Lifetime prediction of valves subjected to impact erosion

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Engineering issue and project goal

• Valves in fields with sand production often experience impact erosion.
• Consequences are reduction of the useful life time of the devices, failure, service downtime, forced maintenance jobs, all resulting in high economic costs.
• Goal of this research is the development of models for estimating the useful life of valves working in such heavy-duty conditions.

Research approaches

• The project involves a synergy between numerical simulations and experimental testing.
• Two experimental setups have been designed and installed at the Hydraulic Laboratory of Politecnico di Milano, namely: the direct impact test apparatus, in which a slurry abrasive jet impinges at high velocity against a specimen of a target material, in order to assess its erosion characterization; the Erosion-loop, capable in reaching pressure up to 28 bar and flow rates up to 160 m³/h, which is used for erosion testing of the actual devices.

• An in-house code has been developed for erosion calculation, which acts as post-processing stage of a numerical simulation of the fluid-particle flow based on the Eulerian-Lagrangian approach. The code is specifically intended to apply to complex geometries with multiple components, such as valves.

Main publications


Research steps and achievements

• First step. A characterization of the erosion behaviour of the materials of the valves was provided through direct tests. The numerical reproduction of the laboratory tests allowed the proper definition of the erosion prediction model and the assessment of its reliability for the flow conditions of interest.

• Second step. The predictive models were validated by the reproduction of the erosion tests on two actual devices, namely a angle choke valve and a gate valve, performed in the slurry flow loop. The models proved capable in estimating the location of the erosion hotspots and the erosion rate of the most vulnerable valve components.

• Third step. A number of virtual experiments of valve erosion were numerically performed for different operating conditions (that is, valve opening, type of abrasives, and fluid dynamic conditions). Finally, models for useful life-time predictions have been developed after carrying out sensitivity analyses, which were aimed at identifying the most influencing parameters.