

# Chemical Engineering Seminar Series

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Thursday  
April 27, 2017

102 Chemistry  
9:30 - 10:30 am

## The Reversible Nature of Sulfur Poisoning in Automotive Catalysis

### Abstract

It is relatively well known that sulfur is a common catalyst poison in automotive catalysis. Sulfur compounds originating from fuel are released mostly in the form of SO<sub>2</sub> but complicating the effects, SO<sub>2</sub> can be oxidized to SO<sub>3</sub> over an oxidation catalyst, and in the presence of water this leads to easy formation of H<sub>2</sub>SO<sub>4</sub>. SO<sub>2</sub> and SO<sub>3</sub> can have different impacts on the various automotive catalysts, with SO<sub>3</sub> leading to more severe deactivation, at least partly due to its affinity to form H<sub>2</sub>SO<sub>4</sub>. However, automotive catalysts not only survive, but remain highly active (>90%) over long and varied use. This is due to the semi-reversible nature of sulfur poisoning. Here, I will focus on sulfur poisoning of metal-exchanged small pore zeolite selective catalytic reduction (SCR) catalysts. Also, SO<sub>2</sub> interactions with an oxidation catalyst will be discussed, as these are typically found upstream of any NO<sub>x</sub> control systems and thus their chemistry will be relevant to any downstream catalysts, such as the SCR catalyst.

To understand how an oxidation catalyst might be impacted, we investigated the interactions of different sulfur species with a Pt/Al<sub>2</sub>O<sub>3</sub> catalyst, acting as a model oxidation catalyst. SO<sub>2</sub> oxidation kinetics and adsorption/desorption and a model predicting both will be presented. We then studied the poisoning effects of the different sulfur species on the SCR reaction over a Cu-SAPO-34 catalyst. Surface species formed during exposure of the catalysts to sulfur, NO<sub>x</sub> and NH<sub>3</sub> were characterized with in-situ diffuse reflectance infrared Fourier transform spectroscopy (DRIFTS). Temperature programmed desorption (TPD) was also used to characterize the samples after exposure to sulfur. The overall results clearly demonstrate that ammonium sulfate forms and furthermore, what appear to be sulfate species associated with the metal exchanged sites is also present. These will be correlated to activity.

### Biography

Bill Epling is a Professor in, and Chair of, the Department of Chemical Engineering at the University of Virginia. He joined UVa as Chair in August 2016. Bill Epling received his PhD from the University of Florida in 1997 and his BS from Virginia Tech in 1992, both in Chemical Engineering. Prior to joining academia, he followed a relatively unique path that has given him a broad perspective in the field of environmental catalysis, including catalyst design, manufacture, characterization and application. This was accomplished working across a spectrum of locations; a national lab (Pacific Northwest National Lab), in academia (University of Waterloo, University of Houston and University of Virginia), a catalyst manufacturing company (EmeraChem) and an engine manufacturer (Cummins Inc). His research has most recently focused on diesel and natural gas engine emissions reduction and utilization of natural gas in the production of value-added chemicals.