

EFFECTS OF AMMONIA FROM POST-COMBUSTION NO_x CONTROL ON ASH HANDLING AND USE

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Introduction

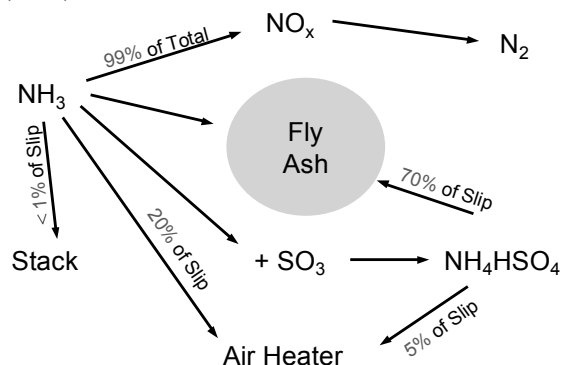
Utilities are increasingly using ammonia-based NO_x reduction processes in response to more restrictive emission limits. Flue gas NO_x can be converted to elemental nitrogen through both high-temperature use of ammonia (SNCR – selective non-catalytic reduction) and the use of ammonia with a catalyst (SCR – selective catalytic reduction). Two technical problems which complicate the use of these technologies are inefficient conversion of ammonia, resulting in ammonia emissions (slip), and the deposition of ammonia on flyash. Several recent efforts have addressed these issues, including the mechanisms for ammonia deposition on ash, as well as resulting effects on ash handling and utilization.

Description of Emissions Control Technologies

SCR and SNCR are the dominant technologies, with SCR more widely used to achieve lower NO_x emissions. SCR is typically located in an area of the boiler between the economizer and air preheater. It operates at a temperature of 600-750 F and uses a chemical catalyst (vanadium pentoxide) to accelerate the reaction of ammonia and NO_x, producing elemental nitrogen. SCR is more efficient than SNCR, producing a slip of 1-5 ppmv. SNCR is located between the combustion zone and the economizer, where it uses the 1600-2000 °F heat as a catalyst for the ammonia and NO_x reaction. The slip is usually greater than 5 ppmv. (Ref. 6)

Ammonia Deposition Mechanisms on Coal Ash

Unreacted ammonia slip typically represents less than 1% of the injected ammonia. In conditions where there is adequate sulfur present (from coal or sulfur burners for ESP performance), Figure 1 shows that the majority of sulfur will form ammonium bisulfate, which is a sticky liquid that adheres to the surface of flyash or to downstream equipment such as air preheaters. For subbituminous coal, ammonia does not have an affinity for the alkaline Class C ash. In such cases, most of the ammonia slip goes up the stack. (Ref.1)



Note: Example values shown for bituminous coal

Figure 1. Fate of ammonia in flue gas

Effects on Utilization Applications

Early results from the U of K project funded by DOE (Ref. 5) indicate that mortar specimens do indeed evolve ammonia under high pH conditions, although the evolution rate is significantly slower than original expectations. As an example, after 500 hours, almost 80% of the initial ammonia was still present in these samples. (Note that EPRI project results (Ref. 2,3) indicate a much faster evolution rate for actual concrete specimens.) Recommendations from this work include a limit of 100 ppmw ammonia for ash used in concrete placed in unvented areas. For well-ventilated areas, the recommended limit is 200 ppmw ammonia. Figure 2 presents a consensus of industry opinions on recommended limits and actions for fly ash containing various levels of adsorbed ammonia.

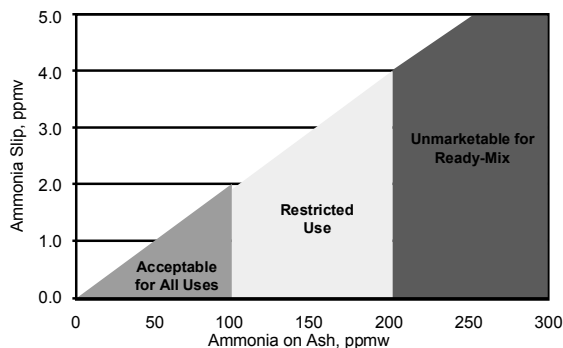


Figure 2. Acceptable levels of ammonia on ash

Note that no results have been reported which indicate decreased performance of concrete or other products containing ammoniated ash.

Effects on Ash Handling and Disposal

Limited experimental data is available at this time for confirmation of issues associated with handling and disposal of ammoniated ash. For evolution of ammonia as a gas, the key driver appears to be pH. At pH values less than 11, evolved ammonia appears to be small during water addition for ash conditioning prior to landfilling. (Ref. 2,3) Ammonia readily dissolves in water, creating greater potential concerns such as nutrient load and aquatic toxicity for water in sluice streams and effluent streams from ponds. (Ref. 4)

Beneficiation Methods

Proven beneficiation methods include combinations of heat and moisture to force faster evolution of ammonia. However, capital and O&M costs associated with the required 700 °F temperature could be significant, unless inexpensive heat is available.

Alternatives include addition of strong oxidants such as sodium hypochlorite to destroy the ammonia prior to evolution. Little published information is available concerning required concentrations for complete inhibition of ammonia evolution, although the EPRI project has reported a 50% reduction in ammonia evolution using a 1.0% solution of sodium hypochlorite. (Ref. 2,3)

Survey of Current Experiences

Table 1 summarizes some of the ammonia issues described in this document above. In 1999 Southern Company performed an informal phone survey of operating SCR and SNCR installations. Results revealed that a majority of these plants sometimes

experienced detectable ammonia odors; however, most were still able to utilize ash for beneficial purposes.

Table 1. SCR/SNCR survey results

		<u>Sites</u>
Ammonia Slip	0 - 5 ppm	12
	> 10 ppm	3
Ammonia on Ash	50 - 300 ppm	3
Ash Handling System	Dry	15
	Reinject Ash	1
Ash Disposal Method	Landfill	14
	Mine Reclamation	2
Ash Utilization	Concrete/Flowable Fill	8
	Other	4
Detectable Odor	At Plant, Disposal, Uses	10

References

1. *Investigation of Ammonia Adsorption on Fly Ash and Potential Impacts of Ammoniated Ash*, Electric Power Research Institute Report TR-113777, December 1999.
2. *Behavior of Ammoniated Fly Ash*, EPRI Report 1003981, February 2002.
3. *Impacts of Ammonia Contamination of Fly Ash on Disposal and Use*, EPRI Report 1004609, October 2001.
4. *Environmental Issues Associated With Ammonia*, Southern Company Internal Publication, July 1999.
5. Rathbone, R. and Robl, T., *A Study of the Effects of Post-Combustion Ammonia Injection on Fly Ash Quality: Characterization of Ammonia Release from Concrete and Mortars Containing Fly Ash as a Pozzolanic Admixture*, University of Kentucky Technical Progress Report, Department of Energy Cooperative Agreement No. DE-FC26-00NT40908, October 2001.
6. Larrimore, L., Monroe, L., Dodgen, D., *Characterization of Ammonia Effects on Ash and Evaluation of Removal Methods*, American Coal Ash Symposium, Orlando FL, January 1999.