf.

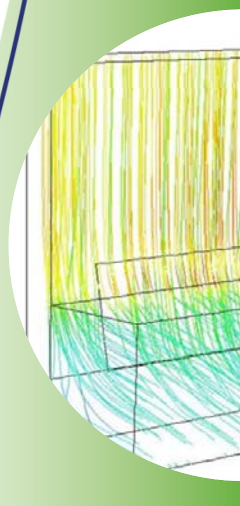
A predictive model of different regions of the cabinet that had been identified to have problems was created, because it was not feasible to create a model of a whole cabinet that included the necessary detail. The areas modelled were the discharge air grille



Three-dimensional predictive models were created using CFX 5.5.1 (CFDS, AEA Technology), a commercially available CFD code. This uses the finite volume technique and an automatic unstructured mesh generator based on a tetrahedral mesh discretisation.

Results

Based on the CFD predictions and observations, a number of modifications were carried out to the cabinet by the manufacturers. A longer evaporator was fitted to the cabinet, the evaporator was repositioned forwards and an angled diffuser was used to gradually widen the duct from the edge of the evaporator to the edge of the cabinet. A deeper air curtain grille (with honeycomb) was fitted to the canopy.



The results from the predictions were verified by re-testing the cabinet. Implementing the changes to the cabinet reduced the average power consumption from 1.37 to 1.29 kW as well as significantly reducing the number of test packs which spent any time above 4°C, from 12 to 1.

Foster, A M, Madge, M and Evans, J A. (2005). The use of CFD to improve the performance of a chilled multi-deck retail display cabinet. Int. J Refrigeration. Volume 28, Issue 5, August 2005, 698-705

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