

Office-Use Ultra-Compact Cup-Type Vending Machine “FJX10”

KUROYANAGI, Yasuhiko* ITO, Shuichi* NISHIKAWA, Yohei*

ABSTRACT

Fuji Electric has developed an office-use ultra-compact cup-type vending machine “FJX10” in collaboration with Japan Beverage Holdings Inc., a cup beverage operator. The unit has been designed to be installed in offices, being characterized by its compact size and low power consumption, allowing it to dispense delicious coffee within the premises of an office. Moreover, the unit utilizes a cup mixing system that achieves a superior level of sanitation and ease of cleaning by adopting the industry’s first horizontal uniaxial conveyance mechanism. Furthermore, it also achieves an industry top-class low power consumption of 849 kWh/y by means of equipping the unit with a high-efficiency energy-saving ice maker, as well as an energy-saving hot water tank that adopts a vacuum heat insulating structure.

1. Introduction

Cup-type vending machines are operated in a variety of locations, such as offices, factories, hospitals and highway service areas. Approximately half of these are used in offices with many workers. Therefore, most of these are medium, large or multi-functional machines that could not guarantee enough sales to recover the investment made in offices with few workers, and it was also difficult to ensure space for installation.

Meanwhile, counter-top machines developed in 2013 that make use of the regular coffee extraction system, a technology in cup-type vending machines, have been highly rated by consumers for the deliciousness of their beverages, and have resulted in a significant coffee sales boom in convenience stores.

2. Development Background

In consideration of cup-type vending machine market conditions and needs felt in the coffee sales market, Fuji Electric has developed an office-use ultra-compact cup-type vending machine “FJX10” in collaboration with Japan Beverage Holdings Inc., a cup beverage operator, with the goal of revitalizing the office market (see Fig. 1). It features a compact size, and provides familiar and delicious genuine coffee.

3. Development Goals and Challenges

Cup-type vending machines are automatic beverage preparation machines that prepare ready to drink beverages from water and ingredients. In other words, the entire supply chain for packaged beverages, from



Fig.1 “FJX10”

the manufacturing plant to the sales floor, is complete in a single unit. Cup-type vending machines are therefore composed of mechanisms that perform a variety of functions, such as paper cup supply, hot water and ice cube creation, ingredient supply and coffee extraction.

In order for cup-type vending machines to be accepted at offices, each mechanism must be more efficiently arranged so that hot and cold beverages can be sold from a unit with a compact size and running costs must be reduced, while ensuring that provided materials are sanitary and safe.

4. Overview of “FJX10”

4.1 Features

- (a) New design door for offices
- (b) Compact-size, hot and cold specifications
- (c) Single cup drip-type coffee brewer that provides delicious coffee
- (d) Cup mixing system that prepares materials inside the cup, and offers excellent cleanliness and sanitation

* Food & Beverage Distribution Business Group, Fuji Electric Co., Ltd.

4.2 Specifications

Table 1 lists the specifications for FJX10.

(1) New design door

An integrated membrane keypad with a high level of design freedom is adopted to completely change the concept of traditional cup-type vending machines. The panel display and membrane keypad are integrated in a single unit, resulting in product displays and selection buttons that are reminiscent of menu boards at coffee shops. The left and right molding are made a silver metallic color to give the machine a high grade look, and are made detachable to allow for future renovation.

(2) The most advanced preparation technology in the industry

The machine includes the regular coffee extraction system, Fuji Electric's core technology in vending machines, which played a role in sparking the convenience store coffee boom in 2013. It also adopts the industry's first horizontal uniaxial conveyance mechanism, so that the cup mixing system can be utilized in a compact unit. Finally, it is equipped with a control function to shake a cup during propeller stirring, in order to increase preparation efficiency.

(3) Environmental support

Table 1 "FJX10" specifications

Item	Specification
Model	FJX10
Dimensions	W550×D600×H1,700 (mm)
Product weight	135 kg
Product display/ push buttons	Flavor: 6 types / Product selection: 12 buttons Function: 9 buttons
Sales ingredients	Regular: 2.1 L×2 Cream: 1.4 L×1 Sugar: 1.4 L×1 Powder: 1.4 L×3
Coffee brewer	Drip-type paper filter Dreg bucket capacity: 14 L
Cup mechanism	Nine ounce only, two types (stores 210 cups)
Ice maker storage capacity	2.1 kg
Hot water tank capacity	3.0 L
Water supply	Directly connected to water service/ cassette tank
Drainage bucket capacity	5.5 L
Refrigerant	HFO-1234yf
Power consumption	849 kWh/y

*1: HFO-1234yf: This non-fluorocarbon refrigerant has a low global warming potential (GWP) of 4, and conforms to "Act on Promotion of Procurement of Eco-Friendly Goods and Services by the State and Other Entities" (Law on Promoting Green Purchasing) standards calling for a GWP of less than 140.

The machine has achieved an industry top-class low power consumption of 849 kWh/y by means of equipping the unit with a hot water tank that uses vacuum heat insulating material for high insulation performance and an ice maker with a highly efficient control function. It also adopts an environment-friendly HFO-1234yf^{*1} refrigerant that conforms to the Law on Promoting Green Purchasing.

(4) Simple operation

The machine is equipped with an auto sanitation function that rinses the stirring propeller for each cup. The cleaning part is structured so that it can be easily removed and washed.

(5) Improved serviceability and assembly

As the machine features a compact size, each mechanism element is given a block structure to facilitate maintenance and assembly. Each block can be detached and reattached.

5. Energy Saving Technology for Cup-type Vending Machines

5.1 Energy-saving hot water tank

Cup-type vending machines work under a wider temperature range (from 97°C for hot water to -10°C for ice cubes) than canned beverage vending machines (from 55°C for hot beverages to 5°C for cold beverages). The "Food Sanitation Act" regulates each control temperature to maintain food safety. One issue we faced was to build a system that prioritizes safety and controls the machine to automatically mark products as sold out if they fall outside of these conditions, while maintaining highly efficient cooling, heating and preparation functions. The hot water tank always stores hot water, and it uses the most electric power when stationary. Therefore, energy saving initiatives are important.

Conventional hot water tanks were insulated only with foamed plastic. To promote energy saving, Fuji Electric used thermography to perform measurement and thermal analysis, and adopted vacuum heat insulating material that offers higher insulation performance. If the vacuum heat insulating material makes direct contact with the hot water tank, various problems could occur. For example, insulation performance could be reduced due to degradation over time or damage to the outer surface. In response, we have adopted a 3-layer heat insulating structure in which the insulating material is pinched from the inside and outside by foamed plastic (see Fig. 2). This reduces the annual power consumption of the hot water tank from 380 kWh/y (conventional models) to 325 kWh/y, a decrease of 14%.

5.2 Energy-saving ice maker

Ice makers are mechanisms that create and store ice. The ice maker compressor repeatedly starts and stops depending on the amount of ice remaining. After

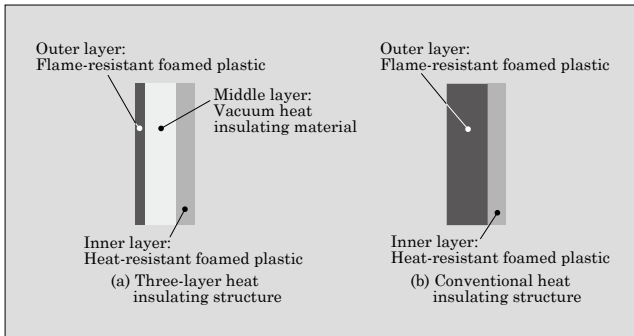


Fig.2 Hot water tank heat insulating structure

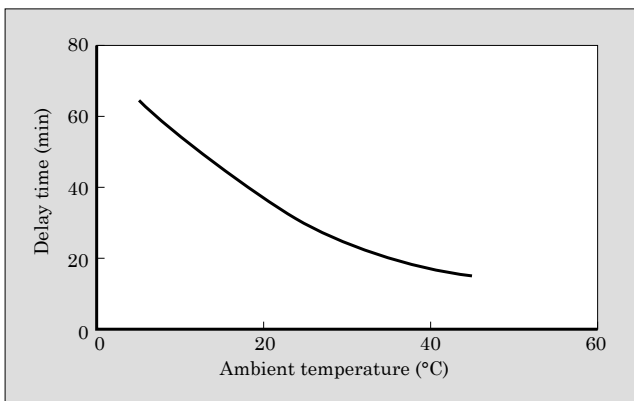


Fig.3 Ice maker compressor operation delay time

the compressor starts, ice cannot be created for 1 to 2 minutes as it takes this long for the refrigerant to begin circulating. In response, we designed the compressor to start less often, and reduced the amount of time spent merely circulating the refrigerant, not creating ice, thus resulting in more efficient ice making.

Demand for ice fluctuates greatly depending on the varying temperatures of the seasons. We have focused on this, and developed highly efficient control functionality that optimizes the amount of ice stored in the ice maker, as a parameter of the ambient temperature. An operation delay time is set in the compressor (see Fig. 3) to increase and decrease the amount of ice made in the summer and winter, respectively.

These improvements have reduced the annual power consumption of the ice maker by 25%.

6. The Most Advanced Preparation Technology in the Industry

6.1 “Shaking control” preparation technology

Cup-type vending machines prepare coffee using a cup mixing system, in which ingredients and hot water are stirred using a propeller in the cup. During propeller stirring, the position, rotating speed and time can be widely set according to ingredient characteristics such as granularity and viscosity. Furthermore, the machine comes with the cutting edge “shaking control” preparation technology that shakes the cup horizon-

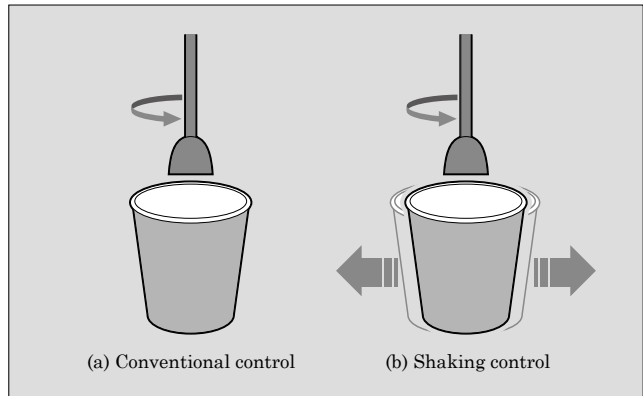


Fig.4 Cutting edge “shaking control” preparation technology

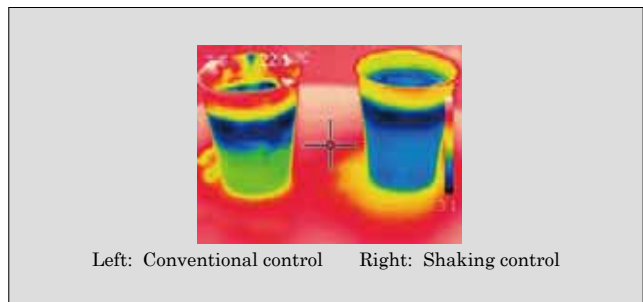


Fig.5 Beverage temperature comparison

tally when stirring (see Fig. 4). This improves stirring efficiency allows for increased beverage variation, improves beverage quality and reduces selling times. Figure 5 indicates the comparison of beverage temperatures after they have been stirred for a certain period of time. This clearly shows that shaking control keeps beverage temperatures uniform in a short amount of time.

6.2 Simple cap mixing sales system

The cup mixing system prepares the beverage in the cup each time a sale is made. In addition to being sanitary, this results in few parts that need to be cleaned.

Conventionally, all sales processes, including cup delivery, ingredient selection, coffee (hot water) selection, propeller preparation, and conveyance to the cup reception window, were performed via 2-axis (X and Y) operation, and required a large space.

In response, we have developed the industry’s first horizontal uniaxial conveyance mechanism in order to save space. This mechanism is capable of performing all preparation processes on a single horizontal axis, as the preparation location and delivery window are shared (see Fig. 6 and Fig. 7).

With conventional machines, the beverages tend to splash when ice is dropped in the cup during preparation, making consumers feel that the cups and the delivery window are unsanitary. In order to resolve this issue, we have implemented a reduction in the speed at which ice is dropped into the cup, and designed a struc-

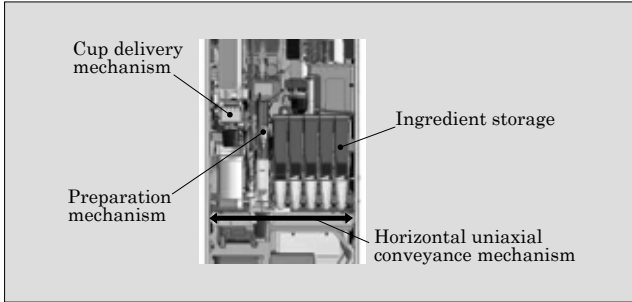


Fig.6 Sales process mechanism

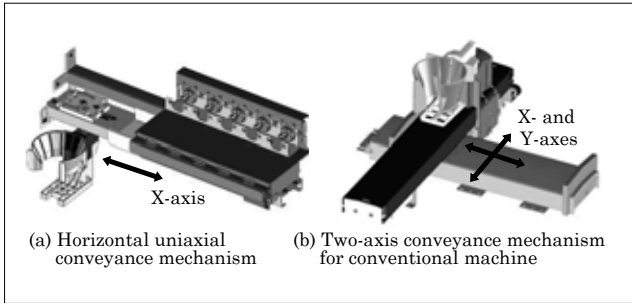


Fig.7 Sales process mechanism

ture where the ice is placed in the cup from directly overhead (see Fig. 8). This reduces beverage splashing.

We have also added a control that changes the timing at which ice is discharged for each beverage. For powdered beverages, we have added a control function that inserts ice after the ingredients have melted in a

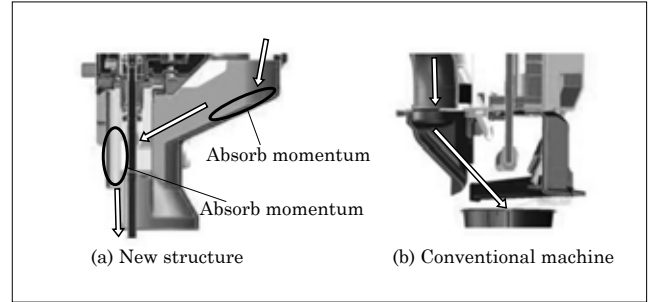


Fig.8 Reduced ice dropping speed

small amount of hot water, then adds more hot water. Adding ice to just a small amount of beverage stops the beverage from splashing outside. For regular beverages (black), we have added a control function that extracts coffee after first adding ice to the cup. These controls form a structure that minimizes beverage splashing outside the cup.

7. Postscript

This paper described the office-use ultra-compact cup-type vending machine “FJX10.” By continuing to seek further energy saving initiatives and improved taste, we will help to expand the cup-type vending machine market. We will continue to observe market needs and plan to continue to create cup-type vending machine products to satisfy consumers.





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