Sulfate, K, Na, and Ca Effects on Vanadia Catalyst Activity

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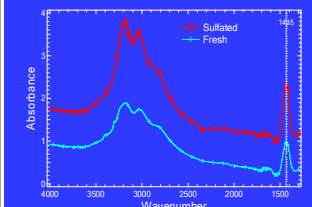
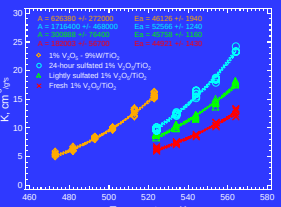
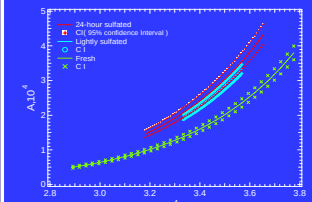
Objectives

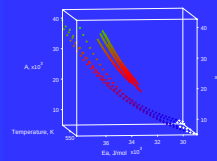
- Determine sulfate species impacts on SCR performance.
- Determine impacts of alkali and alkaline earth compounds on SCR performance.
- Determine mechanisms and rates of tungsten impacts on SCR catalysts.

Sulfate impact on vanadia catalyst behavior

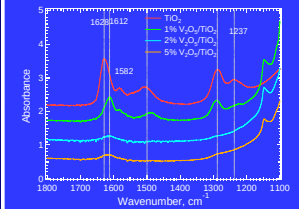


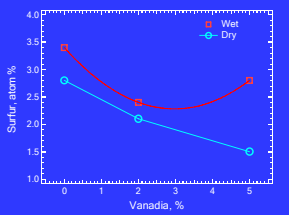


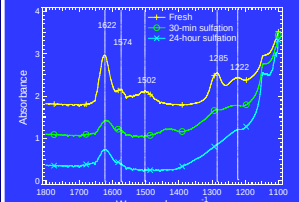




Surface site identification





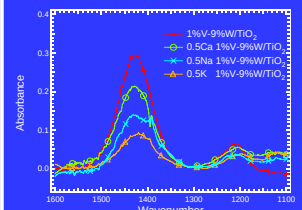


$NO+O_2$ adsorption decreases with increasing vanadia content and sulfate content

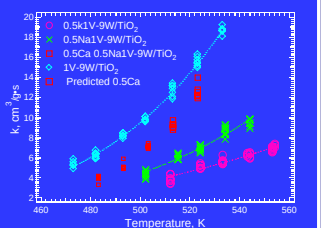
Sulfate content and IR peak intensities decrease with increasing vanadia content

NO, vanadia, and sulfate compete for the same –OH surface sites

Poisons impact on vanadia catalysts



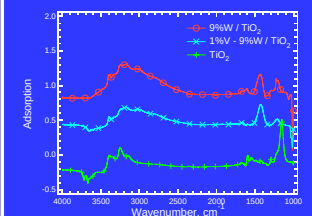
NH_3 adsorption intensities on Brønsted acid sites decrease proportional to metal's basicity



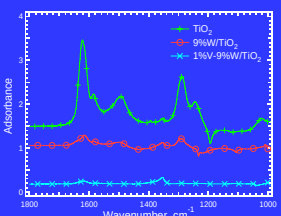
Catalyst poisoning increases with species in the order Ca < Na, < K, which is proportional to bacisity. All alkali and alkaline earth metals are significant poisons.

Tungsten impact on vanadia catalyst

1000 ppm NH_3 adsorption at 50 °C



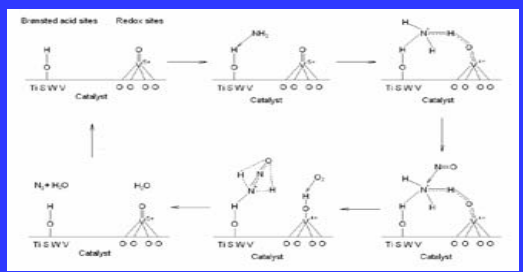
1970 ppm NO + O_2 adsorption at room temperature



Tungsten increases Brønsted acid site density and decreases Lewis acid site density on TiO_2

Tungsten suppresses NO adsorption by occupying its interaction site, –OH.

Proposed Mechanism & Rate Constant



$$k = \exp\left(2.5 - 1.16\frac{K}{V} - 0.76\frac{Na}{V} - 0.3\frac{Ca}{V} + 0.17\frac{S}{S_0} + 0.38\frac{K}{V}\frac{S}{S_0} + 0.55\frac{Na}{V}\frac{S}{S_0} + 0.27\left(\frac{1}{T} - \frac{1}{T_0}\right) - 0.12\frac{S}{S_0}\left(\frac{1}{T} - \frac{1}{T_0}\right)\right)$$

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