

Flue Gas SO₃ Determination – Importance of Accurate Measurements in Light of Recent SCR Market Growth

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Summary

The accurate measurement of sulfur trioxide (SO₃) in flue gas streams is becoming of increasing interest to the owners/operators of electric utility boilers. The installation of ammonia-based oxides of nitrogen (NO_x) removal systems, especially selective catalytic reduction (SCR) has brought to the fore the need for accurate, repeatable and believable SO₃ sampling methods and results. The efficacy of these methods and results is paramount considering that they are often used to demonstrate SCR performance guarantees.

Coal-fired power plants face an enormous challenge to reduce NO_x emissions as a result of the EPA's 22-state SIP call, which may force plants to reduce emissions to 0.15 lb of NO_x per million Btu. Both SCR and selective non-catalytic reduction (SNCR) technologies which utilize ammonia (NH₃) as a reducing agent are finding large scale application to address this burgeoning need. Estimates vary, but the consensus is that at least 60 GW of SCR will have to be installed by May 2004 to comply with the SIP call.

During combustion of fossil fuels, fuel-bound sulfur is converted into sulfur oxides (SO_x) in much the same way as carbon is oxidized to carbon dioxide (CO₂). Sulfur dioxide (SO₂) and sulfur trioxide (SO₃) are the predominant sulfur oxides formed. The presence of SO₃ in low parts per million (ppm) levels in flue gas streams is usually not a cause for concern, and in some instances, small amounts of SO₃ can have a beneficial effect on particulate collection equipment because it adsorbs onto particle surfaces and creates a moderate resistivity. One drawback of the SCR nitric oxide control process is the creation of excess SO₃, over and above that which is formed in the combustion process. SO₃ is corrosive to downstream equipment such as air heaters, baghouses, and electrostatic precipitators. SO₃ can also combine with unreacted NH₃ to form ammonium salts which tend to be extremely tacky substances, which can foul heat exchanger internal elements. SO₃ can also react with chlorides in the flue gas stream, to form sub-micron aerosols that create an opacity plume. These

small mist particles create a “blue plume” due to light wave refraction off of the sub-micron organic particles.

The SCR process employs the injection of either anhydrous or aqueous ammonia upstream of an active catalyst bed of noble metals. In a temperature window of 600 to 750 °F, the nitrogen oxide (NO) and nitrogen dioxide (NO₂) will react preferentially with ammonia (NH₃) and oxygen as it comes in contact with the catalyst to form nitrogen and water vapor. NO_x removal efficiencies with SCR range from 80 to 90%. An NH₃/NO_x mole ratio of 1.0 to 1.5 is typically used, although the theoretical ratio is about 0.67. Although a significant portion of the excess NH₃ decomposes in the SCR reactor, a small amount remains in the treated gas stream and can cause problems in downstream equipment.

Clean Air Engineering has extensive experience testing a variety of sources for sulfuric acid mist concentrations, and has a working familiarity with many of the available test methods. This paper presents background information on SO₃ formation, SCR operation, as well as a discussion of the inter-related nature of SCR performance and SO₃, and how each can affect balance of plant operation. A detailed discussion of applicable EPA, ASTM and instrument test methods for the determination of sulfuric acid mist is also presented, as well as a new procedure developed by Clean Air Engineering. Testing challenges associated with flue gas sampling downstream of wet scrubbers is also discussed, as well as the limitations of each of the relevant test methods.

The limitations and applicability of each of the SO₃ testing methodologies must be understood by SCR system vendors as well as utility boiler operators and their engineers. This is especially true when one considers that contractual performance guarantees are many times tied to SO₂ to SO₃ conversion rates. SO₃ testing methods are not interchangeable. The proper procedure must be specified for a given test location. Thought must be given to the aforementioned issues early on in the project genesis in order eliminate conflicts arising from testing inaccuracies.