"EVOL100-400B/M" High-Speed Corrugated Board Box Making Machine

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1. Introduction

Corrugated board boxes are the most familiar packaging material and are a key part of the world's logistics and commodity distribution systems. They are also considered to be up-to-date, earth-friendly products that cope with difficult global environmental problems in modern society because they can be recycled after use as one of the recyclable packaging materials.

Mitsubishi Heavy Industries Printing & Packaging Machinery, Ltd. has been manufacturing corrugating machinery since 1955, and has produced corrugators that make corrugated boards and box making machines that make corrugated board boxes for customers all over the world.

We have developed and brought to the market the EVOL series of box making machines sequentially in order to respond the higher production capability needs from the market: The EVOL84 (capable of making 400 blanks per minute with a maximum width of approximately 84 inches (2140 mm)) in 2012 and the EVOL100 (capable of making 400 blanks per minute with a maximum width of approximately 100 inches (2555 mm)) in 2015. The production of 100-inch width boxes at the speed of 400 blanks per minute is the world's fastest. This paper presents the EVOL100, which has a production capability of 400 blanks per minute.

2. Corrugated board box making machines

Figure 1 shows the basic configuration and the production process of a corrugated board box making machine. The flat corrugated board stacked in the feeding unit enters the machine one sheet at a time. The printing unit prints on the board while it is being transferred by the transfer conveyor. In the creaser slotter unit, the board is creased and slotted to enable folding; it is then glued, folded, and formed in the folding unit. When the sheets finally reach the counter ejector, they are counted and stacked.

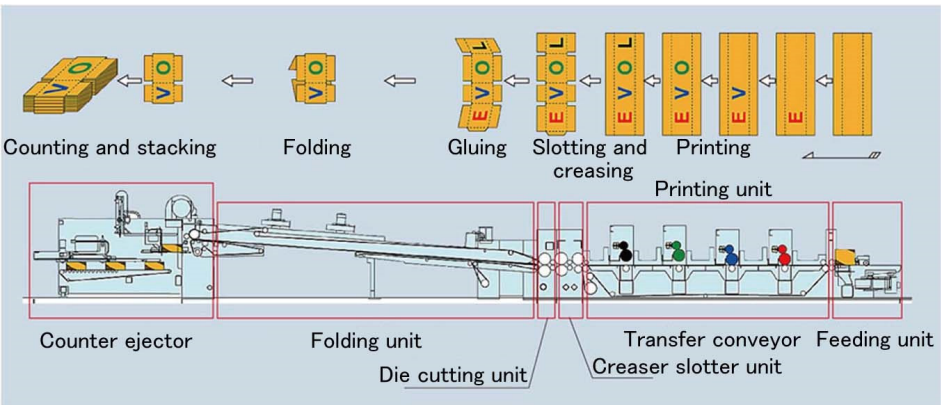

Figure 1 Basic configuration and production process of corrugated board box making machine

3. Basic specifications of EVOL100 with production capability of 400 blanks per minute

The development of a box making machine with a production capability of 400 blanks per minute aimed at (1) an increase in the machine maximum speed, (2) the alleviation of the speed limit due to the sheet size (length), and (3) the alleviation of the die cutting speed limit. We set the target to enhance the average production speed by increasing the machine maximum speed from 350 blanks per minute to 400 blanks per minute through a review of the basic configuration and improvement in the strength, as well as by alleviating the speed limit that depends on conditions such as the size and material of the corrugated board.

Table 1 compares the specifications of the EVOL series.

Table 1 Comparison of specifications between EVOL series

Item	EVOL84	EVOL100	EVOL115	EVOL125
Maximum machine speed (blanks per minute)	400	350 → 400	300	250
Die cutting speed limit (blanks per minute)	300	250 → 300	250	150
Maximum feed paper dimension Length x Width (mm)	870 × 2140	950 × 2555	1150 × 2930	1150 × 3185
Minimum feed paper dimension Length x Width (mm)	220 × 690	250 × 690	290 × 690	290 × 690

4. Features of EVOL100 with production capability of 400 blanks per minute

This section explains the new functions added to the existing EVOL100 to enable further higher-speed production.

4.1 Alleviation of the speed limit due to the sheet size (length): enhancement in capability to handle large sheets at a higher speed

Even during high-speed production, the required stability of the corrugated board folding accuracy and stacking accuracy is at the same level as production at ordinary speeds. The EVOL100, which has a production capability of 400 blanks per minute, has the following features to deal with such requirements.

(1) Folding unit: Addition of fan-type folding equipment (**Figure 2**) and extension of folding distance (**Figure 3**)

A sheet is folded while both sheet edges (Face 1 and Face 4) are guided by the belt. When the speed increases, the tendency of the occurrence of incorrect folding and flapping of a sheet increases, and the folding accuracy becomes increasingly unstable. As a countermeasure, fans that help the folding of both sheet edges were added to the operating side and the driving side at the folding start point and the 90 to 180° sheet raising point (Figure 2). In addition, the folding distance was extended (Figure 3) to enable slow and smooth folding. In this way, the folding accuracy during high-speed production is stabilized.

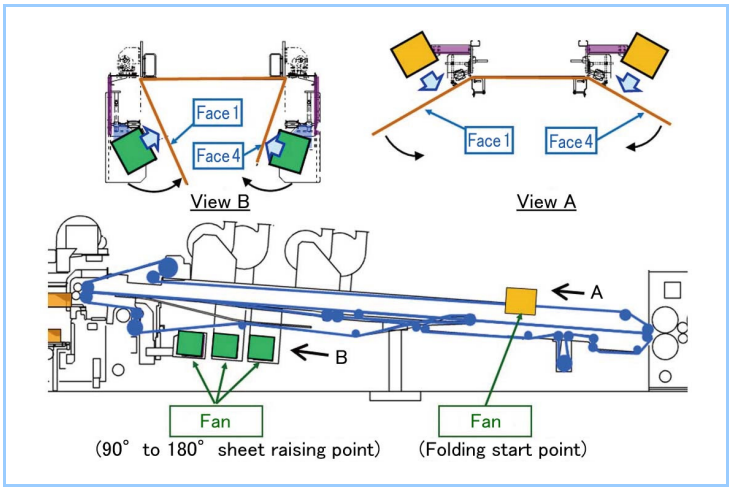

Figure 2 Fan-type folding equipment

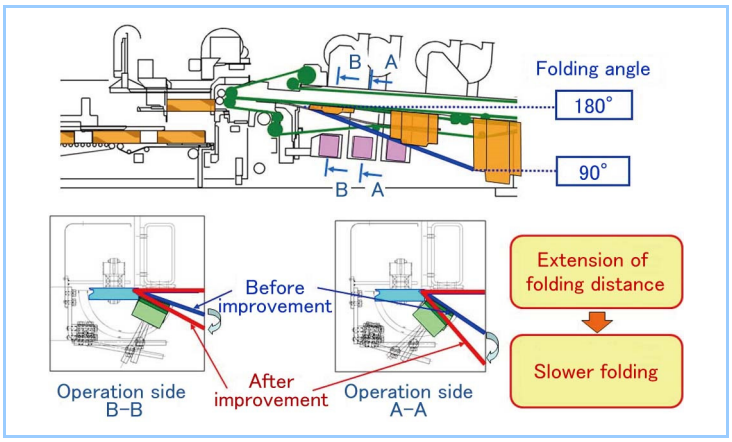

Figure 3 Extension of folding distance

(2) Stacking unit: improvement of shock absorbing plate (**Figure 4**) and addition of sheet guide (**Figure 5**)

Corrugated board boxes folded and transferred at a high speed collide with the shock absorbing plate and are then stacked. When the speed increases, the tendency of the occurrence of damage to the sheet edge and bending of the front flap caused by collisions with the shock absorbing plate increases. Therefore, the shock absorbing effect was improved by extending the stroke and optimizing the position of the shock absorbing plate to reduce damage and the rebounding of the sheet edge.

In addition, the shock absorbing plate was slanted to change the sheet edge rebound direction upward and then stabilize the sheet stacking posture. Moreover, a guide roller was added to the entrance of the sheet stacking unit to raise the sheet passing line (passing position) so that even sheets made of softer material can reach the shock absorbing plate stably in a horizontal entering posture without dropping of the sheet edge.

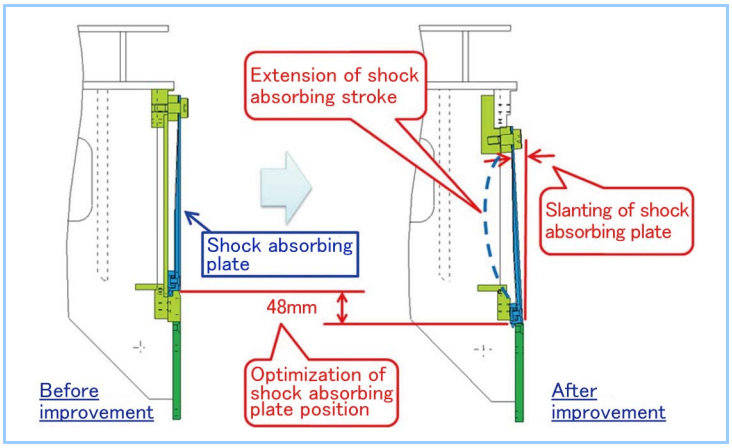

Figure 4 Improvement of shock absorbing plate

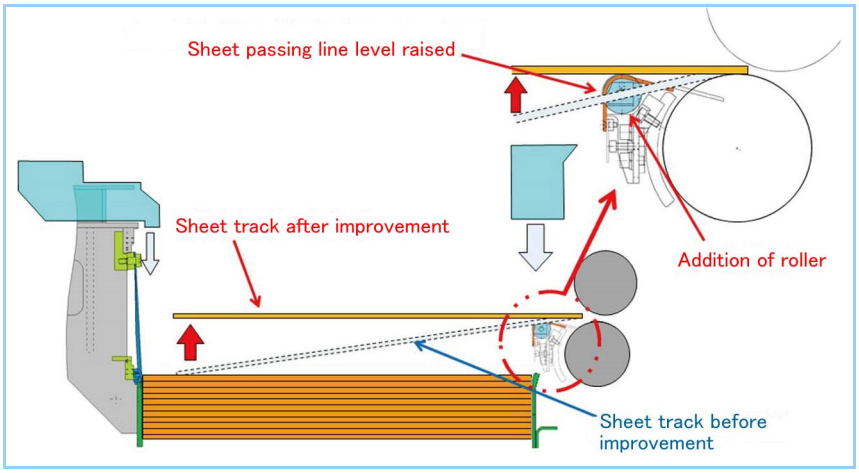

Figure 5 Addition of sheet guide

By adding these functions, performance much higher than the target folding accuracy of +/-3.0 mm/3σ at the maximum production speed of 400 blanks per minute was attained (**Figure 6**).

For example, a comparison between production cases of the existing machine with a production capability of 350 blanks per minute and the developed machine with a production capability of 400 blanks per minute under the same conditions shows that the variation of the bending accuracy is smaller in the case of the developed machine. This indicates an increase in the stability (**Figure 7**).

In this way, an increase in the average production speed is enabled due to the stabilization of product quality during high-speed production.

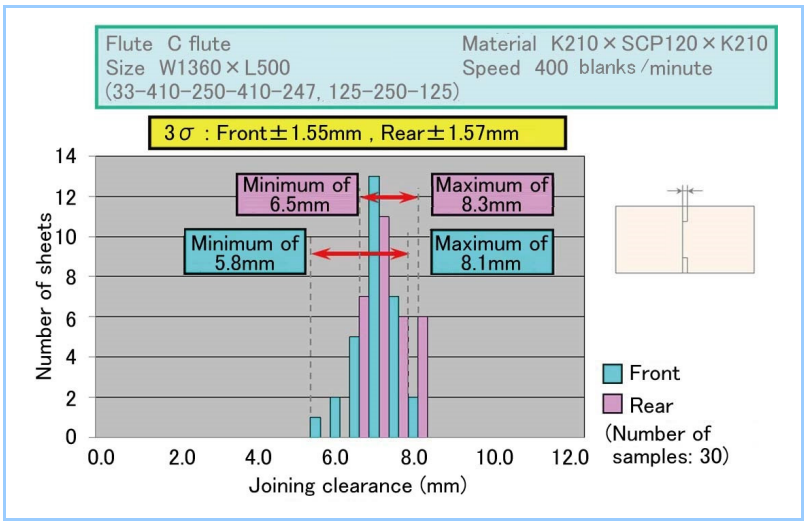

Figure 6 Example data of folding accuracy at production speed of 400 blanks per minute

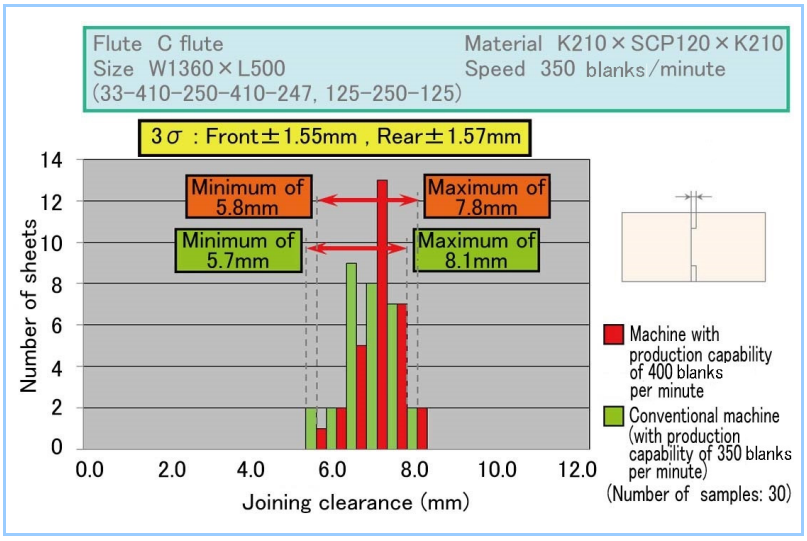

Figure 7 Comparison of folding accuracy between machines with production capability of 350 blanks per minute and 400 blanks per minute operated at 350 blanks per minute

4.2 Alleviation of die cutting speed limit

Hand holes and sheet edges in the case of bottom lock boxes are die-cut by pushing the blade embedded on the wooden die attached to the roll onto the sheet. In the moment of die cutting, too much force is applied onto the roll, and therefore the speed needs to be limited. For the alleviation of this speed limit, the following improvement measures were taken.

Too much load in the moment of die cutting causes deformation of the cylinder and lowers the die cutting accuracy. As a countermeasure, the cylinder shape was reviewed and the rigidity was enhanced.

4.3 Stable operation of gluing equipment at speed of 400 blanks per minute

The EVOL has gluing equipment for sticking the parts of the folded and formed box together. This equipment brings the glue discharge nozzle into contact with the surface of the corrugated board to apply the glue. To attain stable sheet handling operation of the gluing equipment at the speed of 400 blanks per minute, a continuous adjustment function of the nozzle contact gap and the nozzle contact pressure was adopted to enable stable sheet handling (**Figure 8**).

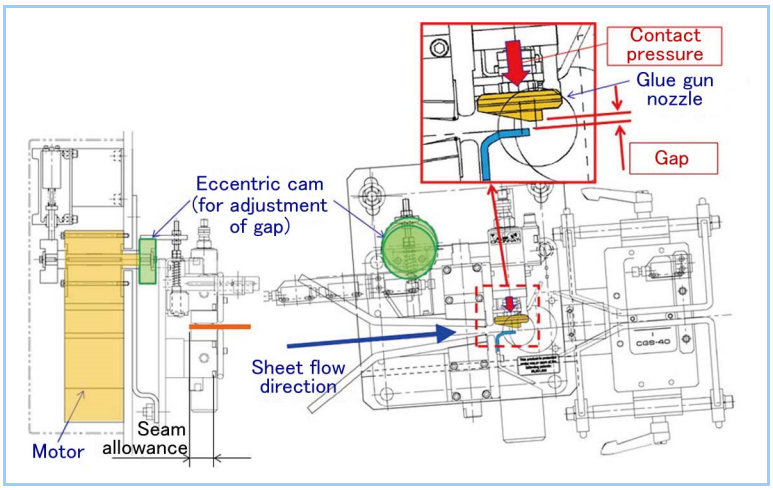

Figure 8 Performance stabilization of gluing equipment

5. New efforts

The EVOL100, which has a production capability of 400 blanks per minute, has the features described above and attains higher-quality, higher-speed operation and easier work. We will further improve our products in response to the needs of our customers and contribute to the enhancement of their production activities.