SCR OPERATION OPTIMIZATION:
SO_3 REMOVAL TO OPTIMIZE CATALYST LIFE & NH_3 DISTRIBUTION IN WASTEWATER

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SUMMARY

Introduction

The SCR catalyst life for coal-fired applications in the US is typically determined by limiting ammonia (NH_3) slip to 2 ppm. The general basis for limiting NH_3 slip is to prevent the formation of ammonium bisulfate (ABS) deposits in the air heater. Last year's paper showed:

- SCR's NH_3 slip will be removed in the air heater, on ESP fly ash and in FGD slurry
- Low and medium sulfur coals can have higher NH_3 slip before the formation of ABS in the air heater
- Since NH_3 is soluble, the NH_3 slip eventually ends up in a wastewater discharge

Last year's paper recommended the use of an SO_3 removal system after the SCR and before the air heater to allow for balancing the NH_3 distribution between air heater deposits and the ESP flyash.

Further evaluation of SCR ammonia slip in high sulfur applications with an SO_3 removal system has shown that SO_3 removal may also result in a significant fraction of the ammonia reporting to flue gas desulfurization (FGD) depending upon the molar ratio of SO_3 and NH_3. This year's paper will further refine the distribution of ammonia in plant wastewaters and estimate the economic impact of catalyst life vs. ammonia slip as a function of coal sulfur and SO_3 removal.

Impact of NH_3 Slip & Increased SO_3

The formation of ABS from the reaction of SO_3 and NH_3 will result in ABS in air heater deposits, on ESP fly ash and in FGD slurry. In 1980, Radian International (now a division of URS corp.) developed an equation to predict the formation of ABS in air heaters and the literature has several references to NH_3 as a contaminate in fly ash. In this work, a spreadsheet was developed to calculate the concentrations of NH_3 in the resultant wastewater effluents from air heater washing, ash disposal (wet pond and dry landfill) and FGD blowdown. The percentage distribution is a function of the SO_3:NH_3 molar ratio and will change with coal sulfur.

The following NH_3 concentrations are possible from high-sulfur coal SCR applications at the end of catalyst life:

- Air Heater – up to 2500 ppm in wash water

- ESP Fly Ash – up to 1 ppm (sluice water) or > 100 ppm in dry ash & up to 50 ppm in leachate
- FGD – up to 20 ppm in the gypsum interstitial water (closed loop)

In addition, an attempt was made to estimate the NH3-contaminated run-off (leachate) from an ash landfill.

Economics

In order to evaluated the economic impact of wastewater treatment and early & later catalyst replacement, capital and operating costs were estimated for the following scenarios:

- SO_3 removal – including alkali
- Air heater washing - including loss of load from off-line washing
- Wastewater treatment for several effluent streams – producing a ABS byproduct
- Avoided cost of ash and gypsum disposal (from loss of byproduct sales)
- Catalyst replacement - earlier with lower NH_3 slip & later with higher NH_3 slip

There are two primary economic results of ammonia slip:

- For high sulfur coal, the cost of additional air heater washings and air heater wastewater treatment is significantly less than the cost of SO_3 removal
- Earlier catalyst replacement eliminates the need for SO_3 removal
- All SCR may require wastewater treatment for the air heater wash water

Early catalyst replacement to limit NH_3 slip may be an economic option for SCR on high-sulfur coal.

Conclusions

Ammonia slip from SCR or SNCR operations can have many fates in a power plant, depending upon plant specific design. The major factor in the distribution of NH_3 in plant wastewater discharges is the SO_3 concentration. These wastewaters may need to be treated to remove the ammonia contamination. Treatment schemes will vary depending upon plant design and ammonia distribution.

All plants with SCR should do two sets of sampling and testing early in SCR operation:

- NH_3 material balance during SCR operation to determine the distribution of ammonia deposits
- Determine the plant's Radian number by increasing the NH_3 slip to cause an increase in air heater deposits

The NH_3 slip from SCR is going to be discharged as an effluent – the only question is which effluent and at what concentration.