Polymer Resin Slurry Filter Optimization

Overview
Dow utilizes a filter in one of their reactors that separates small polymeric beads from organic solvents. The typical service life of the filter is 3-6 months and as a result the production has to be stopped a couple of times in a year to replace the filter. The group was asked to propose a filter system that would last for 1 year and analyse the cause of failure for existing and prototype filter designs.

Objectives
Material exploration: Chemical compatibility of different fluoro-polymers was investigated.
Stress Calculation: Hoop stress for the filter was calculated.
Failure Analysis: Scanning Electron Microscope (SEM) imaging was used to find cause of failure.
Mechanical Testing: Uniaxial tensile testing was performed to find mechanical strength of filter mesh.

Approach
- Current design is Tefzel mesh with a Kynar support. Service life is about 3-6 months.
- Tantalum mesh was used in two prototype designs that failed in 1 day and 3 weeks.
- Kynar chemical compatibility with amines and sodium hydroxide was found out first.
- SEM imaging of failed and unused tantalum mesh was performed to investigate the microstructure.
- Uniaxial tensile testing of unused tantalum mesh was performed to find the tensile strength and yielding points.
- Hoop stress on filter due to swelling of Kynar support was calculated.
- The data from failure analysis, mechanical testing and stress calculations was used to suggest an alternative material.

Outcomes
- Failed and unused tantalum microstructure showed voids and no chemical attack.
- The tensile strength of tantalum was found to be 13.34 Kpsi which is lower than Dow’s expectation (25 Kpsi).
- The yield point was found at 14% strain whereas the Kynar experiences 20% swell. So mechanical properties degrade beyond 14% swell.
- Hoop stress calculation proved that back pressure for purge in not cause of failure.
- Teflon was suggested as an alternative to Kynar because of resistance to chemicals, less swelling and easy fabrication.

Figure 1: Void in cross section of tantalum wire