【Technical Report】

New Flange Gasket for Sodium Hypochlorite Piping Line

"JIABLOCK" (IIR-C) AV gasket to prevent accidents on sodium hypochlorite piping lines

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Introduction

Asahi Yukizai Corporation is a manufacturer of piping materials that has been involved in the manufacturing and sales of thermoplastic (resin) valves, pipes and pipe joints for more than 60 years. During the installation of such piping materials, gaskets are used for the flange joints. Gaskets provide sealing performance when bolts or other fastening mechanisms are used to compress the actual gasket. Sealing material used in stationary areas is usually called gaskets, and those used in moving area are referred to as packing, however these are both commonly called gaskets. With its expertise as a manufacturer of plastic piping materials for use in applications where chemical resistance is required, Asahi Yukizai has developed a broad range of rubber gaskets to suit the properties of chemicals flowing through them. Gasket materials are essential during the installation process, and selecting the incorrect type from the extensive range available can result in accidents caused by chemical leaks. Flange gaskets used in sodium hypochlorite piping lines, the topic of this report, typically used FKM gaskets or PTFE-covered gaskets, however even these materials can result in leakage accidents. To address this issue, a new type of butyl rubber AV gaskets ("JIABLOCK", material: IIR-C) was released to prevent leakage accidents on sodium hypochlorite piping lines. This report provides information on this new type of butyl rubber gasket, while also comparing the different types of gaskets available for use on sodium hypochlorite piping lines.

AV Gasket types and materials

AV gaskets feature a dual-layer O-ring protrusion that is designed to prevent leaks even at low surface pressures. The appropriate rubber hardness also exerts a buffering effect against heat stress and piping stress. Typical precautions when using AV gaskets include selecting a material type that is compatible with the chemical being used, as well as adhering to installation procedures such as the correct temperature and pressure ranges. There are many types of AV gaskets available, such as full face shapes that include bolt holes and inner face shapes without bolt holes, JIS10K and JIS5K plumbing standards, rubber materials like EPDM, FKM and IIR, and some types that have PTFE and PVDF-covered sections for parts that are in contact with chemicals. The types and materials are shown in photo 1 and tables 1 and 2. A list of sodium hypochlorite-resistance of various AV gaskets is also shown in table 3.

Table 1. Types of AV Gaskets

Type \ Standard	JIS 10K	JIS 5K	Clean water "JWWA"	ANSI,DIN
Full Face Gasket	○	○	○	○
Inner Face Gasket	○	○	○	–
PTFE Covered Gasket	○	–	–	○
PVDF Covered Gasket	○	–	–	○

Table 2. Applicable materials for AV Gaskets

Materials				
EPDM	NBR	SBR	IIR	IIR-C
FKM	FKM-F	FKM-C	PTFE Covered	PVDF Covered

Full Face Gasket

Inner Face Gasket

PTFE Covered Gasket

Photo 1. AV Gasket

Sodium hypochlorite

Sodium hypochlorite solution is a transparent pale-yellow liquid with a distinct odor similar to chlorine. A strong oxidizer, sodium hypochlorite has a broad range of applications including disinfecting pools, sterilizing, disinfecting and treating water and sewage systems, treating industrial wastewater, and as a household bleach and sterilizer. More recently, changes to the Water Supply Act have resulted in more stringent standards for impurities in the water supply due to greater quality demands for sterilization application. Some 900,000 ton are produced annually, and there are 30 electrolytic solution plants in Japan manufacturing sodium hypochlorite by passing chlorine though sodium hydroxide solution.

Table 3. Performance of Sodium hypochlorite-resistant

Sodium hypochlorite	5%		13%	
	20℃	40℃	20℃	40℃
NBR	×	×	×	×
EPDM	○	○	×	×
FKM	◎	◎	◎	◎
PTFE Covered Gasket	◎	◎	◎	◎
“JIABLOCK” (IIR-C)	◎	◎	◎	◎

“JIABLOCK” (IIR-C) characteristics

Rubber deteriorates in a sodium hydroxide solution as the chlorine in water is adsorbed onto carbon black, combined with the oxidizing effect that breaks down the polymer chains. To address this issue, Asahi Yukizai developed a rubber compound for sodium hydroxide by harnessing the plastic compounding technology it has engineered over the years with PVC and PP as a manufacturer of piping materials, by using the processing of (1) Selecting a polymer type with excellent resistance to sodium hydroxide; (2) Selecting a compounding agent that limits the adsorption of chlorine onto carbon black; and (3) Optimizing the compounding agent to limit deterioration.

Table 4. Performance comparison of various gaskets

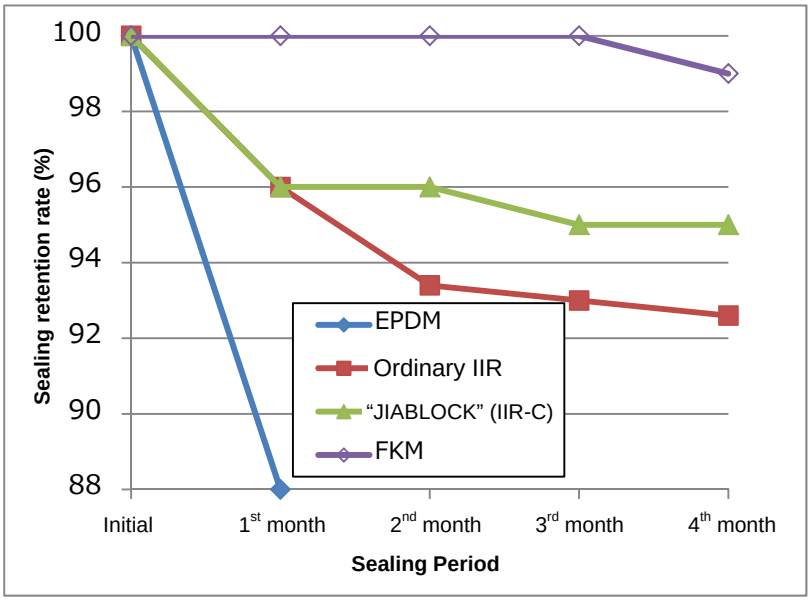
	Chemical Resistance	Sealing Performance	Cost Benefit
EPDM	1	5	5
FKM	5	5	1
PTFE Covered	5	2	2
Ordinary IIR	3	5	3
JIABLOCK (IIR-C)	4	5	4

The resulting product lineup uses butyl rubber as the main ingredient, combined with a vulcanizing agent, filling agent and plasticizer that have a high resistance to chlorine, to achieve an ideal balance between chemical-resistance, sealing and cost-effectiveness. Table 4 shows a comparison of performance between various types of gaskets used on sodium hydroxide piping lines. FKM gaskets that were typically used on sodium hydroxide piping lines offered excellent chemical-resistance and sealing, but were not very economical. PTFE-covered gaskets also had excellent chemical resistance. However the hard covering provided a poor level of sealing compared to rubber gaskets, which resulted in minor leaks. They were also not very economical. “JIABLOCK” (IIR-C) provides an excellent balance between chemical-resistance, sealing and cost-effectiveness, with better performance than conventional IIR gaskets.

Flange sealing performance comparison

Image 1 shows the test results of sealing performance of various types of gaskets used in flanges on 13% sodium hydroxide piping lines operating at ordinary temperatures, comparing the initial level of sealing with the performance after a specified period of time.
There was no significant decrease in sealing performance of FKM gaskets observed over the time measured during the test. Ordinary EPDM rubber, however, has poor resistance to sodium hydroxide and suffered from a major decrease in sealing after just one month of use, with a high possibility of leaks if the gasket was to be continue being used. Ordinary IIR and “JIABLOCK” (IIR-C) retained a similar level of sealing performance as it initially did even after four months of use.

Image 1. Level of sealing retention



Chemical-resistance comparison

A comparison of chemical-resistance was conducted to further study the decrease in sealing observed in Image 1. Sodium hydroxide causes deterioration of rubber gaskets which not only results in leakage accidents, but can also lead to turbidity (blackening) caused by peeling rubber and carbon black. This contamination can result in dirty equipment and cause contamination in products. Asahi Yukizai tested this deterioration based on contamination levels, which involved wiping the surface of the rubber with a white cloth to determine the state of degradation from the amount of black dirt on the cloth. A contamination level of “1” meant no black dirt adhered, “2” indicated that slight adhesion was observed, “3” indicated that heavy adhesion was observed, and 4 meant that there was an extremely high level of black dirt.

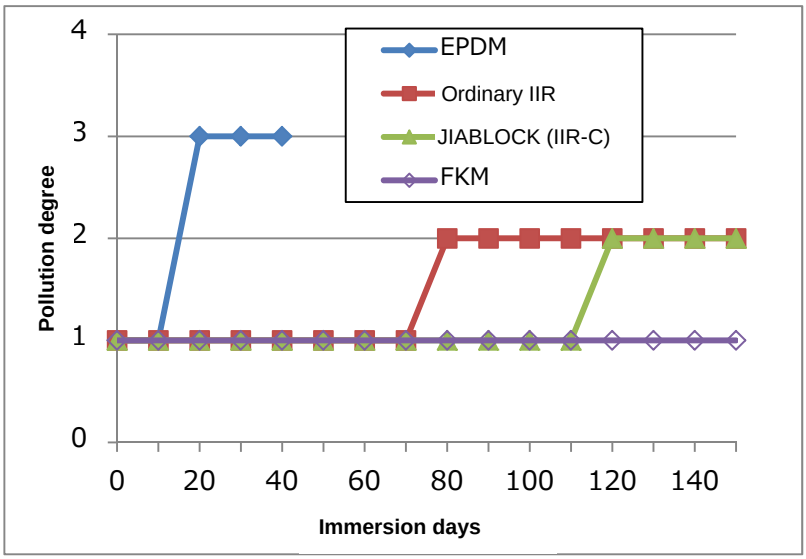
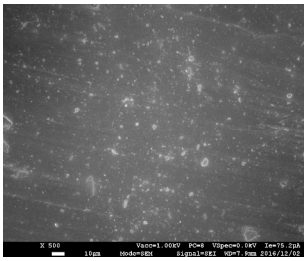
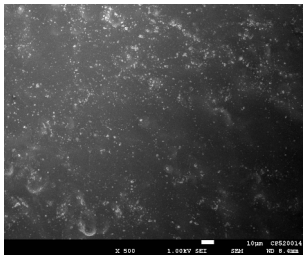
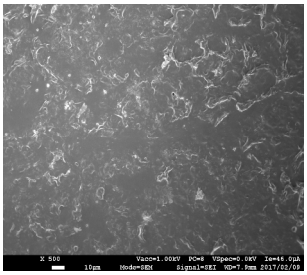
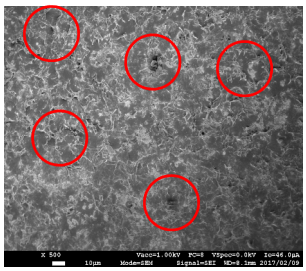


Image 2. Contamination level test

Image 2 shows the test results of contamination levels after immersing different types of rubber into a solution of 5% sodium hydroxide at 40°C. No contamination was observed with FKM during the test period, however black particles were observed with EPDM after 20 days, followed by 80 days with IIR, and 120 days with “JIABLOCK” (IIR-C). These results are in line with the level of sealing retention shown in Image 1.

Table 5. Observation of surface conditions using SEM

Product	“JIABLOCK” (IIR-C)	Ordinary IIR
Surface before immersing in sodium hydroxide		
Surface 60 days after immersing in sodium hydroxide		

The surface condition of “JIABLOCK” (IIR-C) and ordinary IIR was observed using a scanning electron microscope (at 500x magnification) before the test and after 60 days immersed in solution, with the results shown in Table 5. After 60 days, many voids were observed in the ordinary IIR, which are thought to be caused by peeling rubber or carbon black caused by deterioration. This peeling poses the risk of contamination being mixed in the solution. No voids were observed with “JIABLOCK” (IIR-C), indicating that the material does not readily deteriorate.

Conclusion

“JIABLOCK” (IIR-C) provides excellent sealing and chemical-resistance to sodium hydroxide, and can help prevent leakage accidents and contamination when used for long periods of time.

In addition to “JIABLOCK” (IIR-C) for sodium hypochlorite piping lines, the Asahi Yukizai product range also includes ball valves with holes to prevent accidents related to abnormal gas pressure increases, space-efficient mixers to reduce compounding or concentration fluctuations of flowing liquids, and ejectors that do not require suction pumps. A unique PVC pipe (Chemical Pipe) lineup that provides excellent chemical-resistance is also available as part of the range of Asahi Yukizai thermoplastic piping materials designed for maximum compatibility with the chemicals used in sodium hypochlorite piping lines.