3D Analysis of Cavitation in Control Valve by Pressure Variation.

Edelson C. Luz,[1,2] Davi M. P. Cunha[2], Victor H. C. Lemos[2]

1. Universidade Federal do Pará - UFPA, Belém, PA, Brasil;
2. Centro de Instrução Almirante Braz de Aguiar - CIABA, Belém, PA, Brasil.

Introduction: The phenomenon of cavitation can severely affect the working of valves used to control liquid flow. Cavitation occurs when the pressure is reduced and the water evaporates, forming bubbles. In this work, we model the effects of valve closing by simulating liquid flow through different apertures of a globe valve. This study allows to analyze cavitation when the valve is partially closed, at given temperature and pressure.

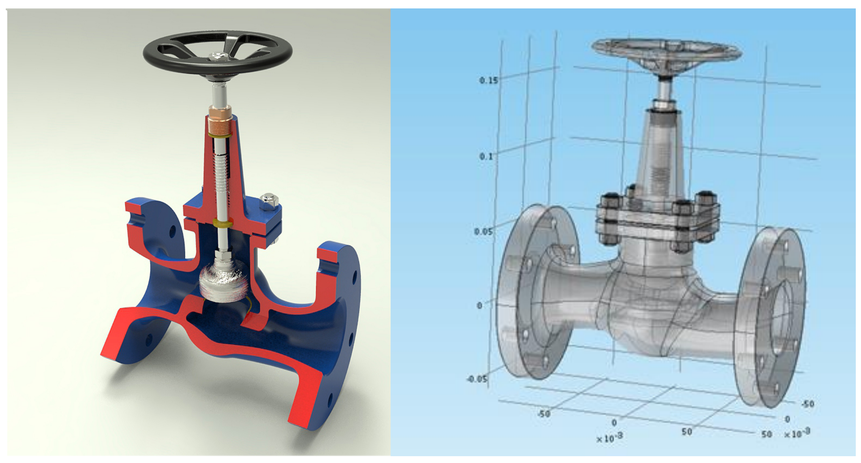

Figure 1. Visualization from GrabCAD (left) and imported on COMSOL Multiphysics® (right). Source https://grabcad.com/krisb-1/projects.

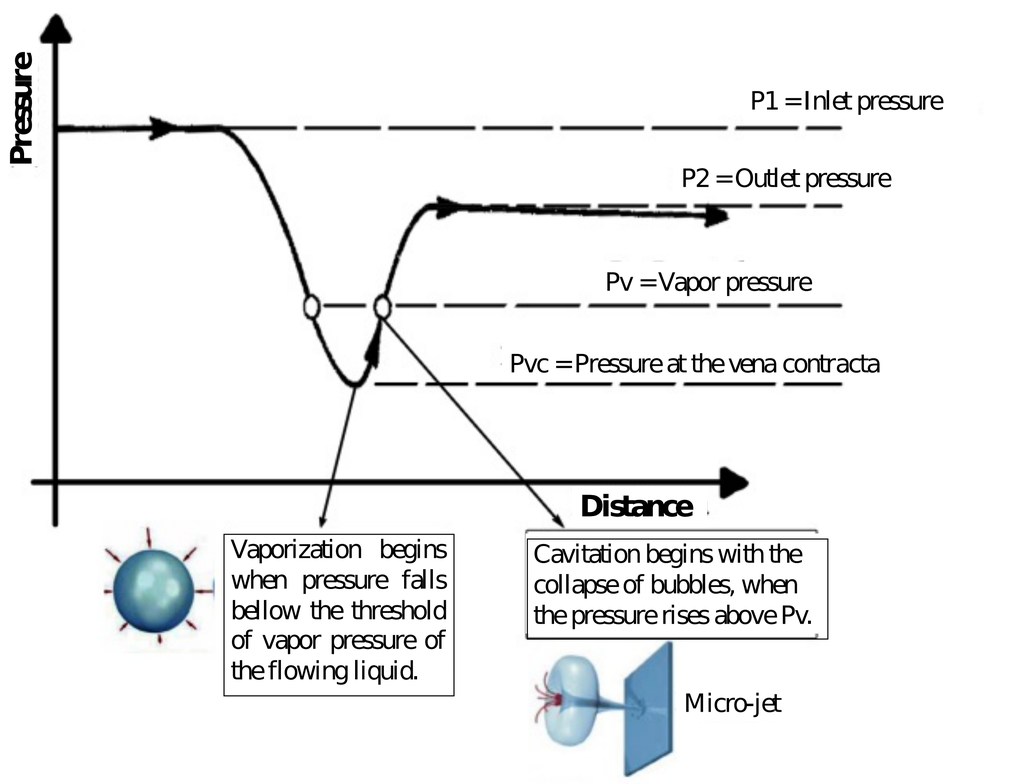

Figure 2. Pressure and cavitation. Adapted from RIBEIRO (2003).

Computational Methods: The simulation of the in and out flow through the valve was performed using the k-e turbulence model on COMSOL Multiphysics, with a temperature 80 °C, while the inlet pressure was 100 kPa, and the outlet was 60 kPa, assuming isothermal and stationary flow, and no heat transfer. Calculations were made considering the valve partially open with several different apertures. The results in the figures are for the 7mm aperture.

Results: Figure 3 shows the velocity field through the valve. Figure 4 shows the pressure field, correlating low pressures with high fluid velocity. Considering that the vapor pressure of water at 80 °C is 47.35 kPa decided to display only the region where the pressure falls below this value. It is in this region the highest probability of formation of vapor bubbles (Figure 4).

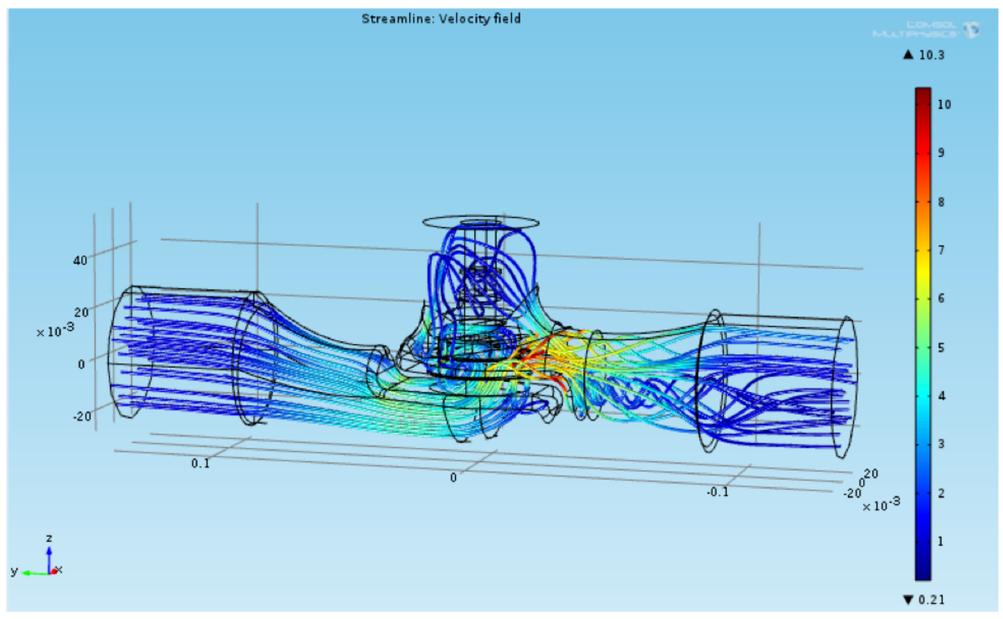

Figure 3. Stream lines of velocity.

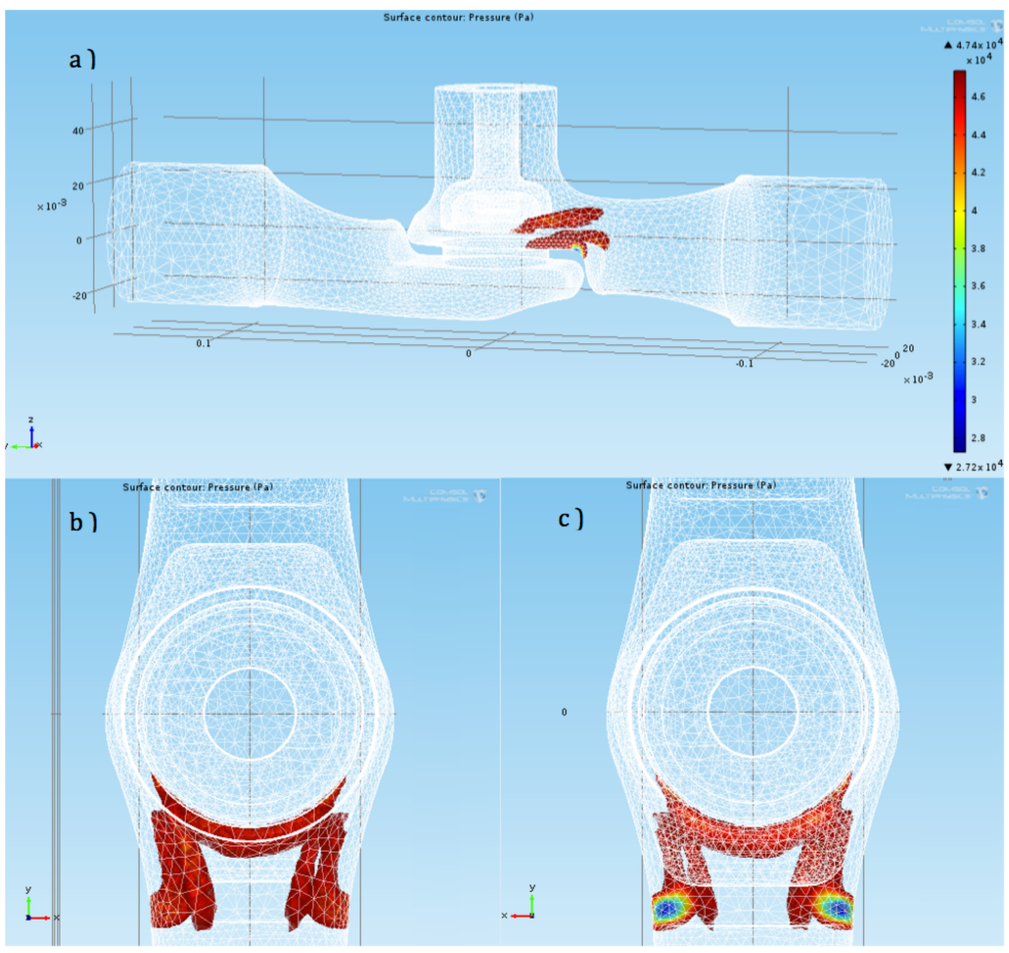

Figure 4. Points where pressure drops below vapor pressure of water : a) general view b) superior view c) bottom view.

Conclusions: The study in 3D gives us a great detailing of critical points throughout the interior of the valve, which was found possible sources of cavitation at the outlet of the valve.

References:
RIBEIRO, M. A; *Válvulas de Controle e Segurança*. Salvador, 2003.
https://grabcad.com/krisb-1/projects
www.comsol.com.