Premium Joint "JFELION™" for OCTG

1. Introduction

In recent years, the number of easily-developed oil and gas wells has decreased, while wells with deeper depths and high temperature/high pressure conditions have increased. As a result, higher requirements are now applied to OCTG joints, for example, requirements for sealability under combined loads such as tension, compression, internal pressure, external pressure, bending, etc. JFE Steel developed the premium joint JFELION™ which can be applied in these environments.

2. Features of JFELION™

Figure 1 shows a schematic diagram of JFELION. In JFELION, improved compression resistance and external pressure sealing performance compared with conventional products is realized by optimizing the seal and thread shapes. A wide range of sizes have passed the makeup/breakout galling test and the sealability test specified in ISO13679: FDIS2011 or API RP 5C5:2017, which are performance evaluation standards for OCTG, and the sealability performance shown in **Fig. 2** is guaranteed. At present, sizes from 2–7/8 inches (73.025 mm) to 14 inches (355.6 mm) have been commercialized.

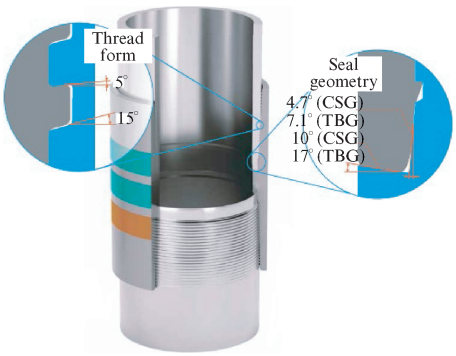

Fig. 1 Overview of JFELION™ thread shape and seal shape

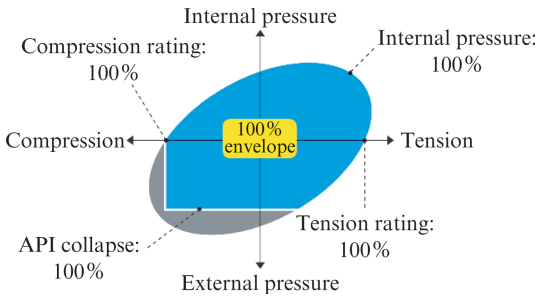

Fig. 2 Seal performance of JFELION™ under combined load

2.1 Seal Shape

2.1.1 Problems with conventional connections

Conventionally, OCTG connections like that shown in **Fig. 3** have been used. Sealability is ensured by metal-to-metal contact between a female screw member (BOX) and a male screw member (PIN) in the seal area, and the shoulder area plays the role of a contact surface which stabilizes the position of completion of make-up. However, the shape and size of the conventional connections have not been optimized. When the seal area is arranged near the shoulder area, as shown in Fig. 3, large plastic deformation occurs in the seal area when high compressive force is applied, resulting in loss of sealability. Conversely, when the seal area is located at a distance from the shoulder area to avoid deformation of the seal area by high compressive force, the contact pressure of the seal area cannot be adjusted and galling (abrasion) occurs during make-up.

2.1.2 Features of JFELION™ seal shape

A seal area shape that can satisfy both high sealability and galling resistance, even when the seal area is arranged at some distance from the shoulder area, was considered. As a result, as shown in **Fig. 4**, it was found that high sealability can be obtained by using a male screw seal shape with a composite R curve, in which a

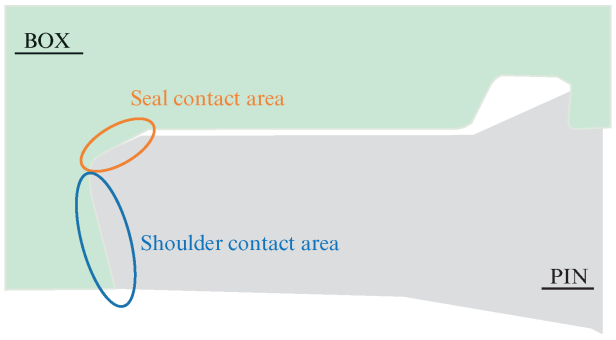

Fig. 3 Example of conventional connection seal

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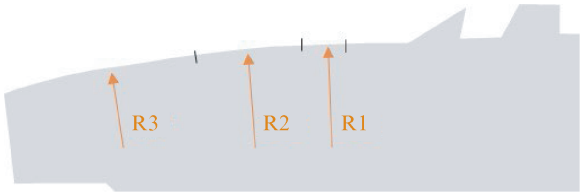

Fig. 4 Seal area of JFELION™

plurality of circular arcs sequentially come into contact and form a convex shape to the outward side, and increasing the radius of curvature R of the circular arcs as the distance from the tip of the male screw increases. **Figure 5** shows a comparison of the contact pressure distribution of the seal area of the JFELION™ seal area shape with that of a conventional male screw with a convex curve of a single R curve shape. As shown by the broken line in Fig. 5, in the case of the single R curve, a high maximum contact surface pressure and small contact area were problems. This gave rise to the problem that the contact area decreased and sealability was reduced if the surface pressure was lowered to prevent galling, and conversely, galling occurred if the surface pressure was raised to ensure sealability. In contrast, in the JFELION, as shown in **Fig. 6**, the seal area of the male screw consists of a convex composite R curve, and in the seal area, sealability is ensured by metal contact with the tapered seal area of the female screw. As shown by the solid line in Fig. 5, the contact area is widened while the maximum surface pressure is reduced, and as a result, both high sealability and galling resistance are achieved.

2.2 Thread Shape

In JFELION, a hook screw with a negative load flank angle of −5° is adopted (see Fig. 6). The hook screw is superior to trapezoidal screws, represented by the API buttress screw, in terms of tension and bending. In addition, the angle of the stab flank (see Fig. 6) is increased to 15° to improve the insertion (stabbing) of the pipe into the coupling.

In order to improve compression resistance, it is desirable to reduce the clearance between the stab flank side of the pipe and the coupling, but if the clearance is too small, it will lead to a heightened risk of galling caused by interference between the thread flanks in case there are variations in the thread pitch. JFELION is designed in the optimum range of the clearance of the stabbing surface considering both of these points.

3. Performance Evaluation of JFELION™

JFELION was developed as a product line-type product with a rich size lineup. The "product line" is a

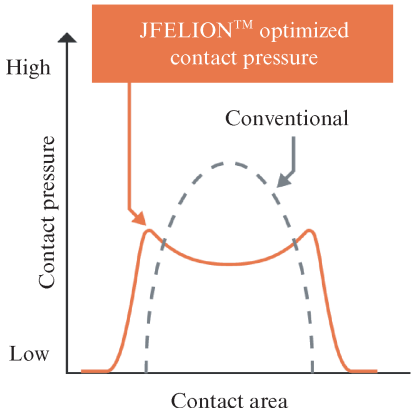

Fig. 5 Distribution of contact pressure at seal area

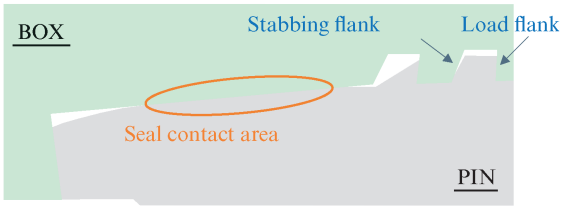

Fig. 6 JFELION™ connection assembly

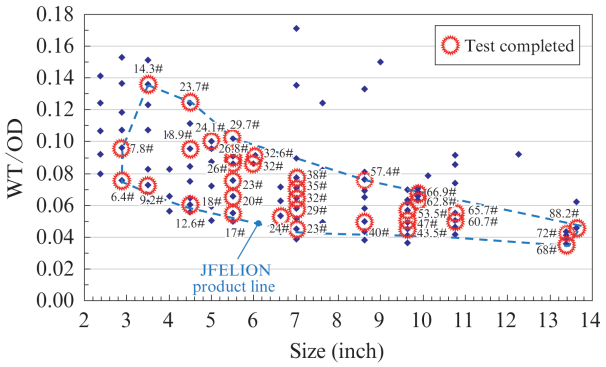

Fig. 7 Actual test results of JFELION™

division that includes the sizes to be commercialized for the matrix of outside diameters and wall thicknesses of OCTG, and is a technique for guaranteeing the reliability of products by carrying out actual tests of the corner sizes and mass sale sizes of the division and interpolating the sizes between them by FEA. The actual tests of JFELION are conducted according to CAL (Connection Application Level) IV of the API RP 5C5:2017 or ISO13679: FDIS2011 test standard. CAL levels from I to IV exist, and show that connections that pass CAL IV, which has the highest degree of difficulty, provide the highest performance. The performance of various sizes has been evaluated by actual tests, as shown in **Fig. 7**.

4. Conclusion

JFELION™, a premium joint for OCTG suitable for the development of high depth, high temperature and high pressure wells, has been highly evaluated for its features introduced in this paper, as well as the ease of tightening work in wells. It has been shipped to users around the world, and production volume is increasing steadily. We will continue to expand the production and technical service system for this product as a high-performance premium joint of JFE Steel.

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