

Twin Rotary Die Cutter “EVOL5084TR” High Productivity with High-Quality Die-Cutting Boxes



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Corrugated board boxes are the most familiar form of packaging and are a key part of the world's logistics and commodity distribution systems. They are also considered to be environmentally-friendly products in terms of the global environmental problems that are major issues facing today's society, because they are circulation-type packaging materials that can be recycled after use.

The EVOL box making machine, the main product of Mitsubishi Heavy Industries Machinery Systems, Ltd. (MHI-MS), has expanded its sales channels to the whole world due to the steady growth of the corrugated board market led by the expansion of the global online shopping market, etc., and boasts a sales record of about 500 units for the entire series. The EVOL series box making machines are roughly divided into two types: the flexo folder gluer, which makes folded and glued corrugated board boxes, and the rotary die cutter, which makes die-cut boxes. This report presents our new EVOL5084TR rotary die cutter, which can make various die-cut boxes with high precision and at high speed.

A die-cut box is made by applying printing on a rectangular sheet of corrugated board, and die-cutting and creasing (applying folding lines to) it. Die-cut boxes are delivered in an unfolded flat state to end users, and then assembled when used for packing products.

1. Rotary die cutter

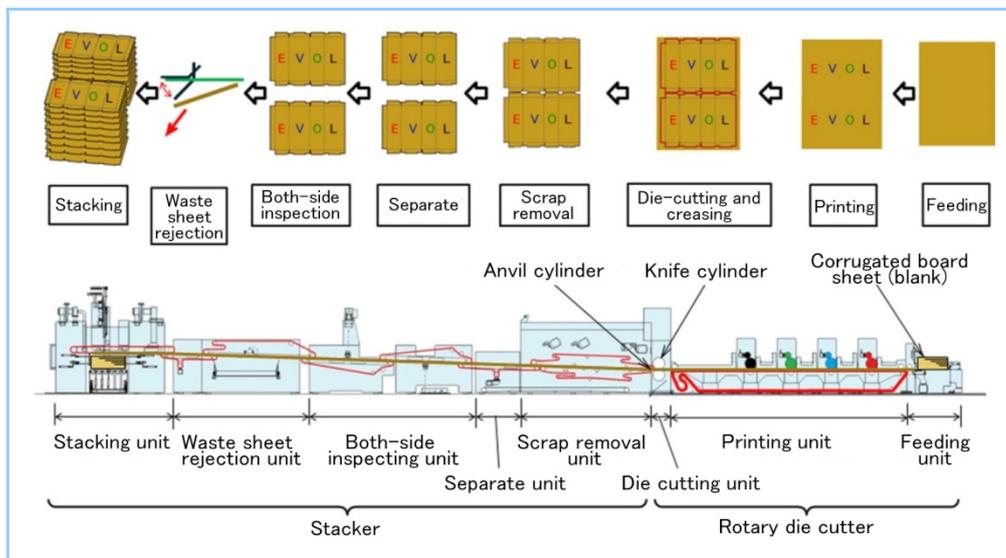


Figure 1 Block diagram of conventional rotary die cutter

A corrugated board die cutter is a machine that applies printing on corrugated board, and die-cuts and creases the corrugated board to make a box as shown in Figure 1. Die cutters include rotary die cutters that die-cut corrugated board between a rotating knife cylinder and an impression cylinder (anvil cylinder), and flatbed die cutters that die-cut corrugated board between a reciprocating cutter holder and an impression base. The characteristic of rotary die cutters is their excellent productivity because they are rotary machines. On the other hand, flatbed die cutters have the characteristic that the box accuracy such as creasing strength (force required for folding the

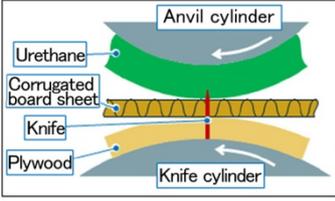
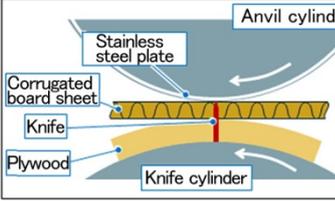
creasing line) accuracy is excellent, but the operating speed is slow. Figure 1 illustrates a block diagram of our conventional rotary die cutter.

With the spread of automatic boxing and packing machines (automatic casers) for automating packaging processes, die-cut boxes are required to have high box accuracy, and in 1995 we developed and commercialized a semi-hard rotary die cutter. In recent years, we have developed a new twin rotary die cutter to meet the demand for higher box accuracy and productivity.

2. Die cutting method of rotary die cutter

The die cutting unit for die-cutting and creasing corrugated board uses a soft cut method that performs die-cutting by making the knife dig into an anvil cylinder wrapped with urethane on the outer circumference, or a semi-hard cut method that performs die-cutting by making the knife dig into an anvil cylinder wrapped with a stainless steel plate on the outer circumference, and each has advantages and disadvantages. **Table 1** shows comparison of soft cut method and semi-hard cut method.

Table 1 Comparison of soft cut method and semi-hard cut method

Cutting method		Soft cut	Semi-hard cut
Anvil material		Urethane	Stainless steel plate
Cutting mechanism	Layout		
	life time of knife	Superior	Sufficient
Characteristics	Creasing strength accuracy	Sufficient	Superior
	Knife height adjustment	Unnecessary	Necessary

2.1 Soft cut method

The soft cut method uses urethane on the surface that receives the cutting pressure of the knife, and digs the knife 1 to 2 mm into the urethane to perform die-cutting. This method digs the knife into the soft urethane, so the life time of the knife is long and fine adjustment of the knife height is unnecessary. However, each time die-cutting is performed, cuts from the knife are generated and the urethane wears unevenly, so the creasing strength accuracy is likely to vary, which is a performance bottleneck in particular in the case of die-cut boxes for automatic casers required to have high creasing strength accuracy.

2.2 Semi-hard cut method

The semi-hard cut method uses a low-hardness stainless steel plate wrapped on the anvil cylinder surface that receives the cutting pressure of the knife, and digs the knife into the surface to a depth as shallow as approximately 0.1 mm to die-cut corrugated board. This method does not result in uneven wear of urethane unlike the soft cut method, so high creasing strength accuracy can be obtained. However, it is difficult to evenly dig the knife into the entire stainless steel plate surface, so it is necessary to perform fine adjustment to make the knife height uniform (removal of unevenness). If this adjustment work is insufficient, defective cutting is likely to occur.

3. Development of twin rotary die cutter (EVOL5084TR)

3.1 Aim of twin rotary die cutter

Accordingly, we worked on the development of a twin rotary die cutter that offers a semi-hard cut method (creasing strength accuracy is high) unit and a soft cut method (knife height adjustment is unnecessary) unit mounted in tandem to give each of the two units an independent role and benefit from the advantages of both.

3.2 Configuration of twin rotary die cutter (EVOL5084TR)

Figure 2 depicts the configuration of the twin rotary die cutter. To achieve the

aforementioned aim, we adopted a twin rotary die-cutting method that has two die cutting units mounted in tandem to perform creasing and die-cutting separately. By using a semi-hard cut method with high creasing strength accuracy for creasing as well as a soft cut method for which knife height adjustment is unnecessary for die-cutting, both high creasing strength accuracy and die-cutting requiring no knife height adjustment are achieved and the high-efficiency production of high-quality die-cut boxes is enabled.

The biggest technical issue in the development of the EVOL5084TR was the unstable corrugated board sheet transfer that may occur in the transfer between the two die cutting units. This is because creasing and die-cutting, which were conventionally performed at the same time by a single unit, are performed by separate and independent units. If the corrugated board sheet is displaced by slipping during transfer between the two units, the relative positions of the creasing and cutting become displaced and the dimensional accuracy of the box deteriorates.

As a countermeasure against the displacement of corrugated board during transfer between the two die cutting units, a suction box type roll transfer method is adopted. Various technologies cultivated in the long history of developing and improving the EVOL box making machine series are also incorporated, including backlash reduction of drive gears of the transfer roll and slippage prevention using a special roll surface treatment.

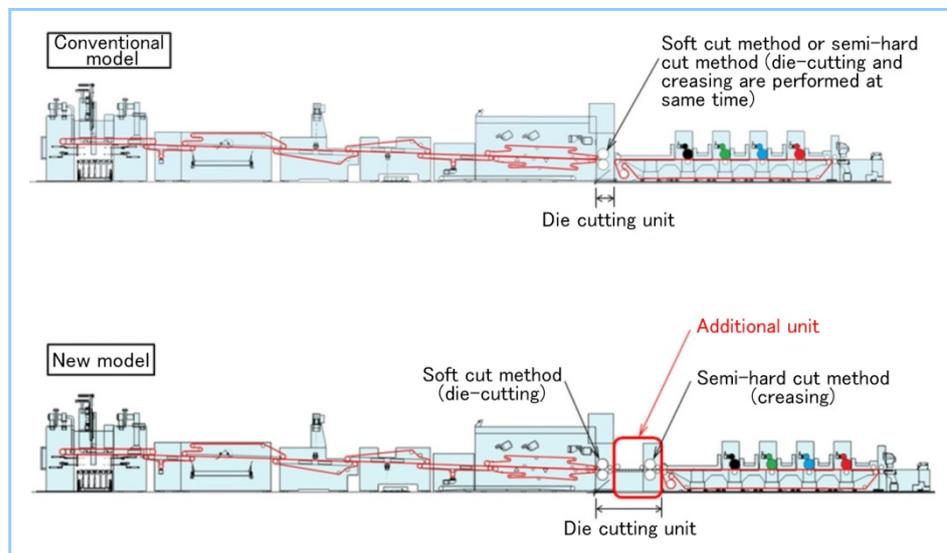


Figure 2 Configuration of twin rotary die cutter

4. Specifications and product quality of EVOL5084TR

Table 2 compares the specifications of the EVOL5084TR with the earlier EVOL-RC (semi-hard cut method) and EVOL5084 (soft cut method) models. The maximum speed of the EVOL5084TR is the same as the EVOL5084, 250 blanks per minute (twice the speed of flatbed die cutters), and produces a high-quality, highly-accurate product as shown below.

Table 2 Specification comparison of EVOL5084TR and EVOL-RC/EVOL5084

	EVOL-RC		EVOL5084	EVOL5084TR
	72"	84"		
Die cutting method	Semi-hard cut	Semi-hard cut	Soft cut	Soft cut + Semi-hard cut
Maximum speed (blanks per minute)	230	200	250	250
Maximum sheet dimension (mm)	1520×1840	1520×2140	1140×2140	1140×2050
Minimum sheet dimension (mm)	350×650		350×690	350×690
Maximum die-cutting area (mm)	1450×1780	1450×2010	1200×2000	Soft cut method: 1200×2000 Semi-hard cut method: 1040×1780

- Creasing strength accuracy

The EVOL5084TR achieved the same high creasing strength accuracy as flatbed die cutters by adopting the semi-hard cut unit as planned (Figure 3).

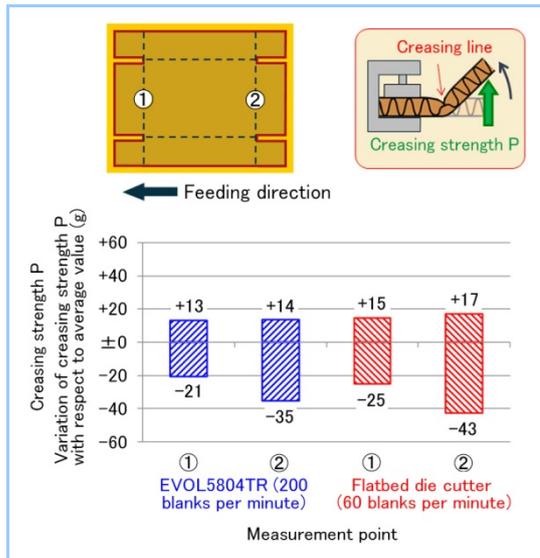


Figure 3 Creasing strength accuracy

- Creasing line positional accuracy and accuracy between creasing line position and die-cutting position

Due to the measures taken, the achieved creasing line positional accuracy and accuracy between the creasing line position and the die-cutting position, the latter of which was a concern, are sufficient to meet the high box accuracy required for automatic casers (Figure 4 and Figure 5).

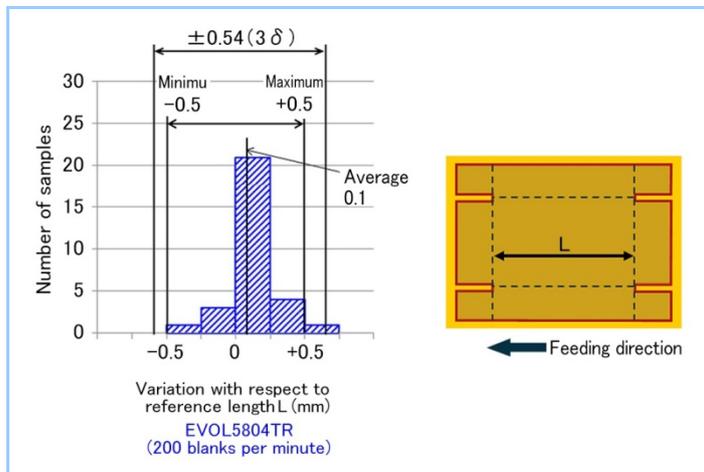


Figure 4 Creasing line positional accuracy

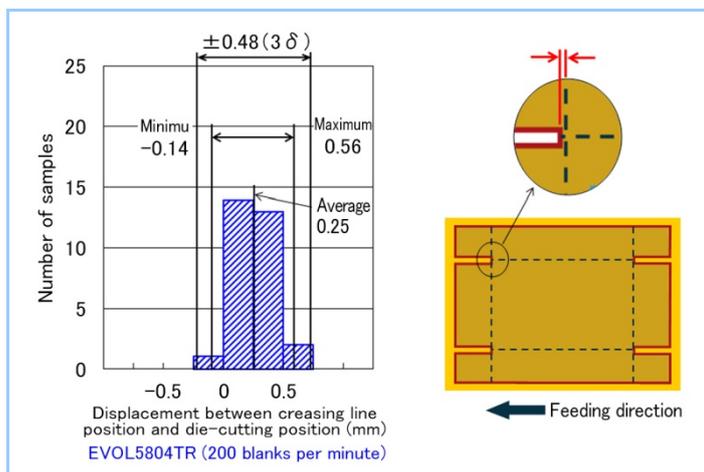


Figure 5 Accuracy between creasing line position and die-cutting position

In this manner, the EVOL5084TR, which is capable of the high-efficiency production of high-quality die-cut boxes, was realized.

5. Future prospects

The development of the EVOL5084TR twin rotary die cutter, which is capable of making a wide variety of die-cut boxes with high quality and at high speed, enabled the high-efficiency production of high-quality die-cut boxes. We will continue to work on improvements and new development issues to meet customer needs and contribute to the productivity improvement of our customers.