Use of an Ice Pig to Help Reduce and Remove Active Contamination

Research area: Waste and Fuel Management

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Figure 1

The Challenge

One of the important aspects of nuclear decommissioning is minimising the resultant contaminated volumes. The use of water, acids, organic solvents in cleaning contaminated equipment results in difficult/embarrassing to handle volumes of active effluent streams. The problem would be simplified and downstream processes easier and less expensive to deal with if the volume could be reduced. The simplest way to achieve this is to increase the mechanical shear on the contaminated surface so as to remove the contaminant with minimal carrier material or cleaning fluids. This may be easily achieved if the geometry allows, however in complex topologies such as in ducts of varying cross-sectional area with branching T's, valves, and instrumentation, all that can be done is increase the flow rate of the cleaning fluids, resulting in increased effluent volumes.

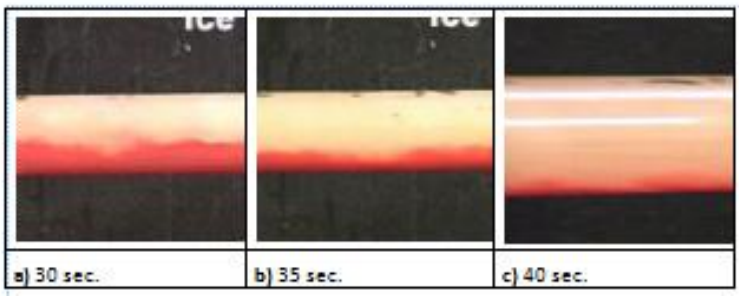
The Solution

A simple solution would be to use a solid object (a pig) to 'scrap' the inside of the duct. However, this can only be used for constant diameter pipes. An elegant way of achieving pig-like shearing on the duct walls whilst guaranteeing that the 'pig' would never get stuck and would be able to cope with varying topology is to use a high ice fraction slurry. This method is known as ice-pigging. The ice pig behaves like a solid, moving through ducts as a plug (with associated plug flow characteristics), but where the topology demands the ice pig behaves like a liquid and deforms to provide high shear rates on all containing surfaces, irrespective of local topology.

This is clearly shown on Figure 1 (above) where the ice pig is seen to flow like a plug through the constant diameter pipe (at the bottom) and then to flow seamlessly through the complex topology of a static mixer. The use of this technology has a number of beneficial attributes; specifically, it physically removes and transports surface contamination from complex geometries with minimal volumes of ice slurry. The ice slurry containing the contaminants is then allowed to melt and the usual effluent processing techniques can be applied to *a* much-reduced volume.

SOUTH WEST NUCLEAR HUB

Figure 2



The ice pig is seen shearing fouling material off a pipe wall in the sequence of pictures on Figure 2 (above). It removes fouling and then transports it out of the duct. The ice pig is inherently inexpensive being essentially a water-ice mix with slurry like rheology. Figure 3 (below) shows a 'pile' of ice slurry, the shape and dimensions of the pipe the pig was pumped through can be clearly seen.

Figure 3

The Impact

The immediate impacts include:

1. Ability to decontaminate 'difficult/impossible' topologies,
2. Reduced effluent volumes,
3. Reduced decontamination times,
4. Reduced costs (due to reduced radiation exposure, reduced storage demands, reduced man power).

The technique lends itself to retrofitting on existing problems/plants and can, of course. be beneficially designed into new processes/activities.

There is also the potential to use the ice pig as a 'carrier' for functional chemicals and instrumentation. This technology makes it feasible to 'transport' active chemicals trapped between two ice pigs to specific parts of the plant without having to flood the plant with the chemical. The ice pig can also be used as the transport vehicle delivering diagnostic instrumentation to 'impossible-to-reach' parts of the plant. The photographs on Figures 4 were taken in a process plant where the ice pig was used to clean out complex food processing equipment. The ice pig went through a pump, a monitoring wheel and through an open butterfly valve, cleaning as it went.

Figure 4

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