ThreeBond TECHNICAL NEWS

Three Bond Technical News 24

Hy-Molding System

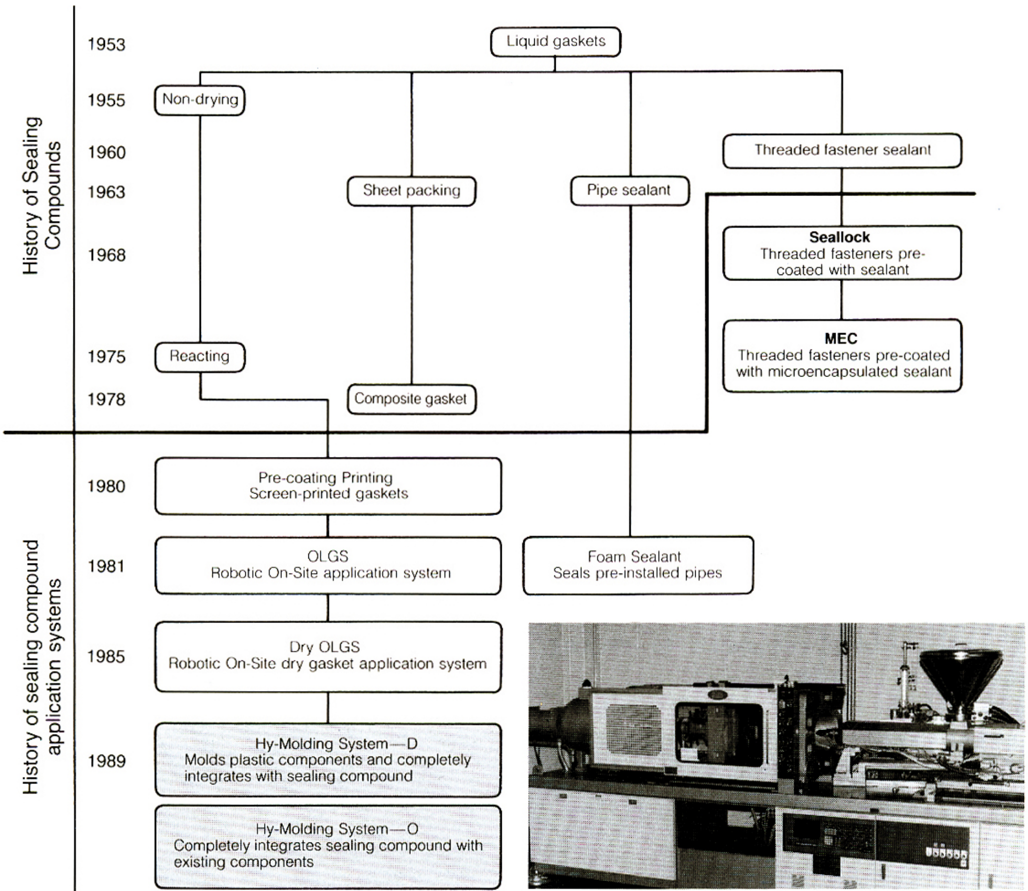


Fig. 1 Background of Hy-Molding System

Photo 1 Hy-Mold System—D

Contents

1. Sealant & Related Technology Background

For over 35 years, Three Bond has developed and marketed state-of-the-art liquid gaskets, sheet gaskets, pipe sealants, threaded fastener locking/sealing compounds and other sealants.

We have also improved sealant application productivity. Manual application of sealing compounds creates a productivity bottleneck as well as inconsistent quality. In response, Three Bond has developed several energy saving sealing systems. Figure 1 recaps these accomplishments.

First, **Seallock** seals and locks threaded fasteners with a sealing compound. The **MEC** process coats threaded fasteners with a microencapsulated sealant. These sealants facilitate parts assembly by fastening on-site. The patented **Foam Sealant** seals pipes on-site after installation. To seal mating surfaces, the **Pre-Coated Printing** system applys fluid gaskets by screen printing which cures prior to assembly. **OLGS** traces sealing compound by robot on the assembly line and the **Dry OLGS** robot traces a bead which cures prior to assembly.

Both **Pre-coat Printing** and **Dry OLGS** systems feature on site sealant application. Unfortunately, the **Pre-coat Printing** applies only two dimentionally and the sealing compound bead must be thin. And the **Dry OLGS** robot traces the sealing compound so the bead pattern and bead joint accuracy has limitations.

To solve those problems and further improve productivity and sealing quality, Nissei Resin and Three Bond have jointly developed a process called, **Hy-Molding System D**. It molds plastic components and sealant in one operation by a revolutionary double injection system. The **Hy-Molding System O**, currently under development, molds sealing compounds to existing components.

"Hy-" stands for "Hybrid" and "D" stands for "Double Injection" and "O" stands for "Outsert Injection". The remainder of this Technical News shall only review **Hy-Molding System D** (hereafter refered to as "Hy-Mold").

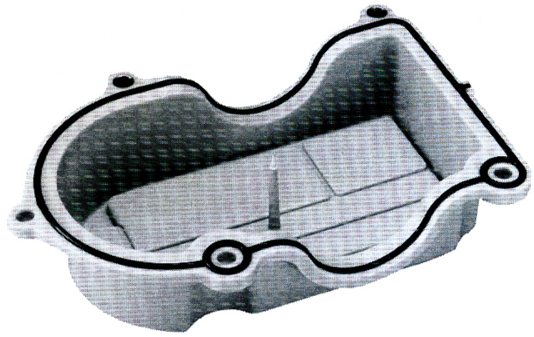


Photo 2 Cylinder Head Cover demonstrated at the
1988 Japan Plastic Exposition
Plastic component: Nylon 6 with 30% fiberglass
Molding time: 30 seconds
Sealant compound: Thermosetting liquid silicone
Molding time: 30 seconds

2. Manufacturing Procedure

The plastic component is injected into the mold first. After it is formed and while still hot and pliable, a projecting cutter presses the inner walls of the sealing compound cavity to form an inversely tapered groove. Followed by the injection of the elastic sealing compound into the groove. Then the assembled component is discharged. At this point an optional device cuts gate.

The Hy-Mold eliminates such manufacturing procedures as mounting solid sheet gaskets, O rings or applying liquid gaskets.

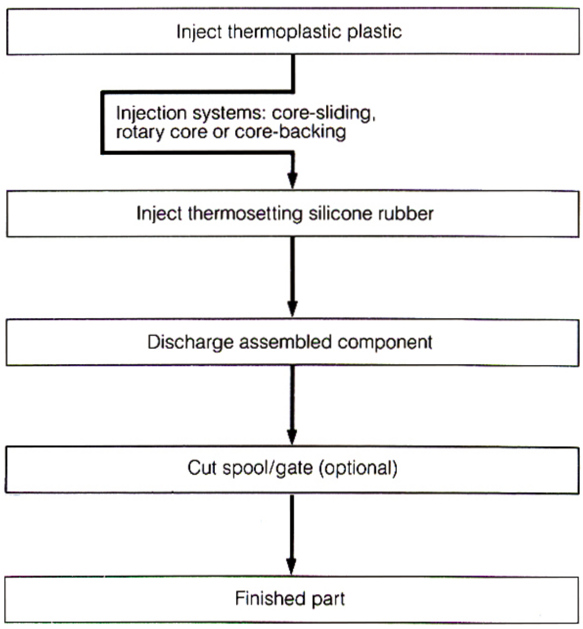


Fig. 2 Manufacturing procedure

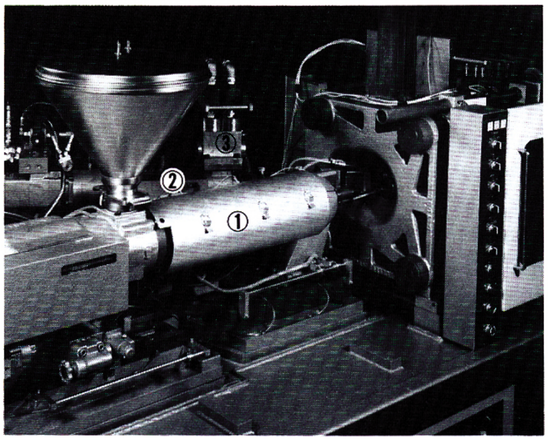


Photo 3 Plastic and Sealant Injectors and Sealant Feeder
(1) Injector-plastic material
(2) Injector-sealing compound
(3) Sealing compound feeder

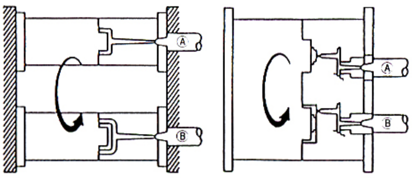


Fig. 3 Rotary-Core Injection Mechanism

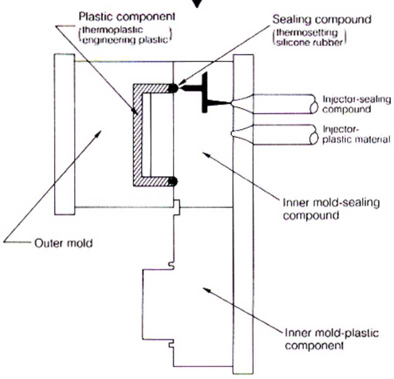


Fig. 4 Cross-cut view of Core-Sliding Injection Mechanism

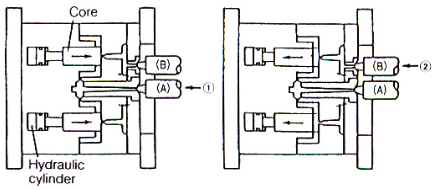


Fig. 5 Core-Backing Injection Mechanism

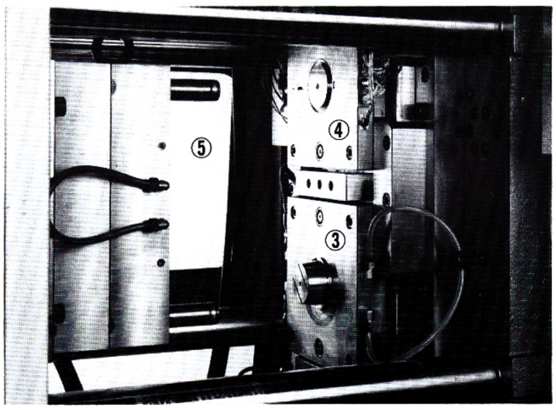


Photo 4 Core-sliding injection system: (3) Plastic inner mold (4) sealing compound inner mold and (5) outer mold.

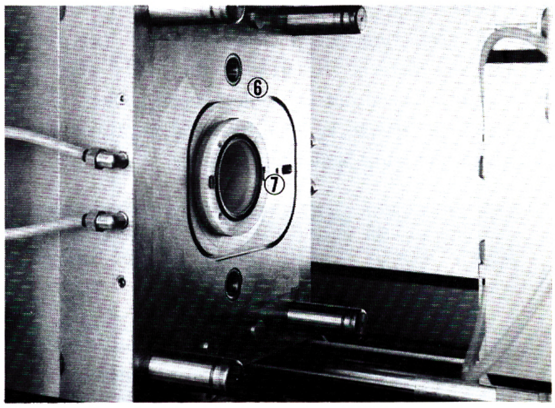


Photo 5 Core-backing injection system: (6) Outer mold and (7) assembled component.

3. 3 Injection System Alternatives

There are three molding systems available. Fig. 6 illustrates the procedure and relative time required to complete one cycle.

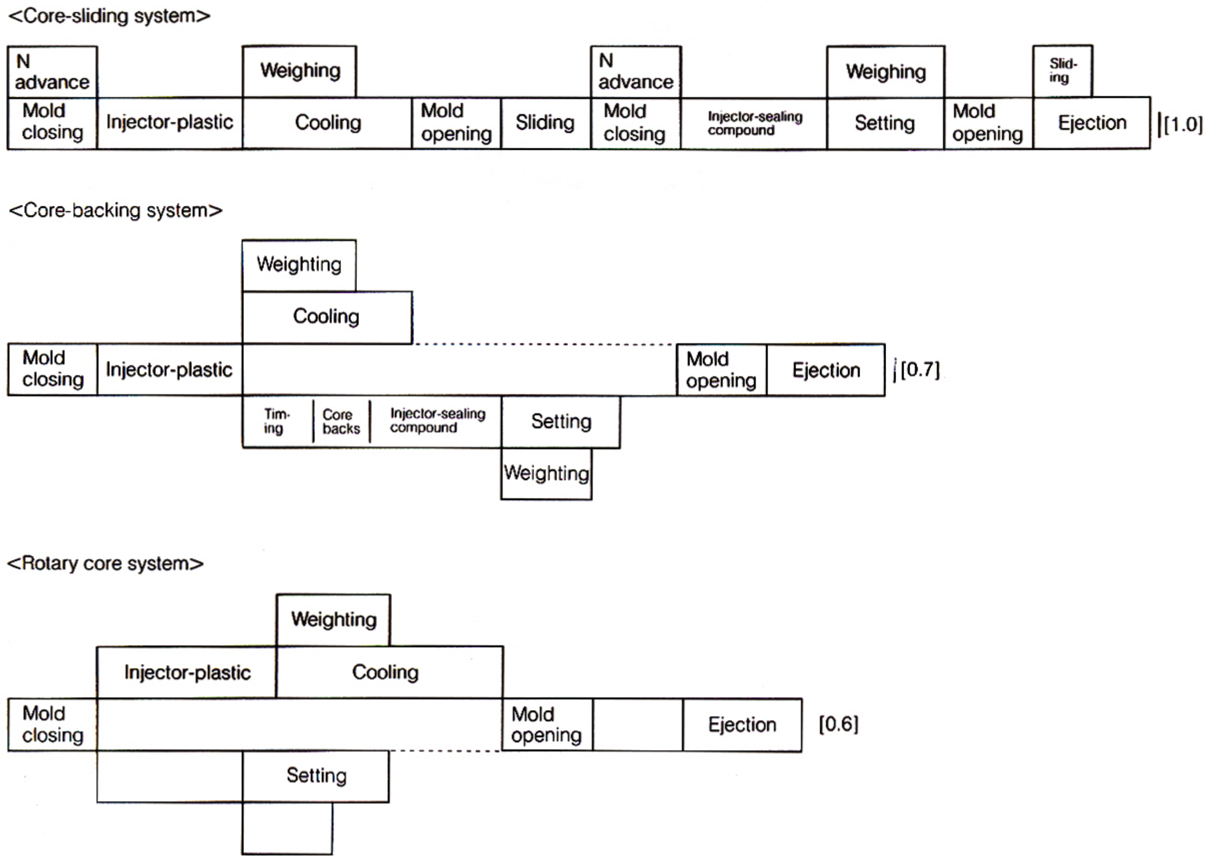


Fig. 6 Comparison of Relative Molding Cycle Time

4. Features

Composite molding of different materials

One machine molds two highly advanced materials with different curing modes and functions, namely, the thermoplastic engineering plastic (structural element) and the thermosetting silicone rubber (elastic sealing compound).

Inversely tapered groove for sealing compound

A projecting cutter locks together the two different materials by pressing the cavity walls to create a flaired out key hole shaped gasket. The press-cut groove is burr free and improves the gasket pressure absorbing capacity.

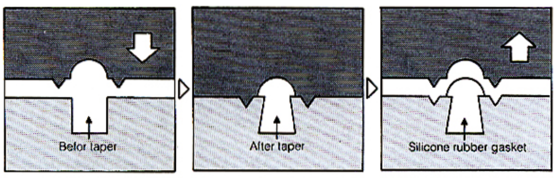


Fig. 7 Inversely Tapered Structure and Principles

High quality molding

The sealing compound is injected immediately after the plastic component has been formed which produces a high quality component free of foreign substance.

Low cost production system

One machine molds and assembles both plastic component and sealing compound. Thus the cost for processing the plastic component and sealant are blended into one which eliminates manual assembling.

Standard equipment

Two injection mechanisms for: 1) thermoplastic resin and, 2) thermosetting resin.

An injection system such as the core-sliding, rotary core or core-backing systems.

Silicone sealant feeder.

Optional equipment

As demonstrated at the 1988 Japan Plastics Exposition in Osaka, Japan, auxillary equipment can enhance automation even further for instance: 5-spindle inserter, spool/gate cutter and product stocker.

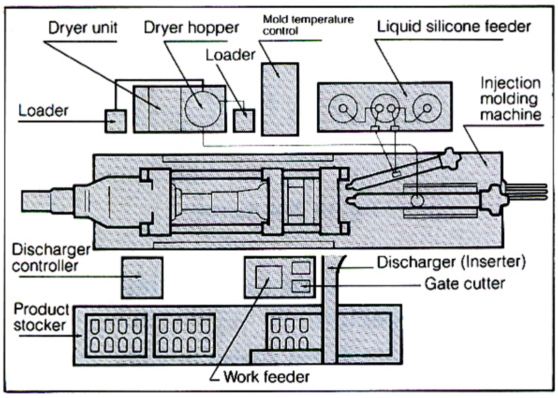


Fig. 8 System Presented at the 1988 Japan Plastics Exposition

5. Three Bond 1270 Series Silicone Resin Physical Properties

Three Bond 1270 Series is a thermosetting silicone resin developed exclusively for Hy-Mold.

The curing temperature of the silicone rubber is mainly restricted by the temperature of the inner mold of the sealing compound. Three Bond 1270 Series cures quickly at low temperature and obtains sufficient pot life so it is ideal for injection molding. It cures almost as fast as the plastic component. Therefore, the assembled hybrid component can be completed in about the same time as the pre-assembled conventional method.

After curing Three Bond 1270 Series has excellent heat and chemical resistance, durability and compression stability like the conventional millable type silicone rubber. And it is available four grades.

Table 1 Physical Properties of Three Bond 1270 Series Sealing Compound

Product Number Grade			1270 Standard		1271 High strength		1272 Oil/steam resistance		1272B Extra hard version of 1272	
	Test criteria	Unit								
Before curing										
Viscosity	—	P	2000		8000		6000		13000 11000	
Pot life	25°C	h	20		7		10		7	
	5~10°C	h	96		30		40		30	
Curing time (4 mm thick sheet)	110°C	sec	50		65		65		50	
	120°C	sec	35		40		40		30	
	130°C	sec	25		25		25		25	
After curing										
Color	—	—	Semi-transparent		Blue		Black		Reddish brown	
Specific Gravity	25°C	—	1.10		1.13		1.24		1.32	
Hardness	—	JIS A	50		50		53		67	
Tensil strength	—	kgf/cm^2	67		85		64		64	
Elongation	—	%	330		500		340		200	
Tear strength	JIS A	kgf/cm	10		38		15		15	
Tear strength	JIS B	kgf/cm	18		35		20		18	
Compression set	150°C/22h	%	20		45		14		12	
Coefficient of linear contraction	—	%	2.18		2.35		1.56		1.17	
Volume resistivity	—	Ω·cm	1.5×10^{16}		2.5×10^{16}		5.7×10^{15}		1.0×10^{15}	
Coefficient of thermal conductivity	cal./cm·sec°C		5.3×10^{-4}		5.5×10^{-4}		6.5×10^{-4}		7.9×10^{-4}	
			Value	Rate of change	Value	Rate of change	Value	Rate of change	Value	Rate of change
Oil resistance: 10 W-30 oil 150°C/7 days										
Hardness	—	JIS A	36	-13	38	-11	45	-8	57	-10
Tensil strength	—	kgf/cm^2	47	-30	60	-32	49	-23	63	± 0
Elongation	—	%	220	-33	320	-36	210	-38	150	-25
Tear strength	JIS B	kgf/cm	13	-28	14	-44	12	-40	12	-33
Compression set	22 h	%	20		45		15		13	
Volume	—	%		+23		+25		+21		+18
Weight	—	%		+17		+19		+14		+11
Steam resistance: 150°C /3days										
Hardness	—	JIS A	56	+7	60	+10	56	+3	69	+2
Tensil strength	—	kgf/cm^2	66	-2	68	-20	58	-9	59	-6
Elongation	—	%	250	-24	280	-44	290	-15	190	-5
Tear strength	JIS B	kgf/cm	15	-17	30	-14	17	-15	14	-22
Compression set	22 h	%	35		70		20		25	

Three Bond 1270 Series Long Term Oil Resistance

The Three Bond 1270 Series has excellent oil resistance like conventional, millable silicone rubber. An intense immersion test was applied by dipping a cured sample into engine oil at 120°C for 1200 hours. The physical properties changed a little due to swelling but soon reached a saturation point thus maintaining stable physical properties for a long time see Fig. 9.

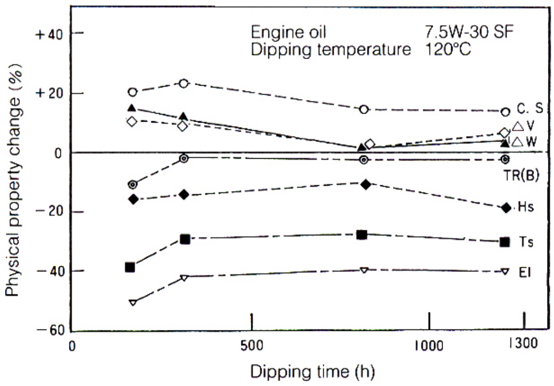


Fig. 9 Three Bond 1270 Series Long Term Oil Resistance

Three Bond 1270 Series Curing Evaluation

Molded Product for Test

A test was applied to a round flange sample shown in Photo 6.

Component material…Nylon 6 with 30% Fiberglass

Sealing compound……………Three Bond 1270

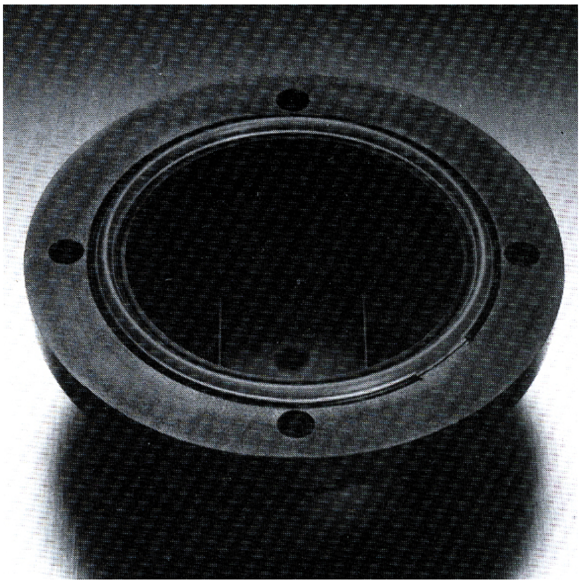


Photo 6 Round Flange Sample

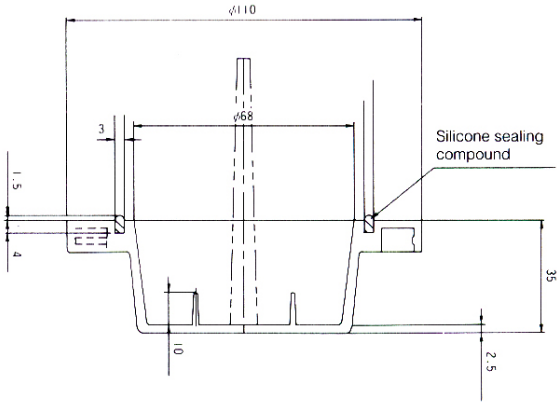


Fig. 10 Test Sample

Relationship Between Curing Time and the Physical Properties

The Hy-Mold silicone rubber reached its maximum strength after curing for 15 seconds.

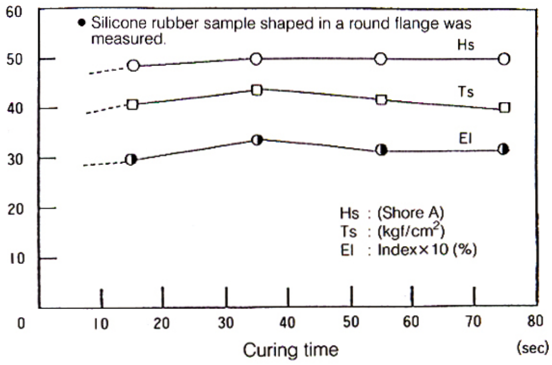


Fig. 11 Relationship between Curing Time and Rubber-like Physical Properties

Relationship Between Curing Time and Pressure Resistance

During the actual molding experiment, the rubber sets within 5 seconds. Tests results indicate that the silicone rubber reached its maximum performance after 15 seconds.

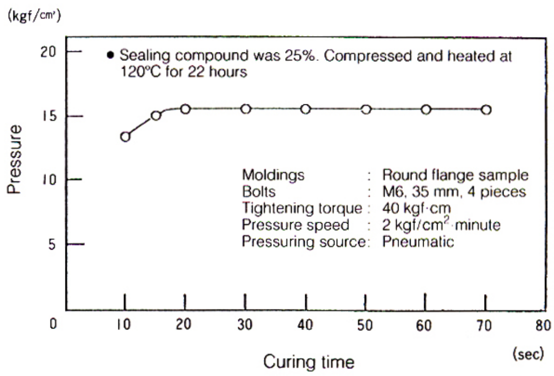


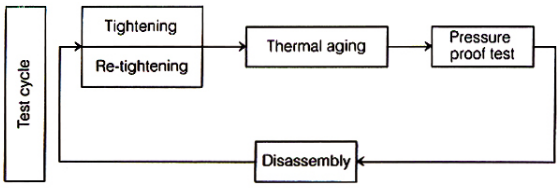
Fig. 12 Relationship between Curing Time and Pressure Resistance

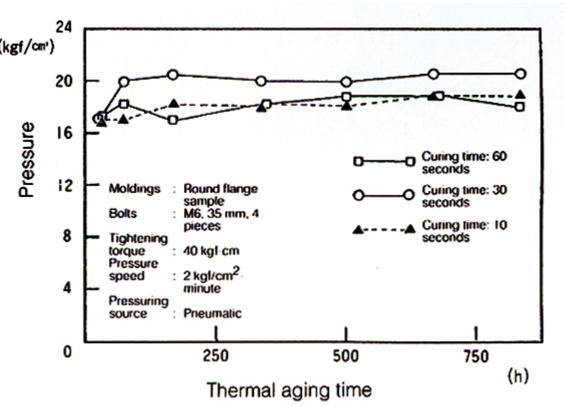
Long Term Heat Resistance and Repeated Usability

A pressure test was applied after tightening the sample component to a torque of 40 kgf·cm and heat aging it at 120°C.

Next the sample component was disassembled, then reassembled repeatedly using sealants with cure times of 10, 30 and 60 seconds. Thermal aging was conducted for 800 hours totally and during the test the sample component was reset 7 times.

The test proves that the resistance to pressure is not materially affected by length of cure time. All test pieces has excellent reliability.





Thermal aging time (hours)	24	72	168	336	504	674	840
Number of retightenings	1	2	3	4	5	6	

Fig. 13 Change in Pressure Resistance Due to Thermal Aging and Retightening

6. Cost Analysis

Despite higher material costs, the Hy-Mold system reduces the per unit cost by at least 20%. The conventional process necessitates separately molding the plastic component and gasket then later assembled; it requires temperatures up 190°C and an extremely long cure time of up to 15 minutes. In addition, the conventional process requires rolling and sheeting operations as pre-processes.

The savings in Table 2 are conservative since it only compares a simple round flange. Complex components can substantially increase the cost per unit savings. The continuous processing stabilizes quality and lowers in-process handling cost as well as related overhead expense.

Table 2 Hy-Mold vs. Conventional Molding Cost Comparison

	Hy-Mold System D	Conventional Molding Process		
		Plastic Molding	Sealing Compound Molding	Total
Assumptions				
Molding time (in seconds)	45	30	10	40
Number of plastic molds	1	2	—	2
Number of sealing compound molds	1	—	9	9
Clampforce of molding machine (tons)	120	120	120	—
Output (1000 pcs./month)	76	115	77 (3 set)	—
Raw material weight (g/finished component)	82.4	77.9	4.5	82.4
Equipment cost (in $1000's)	240	120	240	360
2 rolls (in $1000's)	—	—	120	120
Metal mold (in $1000's)	40	24	72	96
Raw material cost ($/kg)	48.00	6.40	24.00	30.40
Cost per Unit (in dollars)				
Raw Material				
Plastic (includes 3% loss allowance)	$.516	$.516	—	$.516
Sealing Compound (includes 3% LA for Hy-Mold +5% LA for Conventional)	.222	—	$.114	.114
Total Raw Material Cost	.738			.630
Cost of equipment +2 rolls'	.033	.011	.048	.059
Cost of metal mold allocated over 5,000,000 shots[1]	.040	.024	.005	.029
Electricity	.037	.025	.104	.129
Labor				
Molding ($12.80/line hour)[2]	.080	.053	.079	.132
Rolling ($12.80/line hour)	—	—	.079	.079
Assembling ($11.20/line hour)	—			.094
Total Manufacturing Cost	.190			.522
Total Assembled Component Cost	$.928			$1.152

[1] The assumption for net working rate used in calculating the depreciation of a molding machine and a press is regard as 24 hours/day, 20 days/month and for 8 years.

[2] A molding machine or a rolling machine is assumed to be operating manually. In the conventional scenerio, three machines are operated by an operator.

This calculation omits freight, annual interest of land and buildings, taxes and inspection fee.

Hy-Molding System D

winner of

The 1989 Excellent New Technology/Product Award

By Nikkan Industrial Newspaper

ThreeBond TECHNICAL NEWS

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