

## Techniques for Adding Solution Functionality via Application Equipment

### Introduction

At Threebond, we manufacture and supply highly functional, industrial-use adhesives and sealants, as well as develop and supply the equipment used for applying them at our customers’ manufacturing sites. We utilize materials and mechanisms appropriate for each adhesive or sealant’s particular characteristics in our application equipment, offering a massive product lineup to suit each customer’s application needs.

As the automobile industry expands, we have been developing application equipment and technologies with particular focus on those for linear application of FIPG (formed in place gasket) sealants. Recent years have seen improving safety performance as well as rapid progress in comprehensive control technology for automatic driving and as well as hybrid and electric drive technology to handle emissions regulations and CO<sub>2</sub> reduction within the automobile industry. Outside of automobiles, the range of requirements for adhesives and sealants continues to grow with the spread of smartphones and development of wearable devices and other technologies. We are also working on developing unique linear application technologies in order to keep up with these market changes and provide optimal solutions for any situation.

Here we will introduce new application technology with added functionality for patterns that were difficult to implement in conventional technologies.

### Table of Contents

Introduction.....	1	1-4 The ThreeBond Approach .....	3
1. Background.....	2	2. Planar Solution Application Technology	3
1-1 Conventional Application Technology.....	2	3. Micro-Point Solution Application Technology.....	4
1-2 Technological Innovation in Automobiles .....	2	4. Foam Solution Application Technology .	6
1-3 Requirements for Size Reduction, Weight Reduction and Water-Proof Functionality.....	2	Closing .....	8

# 1. Background

## 1-1 Conventional Application Technology

Adhesive and sealant application is comprised of two technologies: pressure transfer of the solution and drive to control the end applying solution pressure via a robot, etc.

FIPG sealant is applied to joints in automobile engines and transmissions to prevent oil and coolant from leaking. These sealants are discharged from a moving nozzle in lines that follow the shape of the adherend (Photo 1).

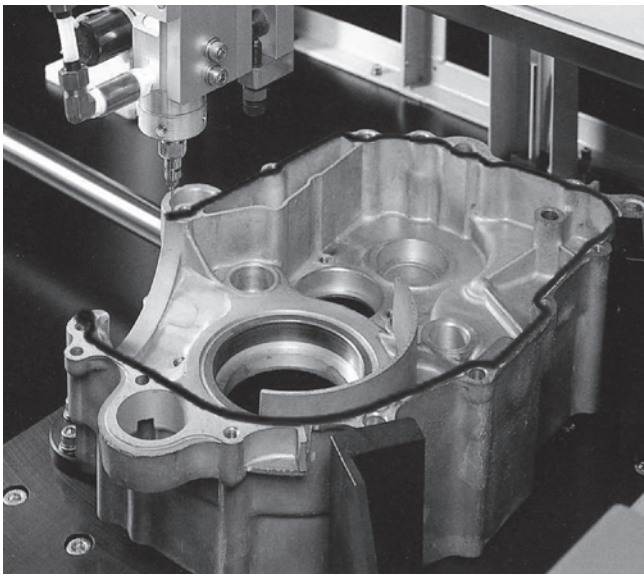


Photo 1 FIPG Linear Application

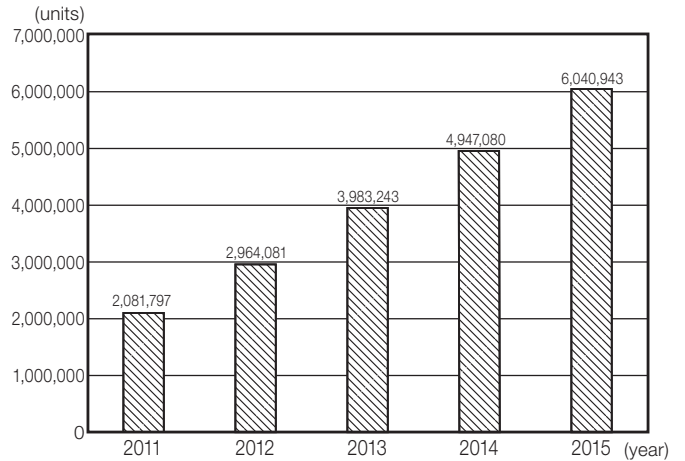
The mechanism that discharges sealant at a constant speed and that which keeps the nozzle following a set and directed pattern and speed are vital here. FIPG sealant has become a market standard due to various characteristics in line with a variety of requirements, as well as its corresponding application technologies.

We have independently developed coating technologies since the initial stages of FIPG, creating technologies known for their accurate application of highly viscous solution on flange surfaces that are currently in use at manufacturing sites across the globe.

## 1-2 Technological Innovation in Automobiles

We have been developing and moving toward further practical application in HV/EV that improves fuel economy in line with global conservation and energy-saving trends. There has also been higher and higher demand for fuel cell vehicles that do not emit air-polluting hydrogen gas and other harmful substances. These next-generation vehicles are developed and sold by manufacturers world-wide, with the number of vehicles registered continuing to steadily grow (Table 1).

Table 1 HV, EV, FCV Units (Japan)

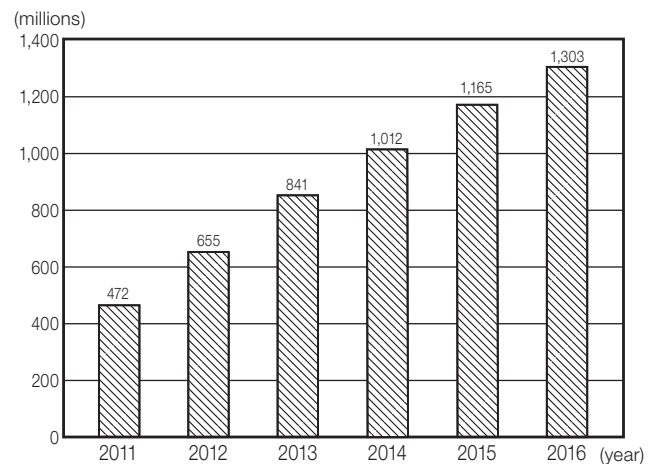


With automobile improvement progressing as we have mentioned above, so too have the requirements for adhesives and sealants. For example, while combustion engines required sealing performance for lubricating oil, performance for electrical systems is required in next-generation automobile power sources. This means that both composition and shape vary, requiring coating methods that differ from the simple linear application used before.

## 1-3 Requirements for Size Reduction, Weight Reduction and Water-Proof Functionality

With the rapid spread of smartphones with higher and higher functionality, smaller and lighter mounting parts are required (Table 2). These requirements are also applicable to the technical aspects of future developments, such as wearable devices and drones, where various parts require water or dust-proofing. To implement these changes, it has become more and more necessary to create coating applications for precisely small amounts in small parts and in shapes suited to the particular application.

Table 2 Smartphone Sale Trends (Worldwide)



### 1-4 The ThreeBond Approach

In keeping with market needs in these times of massive turnaround, ThreeBond is developing a variety of new application technologies that correspond with our highly functional adhesives and sealants as an alternative to conventional application. In the next section, we will introduce three kinds of solution application technologies that add functionality to the solutions to which they are applied.

## 2. Planar Solution Application Technology

The RV-SN Series (Photo 2) equipment applies adhesive and sealant in planes. It dispenses solution in a wide band from a nozzle with a slit opening. Moving the nozzle or the workpiece as solution is being dispensed enables wide-plane

coverage in a short amount of time. The advantage of this equipment is that it applies even fluid pressure for the full width of the slit when discharge begins, so a nearly perfect rectangle can be applied even if discharge is turned on or off at certain positions (Fig. 1).

Similar slot die structures can also produce a uniform thin film but can only discharge continuously. This is appropriate for film lamination processes, but because it is common to reapply adhesive in certain areas, this arbitrary on/off control is important for accurate application.

Screen printing is another form of planar application, but this kind of application can generally only form film thicknesses of around 20µm. The RV-SN Series is designed for film thicknesses from 100 µm to 1 mm.



Photo 2 RV-SN Planar Application Equipment

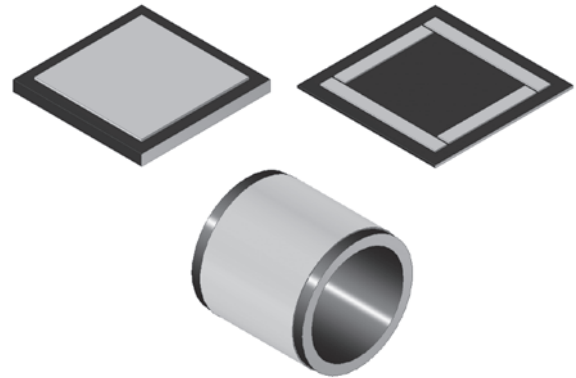


Fig. 1 RV-SN Coating Application

Table 3 PV-SN Series Specifications

Features	PV-SN Series		
Model	RV05-SN50	RV10-SN100	RV15-SN150
Coating width	20 - 50 (mm)	51 - 100 (mm)	101 - 150 (mm)
Film thickness	0.1 - 1.0 (mm) *May be usable outside this range		
Viscosity	0.5 - 700 (Pa-s) *May be usable outside this range		
Durable pressure	0.7 (MPa) or less		
Materials	ThreeBond 1200 and 1500 Series moisture curing sealants and adhesives ThreeBond 2200 Series two-component epoxy resin ThreeBond 3000, 3100 Series UV curing resin		
Drive source	Clean dry air 0.3 to 0.6 (MPa)		
Operational system	Air cylinder controlled valve switch		
Other	Nozzle sizes (application width) available in 1 mm gradations		

### 3. Micro-Point Solution Application Technology

PiT-16 equipment (Photo 3) applies solutions in micro-point diameters of 100 μm or less. Unlike application with a conventional nozzle, even solutions with a large particle size can be applied without the potential of clogging.

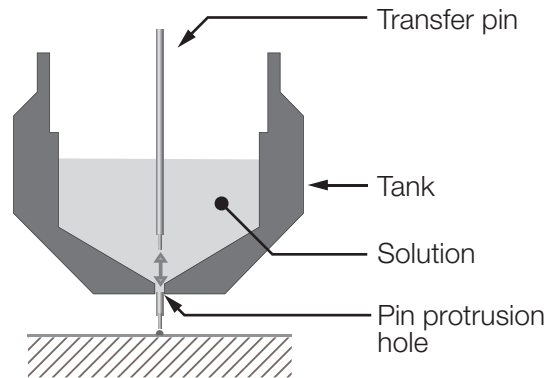


**Photo 3 PiT-16 Micro-Point Solution Application Equipment**

This device features a special pin transfer system. Utilizing this enables micro-point application without clogging the nozzle. The pin drive is a linear motor that speeds up transfer operations while ensuring high durability.

Height of the transfer target can cause deviation in dimensional accuracy during transfer of minute amounts of coating. This is alleviated by taking a preliminary height measurement and having the machine feed that data back during the transfer process to follow, correcting operations as is suitable for the height. This enables highly accurate reproduction of micro-point application.

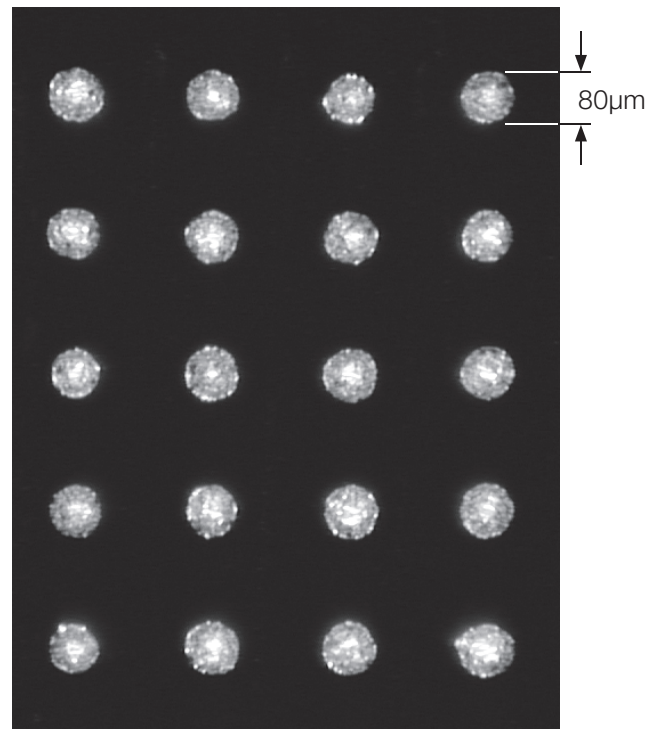
The principle behind this application is that the pin is lowered from the discharge hole. Once it protrudes from the tank the appropriate amount of solution adheres to the pin then is transferred to the adherend (Fig. 2).



**Fig. 2 Principle of Pin Transfer**

Compatible solutions are heat curing electrical conductive adhesive, one-component epoxy resins and UV-curing resins (Photo 4).

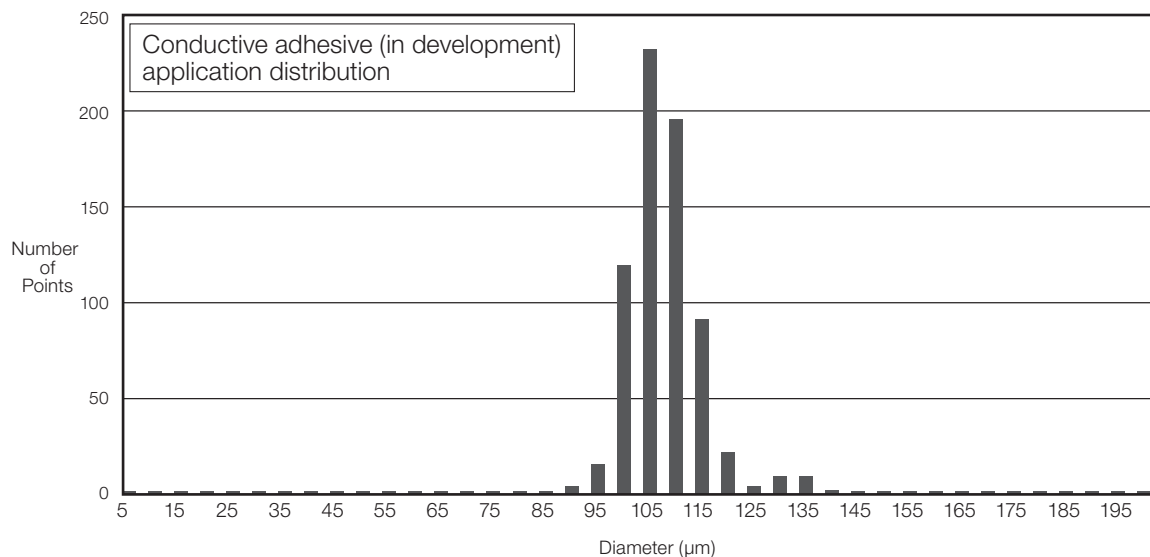
Liquid properties must be suitable for actual use, so a trial in advance of actual application is advised. Not compatible with moisture curing resin, instant adhesive, anaerobic adhesive and the like materials due to the materials used to make the equipment.



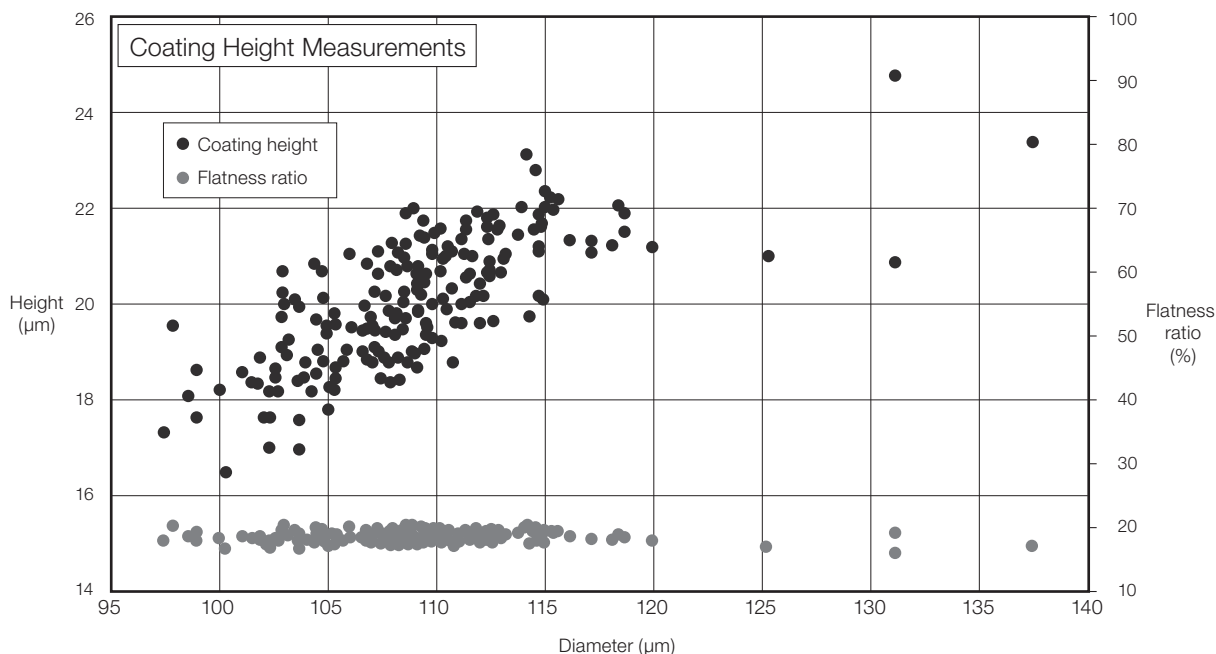
**Photo 4 Conductive Adhesive Application**

Table 4 is a distribution map for coating diameter during 900 repeated point applications of electrical conductive adhesive. Table 5 shows point coating height and flatness ratio (outer coating dimensions vs coating height) for 200 of the 900 points shown above.

**Table 4 Outer Diameter Application Distribution**



**Table 5 Coating Height and Flatness Ratio**



**Table 6 PiT-16 Specification**

Features	Micro-Point Application Equipment
External dimensions (W x D x H)	84.5 × 68 × 242 (mm)
Weight	1.6 (kg)
Drive source	Head: Clean dry air 0.1 to 0.2 (MPa) Motor amplifier: 100 VAC
Compatible solutions:	Conductive adhesive, one-component epoxy resins, light curing resins
Application dimensions	100 (μm) or less *Depending on solution conditions
Operating environment	Temperature: 0 to 55°C Humidity: 20 to 85% RH (no condensation)

#### 4. Foam Solution Application Technology

The MFD-10 compact mechanical foaming system mixes gasses into a single-component liquid and applies them as a foam. Unlike conventional chemical foaming (two-component reaction foaming) where foam is generated through the reaction caused by mixing two liquids, here gas is physically mixed into a single-component liquid to create foam in a stable liquid formation (Photo 5).

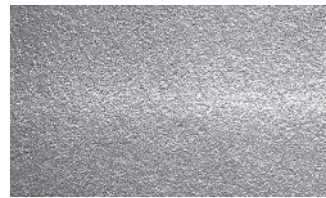
Foam expansion is easily controlled within 1.3 to 3.0 times, making it possible to create cured items with properties that vary with the foaming ratio, even when using the same solution. Because foam is formed independently, it is excellent for applications requiring sealing performance (Photo 6).

For example, you can increase the foaming ratio and lower foam firmness in order to apply sealant without undue stress on typical casing, which has low rigidity.

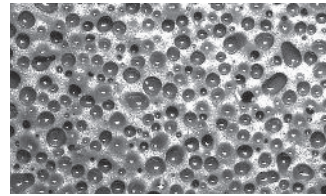
Additional features include:

1. Performance not affected by heat and humidity.
2. Compact for space conservation.
3. Wetted parts are easily separated for simple maintenance.
4. Stable low amount discharge range (0.01 to 1.50 g/sec.).

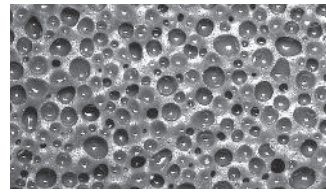
Useable for applications such as soundproofing and sound absorption, vibration protection and suppression, dust and drip-proofing, insulation, weight reduction and shock absorption. We have been highly praised for our contributions to performance, quality and work efficiency in a variety of fields requiring foaming materials.



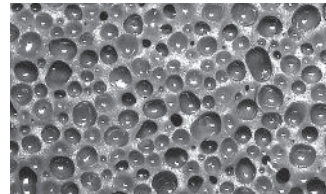
Before foaming  
C hardness: 36



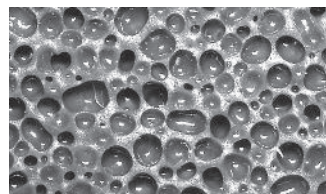
1.4x foaming  
C hardness: 23



1.6x foaming  
C hardness: 19

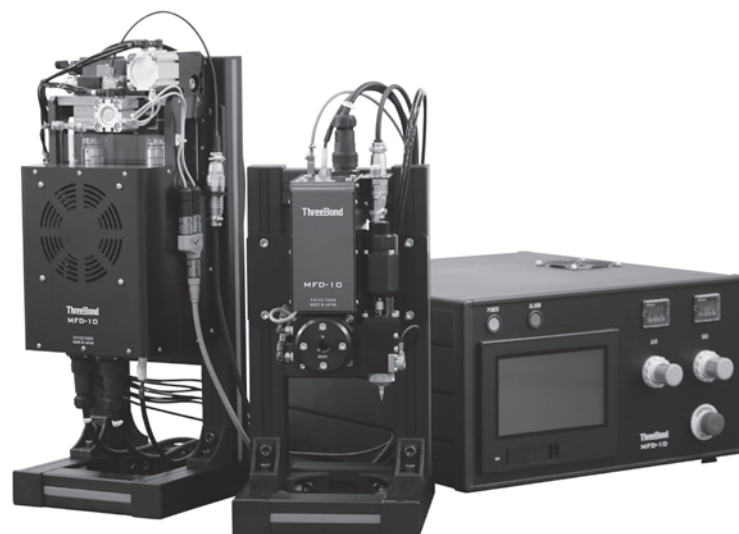


1.8x foaming  
C hardness: 18



2.0x foaming  
C hardness: 16

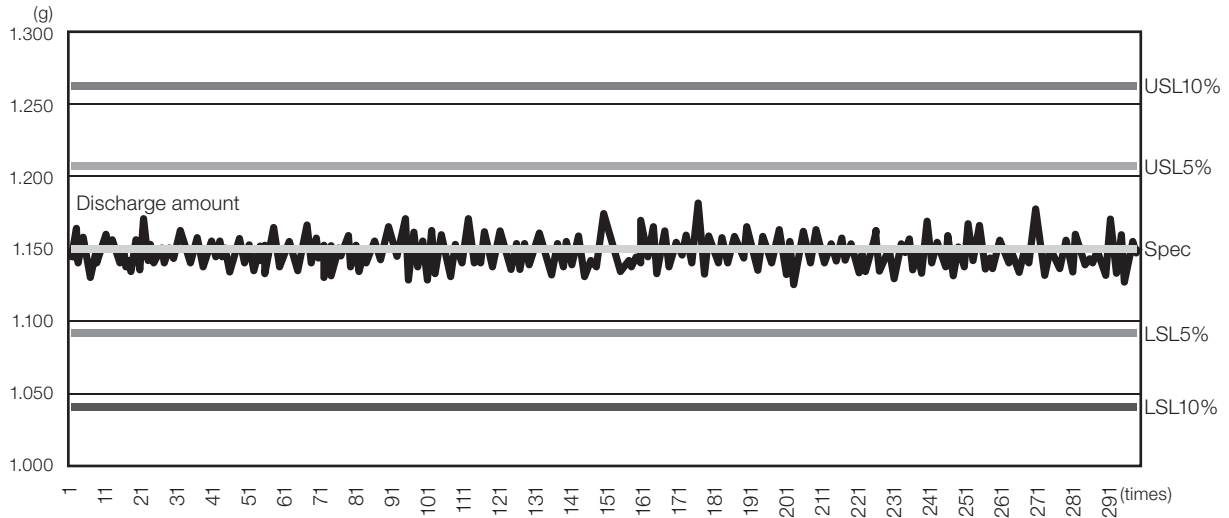
**Photo 6 Cross Section and Hardness of Item Cured with ThreeBond 1234B**



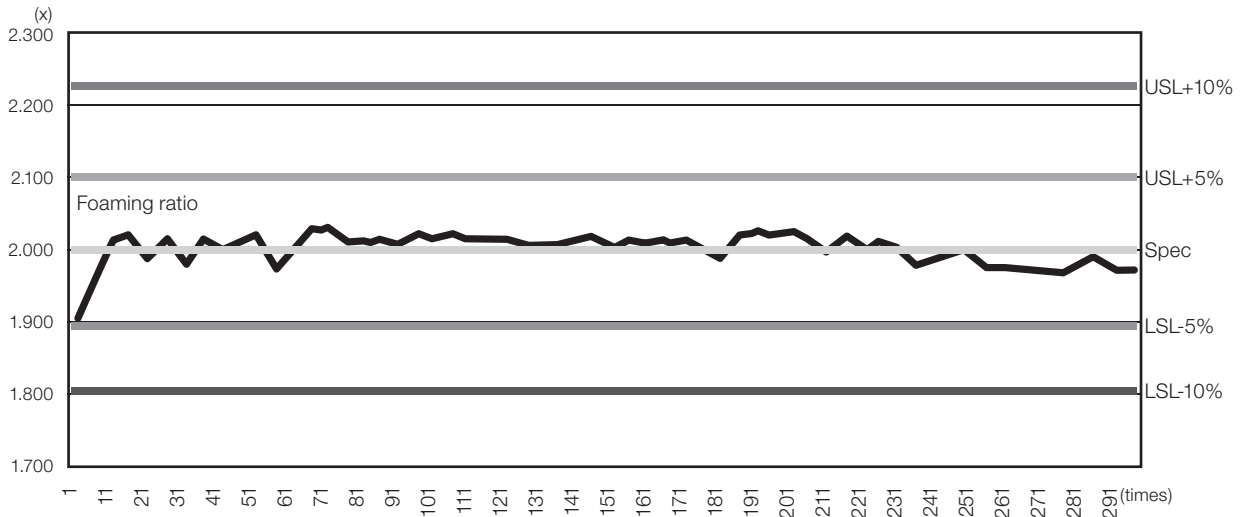
**Photo 5 MFD-10 Mechanical Foaming Dispenser**

Table 7 shows the changes in discharged amount during 300 applications of heat curing silicone resin using the MFD-10. Table 8 shows changes to foaming ratio in the same way. Both are within a range of  $\pm 5\%$ .

**Table 7 Discharge Amount Stability**



**Table 8 Foaming Ratio Stability**



**Table 9 MFD-10 Specifications**

Features	MFD-10		
Model	Foaming Pump	Mixing Head	Controller
External dimensions (W x D x H)	200 x 140 x 350 (mm)	130 x 145 x 250 (mm)	430 x 450 x 230 (mm)
Weight	10 (kg)	4 (kg)	8 (kg)
Drive source	Clean dry air 0.3 to 0.6 (MPa), Power supply: 200VAC, 30A		
Discharge speed	0.05 to 2 (cc/sec) <sup>*1</sup>		
Foaming ratio	1.3 to 3x <sup>*2</sup>		
Viscosity	50 to 400 (Pa·s) <sup>*3</sup>		

\*1: Maximum discharge amount restricted by viscosity of solution used. As a guide, when viscosity is 100 Pa·s, discharge speed is 1 cc/sec

\*2: Foaming ratio restricted by solution used.

\*3: May be usable with solutions other than the indicated viscosity.

## Closing

At ThreeBond we develop adhesives and sealants as well as coating application technology to maximize their performance. Our strength is our deep understanding of product components and compositions that enables us to offer our customers suitable application equipment designed with those characteristics.

Moving forward, we will continue to ensure the usefulness of our sealants and adhesives, as well as their application equipment to support innovation within the manufacturing industry. You can be certain that we will continue to develop further techniques for adding solution functionality via application equipment.

<References>

- 1) Next Generation Vehicle Promotion Center, Statistical Data
- 2) Ministry of Internal Affairs and Communications Website

<Regarding numerical data in this document>

Values indicating dimensions and characteristics are as measured but are not guaranteed.

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