Open Refrigerated Display Cases "ECOMAX Series" for Supermarkets

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1. Introduction

In the midst of a severe economic circumstance as never before experienced, the supermarket industry has also been experiencing a slowdown in sales caused by slumping consumption, and each supermarket chain in the industry, with few exceptions, is facing very severe business conditions. Under these conditions, display cases are required to contribute to total cost reduction, including the minimization of initial expenditures and running costs, and suppression of installation cost; they must also provide enhanced display efficiency and an appealing presentation of product to motivate customers to make purchases, and in addition, provide high-grade freshness control in order to reduce product loss. On the other hand, as the supermarket industry has become more concerned with environmental conservation through such measures as acquisition of ISO 14000 certification, the supermarket equipment users have increased demands on display case producers, and energy saving, waste reduction and other features are requested more strongly.

In response to these needs and by enhancing the advanced features and high performance of the existing series, Fuji Electric has developed and marketed a new series of open refrigerated display cases for supermarkets. This series, named the "ECOMAX series," is easy to install and is customer and environmentally friendly. An appearance of the series is shown in Fig. 1 and an overview of the series is introduced below.

Fig.1 Appearance of an ECOMAX series open refrigerated display case for supermarket use

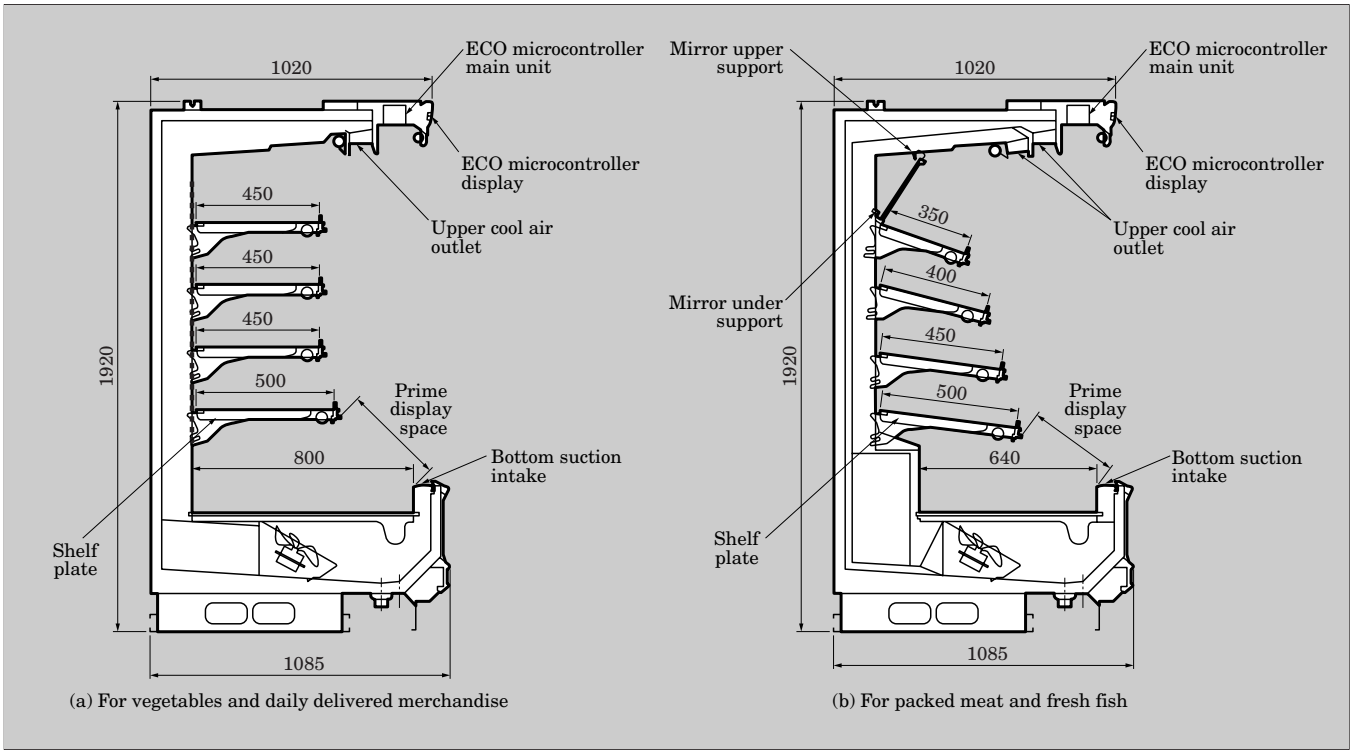
2. Overview of the ECOMAX Series

To be compatible with the various types of selling floor configurations, the ECOMAX series consists of four models differing in their basic cross-sectional profiles: multi-deck, semi-multi-deck, flat and pair-freezer types. Each model can be specialized for use in different working temperature ranges, so the series provides for an abundant variety of 500 model types. Furthermore, the series can meet the needs of diversity and individuality of stores with corner cases, special cabinets and optional parts. The core product line in this series is the multi-deck open display cases.

A cross-sectional view of the ECOMAX series, multi-deck open refrigerated display case, is shown in Fig. 2. In this type of case, an airflow cooled in the evaporator is blown through a backside duct, rectified by a honeycomb rectifier and then blasted out from an upper cool air outlet. This blasted cold airflow is blown down along the front edge of the shelves, tracing out an arc shaped projection, and then is drawn back through a bottom suction intake, so that an air curtain is formed in front of the open space of the display case. This air curtain isolates the interior from the open air and keeps the product in the case cold.

This ECOMAX series multi-deck open refrigerated display case is subdivided into 90 models, differing in storage temperature zones, dimensions of case depth and length, number of air curtain layers, etc. Among these models, there is also a product line of display cases that feature fuzzy logic-based high-grade freshness control and the capability to sense operational and environmental conditions and determine the cooling and defrosting timing accordingly.

Fig.2 Cross-sectional view of the ECOMAX series multi-deck open refrigerated display case



3. Features of the Multi-deck Open Refrigerated Display Case

3.1 Enhanced display efficiency and presentation of product

Each part of the display case was designed so as to create a non-oppressive selling space where customers are able to easily see, select and buy product.

3.1.1 Shelf plate configuration

Based on the eye height calculated from the average woman's height as a reference point, the shelf angle was positioned so as to provide the maximum visible range of shelf plates. Also, the standard shelf plate depth was determined based upon an average woman's reach from a natural standing position. The shelves were configured according to these dimensions so that customers standing near the display case can easily view the product from top to bottom, and take out articles easily. In addition, the shelves can be raised or lowered with a 25 mm pitch, and a newly designed bracket for the shelves allows adjustment of the shelf angle in 5 steps.

3.1.2 Upper part (canopy) depth

The canopy depth was shortened to eliminate the oppressive feeling sensed by customers near the display case. Also, the rounded design of the canopy end compels customers, both psychologically and physically, to approach the case closer than before when selecting product.

3.1.3 Dimensions of prime display space

As a consequence of achieving a wider prime display space (the space between the lowest shelf and the suction intake) through clever positioning of the evaporator and the use of a thinner duct for the suction, the viewing angle was enlarged so that the volume of the exhibited product appeared to increase.

3.1.4 Presentation effect of mirror

To stage the product so that is presented with a sense of volume and continuity, 5 types of inclined mirrors are provided, so that a mirror with an appropriate width can be selected according to the exhibited product, the shelf dimension, and so on. Furthermore, the presentation of the product was significantly enhanced by the structure of the upper support of the inclined mirror to which a POP (point of purchase) hanger can be attached and the under support whose structure allows the mirror angle to be changed easily depending on the shelf angle.

3.2 Reduction of total cost

3.2.1 Reduction of initial cost

Standardization of components among the model types was promoted and executed thoroughly based on review of the skeletal structure. Also, use of a riveted structure, component integration and so on, enables the number of screws to be reduced.

Furthermore, through incorporating various individual specifications to meet the diverse needs of customers to the extent possible into the standard specification during the initial phase of the development, the generation of special components was strongly suppressed. Additionally, options were cleverly designed to be easily attachable.

3.2.2 Reduction of running cost

(1) Reduction of the required refrigerating capacity

The development of a newly designed high-efficiency evaporator based on review of the optimum heat transfer area and fin pattern enabled clogging by frost deposits to be reduced drastically. Also, by increasing the number of refrigerant paths, loss of the evaporator was reduced and efficiency was improved. As for the air curtain, by means of simulation analysis, the correlation between the air velocity of the air curtain and the back flow from the interior backside was optimized, and the optimized results were applied to actual products (Fig. 3). Furthermore, the ability to shutout outside air was enhanced extensively through making the velocity of the air curtain uniform in the lengthwise direction of the case and improving the rectifying effect by modifying the shape of the honeycomb rectifier.

Additionally, in display cases for vegetables and daily delivered merchandise with high working temperature zones, a "rear jet air curtain system" was developed from the existing one layer air curtain system. In the new system, to improve the ability to shutout outside air, a slit type air outlet was added inside of the existing air outlet. This new system achieved a dramatic improvement in the rectifying effect of the air curtain. Figure 4 shows the structure of the air outlet of the display case for vegetables and daily delivered product. Through the above-mentioned improvements, the required refrigerator capacity was reduced by approximately 20 % in display cases for packaged meat and fresh fish and by approximately 10 % in display cases for vegetables and daily delivered product, as shown in Fig. 5.

Fig.3 Example of the simulation analysis

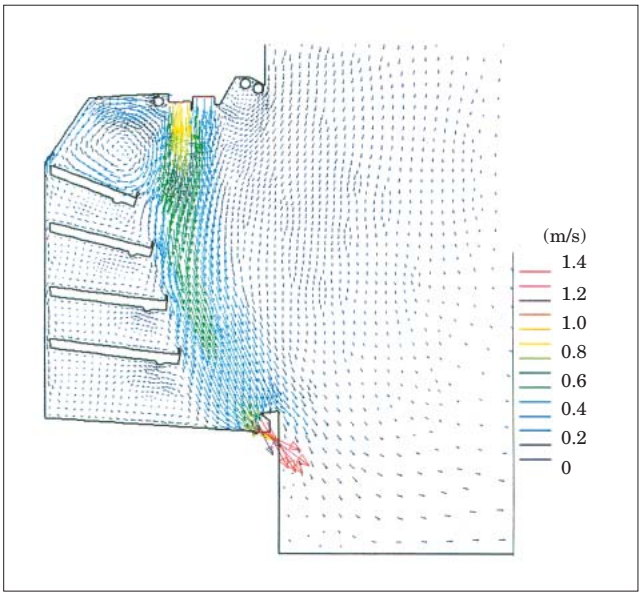
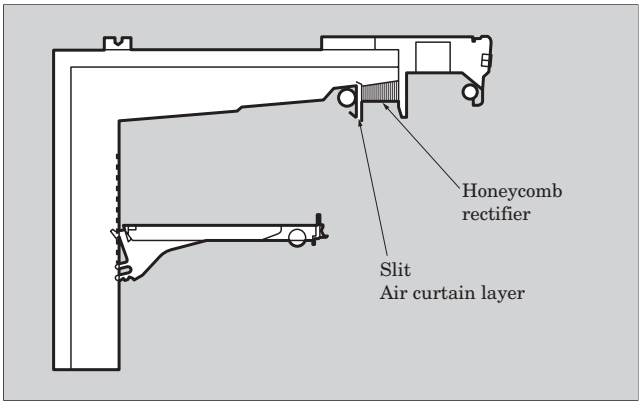


Fig.4 Structure of the air outlet part of the display case for vegetables and daily delivered merchandise



(2) Microcontroller

In the ECOMAX series, a microcontroller (the ECO microcontroller) is equipped as standard equipment in each display case. Figure 6 shows the input-output configuration of the ECO microcontroller. With this ECO microcontroller, all sorts of control for the display case, e.g. temperature control, defrost control, alarm output and so on, is centralized, and also the temperature control in the case interior is executed precisely through significant improvement of the operation control accuracy to realize high freshness control of the merchandise. Furthermore, when applied in combination with the total control system "ECOMAX V," which provides total control of the display case and the refrigerator, a dramatic energy savings (49 % reduction of the annual electrical power consumption) through the reduction of refrigerator power consumption and a large improvement in freshness control ability (50 % lowering of the temperature fluctuation) were both realized.

(3) Electronic ballasts provided as standard equipment

Energy efficiency was improved by providing electronic ballasts as standard equipment and installing

Fig.5 Comparison of refrigerating capacities (with our existing type)

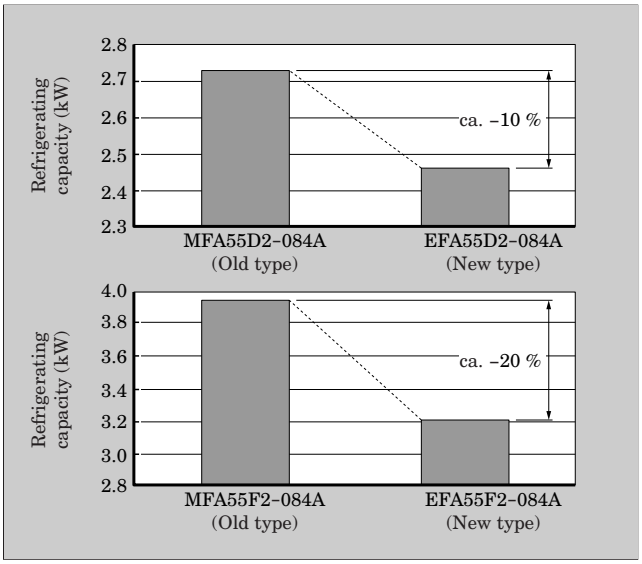
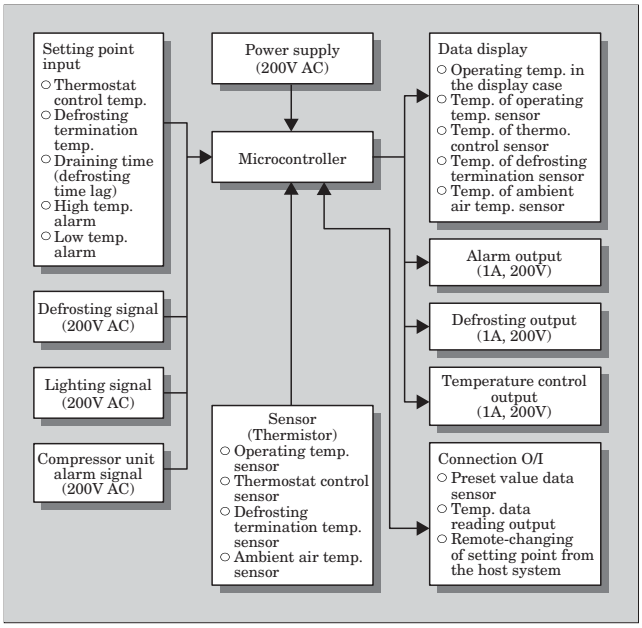


Fig.6 Input and output configuration of the ECO microcontroller



them for the canopy lighting, the interior lighting and the shelf lighting in chilled storage display cases, and electric power consumption was reduced by 26 % compared with the existing ballast. Also, since high-frequency lights were used, the flickering of fluorescent lighting was suppressed, resulting in illumination that is easy on the eye and shows off the merchandise well.

3.2.3 Easier installation

The power supply for the lighting, fan motors, dew prevention heaters and ECO microcontroller was changed to a single-phase, 3-wire, 200 V power supply from the former single-phase, 100 V power supply. As the number of circuits was reduced to less than one half of the former system, a drastic reduction of installation materials and manpower and also shortening of the construction period were realized. Also, by pre-installing the defrosting synchronous wiring of the display case into the main wiring of the case, the onsite wiring work was simplified.

The quality of the installation of the solenoid valves and the defrost timer is improved by preparing kits in advance according to the ordered options and the work standards for onsite installation.

3.2.4 Easier maintenance

(1) Detachable honeycomb rectifier

Since the honeycomb rectifier mounted on the air curtain's air outlet requires periodic cleaning, an easily detachable wire fastening method was newly adopted.

(2) Lighter shelves

The shelf structure has been redesigned with 15 % less mass than before while maintaining the same strength. This enhancement improves makes it easier to change the position or inclination of the shelf.

(3) Central monitoring of the display cases

The above-mentioned ECO microcontroller is equipped with a communication function that enables central monitoring of the display cases when used in conjunction with Fuji Electric's "ECOMAX-Net" central monitoring system. Central monitoring greatly enhances the efficiency of maintenance management.

3.3 Measures for environmental conservation

3.3.1 Discontinuance of chlorinated vinyl materials and improvement of recycling capability

In the ECOMAX series, as a part of the measures for environmental conservation, the use of chlorinated vinyl materials for resinous components was discontinued with the exception of material for lead wire insulation, because chlorinated vinyl can become a source of dioxin emission and might produce poisonous gas. This measure was pursued aggressively by using highly safe materials, such as ABS (acrylonitrile butadiene styrene), PP (polypropylene), AES (acrylonitrile ethylene styrene) and so on, instead of chlorinated vinyl materials. Also, in order to improve recycling capability, material names were marked on the resinous components.

3.3.2 Lighter mass product

By redesigning components, using resin-based trims and the like, the product was simplified and the amount of on-site waste material was reduced.

3.3.3 Use of new refrigerant

The ECOMAX series uses substitute chlorofluorocarbons (HFC) with low ODP (Ozone Depletion Potential) instead of the designated chlorofluorocarbons (HCFC) with high ODP., R404A, having zero-ODP, may be used.

4. Conclusion

An overview of the open refrigerated display cases "ECOMAX series" for supermarkets has been presented above. As supermarkets trend toward diversification and individualization when seeking a new store style, display cases will increasingly be required to breakaway from undifferentiated designs. Therefore, Fuji Electric will strive to further the expansion of this series and the development of new characteristic products.

In closing, the authors wish to thank the related individuals who offered their assistance and cooperation in the development of this series.