The Effects of AFC-705 on SO_X

The treatment of carbon based fuels with AFC-705 has a significant effect on trace sulfur combustion chemistry. In diesel engines, gasoline engines and open flame applications (boilers) the use of AFC-705 treated fuel will significantly reduce sulfur oxide (SO_X) emissions, and related sulfur acid corrosion problems.

AFC-705 does not react with the sulfur in the fuel nor does AFC-705 have any effect on the sulfur content of the fuel. AFC-705 does not effect fuel specifications at recommended treatment levels. Fuel containing one percent sulfur prior to AFC-705 treatment will still contain one percent sulfur after AFC-705 treatment. However, the use of AFC-705 will determine where the sulfur ends up and what its chemical state will be after combustion.

The combustion of sulfur in fuels invariably leads to the formation of sulfur dioxide $S + O_2 \rightarrow SO_2$ (1) and sometimes sulfur trioxide $2SO_2 + O_2 \rightarrow 2SO_3$ (2). Sulfur trioxide formation is catalyzed by vanadium pentoxide (V^{5+}). This is the most stable oxidation product of vanadium, when vanadium containing fuels are burned in air $4V + 5O_2 \rightarrow 2V_2O_5$ (3). The catalytic effect is thought to relate to the reversible dissociation $2V_2O_5 \rightarrow 2V_2O_4 + O_2$ (4) at temperatures between 700^{O}-1125^{O} C. The sulfur trioxide reacts with water vapor to form sulfuric acid $SO_3 + H_2O \rightarrow H_2SO_4$ (5) which is primarily responsible for acid corrosion problems in combustion equipment.

AFC-705 affects the production of gaseous SO_X emissions. It enhances the formation of CO_2 during the combustion phase thus limiting the amount of SO_X produced during the exhaust phase. The increased production of CO_2 reduces the amount of excess O_2 available for other reactions. The difference in the amount of CO_2 produced during the combustion and the exhaust phases correlates to a temperature differential. This temperature differential results in lower exhaust temperatures and shorter heat transfer times.

Minerals contained in fuel are generally oxidized to metal oxides during the combustion process. When vanadium is oxidized to $V^{5+}$the production of sulfur trioxide increases due to reversible dissociation, and sulfuric acid is ultimately formed. The use of AFC-705 inhibits the formation and reversible dissociation of V^{5+} during the exhaust phase by limiting the available O_2**,** high temperatures, and time periods needed for these reactions to occur.

This greatly reduces the catalytic effect V^{5+} has on the formation of Sulfur trioxide and thus the formation of sulfuric acid. By reducing the catalytic effect of vanadium, AFC-705 promotes the combination of SO_X compounds with other minerals in the fuel such as Na and Ni. This leads to the formation of stable mineral salts and mixed mineral sulfates found in the clinker or fly ash.

In this manner, **AFC-705 decreases the gaseous sulfur emissions** by increasing the particulate portion of the combustion residue products. AFC-705 treated fuels will therefore show slightly higher sulfate content in the ash than untreated fuel.