ThreeBond
TECHNICAL NEWS

Three Bond Technical News
Issued Apr. 1, 1986

14

# Liquid Gasket Automatic Coating System in Automobile Assembly Line

## Introduction

It has been almost 5 years since the beginning of the widespread single use of liquid gaskets in Japan. During these years, they have come into wide use in such as engines, transmissions, and differential gears of automobiles and farm machinery, contributing significantly to cost reductions and the streamlining of assembly processes.

On the contrary, FIPGs (Formed In Place Gaskets), that was born in the United States about 10 years ago, has spread temporarily to oil pans and rocker covers of automobile engines in the United States. But now there is a retrograde phenomenon, technical staff of several automobile manufacturers and engine manufacturers are coming to Japan to study the technology.

The main reason why it has not been developed in the United States is that material manufacturers, coating equipment manufacturers, and users were too specialized. Since they were not much connected organically, even when several kinds of problems occurred, they could not correspond to them swiftly.

For a few examples, when acetic acid type RTV silicone, that is used mainly for construction, was used for joint surfaces of such as engines, even in case it has caused metal corrosion or deterioration of working environment due to bad smell, swift material development and confirmation experiments have not been conducted.

Also for coating equipment, no close cooperation has been taken among equipment manufacturers, material manufacturers, and users regarding several technical problems such as definite reproducibility of coating patterns, durability, and the uniform beat coating.

In Japan, specialized manufacturers of liquid gaskets have established comprehensive technical know-how of not only materials but also from sealing theory and application tests (bench tests etc.) to coating equipment. Users have conducted confirmation experiments for the material, which was recommended by the manufacturer, and they request improvement according to the needs to promote materials development. Also for coating equipment used in assembly process, since they could select the best model following the advice from material manufacturers, problems risen after the adoption also have been resolved swiftly.

When we look at these differences between Japan and the United States, the role, that liquid gasket manufacturers have done, is important. The single use has begun to spread mainly with automobile related international companies in Taiwan, South Korea, Mexico, and Russia etc. now, attention is paid as world-wide proprietary technology.

In the trend of single-use liquid gaskets, at this time, we will introduce the latest technology and application examples of automatic coating system.

## Contents

## 1. Types of Coating Equipment and the Latest Adoption Trend

The coating methods of liquid gaskets are classified into 3 methods as shown in Table 1. We will describe mainly regarding the mainstream tracing method.

The tracing method is the method to draw the material, that is dispensed from the nozzle by pressure feed, as a line following the pattern. They classified into 4 types as shown in Table 2, in which the template type and the computer-controlled type are predominantly adopted recently.

Because the template type is low-cost and provided with good maintainability, it is used as a dedicated coater for the same pattern. The computer-controlled type is adopted in case where many kinds of complex patterns are needed to be coated with high speed. The disk type is used in the case where patterns are complete rounds like with differential cases. Since the photoelectric tube type is slow and is not provided with good maintainability, it is less adopted recently.

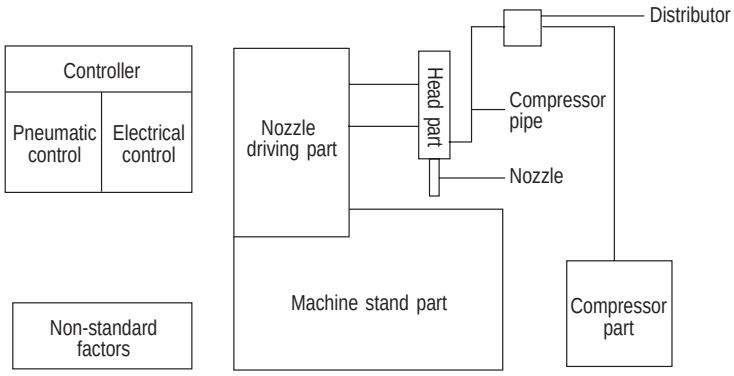


Figure 1. Constitution of tracing method diagram

Table 1. Types of liquid gasket coating method

| Method | Tracing method | Screening method | Stamping method |
|---|---|---|---|
| Overview | Gasket material fed from the pressure feeder through the feeder pipes is dispensed from the nozzle tip in string form. The material is applied as a line on the surface by moving the nozzle parallel to the surface. | Gasket material is placed on the screen that masks the patterns not to be coated, and the joint surface is set under the screen. The material is then squeezed down through the opening by a squeegee. | A box-type drum is rotated in a liquid bath to form a film of certain thickness on the drum surface. The joint surface is then pressed against the drum surface to transfer the film for coating. |
| Applicable gasket materials | Solvent type, aqueous type, silicone type, and anaerobic type | Anaerobic type | Solvent type and aqueous type |
| Characteristics | Applicable for three dimensional surface coating.<br>Applicable to all types of gasket materials.<br>Allows easy adjustment of coating amount.<br>Can be integrated into automated lines. | High coating speed.<br>High dimensional accuracy of coating pattern.<br>Allow thin film coating.<br>Can be integrated into automated lines. | High coating speed.<br>No restrictions on complexity of coating surface or surface width.<br>Allows thin film coating.<br>Good maintainability. |
| Automatic coating equipment types | Following four types are available according to differences of nozzle drive type:<br>1. Template type<br>2. Photoelectric tube type<br>3. Computer-controlled type<br>4. Disk type | Coating operations can be automated by driving the squeegee automatically. | This cannot be said as perfect automated coater because the object to be coated must be handed manually for transfer. |

Table 2. Types and general specifications of tracing methods

| | | | Template type | Photoelectric tube type | Computer-controlled type | Disk type |
|---|---|---|---|---|---|---|
| Overview | | | The magnet roller is driven along with template that is cut same as the coating pattern. Coating is performed with the nozzle mounted on the center of the roller. Both the outer periphery and inner periphery of the template may be used. | The photoelectric tube reads the coating pattern drawing drawn on a white paper, and a servo motor mounted on the XY table is driven by the signals from the tube. Coating is performed with the nozzle mounted on the arm that is extended from the XY table. | The computer memorizes the specified coating points and moving conditions of point-to-point movements, while the nozzle tip traces the surface of the work piece set at the coating position.(Playback system) Coating is then performed with playing back the memorized pattern. | A nozzle-driving method used exclusively for circular coating. The nozzle is attached to the circumference of a disk. The disk is rotated with a motor through gears to perform coating in circular patterns. |
| Specification | Nozzle drive speed | | MAX 4m/minute | MAX 2m/minute | MAX 12m/minute | MAX 12m/minute |
| | Partial speed change | | N/A | N/A | Available | N/A |
| | Trajectory | Minimum circular arc | 6R | 6R | 5R | 50R |
| | | Noncontinuous line | N/A | Available | Available | Available |
| | | Crossover line | N/A | N/A | Available | N/A |
| | | Double line | N/A | N/A | Available | Available |
| | | Three dimension | N/A | N/A | Available | N/A |
| | Interchangeability | Method | Plate exchange | Diagram exchange | Selection switch | Change of nozzle mounting radius |
| | | Time | 5 min. | 3 min. | 1 sec. | 3 min. |
| | | Type | Not limited | Not limited | 6 types (can be increased) | Not limited |
| | Reproducibility precision | | ± 0.1mm | ± 0.1mm | ± 0.2mm | ± 0.1mm |
| | Working range | | MAX 300 X 500mm | MAX 300 X 400mm | MAX 600 X 1000mm | MAX 600 ϕ |
| Characteristics | | | Tracing method ensures accuracy. Low cost. Good maintainability. | Excellent pattern interchangeability. Allows simultaneous multiple coatings. Low cost. | Allows high-speed three-dimensional coating. Excellent pattern interchangeability. Allows flexible setting of coating conditions. | Simple and reliable. Good maintainability. |
| Applications | | | Cylinder head cover for motorcycles<br>Transmission case for FF for automobiles<br>Oil pan for automobiles | Gas meter counter case<br>Transmission case for automobiles<br>Caulked section of condenser | Lower case for motorcycles<br>Baffle plate for automobiles<br>Oil pan for automobiles | Differential case for automobiles<br>Mounting portion of wheel drum for automobiles<br>Wheel assembly for automobiles |

## 2. Latest New Technology Related with Coating Equipment

We describe major new technology developed lately for tracing method coating equipment.

1) Refinement and Improvement of Computer-controlled Type

Three-axes orthogonal system has been used for the nozzle-driving section of conventional models. The panto arm system, that applies the isosceles triangle principle, has been adopted for Y-axis. Drastic reduction in footprint (36%) and elimination of chatter phenomenon at the nozzle tip due to impact at high-speed operation have been realized.

In addition, by adoption of the 16-bit microcomputer, increase in storage capacity and multisystem program calling system have become available. The work of pattern program generation has been improved to let anyone can run easily, including teaching guidance of operation in Japanese on LCD, all-out hand operation by teaching box, block regression operation, that makes correction work easy.

The conventional coating robots were no more than the welding or handling robots. To support the increase in demand, the development of single purpose robot dedicated for coating of gasket materials has a significant meaning for single-use liquid gaskets.

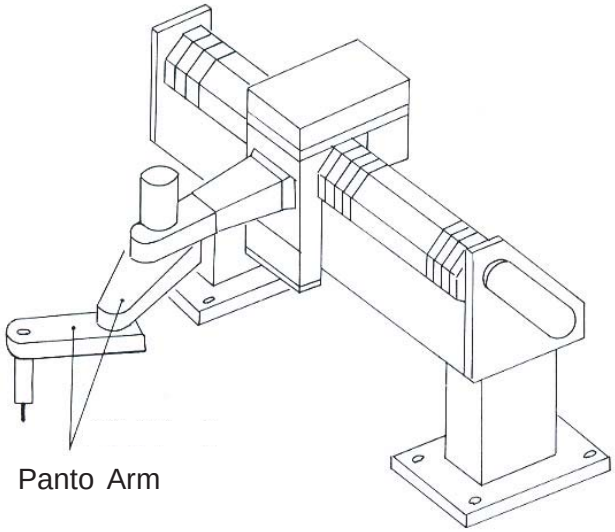


Figure 2. Structural drawing of coating robot with panto arm system

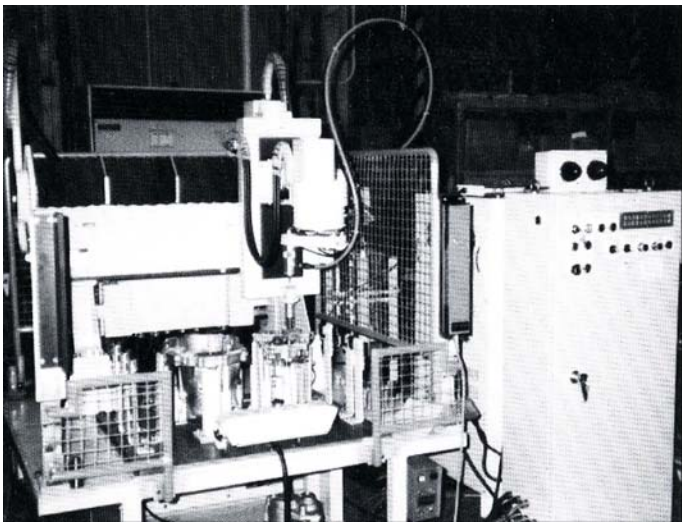

Photo 1. Dedicated coating robot with panto arm system

2) Developing Peripheral Technology of Template Type

Handling of several work pieces, that was a weak side of template type, and simultaneous multiple coatings have become available only by adding a simple equipment.

For handling several work pieces, the adding system of templates were adopted for the work piece, that has partially different coating patterns. For all-out different cases, we have succeeded in developing the rotating system and the coupling system of templates. Regarding jigs to set work pieces, handling of various work pieces is available with the up-down system of pins.

For simultaneous multiple coatings, it was enabled by combination of single template and the XY table.

In addition, the mounting/dismounting of work pieces have become easy by the development of the nozzle origin withdrawal system using templates with cuts. Furthermore, 8-shaped type template, that conducts overlap of application beads surely, has been developed.

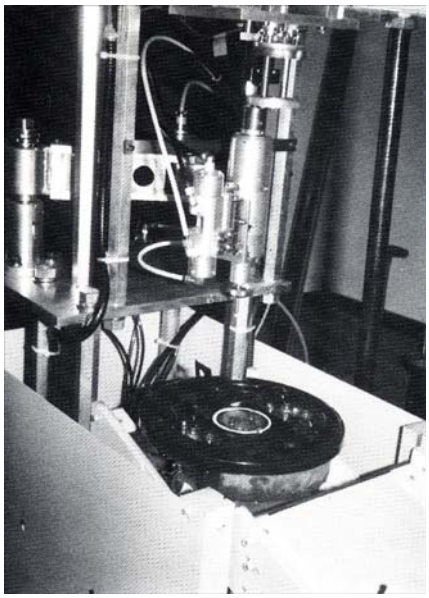

Photo 2. Two type available coater with additional template

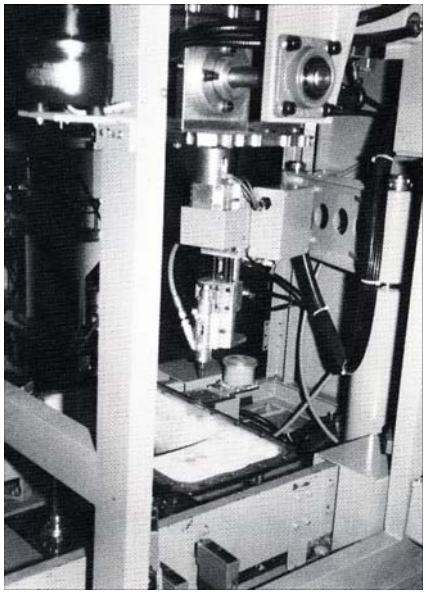

Photo 3. Two type available coater with rotary template

Photo 4. Simultaneous multiple coater in combination with template and the XY table

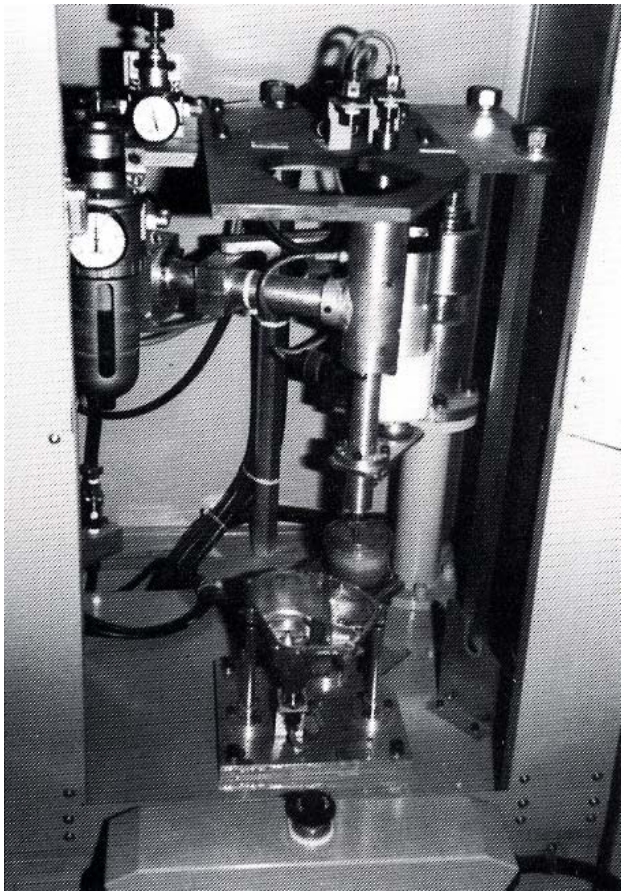

Photo 5. Nozzle origin withdrawal system using template with cuts

3) Developing Mobile Disk Coating Equipment

In case of such as differential gear cases for large trucks and buses, work pieces are conveyed on the conveyer at assembly process without positioning. A worker sets the coater, that was pulled up by the balancer, to the work piece and assembles gears to the work piece ahead already coated. The equipment, which keeps coating on the moving conveyer altogether with the work piece, has been developed.

4) Eliminating Pulsation of Material Pressure-feed Equipment

For pressure-feed method for RTV type silicon, one of the materials of liquid gaskets, versatile flip-flop type air pump on the market has been used conventionally. There was a problem of pulsation at the top dead point and the bottom dead point. To resolve this problem, single acting type booster dedicated for RTV silicon or dedicated for bead shape coating has been developed.

It makes the blunger go and return per coating of a single work piece. It is the system to pressure-feed materials by bringing down the blunger at coating, ascend it by sacking them at the very moment after completing work, and then wait until the next coating.

In addition, as an ancillary effect, the durability of the gaskets of shaft seal part have been drastically improved thanks to the non-energized booster during pause time of the coating.

5) Operability Improvement in Material Pressure-feed Equipment

A detach system wiper plate made from plastic (see Figure 3) has been developed for the replacement of wiper plates made from rubber, that slide inside the container of the material used for conventional pumps on the market.

This wiper plate is set at the time with exchanging the material. When all the material is used, the pump is raised with the material remained on the bottom of the container. The detached plate is taken from the container with a plastic bag altogether. After standing, the material attached to the plate is coagulated for removal to be reused.

Thanks to adopting this detach system wiper, bonding quantity to the wall of the container has been decreased compared with the one with the rubber wiper. Thus, the material comes down smoothly with the decrease in the quantity of the material in the container, stable pressure feed of the material has become available. Also, since the

removal work of the bonded material to the wiper during the replacement of the material, the quantity of air included has been decreased, which mitigated the air release work.

Moreover, the elimination of the drop of the material from the wiper during ascending the pump, the reduction in quantity of the remaining material at the bottom of the container thanks to the flat shape of the base of the wiper, and the reduction in leakage of the material from the inscribing part between the container and the wiper have been achieved. These improvements of operability during replacement of the material and the effects of drastic reduction in wastes of materials are so remarkable that they are being well received by user side.

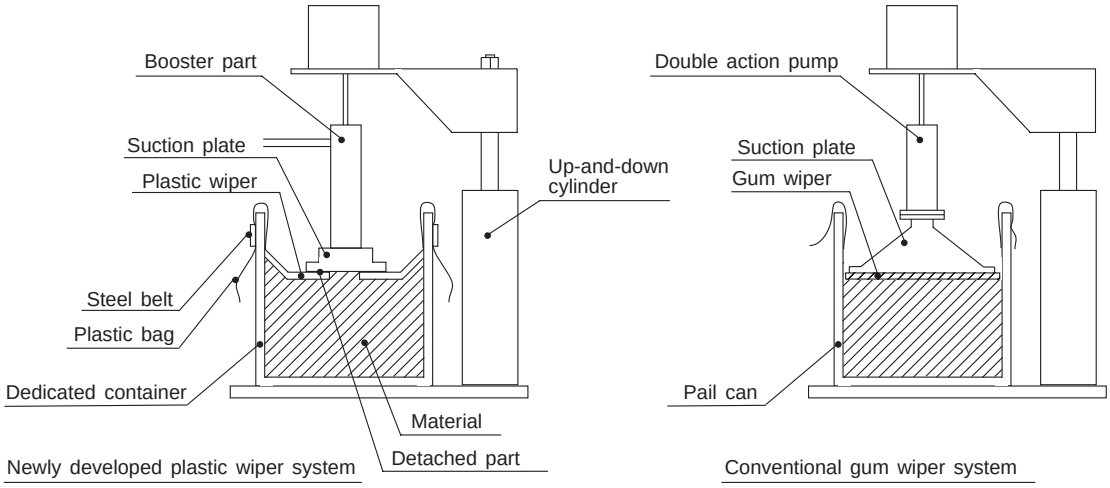


Figure 3. Explanatory drawing of detach system wiper plate

6) Developing Cobwebbing Elimination On-off Valve

Thanks to the development of compact and light suction type material on-off valve, that can support high pressure, the cobwebbing of the nozzle tip at the close down of dispensing has been improved, which prevented the work piece and the machine from staining.

We have described major new technologies regarding the coating of tracing method. These technologies have born inevitably from the requests of users in the trend of single-use of liquid gaskets, that has advanced rapidly. To put together these requests meticulously for the production technology under material manufacturers' leadership is the success factor in Japan as mentioned in the opening.

## 3. Application Examples of Liquid Gasket Coating System

Table 3 shows the application examples of the coating system. The latest examples are listed below.

1) Put the top priority on the safety of workers
2) Take the processes besides coating into the system
3) Higher output power of pressure-feed pump due to the high viscosity of the material
4) Coating of extra fine beads due to the development of small parts
5) Increase in efficiency of operability by the design of the loader and unloader for the work piece

Table 3. Application Examples of Liquid Gasket Coating System

| Classification | Element place | Types of coaters used and overview | Employed material and characteristics |
|---|---|---|---|
| Small-sized automobiles | Oil pan | It is the dedicated coater installed on the line side. Often coated on the side of the oil pan. In rare cases, coated on the side of the cylinder block as well. Adoption of the computer-controlled type and the template type are fifty-fifty. To enable workers to conduct the exchange operation of the work pieces efficiently, the loader and unloader of the work piece are usually devised. | RTV silicone<br>Initial pressure resistance<br>Peeling property at disassembling |
| | Transmission case<br>Rear cover<br>Flywheel cover | There are cases where they are coated automatically on the conveyer line and coated on the line side. Depending on the assembly circumstances, the ratio is fifty-fifty. The computer-controlled type and the template type are adopted. Since the fine and uniform beads are required because of the need to reduce the extrusion at assembly as much as possible, pulsation during pressure-feed is not permitted. | RTV silicone<br>Gear oil resistance<br>Torque converter oil resistance |
| | Oil pump case<br>Oil seal retainer | Although the coating by template type coater on the line side is predominant, computer robots dedicated for two-wheel are sometimes used as well.<br>Since assembling accuracy is required, an alarm device, that checks the elapsed time after the coating, is needed. | RTV silicone<br>Thick film fast-curing property<br>Engine oil resistance |
| | Thermostat case<br>Water outlet cover<br>Distributor<br>Breather cap | Since it is a small part, it is usually coated by desktop template coater on the line side. Thanks to the development of the template cutting type origin withdrawal system, the coater has become compact much more. Since the amount of the material used is little, pressure-feed system by cartridge tank is used. The alarm device to check the remainder in the cartridge has been developed. | RTV silicone<br>Water resistance |
| | Axle dust cover<br>Adjustment shim<br>Front axle | Although circle shape patterns are predominant, there are some patterns with protrusion on the circle and there are cases of intermittent coating, where certain parts on the circumference are not coated. Therefore, for the axle dust cover, the template type is adopted. For the front axle, the disk type is always adopted. | RTV silicone<br>Water resistance |
| | Differential case | Small differential cases such as light automobiles are sometimes coated automatically on the conveyer; however, they are generally coated by the disk type coater on the line side. The seal of the tap holes of stud bolts of the flange surface also is sealed by the sealant, that was coated in circle shape against the flange surface. | RTV silicone<br>Gear oil resistance |
| | Baffle plate | The computer-controlled type coater is used because of the complex patterns and the need to comply with various types. Since the deep base is coated by extra fine beads, narrow and long nozzle is used. Therefore, cobwebbing elimination valve is used. | RTV silicone<br>Engine oil resistance |
| Large-sized automobile | Differential case | There are many cases where coating is made manually by connecting the high-pressure feed pump to the flow gun. If it is difficult to coat because hands cannot reach the center part of the conveyer, newly developed disk type mobile coating equipment is used. It serves as seals of stud bolts as well like the case with differential cases for small-size automobiles. | RTV silicone<br>Gear oil resistance |
| | Transmission cover | There are many kinds of covers, and in some cases, coating of vertical planes is included. Due to large scale, positioning is difficult. Since automatic coating is difficult from these reasons, all of them are hand coated with high-pressure feed pumps and flow guns. | RTV silicone |
| | Various covers around engines | Relatively small covers, that have similar assembly processes together, are coated all at once by the combination system template type coater for various types. The other large-scale covers are hand-coated by flow guns or cartridge guns. | RTV silicone<br>Engine oil resistance<br>Water resistance |

Table 3. Application Examples of Liquid Gasket Coating System (continued)

| Classification | Element place | Types of coaters used and overview | Employed material and characteristics |
|---|---|---|---|
| Motorcycle | Crank case<br>Lower case | The automatic coating is performed to the work pieces conveyed on the conveyer by the computer-controlled type coating robot.Various models and high-speed coating (12m/minute) are needed in many cases. Technologies such as multisystem program calling and work piece orientation sensor are needed. | RTV silicone<br>Aqueous type liquid gasket<br>Engine oil resistance |
| | Cylinder head cover<br>OHC bearing case | In case of large-scaled models of motorcycles, multiple cylinder head covers are mounted on the single engine. Therefore, the template type coater of simultaneous multiple coatings is adopted. | RTV silicone<br>Engine oil resistance |
| Farm machinery | Covers around engines<br>Oil pan | The computer-controlled type is used to support many kinds of work pieces. There are examples where work piece fixture is four-plane rotating drum type with 5 to 6 jigs being set per single plane. | RTV silicone<br>Engine oil resistance |
| | Transmission case | For relatively mass-produced transmission covers, the template type coater is used. For small production, they are hand-coated by cartridge guns and etc. | RTV silicone<br>Gear oil resistance |
| Others | Outboard engine<br>Snow mobile<br>Gas meter<br>Pump casing<br>Stove<br>Washstand | For bathroom vanities, because of not only their various types but also high-speed coating, the computer-controlled type coating robot is used. Because of large volume of material used, the technology of high-pressure booster (100:1) is needed. Others are usually coated by the template type coater or handguns etc. | RTV silicone<br>Aqueous type liquid gasket<br>Application property of coating to extruded part<br>Propane resistance<br>Water resistance |

## Conclusion

The popular method of single-use liquid gaskets at present is the wet type, with which work pieces are put just after the coating before the material solidifies. Since it is based on some extent of adhesive force for sealing property, there is a problem of disassembling at maintenance.

For future direction, the dry type is becoming popular. With the dry type, the elastic gasket is formed on the seal plane by solidifying the material coated on the cover side for the parts, which need to be taken out frequently. This formed gasket is called pre-coating gasket as well.

With the dry type, in the assembly process for covers, it is rationalized because the coating process is omitted. The important issue, that influences economy, is where to conduct pre-coating process and how to conduct it efficiently.

Although it is ideal to conduct this pre-coating process at online, it is impossible because of the line tact from the viewpoint of low curing rate of the material.

As processing at offline, the cases conducted by such as users, parts manufacturers of covers, and material manufacturers are expected. For the moment, if the manufacturers provided with coating technology and curing facilities conduct, they can support it immediately.

However, from the viewpoint of parts distribution, it is efficient if users or parts manufacturers conduct it. The development of fast-curing new materials and mass production processing system by material manufacturers is expected to realize this.

From the material side, fast-curing at room temperature is fine; however, as the methods with possibility, following methods are conceivable.

- To adopt the two-part reactive type
- To adopt the add type of heat or ultraviolet radiation
- To use microcapsules

For processing equipment, with dry type, coating should be performed with some extent of film thickness because sealing property is expected for restoring force toward tightening. Therefore, the tracing type and the screening type are mainly used; however, the molding method toward processing plane using dies is conceivable.

In all cases, uniform high-speed coating of beads and high-speed curing are required economically. In addition, the development of the monitoring system, that monitors whether the prescribed coating beads have been coated on the joint surface surely or not, is the key issue.

— End —

**Research Laboratory**
**Industry Application Technology Group**
**Labor Saving Equipment Division**

Yasuji Nakane

# Tightly Guard the Body of Automobiles with Excellent Coating Film!


## ThreeBond 6107 (white)
## ThreeBond 6107B (black)
## Chipping guard

ThreeBond 6107 (white) and 6107B (black) are protective coating agent, chipping guard for wheelhouse, rocker panel, and skirt part of automobiles.

After the coating, the body is strongly protected from gravels, stones, metal pieces, and anti-freezing agents etc. and protected from corrosion.

### Characteristics

1. Fast-curing type. The surface dries after 20 to 30 minutes (25 °C) after coating.
2. Excellent in water resistance, alkali resistance, acid resistance, corrosion resistance, and shock resistance.
3. Excellent in adhesive property and finish coating of various color paint is available after dried out.
4. Thanks to the aerosol type, everyone can use easily in elsewhere.

### Major Applications

- Wheelhouse, rocker panel, front end panel, and rear end panel etc.

ThreeBond TECHNICAL NEWS

THREE BOND CO., LTD.

1456 Hazama-cho, Hachioji-shi, Tokyo 193-8533, Japan
Tel: 81-426-61-1333