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**Question 82: For those operating units with electrostatic precipitators (ESPs), share your experience with using SO<sub>x</sub> (sulfur oxide) reduction additives and their impact on: 1) ESP performance, 2) stack opacity, and 3) filterable solids mass.**

**BULL** (Valero Energy Corporation)

We have two ESPs in our system. One of them is on a unit currently using less than 2.0% of SO<sub>x</sub> additive. We have not seen any impact at all on performance, opacity, or filterable solids. The other ESP went through a retrofit within the past four years, going from a smaller, older version of an ESP to a larger ESP with more modern technology. Today, the refinery does not see any issues with SO<sub>x</sub> additives or the SO<sub>x</sub> level in the regenerator. The old ESP design was smaller and occasionally created issues for us. This unit has a cat-feed hydrotreater that lowers the sulfur to ppm (parts per million) levels in the feed to the FCC. So, there were times when we would see low levels of SO<sub>x</sub> out of the regenerator. In that case with the older ESP, there were actual occasions when we had to back off on the severity of the gas oil hydrotreater to try and bring the opacity and performance back in line.

We did an experiment on that unit during one of our stack tests. We put some filter paper into the flue gas flow to analyze the particulates present at that time. We sent the sample to INTERCAT to prove that there is really no difference between the losses of the base catalyst and the SO<sub>x</sub> additive. So, we do not believe it is caused by the actual additive itself. More of it, I think, depends on the method you are using to measure particulates in the stack, whether it is a filterable solid or not, and what happens with that when it gets to a really low level of SO<sub>x</sub>.

**PAUL DIDDAMS** (Johnson Matthey INTERCAT, Inc.)

As I am sure most of you are aware, INTERCAT manufactures SO<sub>x</sub> additives. We have had SO<sub>x</sub> additives in many units with the ESPs. Generally speaking, there is little or no impact. However, at ultra-low sulfur or SO<sub>x</sub> levels (e.g., 5 to 10 ppm), the reduction in ionizable gases going into the ESP may decrease ESP efficiency and lead to increased opacity and losses. When you look at the captured particulate material from the stack (the filterable material) in the electron microscope, you find that it is almost entirely catalyst and virtually no SO<sub>x</sub> additive. What happens is that the additive itself picks up the SO<sub>x</sub> in the flue gas as the microparticles travel down the flue gas line. They enter the ESP and are very efficiently captured. Because there is less ionizable gas present, some catalyst can now escape, thereby increasing opacity and losses. It is not the SO<sub>x</sub> additive or catalyst properties, per se, that got worse; rather, it is poorer ESP efficiency due to lower flue gas SO<sub>x</sub>. One way to counteract this effect is to adjust your ammonia injection in the ESP to compensate for the decrease in ionizable gas.

We have two refineries with ESP units, and one of those refineries has not seen any impact from the use of SOx reduction additives. This unit operates at levels below 2% of the catalyst inventory.

At our other plant, we recently put a new ESP in service. When we had the older ESP, there were times when we adjusted the WABT in the GOHT to increase our FCC feed sulfur and elevate the SOx level to improve the opacity. The SOx shifted from 40 to 50 ppm up to 100 to 120 ppm. This seemed to help with the opacity and appeared to lower the resistivity of the catalyst fines.

Since we have gone to a more modern, larger design for our ESP, we have not had the same issues. During one stack test, the testers put a filter paper into the flue gas flow. We then gave this filter paper to INTERCAT for close examination. They found only traces of the MgO (magnesium oxide) present in their Super Soxgetter™. This dispelled the theory that Super Soxgetter™ is going right out of the stack and increasing opacity due to the 'softness' of this additive.

From speaking with other refiners, I have heard that several have experienced reductions in particulates, which is attributed to a reduction in SO3. This is highly dependent on the method they are using to analyze for particulates and based on how the filterable and condensable particulates are handled in a given method.

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