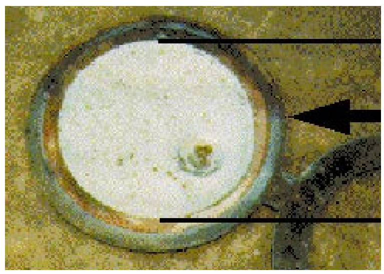
WEAR PREDICTION IN SLURRY PIPELINES

by Gary J. Brown, Alcoa, Kwinana, Australia

Alcoa of Australia Ltd. operates two bauxite mines and three alumina refineries in Western Australia as part of the Alcoa World Alumina system. Current levels of production at Alcoa's operations in the region make this the biggest single source of alumina in the world.

CFX is used within Alcoa of Australia for the design and optimization of process equipment used in the Bayer process for alumina refining. Operating conditions within the plants are particularly harsh since the slurries involved are highly abrasive and will deposit scale on surfaces where the flow is allowed to stagnate or cool. Good fluid dynamic design is therefore essential to minimize maintenance costs.



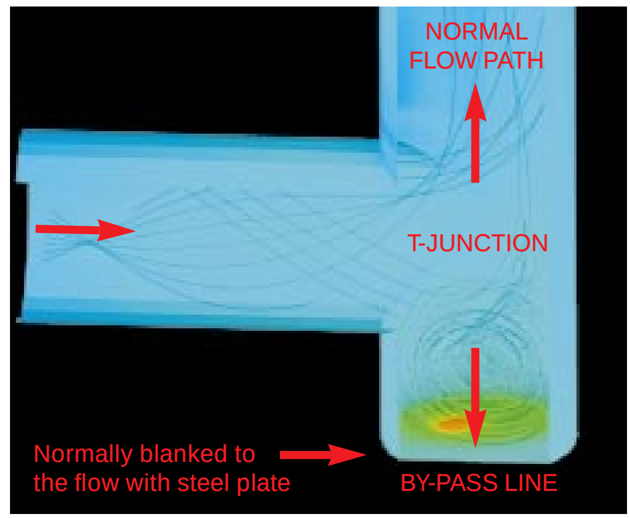
An eroded hole in a typical steel plate removed from the plant. The arrow and lines show the orientation of the inlet stream.

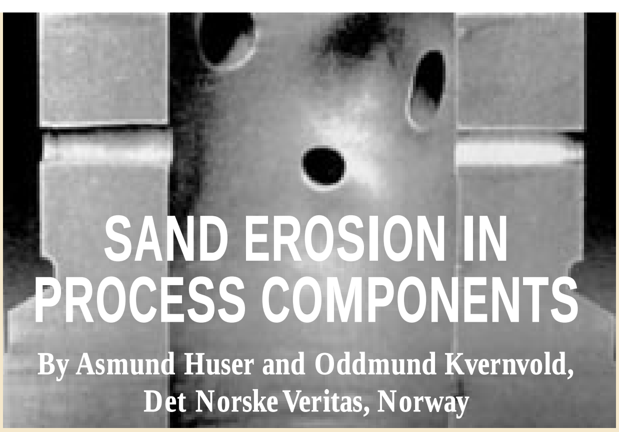
A typical wear problem involved a slurry pipeline system in which a metal plate inside a T-junction acted to switch the flow between two possible paths. It was found that a concentrated hole was being worn through these plates inside 13 weeks of operation. This would allow slurry into the by-pass piping, where scaling would occur causing significant operational problems.

A two-phase Eulerian-Eulerian model of the flow of liquid and solid particles in the T-junction was developed using CFX-4. Initial simulations assuming fully-developed inlet flow gave no indication of the cause of the erosion. However, the configuration of the vessels upstream suggested that the flow could be swirling. When this was implemented in the model, the results revealed particles accumulating on the steel plate at the centre of a slow-moving vortex, the location of which was in excellent agreement with the observed wear.

Further modelling of alternative designs helped engineers to develop a modified piping system which has eliminated this wear problem.

Surface plot of particle volume fraction illustrating the accumulation of particles where the hole is found to form in practice. Liquid-phase streamlines show how the swirling flow creates a vortex centred on the point where the particles accumulate.





Photograph of MOS choke applied in tests indicates that the regions of erosion attack are close to the exit holes.

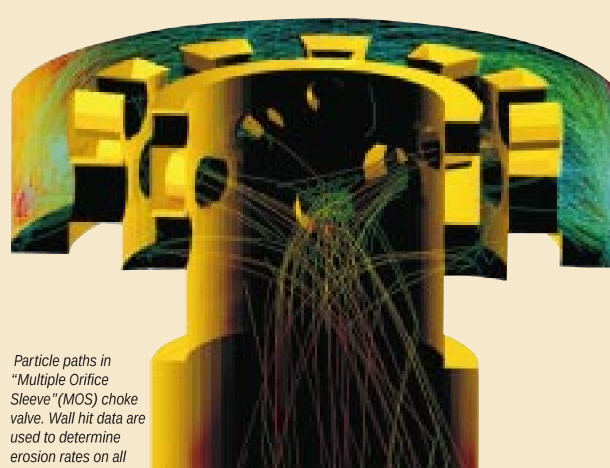
SAND EROSION IN PROCESS COMPONENTS

By Asmund Huser and Oddmund Kvernvold, Det Norske Veritas, Norway

Det Norske Veritas AS (DNV) has been heavily involved in assessing process component erosion for the oil and gas industry since the early 80's. Erosion is caused by the impact of sand particles carried by the oil/gas from the reservoir, and pipe bends, T-junctions, valves and chokes can all suffer extensively. Control chokes are perhaps the most critical components due to the high velocities (~500 m/s) that can occur when the device is operated at large pressure drops. In extreme cases, erosion through the body has been experienced in a matter of hours. With subsea choking now common, erosion can be critical, both for environmental and safety reasons as well as economic ones - the cost of replacing a subsea choke valve is typically £1-2 million.

DNV has found CFX to be a powerful tool for erosion assessment in complex geometries and uses CFX to analyze many major types of choke over a wide range of operating conditions. Results from these analyses have been used for design and production optimization, for the prediction of choke life and to determine operational limitations, as well as for inspection planning.

A separate routine has been developed that calculates erosion on all surfaces using the CFX flow and particle tracking results. Based on extensive experimental testing, it takes into account the different material



Particle paths in "Multiple Orifice Sleeve"(MOS) choke valve. Wall hit data are used to determine erosion rates on all internal walls.