Application and Operating Results of Low SO_2 to SO_3 Conversion Rate Catalyst for DeNOx Application at AEP Gavin Unit 1

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Summary

The impact of increased SO2 to SO3 oxidation due to the installation of an SCR on many units in the United States that burn high sulfur coal was more significant than expected. Soon after the SCR start up on Gavin Units 1 and 2, AEP recognized this issue and began the evaluation of several mitigation techniques and technologies to reduce SO_3 emissions. At the same time, the development of low SO_2 to SO_3 conversion rate catalyst became one of the most important research projects for catalyst manufacturers. After extensive research work, Babcock-Hitachi developed low SO_2 to SO_3 conversion rate catalyst while maintaining high DeNOx activity

Identification of the Necessity for Low SO_2 to SO_3 Conversion Rate Catalyst

The first catalytic DeNOx system for large utility boilers was commissioned for operation in 1977 in Japan. Since then, SCR applications have been applied for various fuels such as gas, oil and coal, and the installations have expanded to many industrialized countries around the world.

In the past several years, the SCR units in the US that burn high sulfur (3-7%) Eastern Bituminous coal experienced operational difficulties such as severe blue plume generation and acid mist emission. The increased SO3 concentration also causes: acceleration of corrosion of downstream equipments, increased possibility of ammonium bisulfate (ABS) formation within air preheater elements and increased PM emission.

To overcome this problem, several research efforts to reduce SO_3 emissions were conducted such as injecting different additives. The development of low SO_2 to SO_3 conversion rate catalyst can be a very cost effective solution to minimize the production of SO_3.

Development of Low SO_2 to SO_3 Conversion Rate Catalyst

The development of low SO_2 to SO_3 conversion catalyst focused on the SCR units in the US firing high sulfur Eastern Bituminous coals with high DeNOx efficiency, low ammonia slip and a gas temperature range from 690^0 F to 790^0 F. It was decided that the target SO_2 to SO_3 conversion rate of less than 0.5% for initial installation would be optimal.

A discussion of this development was addressed in a paper at the ICAC Clean Air Technologies and Strategies in March, 2005 titled," Development and Operating Results of Low SO_2 to SO_3 Conversion Rate Catalyst for DeNOx Application". The results of this research were the development of a new series of low SO_2 to SO_3 conversion rate catalysts called the CX series.

SCR Start Up and Initial Observation of Increased Levels of SO3 at Gavin Unit 1
The Gavin Plant is located in Cheshire, Ohio. It has two 1300 MWnet sister Units. Each Unit has B&W pulverized coal, dry bottom boiler. The Gavin Plant has been burning high sulfur (6.5 lb SO_2/mmBtu) coal since mid 1980's.
The initial start up of the SCR at Gavin Unit 1 was on May 1, 2001. This is the largest SCR installed on a US boiler. The Gavin Units has always burned a high sulfur coal and when the initial catalyst design parameters were specified, the SO2 to SO3 conversion rate was 1.5% which was the industry standard. The SCR arrangement for each Gavin unit was divided into three equally sized parallel reactors to match the three air preheaters. The reactors are a 3 + 1 (three initial layers and one spare) layer design and the catalyst volume for the initial three layers was 2124 m3. The initial design parameters were typical for a retrofit SCR with a life guarantee of 16,000 hours and a SO2 Conversion rate of 1.6%.

Results of the AEP Study to Mitigate SO_3 at Gavin Units 1 and 2
Following the start up of the SCR at Gavin unit 1 in 2001, AEP recognized the need to lower the SO_3 emission and began a study to determine the best means to mitigate the increase of SO_3 over the life cycle of the plant. Some of the mitigation techniques evaluated by AEP were: WESP, Magnesium Hydroxide, Low Conversion SCR Catalyst, Hydrated Lime, Trona Ammonia and several combinations of these techniques.
The AEP evaluation determined that the best life cycle cost for this unit was to replace all three layers of existing catalyst with low SO_2 to SO_3 conversion rate catalyst prior to the end of the normal life cycle and to use Trona injection at air preheater outlet.

Operational Results of Low SO_2 to SO_3 Conversion Rate Catalyst at Gavin Unit 1
The application also required DeNOx efficiency of 90% with ammonia slip less than 2 ppm. These conditions require the DeNOx plant to be designed to achieve very good distributions for NH_3/NOx, temperature and gas velocity. The DeNOx system supplier had initially conducted physical flow model testing to achieve the following inlet variations:NH_3/Nox of less than ±5 % RMS, temperature of less than ±20 °F, and Gas velocity of less than ±15 % RMS. Following the removal of the old catalyst and the installation of the new Hitachi catalyst in the spring of 2005, the SCR went into operation. After the initial adjustments, performance tests were performed in June 2005.

The catalyst installed in DeNOx plants at Gavin Unit 1 met all of the guarantees. In particular, the measured SO_2 to SO_3 conversion rate was measured at less than 0.1% which was considerably lower than the guaranteed 0.38% conversion rate.
A comparison of Trona injection rates between Unit 1 and Unit 2 indicates that the Trona consumption of Unit 1 which has Hitachi low conversion rate catalyst is approximately 35% of that of Unit 2.
The SCR at Gavin operated successfully during the 2005 Ozone season without any problem for both DeNOx and boiler systems.

Conclusion
Babcock-Hitachi developed new CX Series Type catalyst having low SO_2 to SO_3 conversion rate while maintaining high DeNOx potential. Since its first application, it has consistently achieved low SO_2 to SO_3 conversion rates as low as 0.1% even at elevated temperature above 740°F.
By application of CX Series Type catalyst in DeNOx plants, the catalyst can achieve various benefits for a wide range of plant applications, operating conditions and fuels.

REFERENCES
J. Cooper, W. J. Gretta, A.C. Favale, H.N. Franklin, *First Application of Babcock-Hitachi K.K. Low SO2 to SO3 Oxidation Catalyst at the IPL Petersburg Generation Station.* ICAC Clean Air Technologies and Strategies, Baltimore, MD, March 2005.