Numerical study of super-critical carbon dioxide flow in stepped-staggered labyrinth seals

Yuming Zhu\textsuperscript{a,b}, Yuyan Jiang\textsuperscript{a,*}, Shiqiang Liang\textsuperscript{a}, Yongxian Guo\textsuperscript{a}, Chaohong Guo\textsuperscript{a}, Peng Yue\textsuperscript{a}

\textsuperscript{a} Institute of Engineering Thermophysics, Chinese Academy of Sciences
\textsuperscript{b} University of Chinese Academy of Sciences

The structure of the stepped-staggered labyrinth seals

In this study, a new kind of axial labyrinth seals, called stepped-staggered labyrinth seals, has been described to reduce process gas escaping from the shaft end of \text{SCO}2 compressor.

This new seal uses stepped structure to avoid the assembly problem and form a staggered chamber in each step to reduce the shaft end leakage, which combines the advantages of stepped and staggered labyrinth seal.

Performance compared with see-through labyrinth seals

To compare the sealing performance of see-through and the new stepped-staggered labyrinth seal, we operate a five-tooth see-through labyrinth.

It can be concluded that the new stepped-staggered labyrinth seal has better sealing performance than see-through with the same seal clearance and sealing length.

From the CFD contour, the relative Mach number distribution of the new labyrinth seal is much more dispersive, which means a much stronger viscous dissipation occurring in seal cavity, so the Mach number is smaller and the seal effect is better.

The effect of different structure

a. The leakage rate increases with increase in radial clearance

b. The seal performance is worst when length/height ratio is equal to 1, and the sealing performance shows a good symmetry of geometric topology with length/height ratio

c. It may exist a best width/height ratio which will lead to the least leakage