Comparison of Semi-Metallic Gasket's Performance and Introduction of Kammprofile Gasket Series

1. Introduction

In the fields of petroleum refining, petrochemical, and energy, semi-metallic gaskets such as Spiral Wound Gaskets, Metal Jacketed Gaskets, and Kammprofile Gaskets are often used.

Spiral Wound Gaskets are widely used from piping to equipment, and Metal Jacketed Gaskets are often used in equipment such as heat exchangers because they have a narrow seal width and can make branched gaskets. The Kammprofile Gaskets have been widely used overseas, but in recent years, it is becoming popular in Japan because of its excellent performance and due to easy handling.

Though semi-metallic gaskets have been used in this way, but with the aging of equipment and the diversification of attitudes toward maintenance management, they have come to be re-selected according to usage conditions. However, there are few performance comparison data for these semi-metallic gaskets. Therefore, this report presents comparative evaluation data of semi-metallic gaskets which provide an indicator for users to select gaskets. At the same time, we will introduce the features of the Kammprofile gasket series which expanded our lineup.

This study was conducted with Spiral Wound Gasket (No.6596V) using expanded graphite, Kammprofile Gasket (No.6540H) , and Metal Jacketed Gasket (No.N520).

2. Comparative evaluation

2-1) Sealing performance at room temperature

Figure1 shows the sealing performance at room temperature. The evaluation was performed based on JIS B 2490. The paste (No. 6) was applied to the metal jacketed gasket based on the general usage.

Sealing performance of the spiral wound gasket was the best at room temperature. The kammprofile gasket and metal jacketed gasket have a large amount of leakage at low gasket contact stress (12.5-50 MPa), and when loaded with 50 MPa or more, the leak amount is less than the measurement sensitivity. The sealing performance is higher than the detection level of the soap bubble test used for the leak detection at the plant.

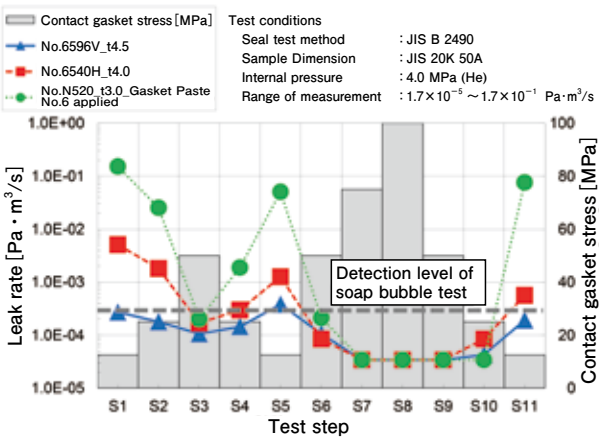

Figure1 Room Temperature Sealing Performance

2-2) Compression and recovery characteristics

Figure2 shows the compression and recovery characteristics. The difference in the amount of gasket displacement between the contact gasket stress at 5 MPa and 100 MPa was defined as the amount of compression. The difference in the amount of gasket displacement between the contact gasket stress at 100 MPa and 12.5 MPa was defined as the amount of recovery. Table 1 shows the compression and recovery amounts of gaskets.

Table1 shows that the spiral-wound gasket had the largest amount of compression and recovery. For the metal jacketed gasket, the compression amount was large but the recovery amount was small, and for the kammprofile gasket, both the compression amount and the recovery amount were small. If the flange gap fluctuation is large due to thermal cycling, a spiral wound gasket with the best compression recovery characteristics isappropriate.

Table1 Compression recovery characteristics

	Compression [mm]	Recovery [mm]
	Contact gasket stress 5 MPa→100 MPa	Contact gasket stress 100 MPa→12.5 MPa
No.6596V t4.5	0.850	0.198
No.6540H t4.0	0.432	0.060
No.N520 t3.0 (Applied No.6)	0.918	0.079

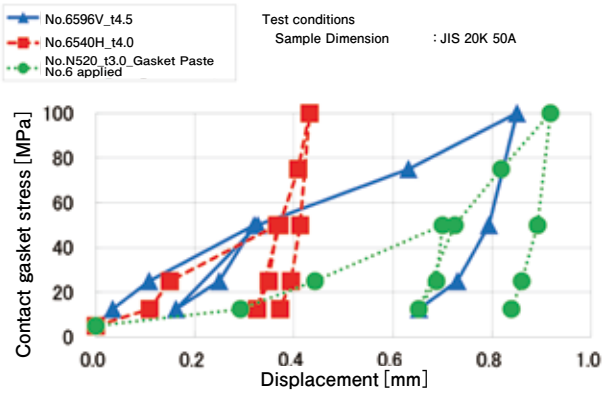

Figure2 Compression Recovery Characteristics

2-3) Sealing performance at high-temperature thermal cycling

For evaluation of sealing performance at high temperature, heating and cooling are repeated while the gasket was tightened to the flange and evaluation was carried out after cooling.

Figures3 and 4 show the sealing performance with the thermal cycle. The tightening contact gasket stress was set to 70 MPa for all samples, and the recommended tightening contact gasket stress for each gasket was also used. The heating temperature was 400℃ and 500℃.

From Figure3 and 4, the spiral wound gasket and the kammprofile gasket maintained stable sealing performance. On the other hand, in the case of the metal jacketed gasket, the leak amount before the heating was less than the measurement detection level, but the leak amount increased after the heating. This is thought to be due to the decrease in the resilience of the core material due to repeated thermal cycles.

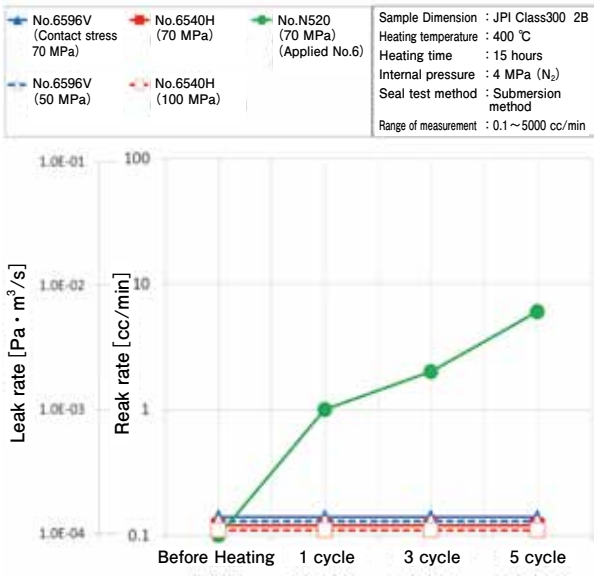

Figure3 Thermal Cycle Sealing Performance at 400℃

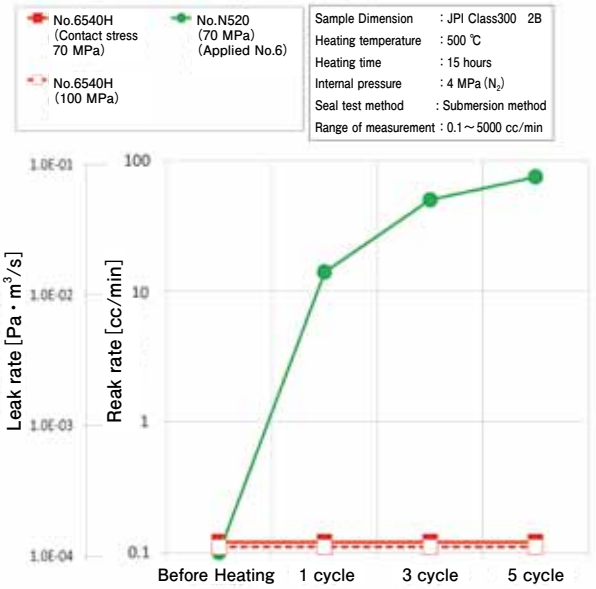

Figure4 Thermal Cycle Sealing Performance at 500℃

2-4) Selective use of semi-metallic gaskets

Spiral wound gaskets are the best semi-metallic gaskets in terms of performance. However, it may be difficult to use the spiral wound gasket, such as a large diameter which is difficult to handle and a shape

witha narrow gasket width. Therefore, when the diameter of the gasket is less than about ϕ1000 mm and the seal width can be secured, the spiral wound gasket is appropriatee. On the other hand, when a large diameter (ϕ1000 mm or more) and seal width cannot be secured, or when working at high places, a kammprofile gasket or metal jacketed gasket isappropriate. Also, metal jacketed gaskets have the advantage that they can be processed into various shapes such as ellipses and rectangles and are more economical than kammprofile gaskets.

3. Kammprofile gasket series

3-1) Features

As previously stated, the kammprofile gasket is becoming increasingly spread in Japan in recent years. In response, we have developed a new profile gasket and expanded our product lineup. According to the usage conditions, it became possible to select the surface layer material to be bonded to the metallic serrated gasket.

Expanded graphite sheet laminated product (No.6540H) is a general-purpose product that can be used under various conditions. When used at 400℃ or higher which is a temperature range in which expanded graphite is liable to disappear by oxidation, the more heat resistant VALQUA HEAT RESIST SHEET™ laminated product (No.HR540H) is appropriate. PTFE sheet laminated product (No.7540H) is used at lower temperatures than the expanded graphite product, but it is appropriatefor lines where it is difficult to use expanded graphite due to the concern of contamination.

3-2) Characteristic evaluation

Heat resistance is one of a features of No.HR540H. Figure5 shows the thermal cyclic characteristics at 600℃ of a kammprofile gasket with a surface layer a VALQUA HEAT RESIST SHEET™ and an expanded graphite sheet.

From the results at 600℃ , the leakage amount of No.HR540H did not change significantly even when the heating temperature was increased, but the leakage amount of No.6540H increased significantly. This is because expanded graphite disappears due to oxidation.Since the expanded graphite gradually oxidizes and disappears above 400℃ , long-term sealability maintenance is a concern. Figure6 and 7 show the rate of weight loss over temperature and time for expanded graphite sheet and VALQUA HEAT RESIST SHEET™. Figure7 shows the evaluation result of up to 240 hours. However, the expanded graphite decreases even at temperatures of about 400℃ to 500℃ , the sealing stability is a concern in the long term of 2 to 4 years. The VALQUA HEAT RESIST SHEET™ loses a little weight at the beginning of heating, and most of it remains unchanged in the long term. In addition, even if the heating temperature is raised, the rate of decrease remains unchanged, and the rate of decrease in the long term is also constant, resulting in stable sealing.

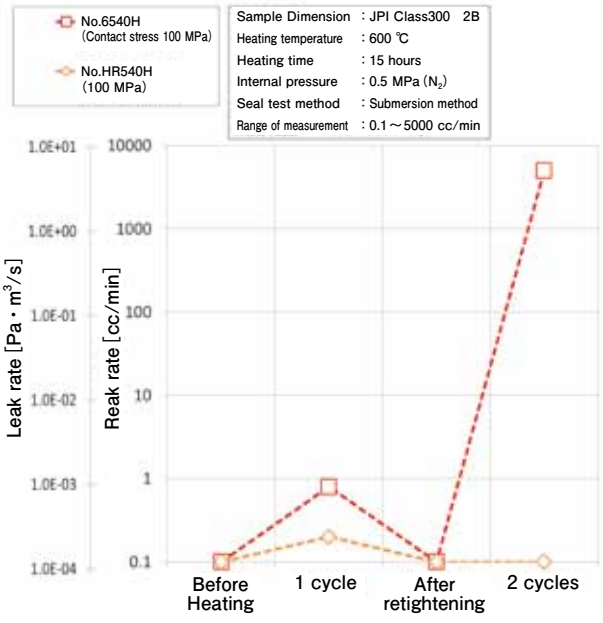

Figure5 Thermal Cycle Sealing Performance at 600℃

Large diameters pipe flange connections or equipment may be subjected to flange rotation, etc., and the gasket may have a load greater than the recommended tightening contact stress. Therefore, there is a concern that the metal part is exposed at the time of tightening and may damage the flange. Table2 and Figure8 show the evaluation results of kammprofile gasket's surface

material which is cracked by applying excessive contact gasket stress. In No.HR540H and No.6540H, no metal exposure was observed even when a contact gasket stress of 200 MPa was applied, and there is a little risk of damaging the flange even if an excessive contact gasket stress was applied. In No.7540H, metal exposure was confirmed at a contact gasket stress of 140 MPa. This is probably because the PTFE sheet is easier to flow than the expanded graphite sheet. However, the recommended tightening contact gasket stress of No.7540H is 60 MPa, and even if a contact gasket stress twice as high as the recommended tightening contact gasket stress is applied, no metal is exposed and it is considered that there is no problem in use.

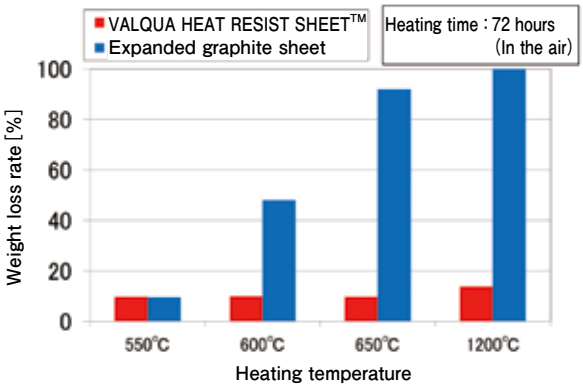

Figure6 Change in weight loss rate with temperatures

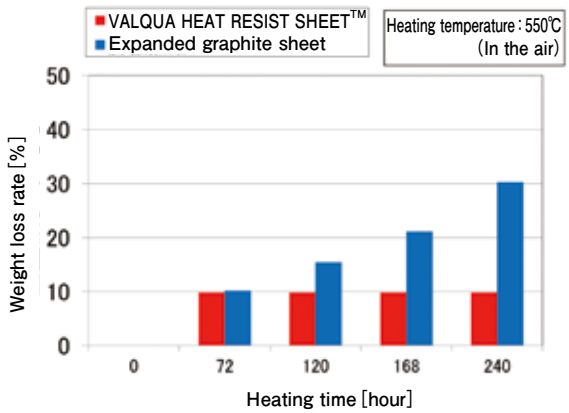

Figure7 Change in weight loss rate with times

Table2 Change in weight loss rate with times

Sample Dimension		Metal exposure
No.HR540H	VALQUA HEAT RESIST SHEET™	No metal exposure at 200 MPa
No.6540H	Expanded graphite sheet	No metal exposure at 200 MPa
No.7540H	PTFE sheet	metal exposure at 140 MPa

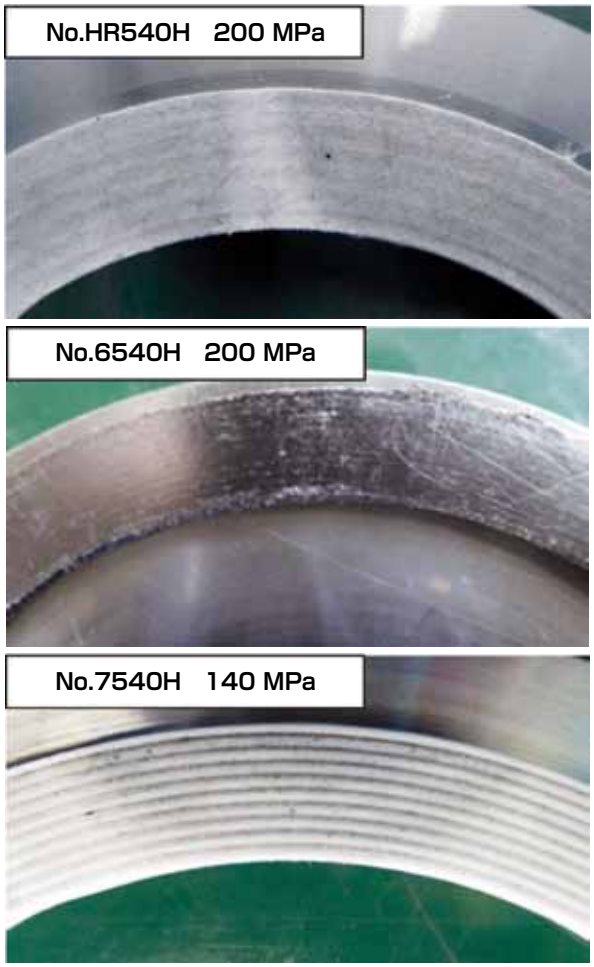

Figure8 Appearance after excessive contact gasket stress

4. Conclusion

In domestic petroleum refining and petrochemical plants, more stable sealing products are required due to the aging of plants and the prolonged periodic maintenance. We hope the performance comparison of these semi-metallic gaskets and the kammprofile gasket series will be an good option in selecting gaskets.

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