Experiences from Three Years of SCR Operation

Jack A. Robinson, Jr. PE
SCANA, 142 Wateree Station Rd., Eastover, SC 29044
E-mail: jrobinson@scana.com ;Telephone: (803) 217-4071; Fax: (803) 933-7029

Summary

South Carolina Electric and Gas Company (SCE&G) owns and operates Wateree Station located in Eastover, SC. The site has two (2) 375 MW each, pulverized coal fired supercritical boilers. In 2002, environmental upgrades commenced to install reverse gas fabric filters and selective catalytic reduction devices (SCR) on each of the units. These projects completed with the start-up of the SCR's in 2003. This paper provides a summary of operational experiences from Wateree Station that may benefit other SCR installations.

The design basis for the SCR on each unit is; inlet nox 0.50 lb/MMbtu, 90% nox removal, 2 ppm @ 3% O2 ammonia slip at 16,000 operating hours, 2 installed catalyst layers plus one spare, SO2/SO3 conversion rate of 1.5% for three installed layers, sonic horn cleaners with provisions for future steam cleaning sootblowers, overall pressure drop 8.0 inch w.g.

Less than four weeks after the completion of the SCR tie in outages, each unit's SCR achieved successful commissioning, start-up and met all performance guarantees. Shortly after initial operation of the unit 1 SCR, the effects of SCR operation changed the fly ash characteristics affecting the unit's fly ash handling system capacity and causing detrimental effects to the fabric filter bags. The design and installation of baffles in the economizer outlet duct eliminated the carry over of oversized ash particles to the SCR.

Fly Ash System

The design conveying capacity of the fly ash system retrofit for the fabric filter is two times the fly ash production rate at full load based on ten percent ash in the coal. The fabric filter's fly ash storage hoppers use heating panels to maintain ash temperature, but do not include vibrators or fluidizing air. Shortly after the SCRs' start-up, a marked decrease in conveying rate capacity occurred.

A detailed analysis of fly ash sampled downstream of the SCR with nox removal at zero, 50, 70 and 90% indicated changes in the fly ash characteristics. Generally, the samples bulk density and rat holing indices increased and the angle of repose decreased as the nox removal percentages increased. System observations indicated the ash sticking at the hopper discharge throat. The plant installed sonic horns in existing ports at the discharge of each fabric filter hopper. This additional fluidization restored the conveying capacity of the system to pre-SCR capacity.

Fabric Filter Bags

The Unit 1 reverse gas fabric filter started service in May 2002 and SCR operation started in June 2003. During the first year of fabric filter operation prior to the SCR, the unit experienced minimal bag failures with a failure rate of less than 0.5 percent of the total installed bags. During the summer of 2003, the bag failure rate increased significantly. During this period, the fabric filter flue gas differential pressure remained constant and operating processes appeared normal.

Measured bag weights indicated that SCR operation affected the fabric filter bags. A program to measure bag weights started shortly after the investigation process began. Weighing bags in compartments after the reverse gas cleaning cycle completed indicated the following, a new bag, out of the box, weighed 15-20 pounds, a bag in service for several months pre-SCR operation weighed 30-40 pounds, while bags in service for a few weeks post-SCR operation weighed in excess of 100 pounds.

A detailed root cause investigation determined that the increased SO3 concentration in the flue gas due to the SO2/SO3 conversion associated with the catalyst led to SO3 condensation from the flue gas reacting with Iron Oxide in the ash. The resulting Iron Sulfate cemented the fly ash to the bag. This cement like material formed a porous filter cake on the bags, not

increasing overall pressure drop, but leading to higher bag weights. Tensioning springs support each bag from the top and the increased bag weight allowed the bags to overcome the spring tension and become slack. This excess slackness allowed bags to rub against each other causing fatigue to the fabric material. This process resulted in the increased rate of bag failures.

The investigation recommended replacing the originally installed acid resistant fiberglass bags with membrane bags on both units' fabric filters. Replacement occurred on a compartment-by-compartment basis and completed on Unit 1 in July 2004 and Unit 2 in November 2004. Since replacement, both fabric filter operational performance and bag failure rates are acceptable.

Economizer Hopper Baffles

During the design phase of the SCR project, the team investigated industry experiences with popcorn ash plugging of catalyst. For the investigation, "popcorn ash" defined ash particles greater than 5mm in size that could plug and lodge in the 4.7 mm pitch catalyst. Initially, the plant did not consider "popcorn ash" as an issue, but ash collection and analysis indicated that Wateree's fly ash contained particles greater than 5 mm in size.

The team evaluated several options to remove the oversized ash particles upstream of the SCR and selected a system incorporating the addition of baffles in the economizer outlet duct and hopper area. These baffles directed particles greater than 5 mm in size into the economizer ash hopper. A series of computational flow models determined the percent capture of particle sizes greater than 5 mm to confirm achieving a design capture rate of 100% of all fly ash particles sized greater than 5 mm.

This system benefited Wateree operations by upgrading the economizer ash collection system. The retrofit replaced the original high maintenance, unreliable water flow hopper to the bottom ash collection with a more reliable dry system. The baffles system successfully eliminated the oversize ash particle carryover without incurring excessive pressure drop. The baffles have done an effective job of capturing the oversize ash particles without increasing the overall accumulation of ash in the economizer hoppers. Observations during visual and annual catalyst inspections indicate minimal plugging of modules and the pressure drop across the catalyst is unchanged during the three seasons of SCR operation.

Summary

The Wateree unit 1 and 2 SCR systems met the system's nox removal requirements and operated reliably for the past three ozone seasons. The identification and corrective actions addressing the fly ash collection and fabric filter system issues improved the reliability and performance of these systems. Efforts by Wateree Station employees and equipment suppliers thru design, investigation and analysis led Wateree's successful SCR operational experience.