

# High efficiency Ammonia Injection Grid (AIG) for SCR systems

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## Summary

To reduce nitrogen oxides in flue gases, which are produced by combustion facilities and incinerators, the SCR process as a stable and approved technology is the most frequently used measure. In the SCR system, nitrogen oxides are reduced to nitrogen and water vapor by the addition of ammonia based reactants in the presence of a selective catalyst.

INTEGRAL has the know-how to design a total SCR system, including the storage, handling and preparation for all kinds of reducing agents. INTEGRAL's proprietary AIG shows excellent results when using pure ammonia, aqueous ammonia or urea. The production of pure ammonia out of aqueous ammonia or urea is an INTEGRAL process technology based on past history.

According to the reaction kinetics of SCR catalysts, the effectiveness of the SCR process is strongly dependant upon the degree of mixing between ammonia and nitrogen oxides. Insufficient mixing of the reducing agent and NOx mass flow necessitates an uneconomically large catalyst volume and/or high NH3 slip to meet the required NOx emission values.

Based on INTEGRAL's process technology and past projects, we have developed a highly efficient and cost saving injection system for a homogeneous distribution of the reducing agent matching the NOx profile of the flue gas, especially for large applications. Patents have been granted and patent applications submitted in a number of countries.

Our injection system combines the requirements of distribution and static mixing with a low-pressure drop and saving of valuable duct space. This can be achieved by introducing an adjustable amount of ammonia with a nozzle lance at a multitude of locations strategically located within a cross section of the flue gas duct, and producing turbulence of the flue gas at the locations at which ammonia is introduced. This will lead to an intensive mixing of the reaction media, combined with a very small pressure drop and minimum space requirements.

Therefore INTEGRAL's AIG system provides a method to achieve homogeneous conditions even in the case of limited space (short distance between ammonia injection and catalyst). This, as a consequence, will lead to smaller boiler dimensions and significantly lower overall investment costs.

The following example shows the first application of the “high efficiency AIG” integrated in the HRSG of a gas turbine. Because of the limited space between the AIG and the catalyst, intensive flow model tests were performed. In these flow model tests, one injection element was also tested at 1:1 scale. Not only did the flow model test perform as expected, this system has been successfully applied in a number of other plants.

Design data:

Flue gas volume	1,210,000 SCFM	(1,950,000 Nm <sup>3</sup> /h)
Hydrous ammonia consumption	0 to 6,614 lb/h	(0 to 3,000 kg/h)
Cross section of flue gas duct	68'-11" x 39'-4"	(21 x 12 m)
Maximum space for AIG	2'-0"	(0.6 m)
Maximum mixing space	3'-11"	(1.2 m)

Realization:

Because of the very high demand on the homogeneous distribution of ammonia we have carried out extensive model testing and optimization. For this purpose, a real size segment was built and tested. Dimensions of the testing segment were 8'-2" x 3'-11" (2.5 x 1.2 m).

All details such as number, type and arrangement of the single components of the system have been varied, tested and optimized.

Because of the excellent results the new ammonia injection system was implemented in the commercial plant in real size. The AIG was manufactured in optimal pre-fabricated segments to help minimize erection and transportation costs.

Results:

Customer's required homogeneous distribution of +/- 5% RMS could be satisfied in all load conditions with the following results:

Load	nominal load	partial load
Deviation	3.4 to 4.0 % RMS	4.0 to 4.8 % RMS

Pressure drop:

The required pressure drop for the ammonia injection of 0.18 inch WC (0.5 mbar) could be reached easily with our system. Measured pressure drop only reached values of about 0.04 inch WC (0.1 mbar).

Integral's experience extends beyond the storage, the handling and the preparation of ammonia out of any reducing agent. It also covers the catalyst design and the injection of the reducing agent into the flue gas with homogeneous mixing in a short space upstream of the catalyst. Thus, it is the most cost saving design not only for investment but also for operation.

This first successful installation of INTEGRAL's 'high efficiency AIG' (installed in 1998) has been implemented in several plants in Europe and Asia to the full satisfaction of our customers.