

EXPERIMENTAL STUDY OF THE PERFORMANCE OF AN OPEN-TYPE REFRIGERATED DISPLAY CABINET

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Abstract

The open-type multi-deck refrigerated display cabinets became very common in retail food stores as promo refrigerators. They attract customers because there is no physical barrier between them and the food products. However, open-type refrigerated cabinets are less energy-effective than closed refrigerated cabinets. This causes additional sufficient expenses, also considering the fact that the price of electricity is constantly increasing. The purpose of the study was to increase the efficiency of the open-type cabinet by improving its design. The open-type vertical refrigerated display cabinet used to store food at temperatures between -1 and $+7$ °C was chosen as research object. The overall dimensions of the cabinet (W·D·H) are the following: 2500·970·1460 mm. The cabinet has 5 shelves for food products with depths ranging from 350 to 600 mm. The spacing between the base and the first shelf is 280 mm, between the other shelves is 250 mm. A summary of the refrigerated cabinet working principle can be presented as follows: air enters the cabinet from the air grill attached to the front of the bottom panel, fans blow air through the evaporator, and cooled air travels through a tunnel to the top of the refrigerator. The perforated distributor at the top distributes the cooled air and part of the air is directed through the perforated back panel, and the other part passes through the air-off honeycomb installed at the front top of the cabinet, thus forming an air curtain between the inside of the refrigerator and the ambient warm air to protect the chilled food products. The air cooled entering through the perforated back panel into the display area helps to maintain the required food temperature. The honeycomb dimensions (W·H) are 120·20 mm. In the study, two versions of refrigerated cabinets were analyzed. The first version is the standard refrigeration cabinet and the second version was the same cabinet but with changed the inclination angle of the honeycomb and reduced the depth of the shelves. The temperatures of air and test food products were measured with thermocouples and a hot wire anemometer, and the electrical energy consumption was measured with the Carel MT300W1100 energy meter. In summary, the following conclusions can be drawn:

- The infiltration ratio decreases from 38.7% to 27.7% in the improved version of the cabinet.
- Electrical consumption at 24 hours decreases from 24.91 to 19.22 kWh.
- The average temperature in the return air grille decreases from 7.5 to 6.5°C with the same temperature settings. The average temperature in the honeycomb shows that the modified version requires less energy to maintain the temperature in the refrigerated cabinet.
- The average temperature of the M packets decreases from 0.2 to 2.2 °C depending on the position of the packet.

Key words: open-type refrigerated display cabinet, air curtain, honeycomb, heat transfer, air temperature, energy consumption