Introduction of new product

High Temperature Steam Resistant Perfluoroelastomer TOMBO No.2675-S2 "Blazer® O-ring – S2"

Elastomer Products Promoting Group, Industrial Product Division

1. Introduction

NICHIAS has been developing "Blazer®" series high performance elastomers which have features of excellent thermal and chemical resistivity. We released steam resistant perfluoroelastomer TOMBO™ No.2675-S2 "Blazer® O-ring - S2" (hereafter called "Blazer® S2"), which shows stable sealing performance under steam at 300°C or in a environment containing nucleophilic agent such as amine, and can be used in saturated steam at 320°C if it is only a short duration (**Figure 1**).

"Blazer® S2" is the successor product of TOMBO™ No.2675-S which was launched in October 2015 and is most suitable for sealing a wide variety of chemicals such as steam, hot water, amines, esters, ethers, ketones, acids, bases, carbon hydrides, chlorinated solvents, and in which the conventional perfluoroelastomer (FFKM) or fluorine rubber (FKM) is difficult to be effective.

Figure 1. Appearance of "Blazer® O-ring – S2"

"Blazer® S2" has superior compression fracture characteristics, and is evan suitable for using even under rapid decompression environment. The realization of this high temperature steam and chemical resistant product of the highest class in the world contributes to increase reliability and decrease maintenance costs of your various equipment and devices such as valves, pumps, turbo equipment, painting machines, centrifugal precipitators, stirring apparatus, analyzers or reactors.

2. Outline of "Blazer® S2"

"Blazer® S2" was developed using our original crosslinking agent and blending technology, and is a product with significantly improved properties of those of conventional FFKM (steam resistivity, heat resistivity, fracture characteristic, and rapid decompression properties). In this report, we evaluate these characteristics.

2.1 High temperature steam resistivity

High temperature steam resistivity of "Blazer® S2" was evaluated by an exposure test in high temperature steam and permanent compressive strain in a steam environment in a pressurized container. A competitor's steam resistant FFKM (hereafter called Other Product) and "Blazer® S" were also tested with "Blazer® S2" for comparison. The test

conditions are shown below:

<Steam exposure test conditions>

・Expose the specimen under saturated steam at 320°C for 72 hours while the O-ring is not pressed.

<Compressed permanent strain test conditions>

・Steam temperature: 250 °C /280 °C /300 °C

・Test hour: 72 hrs.

・Compressibility: 25%

・Sample size: AS568-214

(ϕ 3.53mm × ID25.0mm)

Figure 2 shows the results from the high temperature steam exposure test. "Blazer® S2" keeps the shape even after the exposure, while "Blazer® S" and Other Product have deformed due to hydrolytic cleavage and do not keep the shape of O-ring.

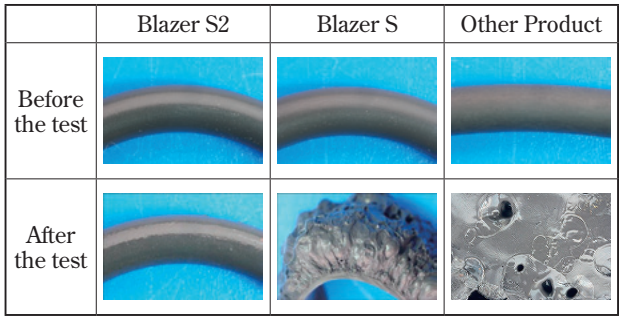


Figure 2. Result of high temperature steam exposure test (320℃ , 72 hrs)

Compressive permanent strain is an index often used as an alternative characteristic for sealing performance of rubber O-rings. The conceptual diagram of compressive permanent strain is shown in **Figure 3** and the calculation method is shown as **Formula 1**.

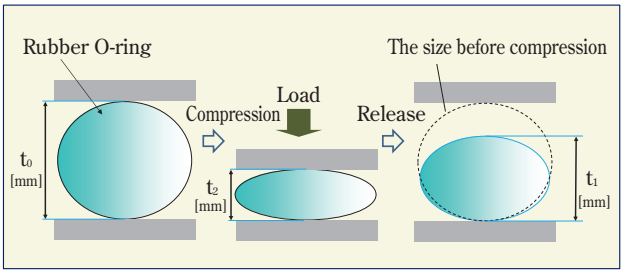


Figure 3. Conceptual diagram of compressive permanent strain

$$C_S = \frac{(t_0 - t_1)}{(t_0 - t_2)} \times 100 \quad \cdots\cdots\cdots\cdots\cdots\cdots \text{(Formula 1)}$$

C_s: Compression permanent strain [%]

t_0 : Initial thickness of the specimen [mm]

t_1 : Thickness of the specimen after the test [mm]

t_2 : Thickness of the specimen when compressed [mm]

If it is considered that when the compressive permanent strain becomes 80% or more it has lost its sealing performance and has there been reached the end of its life time.

Figure 4 shows the result of compressive permanent strain tests under a steam environment. Other product shows 84% at 250°C and 95% at 300°C. "Blazer® S" shows 85% at 300°C. On the other hand, "Blazer® S2" shows 58% at 250°C and 69% at 300°C, showing that it has superior steam resistivity.

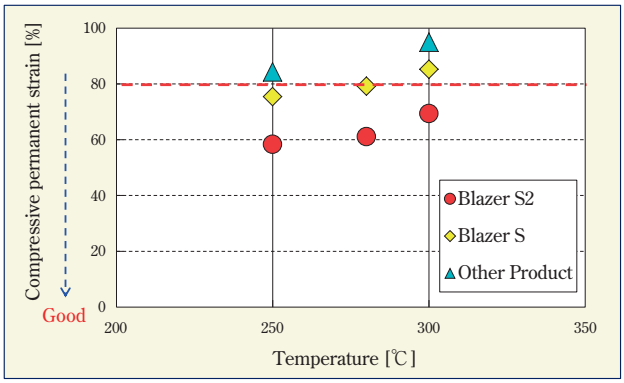


Figure 4. Result of compressive permanent strain test under steam environment

2.2 Heat resistivity

Heat resistivity was evaluated by compressive permanent strain, similar to high temperature steam resistivity. The result of compressive permanent strain of "Blazer® S2", "Blazer® S" and Other Product measured under the following conditions are shown in **Figure 5**.

<Test conditions>

・Temperature: 300°C

・Test hour: 72hrs, 168hrs, and 336hrs

・Ambience: Atmosphere

・Compressibility: 25%
・Sample size: AS568-214
(ϕ 3.53mm × ID25.0mm)

"Blazer® S2" shows smaller compressive permanent strain compared to that of "Blazer® S" and Other Products, which proves to have superior heat resistivity.

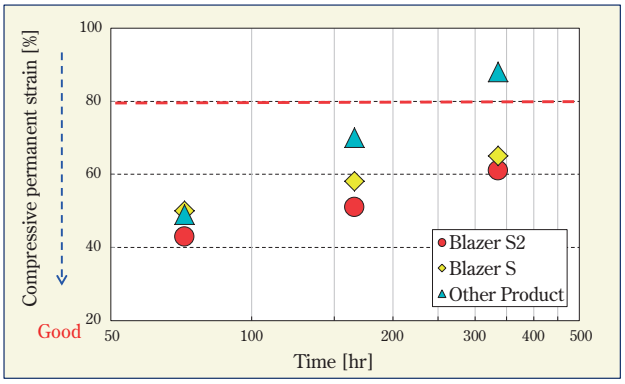


Figure 5. Compressive permanent strain (In the 300℃ atmosphere)

2.3 Compression fracture characteristic

Compression fracture characteristic is an index of nesistance to fracturing when the rubber is compressed with load under the specified temperature. **Figure 6** shows the result of compression fracture test for "Blazer® S2", "Blazer® S" and Other Product carried out under the following conditions.

<Test conditions>
・Temperature: 300°C
・Ambience: Atmosphere
・Compression rate: 0.1mm/min.
・Sample size: ϕ 3.53mm × 50.0mm

The larger compressibility at the point of fracture such as cracking on the test sample is thought to show the better compression fracture characteristic. X marks in **Figure 6** show the points that the samples fractured. From this result, "Blazer® S2" is more durable against high compression under 300°C environment compared to "Blazer® S" and Other Product, and shows superior compression fracture characteristic.

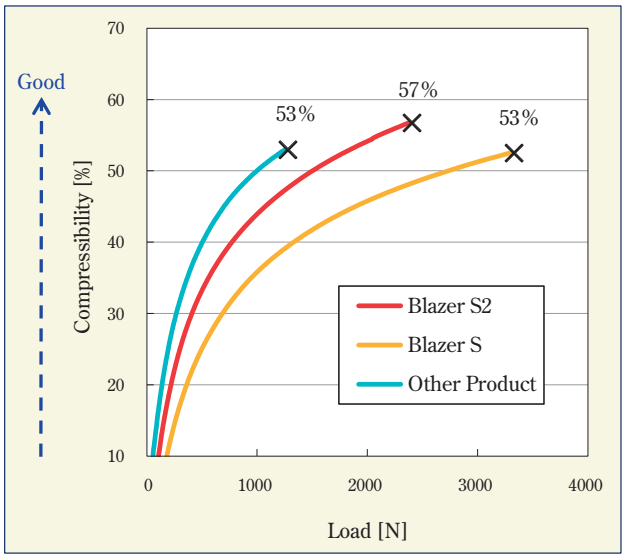
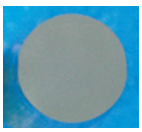
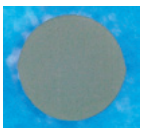


Figure 6. Result of compression fracture test at 300℃

2.4 Rapid decompression property

When rubber is used under high pressure and decompressed rapidly, gases which have penetrated into the rubber expand, which may cause to explode. Hence, rapid decompression test in compliance with the standard of National Association of Corrosion Engineers (NACETM0297) of USA is performed on "Blazer® S2", "Blazer® S" and Other Products. The result is shown on **Figure 7**. The specimens are evaluated by the damage point that is determined by Damage point criteria.

As the result, the damage point of "Blazer® S2" is 1 - 2, which means it has superior rapid decompression property. "Blazer® S" and Other Product also show the similar result. Such property makes suitable these rubber products sealing materials in oil field equipment.

Sample name	Blazer S2	Blazer S	Other Product
Cross section view after the test			
Damage point	1 ~ 2	1 ~ 2	1 ~ 2

*Criteria for damage point (inner situations after the test)
1: No damage
2: One crack or blister on the cross section
3: Cracks or blisters occupy less than 50% of the cross section
4: Cracks or blisters occupy 50% or more of the cross section

Figure 7. Result of rapid decompression test

2.5 General properties

Table 1 shows the general properties of "Blazer® S2".

Table 1 General properties of "Blazer® S2"

Color tone			Black
General properties	Hardness (Duro A)		80
	Tensile properties	Tensile strength [MPa]	15.3
		Elongation [%]	120
		Tensile stress at 100% elongation [MPa]	13.9

3. Standard dimensions

Our O-rings comply with the dimensions in JIS B2401, AS568. We can also produce various shaped products other than O-ring. Please contact us for such requirements.

4. Conclusion

The new product TOMBO™ No.2675-S2, "Blazer® O-ring S2" introduced in this report is a new FFKM that shows excellent performance under harsh conditions such as high temperature steam, in which the conventional FKM and FFKM are difficult to use, and is released as the successor product of TOMBO™ No.2675-S, "Blazer® O-ring S".

We continue to improve and develop our products to meet customer's needs. Please let us know your opinions and/or requests.

As for questions or inquiries regarding this report, please contact Elastomer Product Promoting Group, Industrial Product Division.

* The measurements presented in this report should be used only as a guide and not as the guaranteed values.

column

Comparison of Various Properties for Combinations of Rubber Materials and Crosslinking Agents

Perfluoroelastomer crosslinked by the NICHIAS original crosslinking agent (Blazer® S2) shows superior steam resistivity and chemical resistivity to the conventional perfluoroelastomer that is crosslinked by trialyl isocyanurate(TAIC), or ternary fluorine rubber.

Type of rubber and the chemical structure	Crosslink agent	Approximate resistive temperature	Chemical resistivity										
			Steam less than 200℃	Steam at 200℃ or more	Concentrated sulfuric acid (at 180℃)	Acids	Alkalies	Alcohol	Amines	Aldehydes/furans	Ketones/esters/ethers	Hydrocarbons	Chlorinated solvent
Perfluoroelastomer (FFKM) $-(CF_2\text{-}CF_2)_m-(CF_2\text{-}CF)_n-$ CSM ORf	NICHIAS original crosslink agent	320℃	A	A	A	A	A	A	A	A	A	A	A
	Trialyl isocyanurate (TAIC)	200℃	A	D*	C	A	A	A	A	A	A	A	A
Ternary fluoro rubber $-(CH_2\text{-}CF_2)_m-(CF_2\text{-}CF)_n-(CF_2\text{-}CF_2)_l-$ CF_3	Trialyl isocyanurate (TAIC)	200℃	A	D*	D	A	A	A	D	D	D	A	B

* Melting

● How to read the evaluation symbols

A: Volume change 0-10%	Appearance change is rarely observed. Slight degradation of physical properties is expected under severe high pressure or temperature conditions.
B: Volume change 10-20%	Degradation of physical properties is significant and use for dynamic application cannot be recommended.
C: Volume change 20-40%	Degradation of physical properties is very high and dynamic application is not recommended. It may be used for static application for a short time.
D: Volume change 40% or more	Cannot be used.