Involvement of Multiphysics in Petroleum Research: Case Study on Shock Tube Experimental Setup

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Abstract

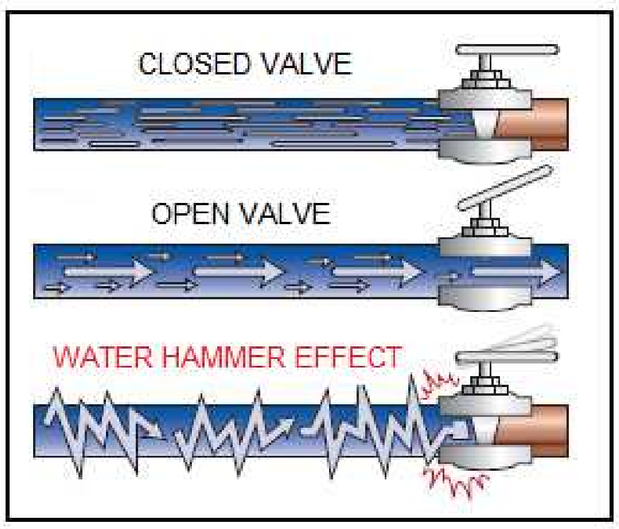
The case presented focuses on “shock tube experimental setup”. The shock tube produces normal shock wave by the sudden interaction of fluids at a pressure difference. In a shock tube, the high-pressure and low-pressure sections commonly referred as the driver and driven sections that interacts with each other by either an opening valve or a bursting disc. This can study some of the key problems faced today in petroleum industry such as water-hammer effect” and cavitation.

The water hammer effect is a pressure surge caused when a fluid forced to stop or change direction suddenly. A water hammer commonly occurs when a valve closes suddenly at an end of a pipeline system, and a pressure wave propagates in the pipe. This pressure wave can cause major problems, from noise to vibration and eventually collapse of pipes and joints. Similarly, cavitation is also a challenge faced in petroleum industry. Cavitation is the formation of vapour cavities in a liquid. It usually occurs when a liquid subjects to rapid changes of pressure. Cavities forms when local pressure gets lower and implode generating shockwaves when local pressure becomes normal. This phenomenon is a significant cause of wear in various units in petroleum industry causing surface stresses through repeated implosions.

The work discusses the use of Multiphysics tools to study the problems faced in petroleum industry such as discussed above. The study is supported by the shock tube experimental setup.

Water Hammer Effect

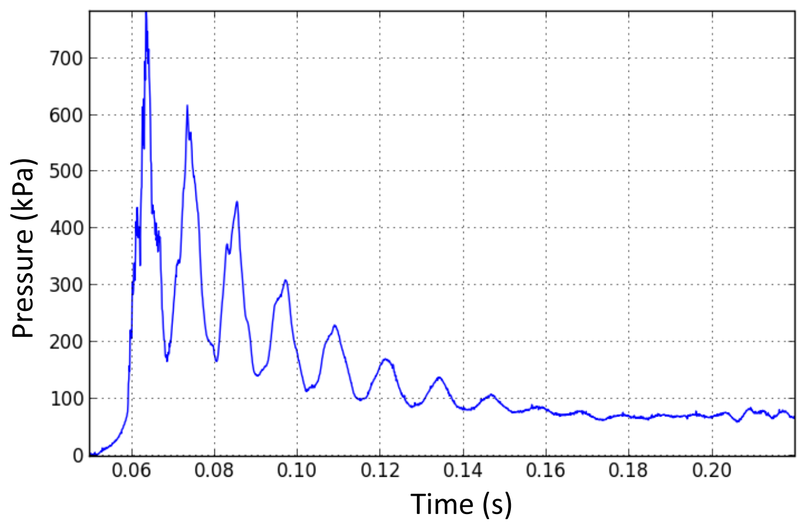
Water Hammer Effect



Issues related to Water Hammer Effect

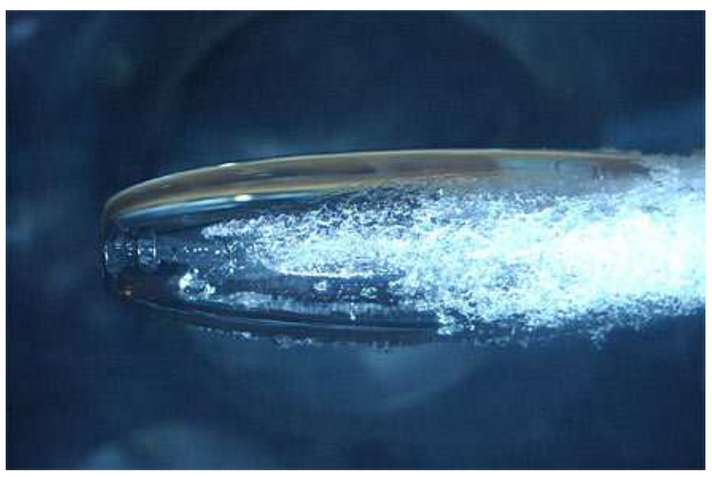
- ❑ Pressure pulsation
- ❑ Reverse flow
- ❑ Vibration in flow pipes and equipment
- ❑ Cavitation and all issues associated with it

Pressure Signal from Shock Tube Experiment



Cavitation

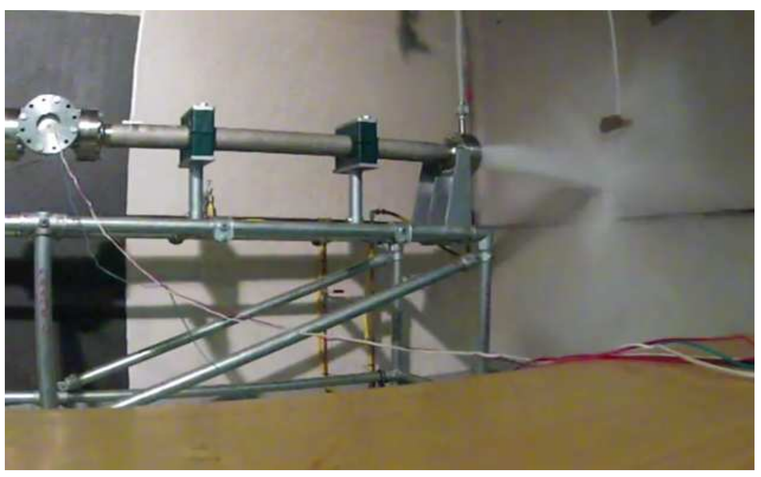
Phenomenon of Cavitation



Issues related to Cavitation

- ❑ Pressure fluctuation
- ❑ Variation in flow rate
- ❑ Wear & tear in the moving parts such as propeller / compressor blades.
- ❑ Erosion in pipes and valves
- ❑ Increased oxidation

Study of Cavitation in Shock Tube



Conclusion

Water hammer effect and cavitation can cause serious interruption in the fluid flow as well as can permanently damage the fluid flow transmission and control equipment. It is found that the shock tube is a promising tool to investigate the water hammer effect and cavitation problem experimentally.

Recommendation

It is recommended to employ shock tube experimental setup to investigate in the water hammer effect and cavitation to device remedy for such phenomenon.

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