



Ammonia-On-Demand™ - Mature and Reliable Technology

Hamilton G. Walker

James J. Ferrigan

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Safe Alternative Approach to Ammonia Supply for SCR and SNCR

- Transportation, storage and handling of ammonia triggers serious safety and environmental regulatory requirements for risk management plans, accident prevention programs, emergency response plans and release analysis.
- Recent tragic accidents involving release of anhydrous ammonia (such as the one in Minot, North Dakota on January 18, 2002), and potential intentional acts, demonstrate the utmost importance of substituting ammonia with a safer reagent.
- 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, which can be safely transported, stored and handled at the plant site, without special precautions.

The First AOD™ Installation - 2000 Ozone Season

- Hera, LLC and Siirtec Nigi S.P.A. pioneered commercial technology for generating ammonia from urea, on site and on demand, which led to the first AOD™ system being installed and operational on a utility SCR before the 2000 ozone season (580 MW boiler).
- This system, generating 600 lb/hr ammonia, proved the importance of the primary features of the patented AOD™ system:



- Efficient multistage hydrolyzer 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 hydrolyzer, as well as potential carryover of such impurities to the SCR.

Large Scale (2600 MW) AOD™ System - 2001 Ozone Season

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



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

- These second generation systems demonstrated impressive performance and availability records, and prompted goals for further refinement in the next generation systems.

AOD™ System Generating 7,000 lb/hr of Ammonia



Third Generation AOD™ Systems – 2002 Ozone Season

- **Design Innovations:**
 - Reduced steps in dry urea handling and solution mixing
 - Long term storage of reagent as solution
 - Number of process skids and redundancy minimized
 - Process reliability increased
 - Simplified overall installation
- **Results justified development of standard system offering.**

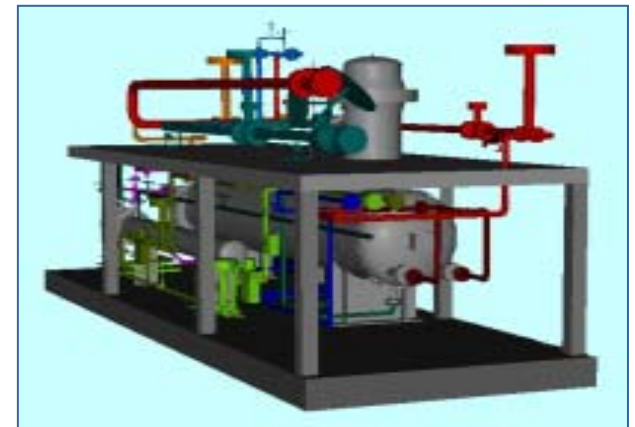
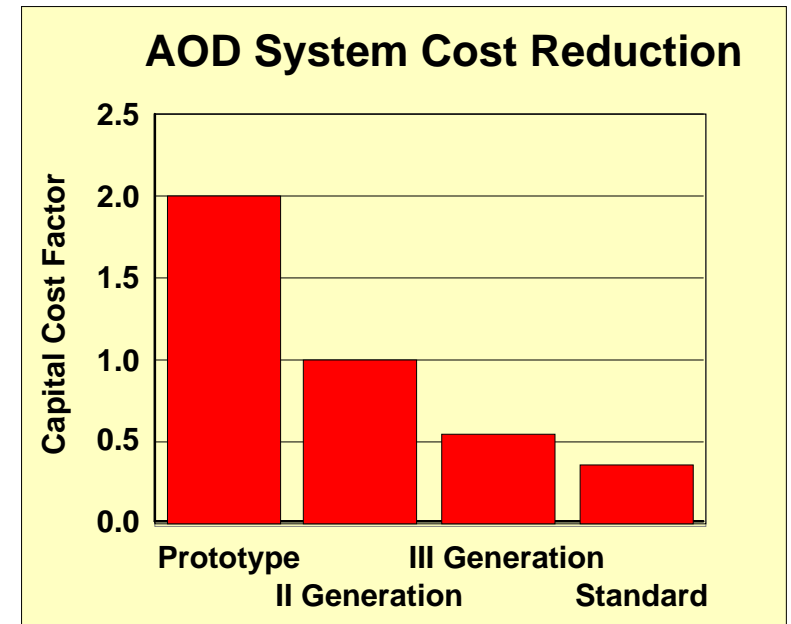


4,000 lb/hr AODTM Module



AODTM Capital Cost Saving Strategy

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



Standard AOD™ Unit Ready for Shipment



Two Most Recent AOD™ Installations - 2003 Ozone Season

- Each power plant has three 2,000 lb/hr AOD™ hydrolyzers 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 is met with two hydrolyzers in service.
- Control of the AOD™ system is through the plant DCS. AOD™ operating logic is installed on the central control system, which eliminates and separate control hardware devoted to the AOD™ system.
- At one plant the AOD™ units came on at various times during the ozone season, since the SCR construction was staged not all were required at the onset of the season.

Two Most Recent AOD™ Installations - 2003 Ozone Season

- At another plant, all units started up May 1, 2003 and operated flawlessly all season.
- The plant could operate on one hydrolyzer with up to three SCR's in service. The addition of a second hydrolyzer for the fourth SCR was accomplished with no interruption in ammonia flow.
- The switchover from one hydrolyzer to another has been completely automated, and is done with a single command from the central control system.
- The complete SCR/AOD™ system has performed very well. Start-up of both the SCR and the AOD™ system were described as non-events.
- The systems are capable of routinely achieve 93-94% NOx removal.

Standard AOD™ System Installation



AOD™ – Mature Technology

- The third generation 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.
- With AOD™ systems (20 units installed treating over 12,000 MW) successfully completing their fourth ozone season of operation, urea based ammonia generation systems are being widely accepted as a replacement for anhydrous or aqueous ammonia systems to provide a safer, more environmentally friendly source of ammonia for utility SCR's.
- The current design, which has been proven to provide reliable operation over two years in 15 installations, is the basis for the standard design over the entire size range of the AOD™ systems.



Contact Information:

James J. Ferrigan

HERA, LLC

www.herallc.com

info@herallc.com

Tel. 949.707.5432

Fax 949.707.5435