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Seal contact performance analysis of soft seals on high-pressure hydrogen charge valves

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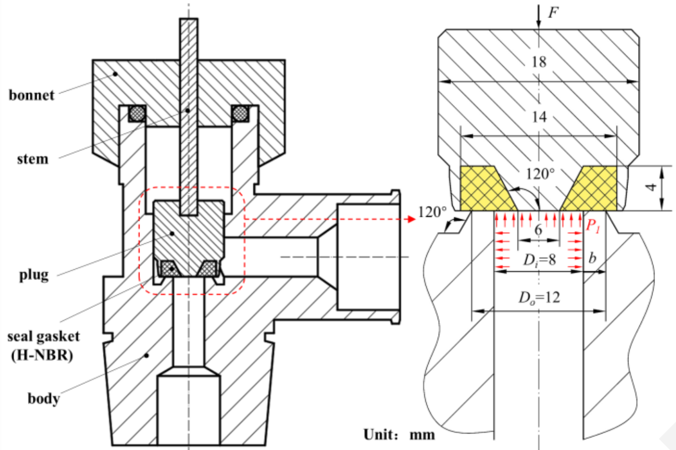
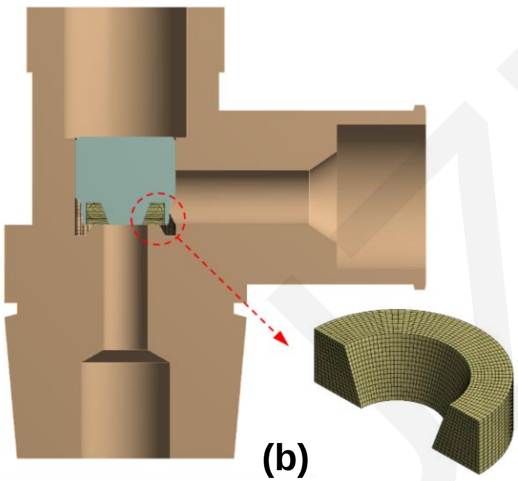
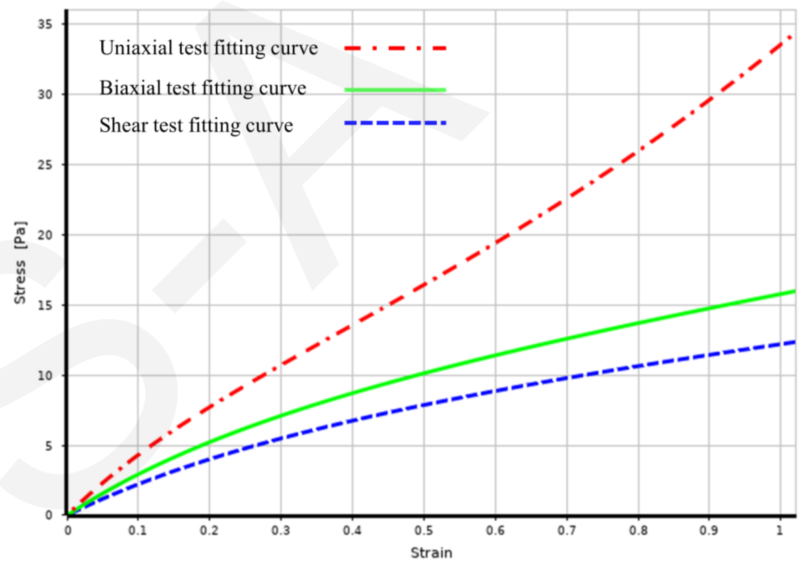
Nonlinear finite element analysis model



(a)



(b)



Poisson's ratio of HNBR is 0.499, and the two-parameter method is used in the material performance setting. The Mooney constants are 2.77 MPa and 1.44 MPa, respectively.

(c)

Fig. 1. (a) Structure of the charge valve, (b) Numerical model and mesh, (c) Performance curve of the HNBR material used in FEA

Seal contact analysis and conclusions

The contact pressure on the seal surface increases with the increase in pre-compression. When the pre-compression is less than 0.15 mm, the contact gap appears in the inner ring of the seal surface.

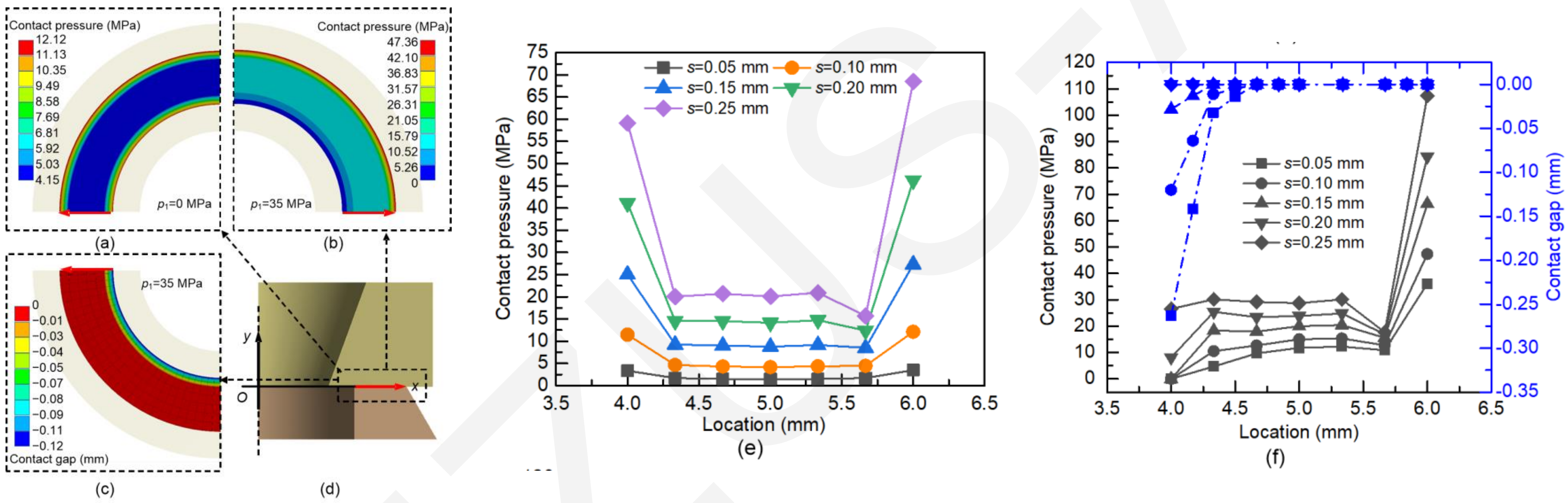


Fig. 2 (a) Contact pressure with p_1=0, s=0.1mm and b=2mm; (b) Contact pressure with p_1=35MPa, s=0.1mm and b=2mm; (c) Contact gap with p_1=35MPa, s=0.1mm and b=2mm; (d) Schematic diagram of data extraction on seal surface; (e) Curve of contact pressure along x-axis with different pre-compressions at p_1=0 and b=2 mm; (f) Curve of contact pressure and gap along x-axis with different pre-compressions at p_1=35 MPa and b=2 mm.

Seal contact analysis and conclusions

For the inner ring of the seal surface, the contact pressure gradually increases with time under the action of pre-compression, and then the contact pressure gradually decreases until it reaches a stable value after the loading of hydrogen pressure is added. For the outer inner ring of the seal surface, the contact pressure gradually increases throughout the loading process.

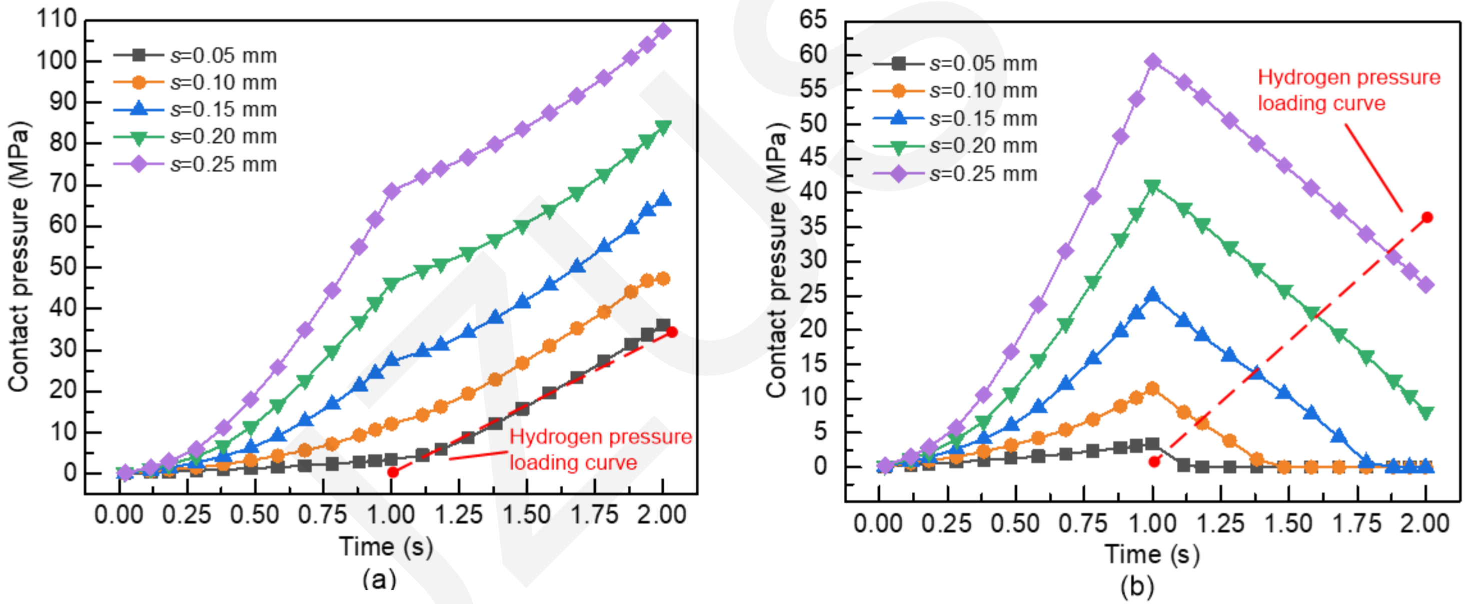


Fig. 3 Variation of contact pressure with time (*b*=2 mm and p_1=35 MPa); (a) Outer ring of seal surface (R_x=6 mm); (b) Inner ring of seal surface (R_x=4 mm)

Seal contact analysis and conclusions

When the seal width is 1 mm, a contact gap occurs between the entire seal surface. As the seal width increases, the contact pressure on the seal surface and the width of the separation area between the seal surfaces also increase

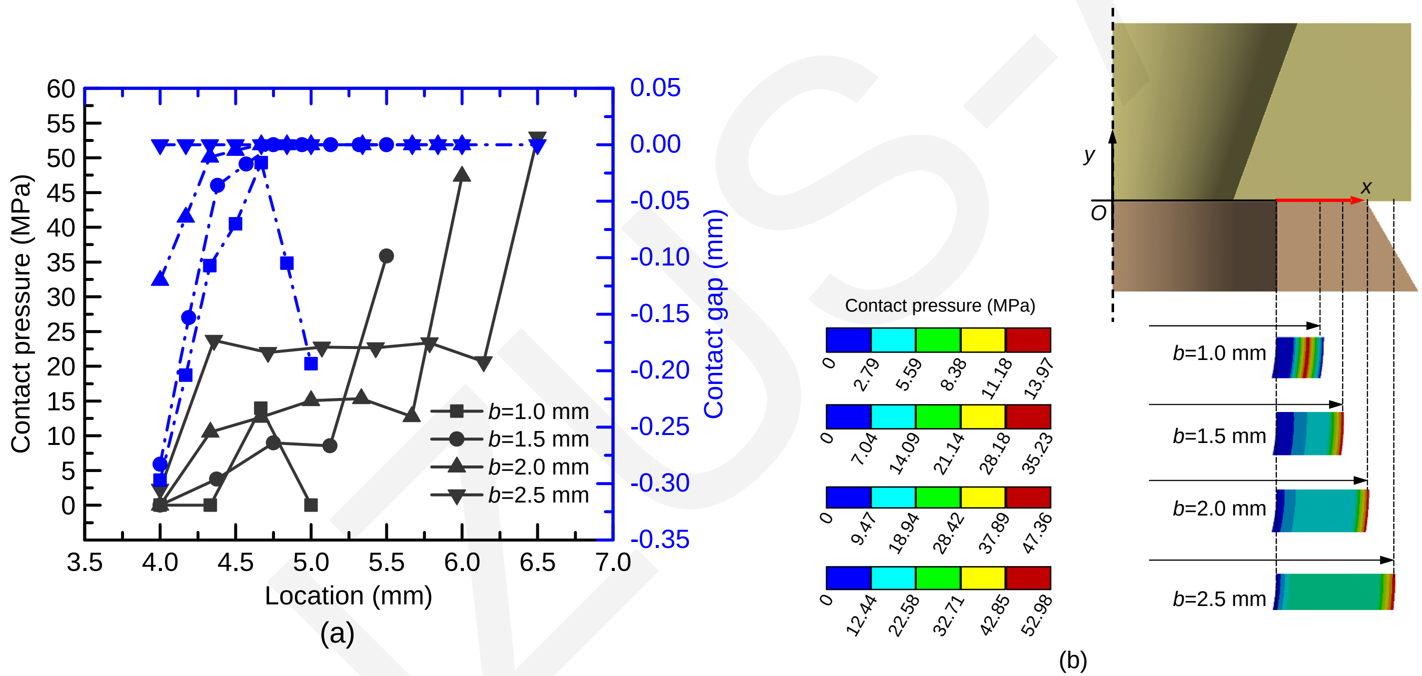


Fig. 4 Contact pressure and gap distribution along the x-axis with different seal widths at p_1=35 MPa and s=0.1 mm

Seal contact analysis and conclusions

With the increase of pressure, the increment of von Mises stresses decreases. The width of the separation area between the seal surfaces decreases with the decrease in the hydrogen pressure.

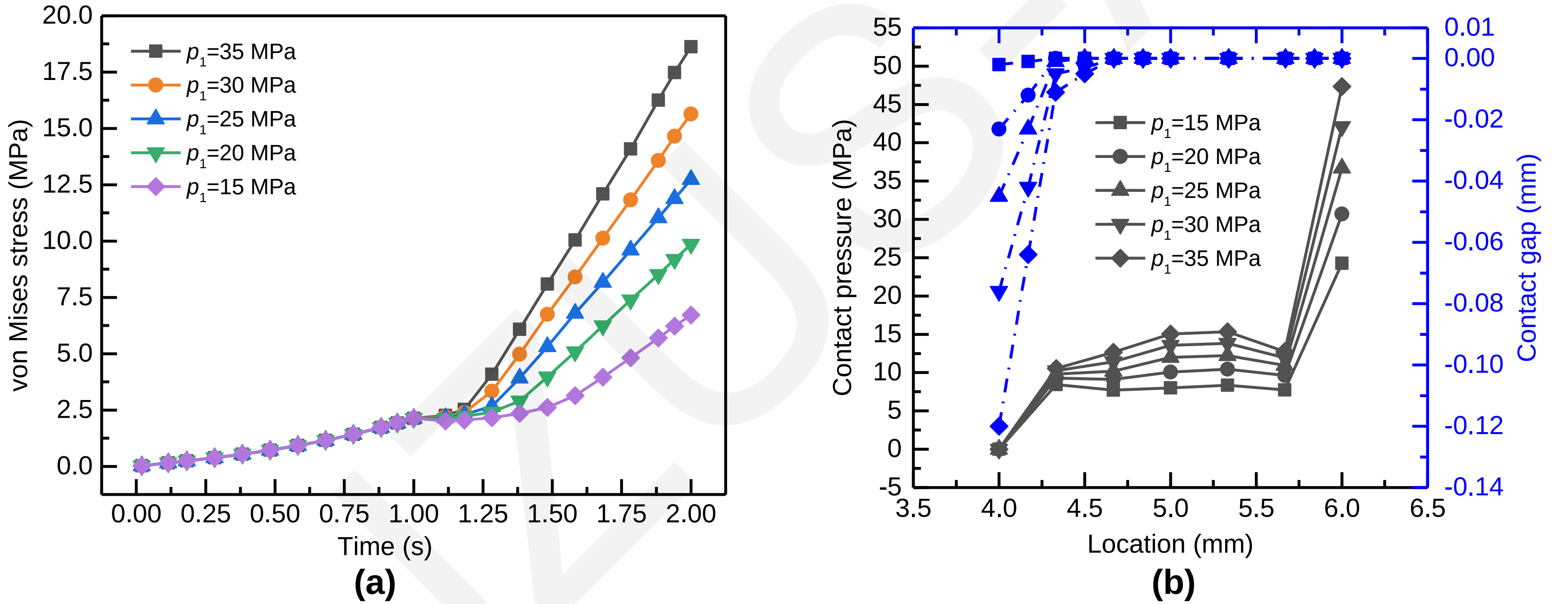


Fig. 5 (a)Maximum von Mises stress of seal gasket with different hydrogen pressures at *b*=2 mm and *s*=0.1 mm; (b)Contact pressure and gap distribution along the x-axis with different hydrogen pressures at *b*=2 mm and *s*=0.1 mm.