1. Introduction

NICHIAS has been developing and marketing high-performance BLAZER™ elastomers known for their excellent resistance to heat and chemicals. On October 1, 2015, we launched an addition to the series, the high temperature and vapor resistant perfluoro elastomer TOMBO™ No.2675-S “BLAZER™ O-ring-S” (hereafter referred to as “BLAZER™ S”), which still offers reliable sealing performance even when in contact with vapor at 300℃ or with amine and other nucleophilic agents (See Figure 1).

BLAZER™ S offers excellent sealability against vapor, hot water and a wide range of chemicals, such as amines, esters, ethers, ketones, acids, bases, hydrocarbons and chlorinated solvents, all of which cannot be handled by the existing perfluoro elastomers (FFKM) and fluoro elastomers (FKM). BLAZER™ S is also ideal for use in rapid depressurization environment. With all these characteristics, BLAZER™ S helps to increase reliability and cut maintenance costs for a wide range of equipment and devices including valves, pumps, turbomachinery, coating machines, centrifuges, agitators, analyzers and reactors.

2. Product overview

Thanks to the special crosslinked system and unique compounding technique used, BLAZER™ S offers substantially improved properties over the existing FFKMs, in terms of vapor resistance, heat resistance, collapsing characteristic and rapid depressurization characteristic.

This presentation will discuss these properties below.

2.1 High temperature and vapor resistance

To verify its resistance to high temperature and vapor, BLAZER™ S was tested in a vaporous environment for compression set.

Compression set is often used as a measure of rubber O-rings’ sealability. Figure 2 shows concepts of compression set. Equation 1 shows the calculation of compression set.
\[ C_s = \frac{(t_0 - t_1)}{(t_0 - t_2)} \times 100 \quad \cdots \cdots \cdots \text{(Equation 1)} \]

\( C_s \): Compression set [%]
\( t_0 \): Original thickness of test piece [mm]
\( t_1 \): Thickness of test piece after compression [mm]
\( t_2 \): Thickness of test piece during compression [mm]

Rubber O-rings are generally regarded as having reached the end of their service life, no longer offering sealability, when compression set exceeds 80%.

Compression set test was conducted in the vaporous environment described below on BLAZER\textsuperscript{TM}S, a vapor resistant FFKM of a competing brand (hereafter referred to as “the competing product”) and heat resistant FFKM TOMBO\textsuperscript{TM} No.2670-BNX “Rubber O-ring BLAZER\textsuperscript{TM} NEXT”\textsuperscript{TM} (hereafter referred to as “BNX”). The results are shown in Figure 3. Their external appearances are shown in Table 1.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|}
\hline
\textbf{Test conditions} & \textbf{BLAZER\textsuperscript{TM}S} & \textbf{Competing product} & \textbf{BNX} \\
\hline
\hline
\textbf{200℃} & Compression set (%) & 22 & 25 & 91 \\
\textbf{} & External appearance & & & \\
\hline
\textbf{250℃} & Compression set (%) & 30 & 38 & Broken down \\
\textbf{} & External appearance & & & \\
\hline
\textbf{300℃} & Compression set (%) & 71 & 96 & Not tested \\
\textbf{} & External appearance & & & \\
\hline
\end{tabular}
\caption{External appearance after testing}
\end{table}

In the test, BNX became 91% compression set at 200℃ and hydrolyzed at 250℃. At 300℃, BLAZER\textsuperscript{TM}S was still below the 80% compression set rate, the service life threshold, and showed no change in external appearance while the competing product far exceeded the threshold. In the end, the test showed that BLAZER\textsuperscript{TM}S can demonstrate reliable sealability in high temperature, vaporous environment.

2.2 Heat resistance

To verify its heat resistance, BLAZER\textsuperscript{TM}S was tested in the conditions described below for compression set in the atmosphere. The results of the test conducted at atmospheric temperatures of 250℃ and 300℃ are shown in Figure 4 and Figure 5.
<Test conditions>
- Test temperature / time
  - 250°C / 72, 168, 336, 1008 hours
  - 300°C / 72, 336 hours
- Compression ratio: 25%
- Test piece dimensions: ϕ 3.53 mm × ID 20 mm (AS568 214 O-ring)

At 250°C (Figure 4), all test pieces were below the 80% life threshold at 1008 hours. At 300°C (Figure 5), the competing product exceeded the 80% threshold while BLAZER™S was below the threshold at 336 hours. BNX, which exhibited the greatest compression set in the vaporous test, fared best in this heat resistance test.

2.3 Collapsing characteristic

Collapsing characteristic is a measure of difficulty with which a rubber collapses when compressed under load at a set temperature.

Collapsing test was conducted in the conditions described below on BLAZER™S and the competing product. The results are shown in Figure 6.

<Test conditions>
- Ambient temperature: 300°C
- Rate of compression: 0.1 mm/min
- Test piece dimensions: ϕ 3.53 mm × 50 mm (string type)

The × marks in the graph represent the points at which the test pieces cracked or otherwise broke.

The graph shows BLAZER™S demonstrating higher resistance against collapsing over the competing product under extreme compression and load at 300°C.

2.4 Rapid depressurization characteristic

In high pressure environment, any rapid depressurization that may occur can cause gases that may have penetrated into rubber products under the high pressure to expand and burst the rubber material. With that in mind, rapid depressurization test was conducted on BLAZER™S and the competing product according to NACE TM0297 of the National Association of Corrosion Engineers in the U.S. The results are shown in Figure 7 where evaluation was made based on the severity of the damage left on a given cross section of each test piece.
BLAZER™ S was rated at 1 - 2 in the severity of damage, proving that it has excellent rapid depressurization characteristics. The competing product had the same rating.

With the proven characteristic, BLAZER™ S is an ideal sealing material especially for oil feed equipment.

2.5 Physical properties

Table 2 shows BLAZER™ S’s physical properties.

<table>
<thead>
<tr>
<th>Physical properties</th>
<th>BLAZER™ S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>Black</td>
</tr>
<tr>
<td>Hardness (Duro A)</td>
<td>82</td>
</tr>
<tr>
<td>Tensile strength</td>
<td>MPa 27.5</td>
</tr>
<tr>
<td>Elongation</td>
<td>% 200</td>
</tr>
<tr>
<td>Tensile stress at 100% elongation</td>
<td>MPa 15.6</td>
</tr>
</tbody>
</table>

3. Product dimensions

The dimensions of BLAZER™ S conform to JIS B2401 and AS568.

BLAZER™ S can be offered in shapes other than O-ring. Contact us for inquiry.

4. Conclusion

The new product presented here, TOMBO™ No.2675-S “BLAZER™ O-ring S”, is an ideal sealing material for high temperature applications in a range of fields, especially for use in severe conditions the existing FFKMs cannot handle.

BLAZER™ S is highly reliable in high temperature environment typically experienced in oil-well drilling, chemical and energy applications, for which metal gaskets have historically been recommended.

Our company policies include continuous development of new products and product improvement to meet customer needs. For that matter, we welcome your opinions and requests.

For any inquiry about this new product presentation, contact Elastomer Products Promoting Group, Industrial Product Division.

* “TOMBO” is a registered trade mark or a trade mark of NICHIAS Corporation.
* “BLAZER” is a trade mark of NICHIAS Corporation.
* The measurements presented here should be used only as a guide and not as guaranteed values.