Ammonia-On-Demand™ Installations at American Electric Power's Clifty Creek and Kyger Creek Plants Provide 100% Availability and Safe Operation

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Due to tightened environmental regulations many power plants have installed or plan to install Selective Catalytic Reduction (SCR) systems to reduce their NOx emissions. Just four years ago all SCR systems and ammonia based SNCR systems in Japan, Germany as well as in the U.S. had to utilize either anhydrous or aqueous ammonia as a feedstock for NOx reducing agent. Unfortunately, anhydrous ammonia, as well as aqueous ammonia in strengths above 20%, pose significant dangers to human health and are classified by OSHA as hazardous chemicals. Their transportation, storage and handling triggers serious safety and environmental regulatory requirements for risk management plans, accident prevention programs, emergency response plans and release analysis. Aqueous ammonia solutions with low concentration present lower health and safety risks but their usage results in a substantial increase in operating costs of SCR and SNCR systems. Recent tragic accidents involving release of anhydrous ammonia (such as the one in Minot, North Dakota on January 18, 2002) and potential threats of terrorist attacks demonstrate the utmost importance of substituting ammonia with a safer reagent feedstock.

An alternative approach to ammonia supply suggested in the late eighties included using benign urea feedstock to generate ammonia on site. Urea is an environmentally safe material used primarily as fertilizer. It can be safely transported, stored and handled at the plant site, without special precautions. In this case there is no need to transport and store a dangerous chemical and the amount of ammonia in the system at any moment is significantly smaller than the EPA reportable spill quantity.

Urea hydrolysis is the preferred process for converting urea/water solution into a gaseous mixture containing ammonia, carbon dioxide and water vapor. The amounts of CO_2 and H_2O injected with ammonia are negligible when compared with concentrations of these components already present in the flue gas. Hera, LLC and Siirtec Nigi S.P.A. pioneered commercial technology for generating ammonia from urea, on site and on demand. In 1999 this technology, "Ammonia on Demand", was licensed to Environmental Elements Corporation for the North American market and the first large scale AOD™ system was installed and operational before the 2000 ozone season.

With AOD™ systems (over 20 units installed treating over 12,000 MW) successfully completing their fourth ozone season of operation, urea based ammonia generation systems are used in lieu of anhydrous ammonia or aqueous ammonia solutions to provide a safer, more environmentally friendly source of ammonia for utility SCRs.

As with every new technology, the AOD™ systems progressed in their development. The prototype system generating 600 lb/hr ammonia at a New England power plant proved the importance of the main patented features of the AOD™ system:

- Efficient multistage hydrolyser design, providing high turn down ratio and ramp rate, load following and fully automatic operation.
- Lean urea solution recycling concept, reducing energy consumption and accumulation of impurities in the hydrolyser.

The second generation of AOD™ system incorporated improvements in the following areas:

- Dry urea handling
- Reduced liquid carryover
- Improved instrumentation
- Automatic operation of multiple hydrolyzers and multiple SCRs.

Second generation systems demonstrated impressive performance and availability records, and prompted different goals for development of the third generation systems:

- Development of standard designs for several sizes in the range 125 to 4,000 lbs ammonia per hour with standardized components
- Elimination of unnecessary redundancies
- Reduction of steps in dry urea handling and storage
- Substantial reduction in capital and installation costs.

The third generation units, operating for the 2002 ozone season, provided 100% availability and "push button" startups. In 2003 more than a dozen AOD™ units installed at five different plants belong to the latest generation. Most recently these systems were installed at AEP's Clifty Creek and Kyger Creek power plants.

- Each power plant has three 2,000 lb/hr AOD™ hydrolysers feeding into a common manifold which supplies ammonia to all five SCR reactors.
- Each plant has a nominal full load ammonia demand of 3,500 lbs/hr. The full load demand was met with two hydrolysers in service.
- At Kyger Creek the units came on at various times during the ozone season, since the SCR construction was staged and not all were required at the onset of the season.
- At Clifty Creek, all units started up May 1, 2003 and operated flawlessly all season. The plant could operate on one hydrolyser with up to three SCRs in service, and when adding a fourth SCR unit the addition of a second hydrolyser went very smoothly. The switchover from one

hydrolyser to another has been completely automated, and can be done with a single command from the central control system.

- Control of the AOD™ system is through the plant DCS, a Westinghouse control system. AOD™ operating logic has been installed on the central control system, which eliminates and separate control hardware devoted to the AOD™ system.
- The complete SCR- AOD™ system at Clifty Creek has performed very well. Start-up of both the SCR and the AOD™ system were so called "non-events". The systems can routinely achieve 93-94% NOx removal.

The current AOD™ units represent a mature technology with excellent reliability, smooth operation, reduced cost and simplified start-up. This technology is meeting the most stringent requirements of the utility industry.