ThreeBond
TECHNICAL NEWS

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51

Anaerobic Sealants for Pipes

Introduction

To maintain the tightness of sealing for air or liquid, all joints, flanges and threads must be free of leakage. Since its foundation, Three Bond has developed sealants to prevent leakage. Recently, we developed a highly reliable anaerobic sealant to prevent leakage from the threads of metallic pipes. This issue introduces that sealant, ThreeBond 1110D, and describes its characteristics and use.

Hereafter, ThreeBond is abbreviated to TB in product names.

Contents

1. Current methods for sealing pipes

1-1. Applications and types of pipes

Table 1 shows the general applications and types of pipes. Steel is the most common material for pipes, and sealants are indispensable to prevent leakage from steel pipes.

Table 1. Applications and types of pipes

	Application						
Pipe types	Cooling water	Vapor, Oil	Refrigerant	Water supply, Fire extinguisher	Drain, Ventilation	Natural gas	LP gas
Steel pipe	○	○	○	○	○	○	○
Steel pipe lined with Vinyl chloride	○			○	○		
Steel pipe coated with poly-powder	○			○			
Coated steel pipe					○		
Stainless steel pipe	○			○			
Copper pipe			○	○			○
Steel pipe coated on outside surface				○		○	○
Cast iron pipe				○	○	○	
Vinyl pipe				○	○		
Polyethylene pipe				○		○	○
Lead pipe					○		
Hume concrete pipe					○		
Flexible pipe						○	

1-2. Method of connection and sealants

Pipes are most commonly connected by means of flanges, welds, and threads. Table 2 lists connection methods and the sealants used with each of them. Liquid sealants, most often solvent-type, are widely used for joints with threads.

Table 2. Pipe joints and sealants

Bonding method	Sealant
Flange bonding	Solid gasket
Welding bonding	——
Screw bonding	Liquid sealant

The following sections describe the differences between anaerobic and solvent-type adhesives.

2. Comparison of anaerobic and solvent-type adhesives

2-1. Hardening and curing

The main difference between anaerobic and conventional sealants for piping is their resin component and their curing mechanism.

In the sealants now in common use, special polymer resin is dissolved in solvent. As the sealant evaporates, the resin returns to its original state; that is, it solidifies.

The anaerobic type does not use solvent. Rather, it polymerizes by a chemical reaction, and therefore it "hardens."

A solvent-type sealant loses volume as the solvent evaporates. Since an anaerobic sealant contains no solvent it loses little volume (Fig. 1).

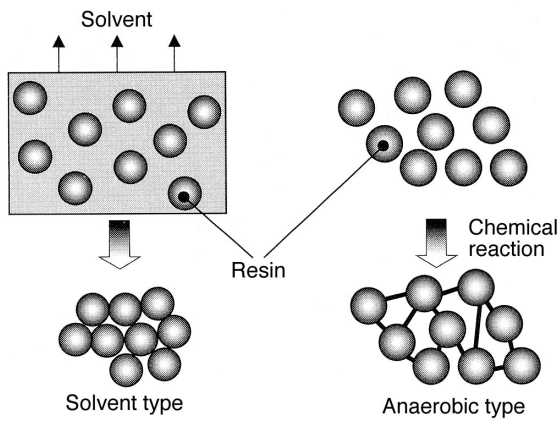

Fig. 1. Solidifying and hardening

2-2. Setting time

Solvent-type adhesive requires setting time to let the solvent evaporate after the sealant is coated on the threads. Anaerobic sealant does not need this time; the thread can be fixed as soon as it is coated. This substantially reduces the working process time (Fig. 2).

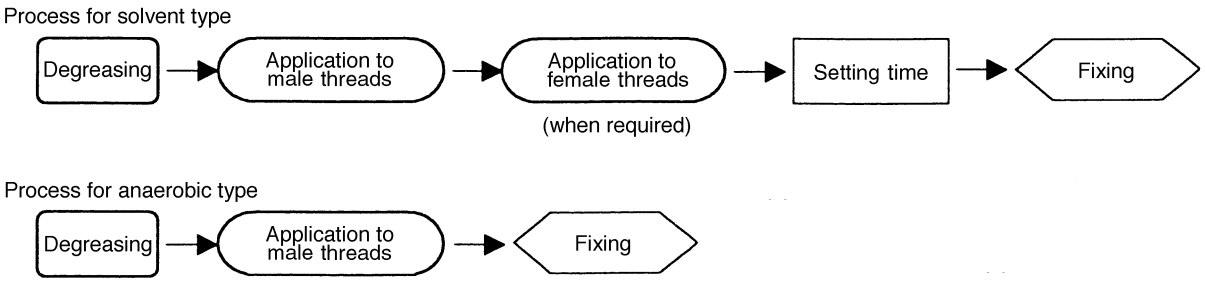

Fig. 2. Working process

2-3. Easy handling

A solvent-type sealant increases in viscosity whenever the container is open, because the solvent evaporates. Anaerobic sealant contains no solvent, so its viscosity remains constant. Also it comes in a tube, which is convenient to carry and handle.

2-4. Coating amount

Anaerobic sealant, unlike solvent-type sealant, does not have to be applied to the entire thread. Applying a small amount to the male threads before fastening yields a good seal. One tube of sealant will seal many joints. For a 3/4-inch pipe, you need only about 0.3 g to seal a joint well.

Table 3 shows the approximate amount of coating needed for different bore sizes.

2-5. Reliability

Anaerobic sealant forms a fine three-dimensional network structure after it is cured, offering excellent resistance to chemicals, solvent, heat, and weather. It gives higher fixing strength than solvent-type sealant, and effectively prevents screws from loosening.

Table 3. Coating amount

unit : g

Bore (inches)	3/4	1	2
Solvent type	0.5	0.7	1.5
Anaerobic type	0.3	0.4	0.8

3. Characteristics of TB1110D

TB1110B, a predecessor of TB1110D that is still sold today, can be used to bond the threads of metallic pipes. However, it has several problems. For example, it is hard to detach connected pipes, or even to determine the area where TB1110B has been applied, because its color is semi-transparent. Pipes connected with TB1110D are easy to detach. Also, TB1110D is elastic, and a coating of it is easy to check. So, TB1110D is suitable to use on pipes.

In the next section, the physical properties of TB1110D are compared with those of anaerobic sealants used for other purposes.

3-1. Physical properties

Table 4 shows the physical properties of TB1110D and anaerobic sealants used for other purposes. All of these products come in tubes and have high viscosity and high thixotropy, which prevent them from running down after they are applied.

Table 4. Physical properties of TB1110D and other anaerobic sealants

Test item	Unit	TB1110D	TB1110B	TB1130	Note
Appearance	——	Milky white paste	Cream color	White paste	
Viscosity	Pa·s {cP}	25 {25000}	34 {34000}	14.5 {14500}	BH, No6, 20
Thixotropic ratio	——	5.5	6.5	4.8	2/20 rpm
Specific gravity	——	1.15	1.11	1.15	Specific gravity cup
Note		For metal pipe bounded by screws; good demountability	Strong fixing strength	For taper plug	

3-2. Strength and removability

As Fig. 3 shows, the break loose torque of sealants increases in proportion to curing time. TB1130 takes more than 24 hours to cure completely and reach its maximum break loose torque. The break loose torque of TB1110B rises quickly, and the final strength is stronger, but pipes connected and sealed with this sealant cannot easily be detached with an ordinary wrench, because the strength reaches 2,000 kgf/cm or more. TB1110B is best when you want a sealant that cures quickly and forms a strong joint on pipes that will probably not be detached. TB1110D, like TB1110B, cures completely in 24 hours, but its final strength is weaker than that of TB1110B and so pipes connected and sealed with it can be detached with an ordinary wrench. For pipe joints that need periodic maintenance, TB1110D is best suited.

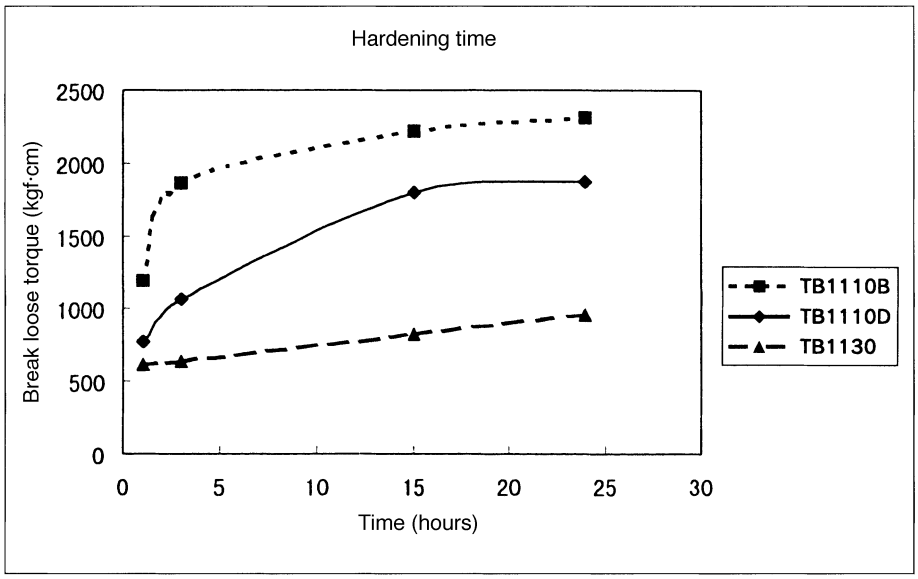

Fig. 3. Curing speed (25°C)

Test conditions

Test piece: 3/4-inch steel pipe, degreased Tightening torque: 58.8 N·m {600 kgf·cm}

3-3. Curing at low temperature

The curing speed of anaerobic sealants is affected by the surrounding temperature. Special care must be taken when curing at low temperature, because the curing speed slows down. As Fig. 4 shows, at low temperature curing slows down and the break loose torque does not increase fast. In such cases, a primer (curing accelerator) can be used to accelerate the curing speed and increase the final strength.

With a primer, Fig. 5 shows, the adhesive cures at a sufficient speed even at low temperature. Also, a primer contains ingredients that increase the final strength.

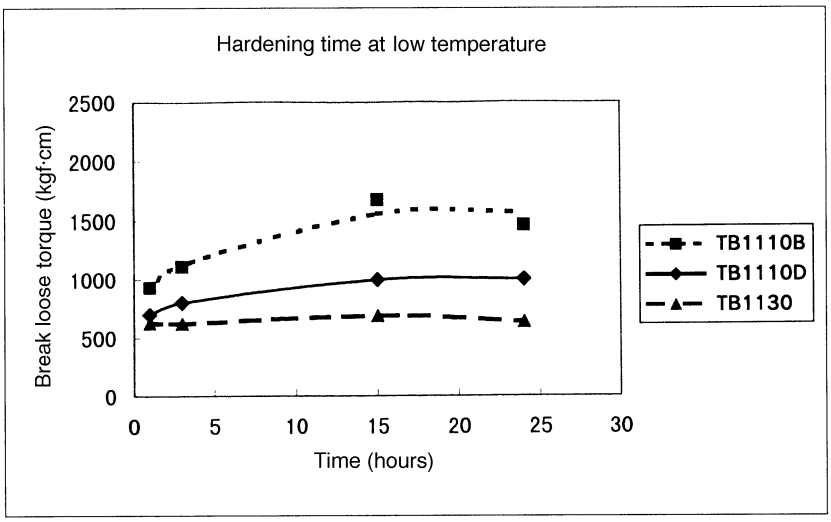

Fig. 4. Curing time at low temperature

Test conditions

Test piece: 3/4-inch steel pipe, degreased Tightening torque: 58.8 N·m {600 kgf·cm}

Curing temperature: 5°C

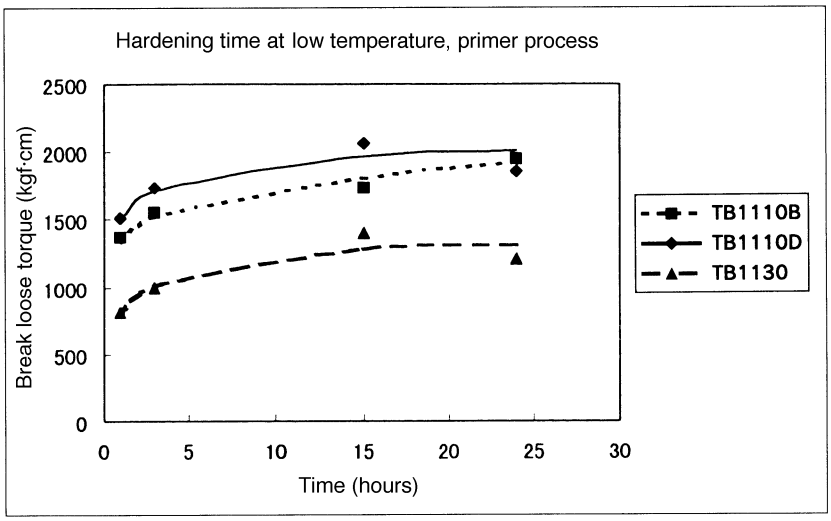

Fig. 5. Curing time at low temperature, primer process

Test conditions

Test piece: 3/4-inch steel pipe Tightening torque: 58.8 N·m {600 kgf·cm}

Curing temperature: 5°C Used primer: TB1390

3-4. Sealing performance

Tables 5 and 6 show the initial sealing performance of anaerobic sealants. As Table 5 shows, TB1110D, TB1110B, and TB1130 offer good sealing performance even shortly, after tightening.

Table 6 shows that after 24 hours no leakage is observed with any of the three sealants.

Table 5. Sealing characteristics (short term)

Compressed medium	Test method	Unit	TB1110D	TB1110B	TB1130	Note
Water	3TS-350-92	MPa {kgf/cm^2}	> 3.43 {35.0}	> 3.43 {35.0}	> 3.43 {35.0}	*1
Air	3TS-350-92	MPa {kgf/cm^2}	> 3.43 {35.0}	> 3.43 {35.0}	> 3.43 {35.0}	*1
Antifreeze	3TS-350-92	MPa {kgf/cm^2}	> 3.43 {35.0}	> 3.43 {35.0}	> 3.43 {35.0}	*1

Tested pipe : 3/4-inch steel pipe. Tightening torque : 58.8 N·m {600 kgf·cm}. Measurment started 5 minutes after tightening.

*1 Compression speed : 0.49 MPa {5 kgf/cm^2}/minute. Peak pressure, 3.4 MPa {35.0 kgf/cm^2}, not sustained.

Table 6. Sealing test (24 hours later)

Compressed medium	Test method	Unit	TB1110D	TB1110B	TB1130	Note
Water	3TS-350-91	——	No leak, abnormality	No leak, abnormality	No leak, abnormality	*2
Air	3TS-350-91	——	No leak, abnormality	No leak, abnormality	No leak, abnormality	*2
Antifreeze	3TS-350-91	——	No leak, abnormality	No leak, abnormality	No leak, abnormality	*2
Turbine oil of JIS type 2	3TS-350-91	——	No leak, abnormality	No leak, abnormality	No leak, abnormality	*3

Tested pipe : 3/4-inch steel pipe. Tightening torque, 58.8 N·m {600 kgf·cm}. Hardening condition, 25°C for 24 hours.

*2 Compression speed, 0.49 MPa {5 kgf/cm^2}/minute. Peak pressure, 3.4 MPa {35.0 kgf/cm^2}, sustained for 1 hour.

*3 Compression speed, 0.98 MPa {10 kgf/cm^2}/minute. Peak pressure, 9.8 MPa {100 kgf/cm^2}, sustained for 1 hour.

4. How to use anaerobic sealants

4-1. Procedure

The following describes the procedure for applying an anaerobic sealant.

(1) Using a cloth, remove debris and cutting oil left on the pipe in the cutting process, and remove grease with solvent.

(2) Coat the male threads except one or two at the top, with the sealant, and clamp the joint to the proper torque (see Table 7).

(3) Wipe excess sealant off the pipe with a cloth.

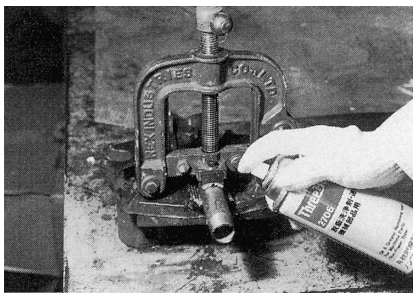

Photo 1

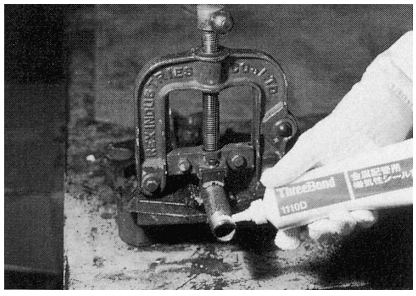

Photo 2

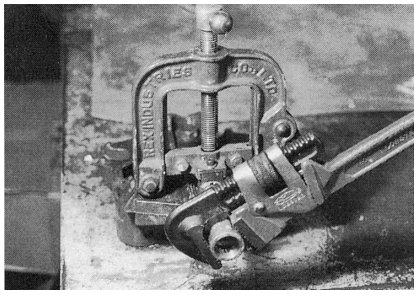

Photo 3

Table 7. Tightening torque

Normal diameter	(Inch)	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3
Standard tightening torque	(kgf·cm)	400	600	1000	1200	1500	2000	2500	3000

4-2. Points to remember

a. Excess sealant

In using anaerobic sealants such as TB1110D and TB1300, one needs to keep in mind that they cure only on metal, within a certain temperature range, and any excess does not cure if exposed to air. If any excess sealant runs inside a pipe and remains uncured, it might clog the filters (Fig. 6). To prevent excess sealant from running into the pipe, leave one or two male threads uncoated when you apply the sealant.

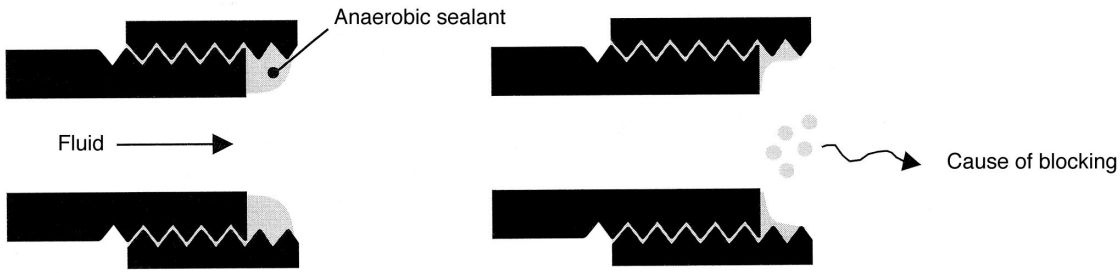

Fig. 6. Excessive sealant in the pipe

b. Primer

As was mentioned above, anaerobic sealants cure more slowly at low temperature. It is recommended that you use TB1390, a primer (cure accelerator) for the preprocessing, when the temperature is at 10°C or below. TB1390 is a spray-type, and is easy to use. To use it, do the following:

(1) Using a cloth, remove foreign matter and residual cutting oil on the pipe after it is cut, and remove oil with solvent (same as for the normal temperature).
(2) Spray the pipe threads thoroughly with TB1390.
(3) When the sealant dries, follow the same procedures to assemble the pipe.

c. Removing oil

TB1110D can absorb a small amount of the cutting oil with no loss of sealing performance. An excessive amount of cutting oil, however, can lower sealing performance, by hindering the adherence of metal and sealant.

Therefore, be sure to remove oil before sealing.

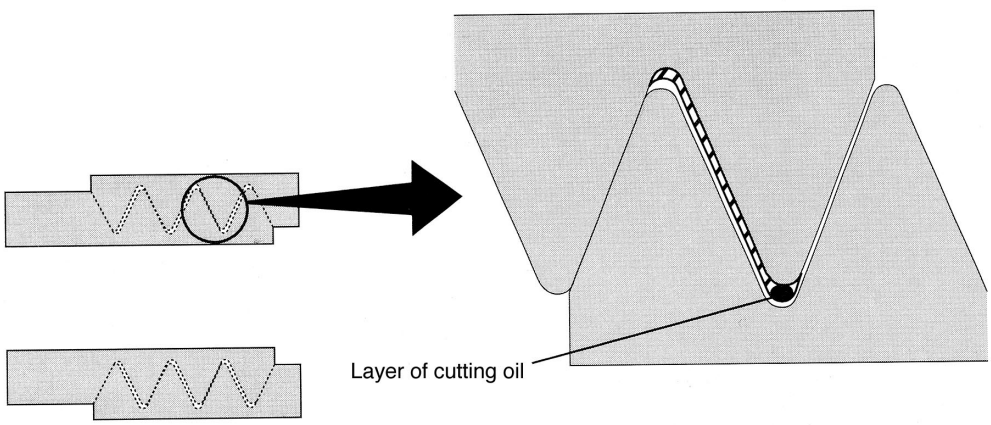

Fig. 7. Residual Cutting Oil

5. Conclusion

TB1110D, a new grade of anaerobic sealant, was released in 1998.

We hope to gather more information about our customers' requirements so that we can provide them with the support they need.

Three Bond Co., Ltd.

Research and Development Division T. Nemoto

Reference

Ministry of Construction, Government Building Dept. (Ed.)

"Common Specifications for Works on Mechanical Equipment"

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