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Mold Investigation Report on the Conversion of Celluloid to Plastic

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1. Introduction

In the Celluloid House, many different molds used for molding celluloid are stored. Among them, about 150 molds at the time of changing from celluloid to petroleum-based plastics were investigated. Since petroleum-based plastics were introduced with new molding technology, this period was also the transition period of molding technology.

Based on this fact, this paper examines the outline of the mold itself (attachment is an example of investigation individual sheet), and also discusses the materials used and the state of the conversion of the molding technology.

2. Collection overview

The center of this collection is the molds of accessory molding contractors, which had been used since the celluloid era, and collectively stored them at the time of discontinuation. There are many molds for jewelry and hair products, reflecting the company's business types. A squeeze mold (about 2000 type) [(1)] used in the age of celluloids is also stored, but this is overlapped by the age and technologically.

3. Notice when organizing

(1) Type of mold

i. Molds of celluloid age

In the age of celluloids, products with complex shapes were made by squeeze molding. As shown in Figure 1 and 2, they were initially single-sheet type. In this mold, only one side of the molded article is molded.

Figure 1. Overview of one-sheet type (cross-sectional view)

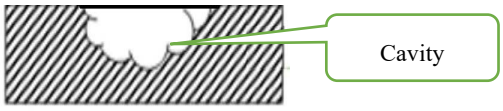
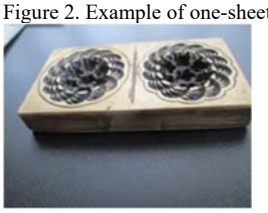


Figure 2. Example of one-sheet type



As shown in Figure 3 and 4, two-piece designs appeared in order to attach designs to the front and back sides.

Figure 3. 2-sheet type overview

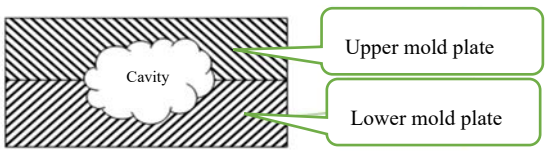


Figure 4. Example of 2-sheet type (open-faced state)

For the two-piece molding

① Open the mold and place the melted and softened material.

② The mold is closed and pressurized to transfer the mold surface to the material.

③ After cooling and solidifying, and proceed as in taking out the molded article.

The dies at that time were not equipped with cooling water holes and protruding mechanisms.

ii. Molds in plastic-age

In the age of plastics, molten resin is filled into a closed mold. For this reason, the cavity is provided with an inlet and a gate for the molten material as shown in Figure 5 and 6. The gate is connected to a resin flow path. The flow path is connected to the mold surface and is called a nozzle. Plastic molds are also provided with cooling water holes and ejection pins.

Figure 5. Overview of plastic mold (cross section)

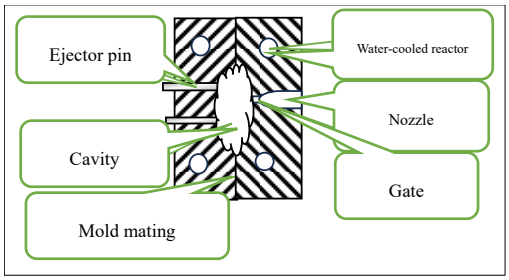
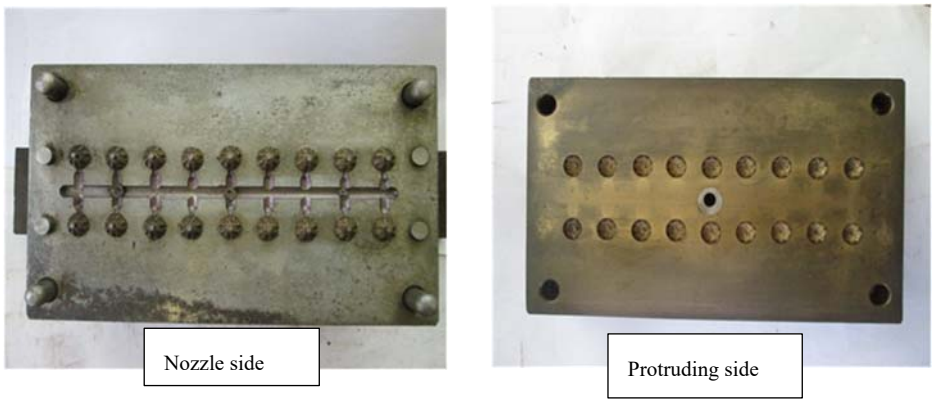


Figure 6. Example of plastic mold



Molding has been automated, and water cooling has been carried out to improve productivity by actively cooling the material in the cavity.

In the era of celluloid, the molds could be taken out by hand if the molds were opened. However, when injection molding is carried out, the molten material is filled into the cavity at high pressure. The molded article was strongly pressed against the inner surface of the cavity, and it became impossible to take it out by human power. Therefore, it came to protrude mechanically.

Therefore, the existence of the cooling water hole and the existence of the protruding mechanism are also important keys to judge the utilization situation of the mold.

(2) Mold elements and molding materials and molding technologies

i. Runner system

When the material in the molten state is flowed at high speed, the temperature increases (shear heat generation). Plastics after acetate do not cause problems (deterioration or carbonization in extreme cases) but celluloid is dangerous to ignite. For this reason, in principle the celluloid was squeezed (the mold is opened and the molding material is charged). Although the plastic can be squeezed, injection molding is directed from the productivity.

ii. Nozzle direction

Figure 7. Example of nozzle provided on the mold mating surface

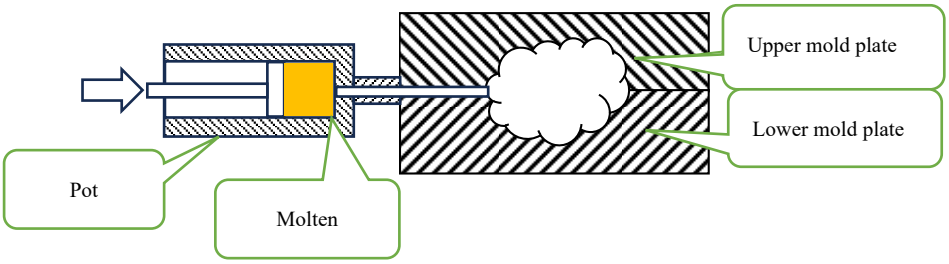
Injection molding machines have a mold clamping mechanism and an injection mechanism integrated together, which regulates the mold structure. Specifically, as shown in Figure 5 (previous page), the nozzle is placed at a right angle to the mold mating surface.

In contrast, there are also machines with the nozzle installed on the mold mating surface [(2)] , as shown in Figure 7.

This is presumably a mold for pot molding, which is said to have been used before the introduction of injection molding [(3)] .

Pot molding was a type of transfer molding used to mold thermosetting resins. As shown in Figure 8, molten material was fed into the mold by a piston pump called a pot in a closed state. Since the mold is sandwiched by a press, a nozzle is provided on the side surface of the mold.

Figure 8. Image of pot molding.



iii. Mold chilling

As described above, there is no cooling water hole in the old mold. In the manual molding, it takes time for mold preparation, filling of molten material, etc., and the molded product cools and solidifies during that time. Therefore, the cooling time had little effect on the productivity. However, the automation advanced in the injection molding, and the mold operation time became short, and the ratio of the cooling time became negligible, and the mold was water-cooled. The mold is cooled by water only when the automation of molding has advanced.

iv. Protruding mechanism

As described above, the extrusion mechanism is related to the pressure applied to the molten material. Molding pressure becomes higher because the higher the pressure is the mold transferability is improved. A mechanism for forcing an article to be removed at a certain point, i.e., a protruding mechanism, was required.

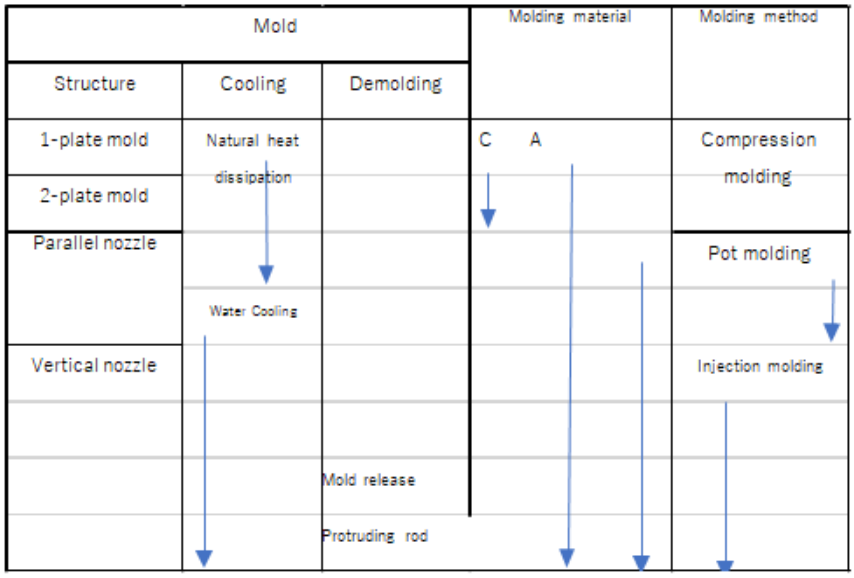
4. Mold classification

The combination of the mold components described above is as shown in Table 1.

For each format, the possible materials used are shown in celluloid: C, acetate: A, and petroleum-based plastic: P. The molding method was also shown in the same way.

Since the rise and fall of materials and molding methods are known to some extent, the approximate age of use of each mold can be clarified by fitting each mold to this type.

Table 1. Die types at turning points



5. Creating a database

Individual votes as attached for each mold were prepared. A total of 147 types were listed.

This is summarized in Table 2 in terms of materials that may have been used. There were no molds that could only be used for celluloid.

Table 2. Classification of collection mold

No.	Possible materials used	Number in stock
1	Celluloid	0
2	Celluloid or acetate	19
3	All possibilities	12
4	Acetate and later	116
Total		147

In the days of celluloid, compression molding was used exclusively. Then acetate was introduced.

As the age of plastics arrived and new information on molding methods began to come in, they were influenced, and two-piece molds began to be made first. These molds do not appear to have been made exclusively for celluloid, but rather for use in conjunction with acetate or exclusively for it.

No. 3 of Table 2 is a pot molding mold, and the mold structure changed greatly. It is presumed that in this period, acetate was the mainstream and petroleum-based plastics were also molded.

No. 4 of Table 2 is an injection mold. Since the injection molding machine was extremely expensive and the productivity is high, the introduction time depends largely on non-technical factors. The time of popularization varies from industry to industry, and it is difficult to estimate the times of these molds. It can be inferred that more than 100 molds for injection molding were left in this collection, and petroleum-based plastics were also utilized.

6. Conclusion

Since the mold is discarded when it is no longer used, it is rarely preserved. In the celluloid house, many molds of the main molding technique in the age of celluloid are stored. This mold is interesting because it is a mold at the time when celluloid is deteriorated and plastics are interested. I would like to further clarify the situation in this period, which is also the transformation phase of material conversion and molding technology.

7. References

(1) Isao Sato, Celluloid House Yokohama Research Report No. 68, Outline of squeezing molds

(2) Takashi Sato, Celluloid House Yokohama Research Report No. 56, Examples of molds during the injection molding transition period

(3) Miyagawa Kasei Kogyo Co., Miyagawa Kasei Kogyo 50 Year History, P102 (1988)

(4) Isao Sato, Celluloid House Yokohama Research Report No. 21, Undercut of the celluloid squeezing mold

8. Attached

(Example of mold survey questionnaire)

No.		D4	Product name	Rhombus	Note
Mold format			Product dimensions	12.4 x 11	4 wire inserts. 1φ
External dimensions	Vertical	74.8			
	Horizontal	151.5	Gate	None	
	Thickness 1	15.2	Runner	None	
	Thickness 2	15.5	Mold release mechanism	None	
Number of take		24	Cooling hole	None	

(Photograph)