PID:4620

CFD simulation of pressure oscillation and cavitation phenomena in the pilot stage of deflector jet servo-valve with large eddy simulations

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Abstract

The output of the deflector jet servo-valve is greatly affected by the features of the flow field during the pilot stage of the deflector jet servo-valve. Pressure oscillations typically occur in the deflector jet pilot stage and lead to cavitation, which generally cause high-frequency noise and servo-valve vibrations. To analyze this problem and consider the internal flow features of the pilot stage, a three-dimensional numerical simulation is carried out in this paper. Simulation is done using ANSYS / FLUENT 18.2 CFD software. Large Eddy Simulation (LES) is used to simulate the phenomena of pressure oscillation in addition the cavitation model to capture unsteady cavitation dynamics under several inlet pressures. The results demonstrate that, the pressure oscillation phenomena is intensified by increasing the inlet pressure. Moreover, the characteristics of generating, growing, and merging cavity shedding phenomena have been identified with in the pilot stage of the deflector jet servo-valve. Finally, we can achieve that pressure oscillation may one of underlying issues of cavitation in the deflector jet pilot stage.

Flow domain and mesh distributions

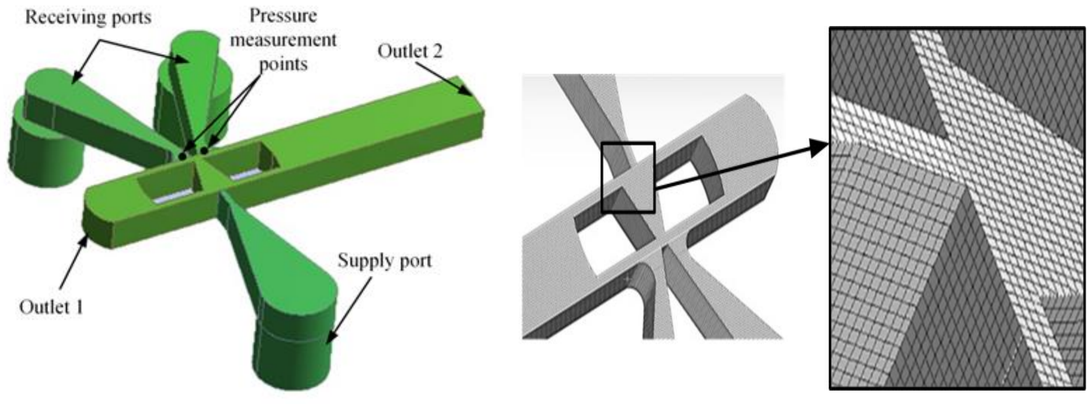

Fig.1 Flow domain and mesh distributions in pilot stage of deflector jet servo-valve.

Flow field distributions

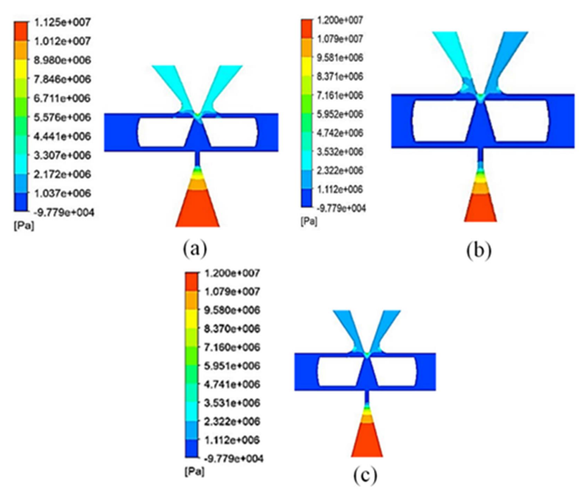

Fig.2 Pressure contours for 12 MPa inlet pressure at time (a) 0.0003 Sec (b) 0.001 Sec (c) 0.002 Sec.

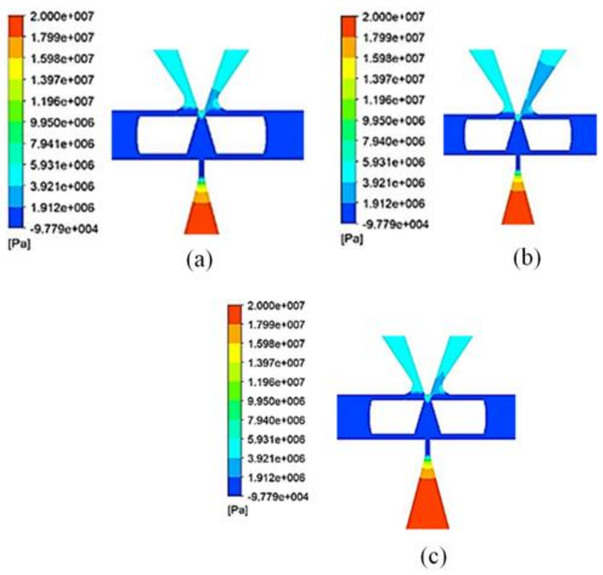

Fig.3 Pressure contours for 20 MPa inlet pressure at time (a) 0.0003 Sec (b) 0.001 Sec (c) 0.002 Sec.

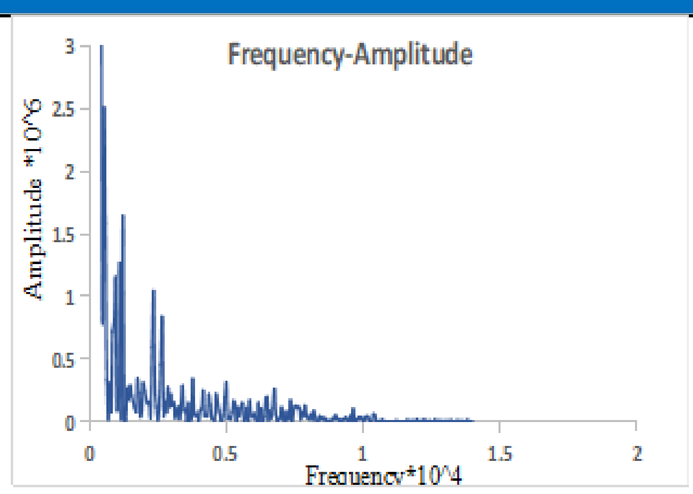

Fig.4 Oscillation obtained by fast Fourier transforms under 12 MPa inlet pressure at the monitoring points.

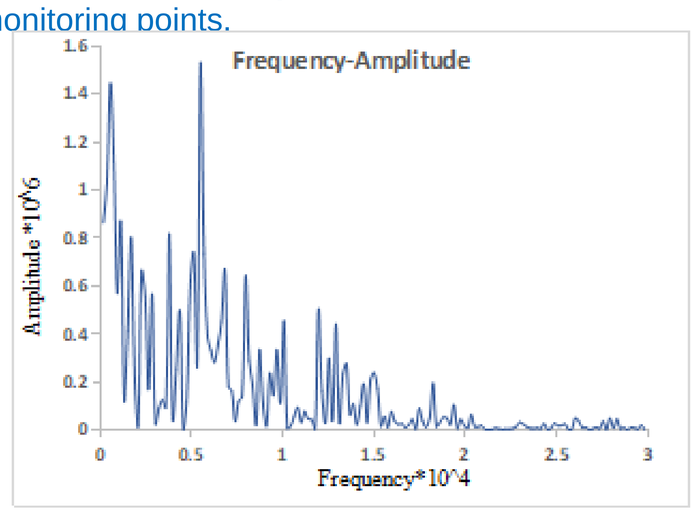

Fig.5 Oscillation obtained by fast Fourier transforms under 20 MPa inlet pressure at the monitoring points.

Cavitation phenomena

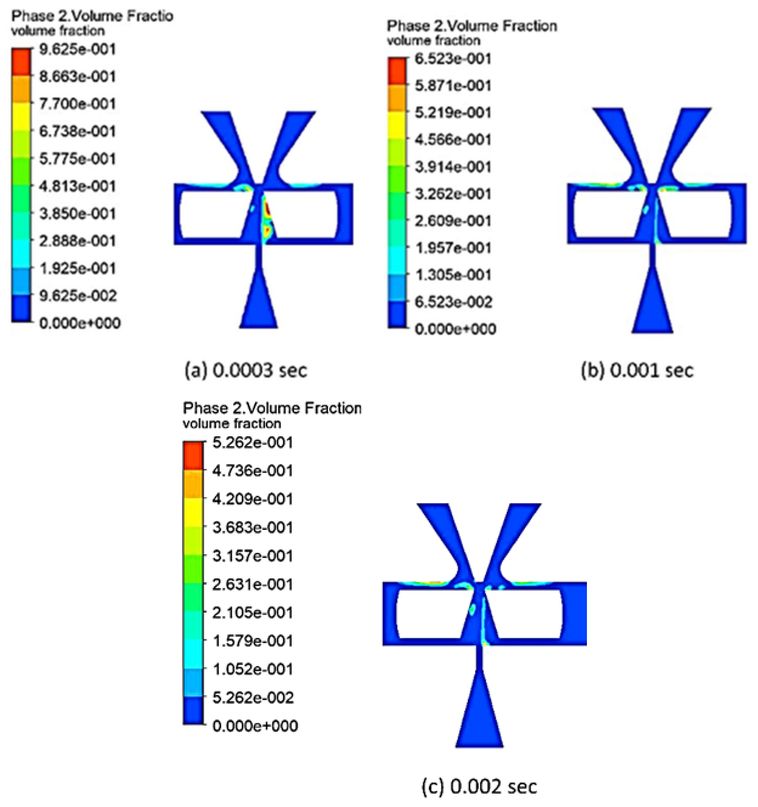

Fig.6 Cavitation distribution for inlet pressure 20 MPa at time.

CONCLUSION

This research provides a computational analysis of the pressure oscillation and cavitation phenomenon in the pilot stage of the deflector jet servo-valve for various inlet pressures using LES method. The location of pressure fluctuations and the presence of cavitation at different time steps are presented. It can be concluded that the presence of cavitation is highly affected by the inlet pressure. The intensity of the cavitation increases with increasing inlet pressure. The frequencies of the pressure oscillation at an inlet pressure of 20 MPa is higher than 12 MPa. As we know the cavitation and pressure fluctuation affect the service life of servo-valves, It would be a great research direction to focus on the reduction of this phenomenon.