# THE REMOVAL OF SULFUR DIOXIDE FROM VARIOUS GAS STREAMS USING CENTAUR® ACTIVATED CARBON

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## Introduction

The use of activated carbon has been applied to the abatement of sulfur dioxide from various gas streams. Activated carbon has the advantage of being able to catalyze the oxidation of sulfur dioxide to form sulfuric acid in the presence of oxygen and water at low temperatures (<80°C), whereas a standard catalyst such as vanadium pentoxide would require higher temperatures that may require additional equipment. Centaur® activated carbon offers a substantial improvement over standard activated carbon for the abatement of sulfur dioxide through faster reaction kinetics that results in smaller equipment.

## Experimental

The sulfur dioxide testing was conducted using Centaur LAD 4x6 that was contained in a two inch inside diameter (I.D.), 5 foot long, 304 stainless steel column. Sample ports were spaced every six inches so that effluent gas samples could be obtained at various contact times throughout the adsorption cycle.

The simulation gas was produced by blending pure sulfur dioxide, air, nitrogen, and water vapor through the use of mass flow controllers and HPLC pumps. The volumetric gas flow was controlled so that the gas contact time with the activated carbon was a total of six seconds based on a four foot carbon bed depth in the stainless steel column. Gas temperature was controlled by flowing the gas blend through a fifty foot section of 1/4" stainless steel tubing wound in a coil and placed in an oven. The outer shell of the stainless steel column was also heated through the use of heat tape.

Regeneration of the spent carbon was accomplished through the use of a Bete stainless steel spray nozzle located in the top of the stainless steel column. The volumetric water flow rate was controlled through the use of a Masterflex pump and controller.

Water washing the spent carbon removes sorbed sulfuric acid which results in a dilute sulfuric acid solution. The concentration of the dilute acid solution was determined by titration with 0.2N sodium hydroxide and a pH meter.

The sulfur dioxide concentration of the inlet and outlet gas was determined through the use of Drager tubes of various ranges and a Bruel and Kjaer Type 1302 Multi-Gas analyzer.

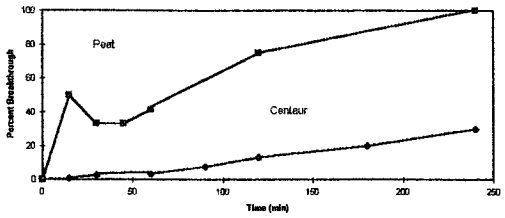
## Results and Discussion

The use of activated carbon for the removal of sulfur dioxide from gas streams has been documented many times using various forms of carbon[1,2,3]. Activated carbon catalyzes the reaction of adsorbed sulfur dioxide with adsorbed oxygen to form sulfur trioxide[4], which is strongly bound to the carbon surface and will not desorb without addition of water to form sulfuric acid, a less strongly adsorbed species. Regeneration of the carbon can then be accomplished by a simple water wash.

The use of activated carbon on the commercial scale has been applied through the use of the Lurgi Sulfacid process which entails the use of a peat-based activated carbon that is periodically washed to remove the sorbed sulfuric acid. Centaur activated carbon has been compared to the peat-based carbon currently being utilized in the Sulfacid process. Data indicate that Centaur is twice as effective in the removal of sulfur dioxide when compared to the peat-based carbon

(Figure I) under identical conditions (3000 ppmV $SO_2$, 11% $O_2$, 30% $H_2O$, 80°C, 2 second contact time).

Percent SO2 Breakthrough Profiles Centaur and Peat Based Carbons
Figure I

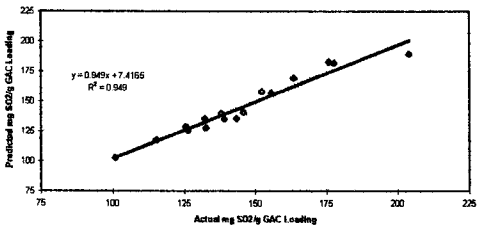



Centaur activated carbon has also been compared to various other activated carbons with similar results[5].

Centaur activated carbon is produced by a patented process that introduces more enhanced catalytic character to the activated carbon, thus allowing Centaur to perform more efficiently than standard activated carbon. In order to characterize this enhanced electronic property, Calgon Carbon Corporation introduced the peroxide number test (U.S. Patent #5,470,748) which measures the catalytic property of the carbon.

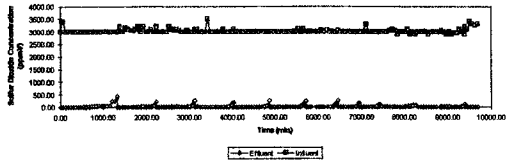
Various carbon parameters have been investigated to determine the effect on the sulfur dioxide removal efficiency. Apparent density, iodine number, and peroxide number have been correlated to predict the capacity after four hours of run time at 3000 ppmV $SO_2$, 11% $O_2$, 30% $H_2O$, 80°C, and 2 seconds contact time. The correlation among these three parameters accounts for 94.9% of the variability in the sulfur dioxide capacity (Figure II).

Correlation Between Apparent Density, Iodine Number, and Peroxide Number with Sulfur Dioxide Capacity
Figure II

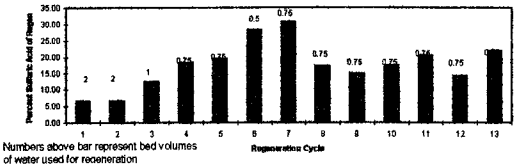



Data using the Centaur LAD 4x6 (0.48 AD, 1080 $I_2$, and 7.1 minute peroxide number) show the carbon can be used continuously (Figure III) and while generating various concentrations of dilute sulfuric acid (Figure IV), depending on the volume of water used to regenerate the activated carbon.

Sulfur Dioxide Removal Study Water Regeneration
Figure III




Sulfuric Acid Concentration Results Using Various Regeneration Conditions
Figure IV




## Conclusions

Centaur activated carbon exhibits improved removal of sulfur dioxide efficiency due to the increased catalytic activity introduced during the activation process, without the use of impregnants.

## References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