Controlled On-Site Urea-to-Ammonia Generation Process (U_2A™)

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The U_2A™ Urea-to-Ammonia Generation Process (patent allowed) is a process developed by EC&C Technologies for use with SCR and SNCR systems. In the process, urea is dissolved into water and injected into a heated in-line reactor at a controlled rate and under conditions to provide a controlled rate of ammonia generation. The process produces a gaseous mixture of ammonia, carbon dioxide and water vapor, which are fed and mixed into the combustion gas stream for use as the reductant in controlling NOx emissions.

The U2A process provides the controlled release of ammonia by thermal hydrolysis of urea according to the overall reaction which includes the intermediate partial hydrolysis of urea to carbamate:

$$NH_2CONH_2 + \quad x\ H_2O <-> NH_2CO_2NH_4 \ -> 2\ NH_3 + CO_2 + (x-1)\ H_2O$$

The overall reaction is endothermic and requires heat input. The rate of the reaction is a strong function of temperature. The reaction kinetics are well understood and were quantified during EPA sponsored SBIR Phase I and II development.

The reactor feed is a solution of approximately 40 to 50% urea in deionized water. At the operating conditions of the reactor the solution approaches equilbrium with respect to the ammonia, ammonium carbamate, dissolved CO2, and urea composition of the reactor liquid.

The hydrolysis reactor operates at elevated temperature and pressure. Operating pressure is maintained in the reactor at a level such that the solution is always maintained below its "boiling" point. Using indirect heat exchange the hydrolysis reactor maintains a closed material balance which provides for straightforward control of ammonia generation based on the temperature of the reactor.

As both ammonia and CO2 are much more volatile than water, the reactor liquid becomes water rich and the ammonia content of the reactor liquid in equilibrium with the vapors is in the range of 2-3%. This limits the total amount of ammonia inventory in the system. The gases are maintained at pressure in the reactor vessel allowing for easily controlled release of ammonia vapors to the process.

The gases leaving the reactor contain only ammonia, carbon dioxide, and water and are further diluted with heated air as a carrier gas such that the ammonia content of the mixture is less than 5% by weight. The resulting gas is maintained at a temperature to avoid water condensation and is delivered to the ammonia injection grid system for the SCR process. For SCR and SNCR systems, NOx reduction results are equivalent to those obtainable with anhydrous or aqueous ammonia.

Utilities, SCR providers and engineering firms have been strongly receptive to this new process which offers the advantage that no storage, shipping, or handling of toxic ammonia solutions is required

Hamon Research-Cottrell and Wahlco Air Systems are exclusive co-licensees of the process. It first commercial demonstration on an existing combined cycle SCR at a New England utility site is expected to be operational in July 2000 to provide confirmation of the work that has already been completed under EPA sponsored grants.