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Parametric design for the valve seat of a high-temperature and high-pressure valve inside wind tunnels

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Method Description

Geometric model

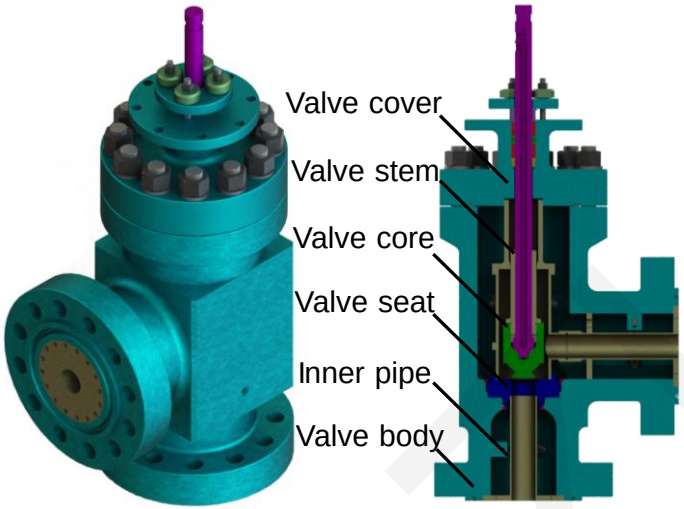


Fig. 1 Geometric model of a high-temperature and high-pressure valve in a wind tunnel

Geometric model of the valve seat

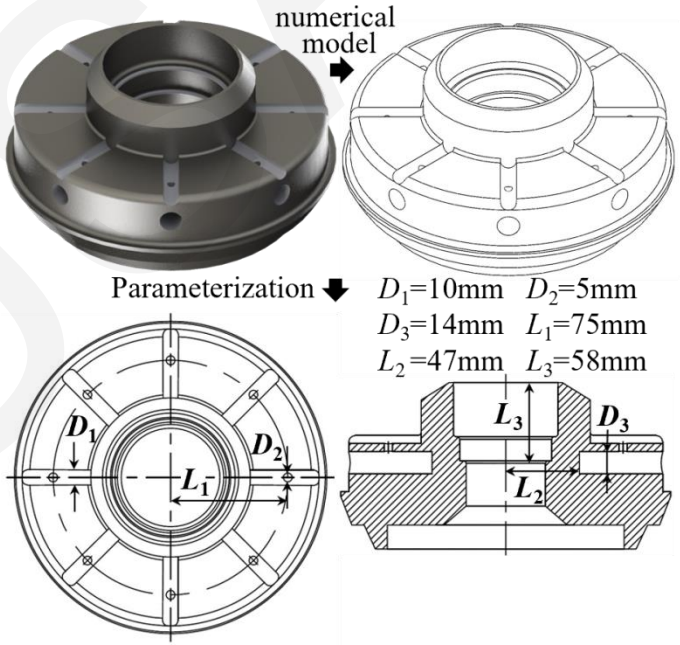


Fig. 2 Geometric model of the valve seat

Method Description

Geometry MESH

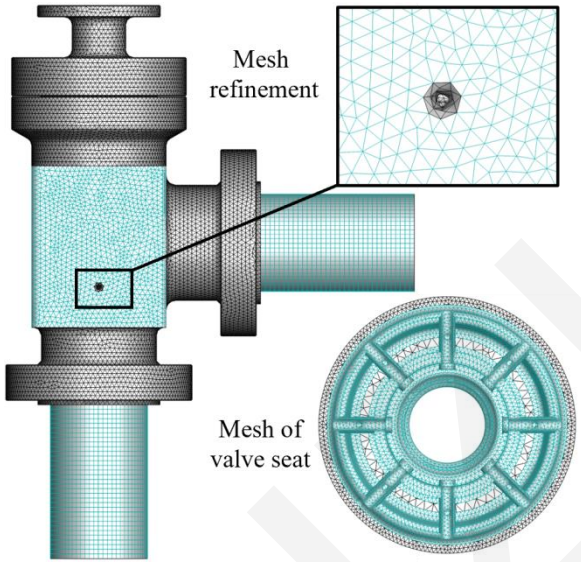
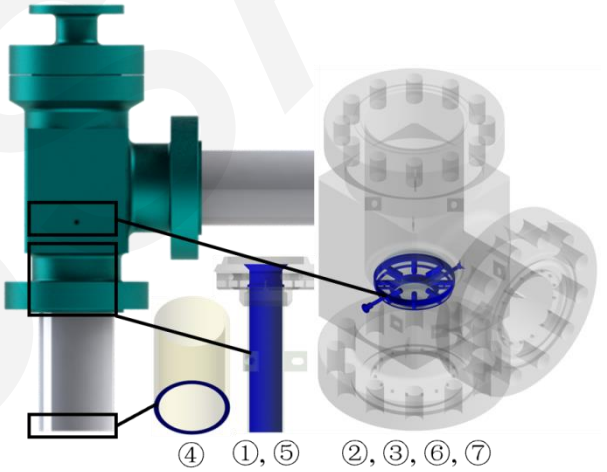


Fig. 3 Mesh of the HTHPV

Boundary conditions



Thermal condition:
① Convection 600°C
② Convection 22°C
③ Convection 22°C

Structural condition:
④ Fixed
⑤ Pressure 14MPa
⑥ Pressure 0.2MPa
⑦ Body temperature

Fig. 4 Boundary conditions of the HTHPV

Temperature and stress analysis

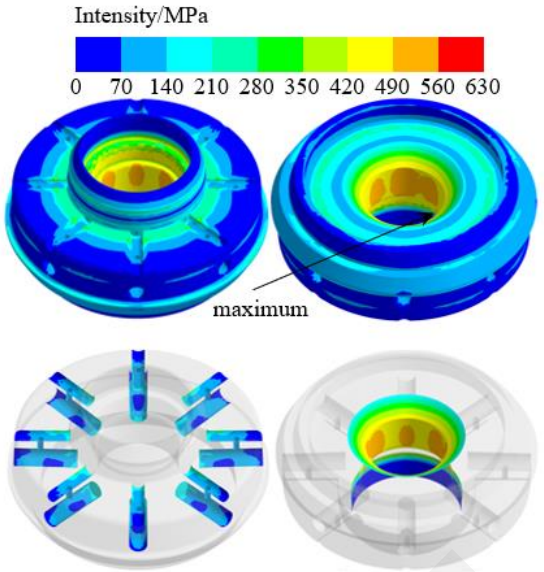


Fig. 6 Temperature distribution of the valve seat

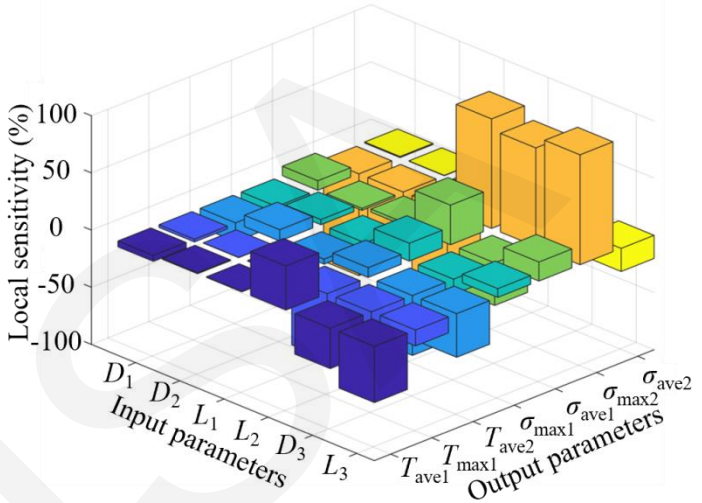


Fig. 8 Responses of the structural parameters to the op-timization objectives

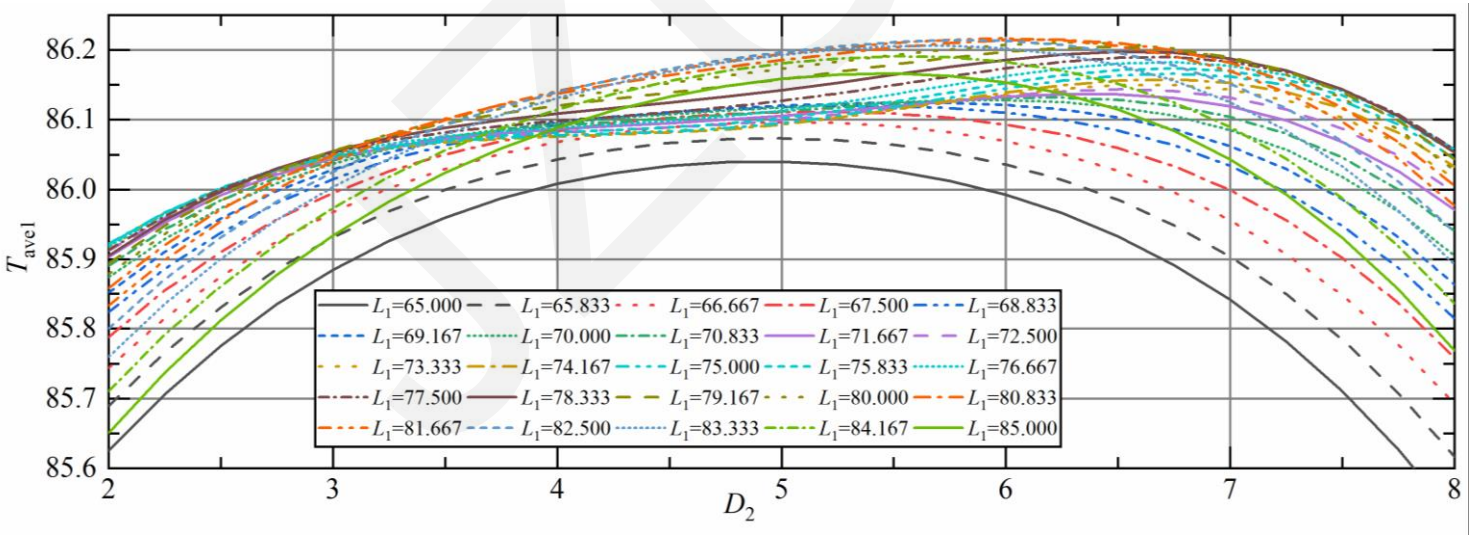
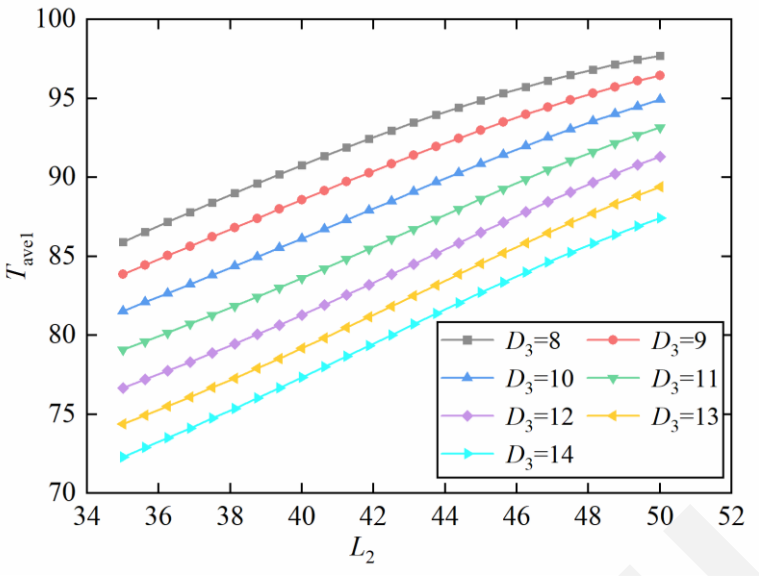


Fig9 Responses of parameters L_1 and D_2 to optimization target T_{ave1}

Structural optimization analysis



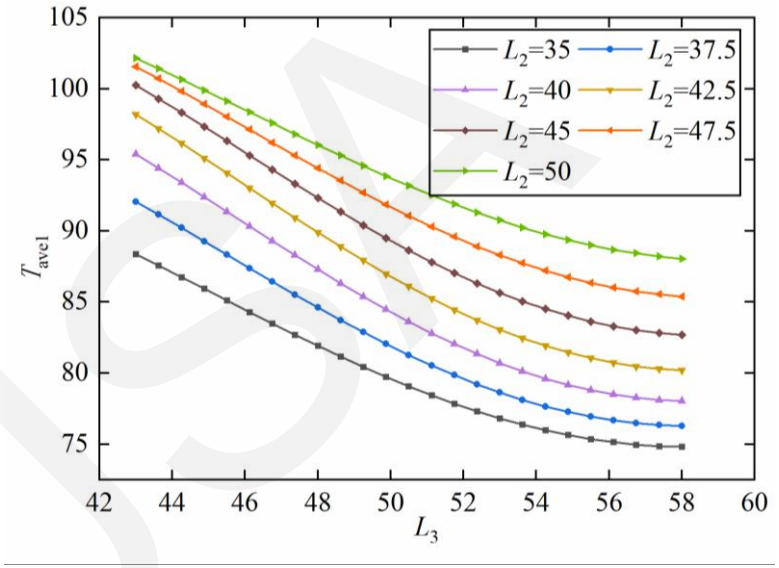
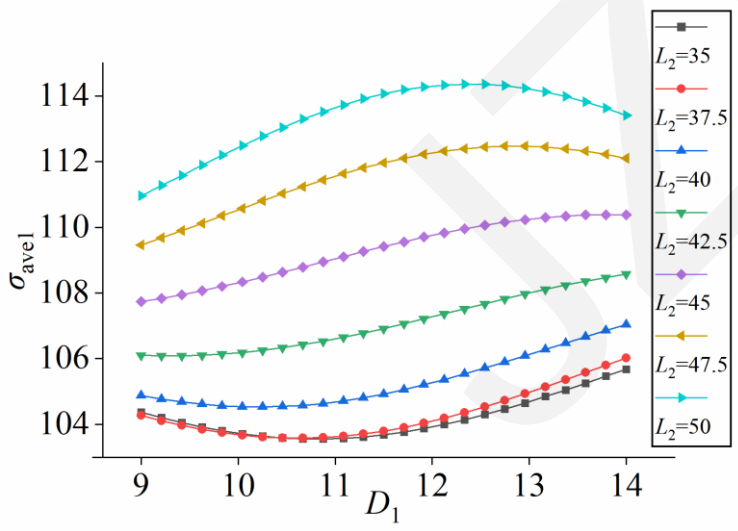


Fig. 10 Responses of parameters L_2(a) and L_3 (b) to opti-mization target T_{ave1}



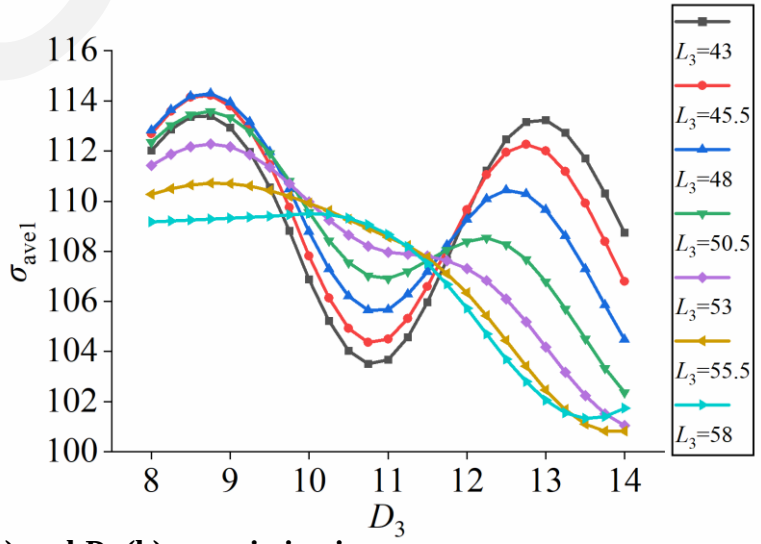


Fig. 13 Responses of parameters D_1 (a) and D_3 (b) to optimization target σ_{ave1}

Structural optimization analysis

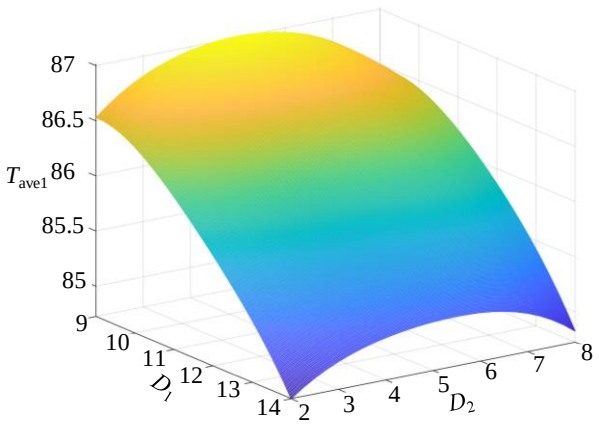


Fig. 7 Responses of parameters D_1 and D_2 to T_{ave1}

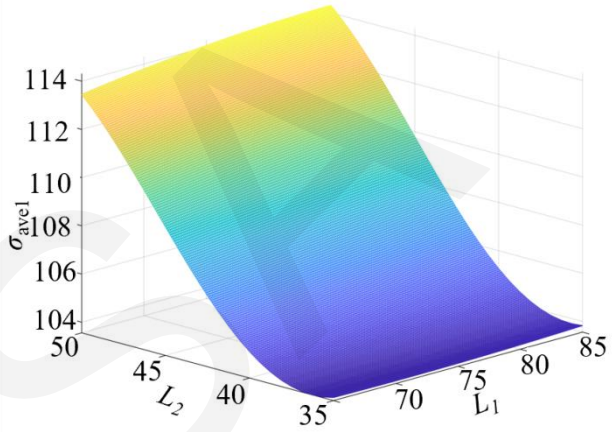


Fig.14 Responses of parameters L_1 and L_2 to optimization target T_{ave1}

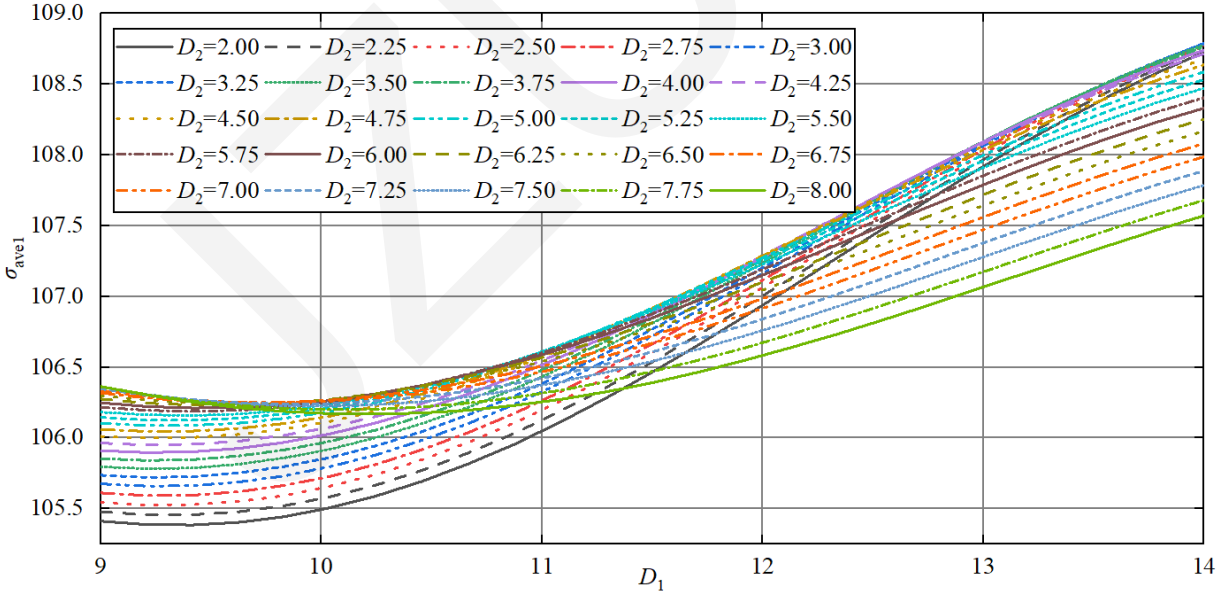


Fig.12 Responses of parameters D_1 and D_2 to optimization target σ_{ave1}

Conclusions

- The cooling structure weakens the pressure-bearing capability of the valve seat. Among the six main parameters of the valve seat, the distance from the end face of the lower hole to the Z-axis and the distance from the axis of the lower hole to the origin of the coordinates have the most obvious effects on the average stress of the valve seat. An optimum design value is proposed. This work can provide a reference for the design of high-temperature and high-pressure valves.

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