SCR: California cleaning

RJM ARIS* (Advanced Reagent Injection System) selective catalytic reduction (SCR) technology recently achieved a 95.9 per cent cut in NO_X emissions on a lean burn natural gas engine in California.

Ravi Krishnan, *RJM Corporation, Norwalk, CT, USA*

The RJM ARIS SCR system was installed on an engine at the corporate headquarters of Clean Air Partners located in San Diego, California. This 320 kW lean burn natural gas engine is expected to generate reliable prime power, but being located in Southern California, it is subject to some of the USA's most stringent air quality regulations.

ARIS SCR technology meters precise amounts of a safe, easy-to-use reagent into the exhaust stream of a diesel or lean-burn natural gas engine. Once in the exhaust, the reagent decomposes and forms ammonia, which passes over a catalyst to turn NO_x into H_2O, N and CO_2.

The ARIS SCR system was delivered and installed on the Clean Air Partners engine in less than two months. The 95.9 per cent reduction achieved has resulted in a NO_x level of 12 ppm.

The unit was tested at an outside temperature of 15ºC (60°F), exhaust temperature of 520 °C. The high temperature catalyst used in the system operates up to 550°C. Table 1 shows NO_x reductions for various load factors.

Urea consumption and economics

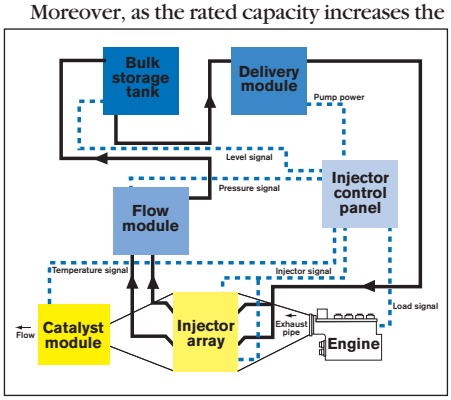
The calculated urea consumption for the engine when operating at 98.5 per cent load conditions was approximately 0.38 gallons/hour. Cost of the urea is about $1.25/gallon in bulk. For example, at 4000 hours of annual operation, total urea consumption cost is less than $1900 per year. Urea consumption for natural gas engines is considerably lower than for diesel engines because of lower baseline NO_x emissions associated with natural gas engines.

Total annualised cost of the system is estimated to be $3846 per ton of NO_x removed, at 4000 hours of operation per year (Table 2). The ARIS SCR system becomes more attractive at 8000 hours of operation, with annual cost/ton estimates for NO_x removed falling to $2205.

Such compliance cost estimates are exceptionally attractive for a natural gas engine, which has lower baseline NO_x emissions (and therefore lower NO_x tonnage reduction potential) when compared with diesel as well as lower additive (urea) costs.

Moreover, as the rated capacity increases the relative cost of compliance is lower due to the fixed nature of hardware and catalyst costs.

The lower rectangular housing on the extreme right (top of trailer) is the ARIS SCR system catalyst



Schematic of ARIS installed on gas engine

Clean and reliable

The successful test results from Clean Air Partners clearly prove that a natural gas engine can generate clean and reliable prime power at an affordable compliance cost.

Table 1. Performance of ARIS SCR system installed on 320 kW gas engine at Clean Air Partners for various load fctors

Load, % of rated	Load, kW	O_2,%	Temp, °C	Outlet NO_X, ppm	Corrected to 15% O_2	% NO_X reduction
52.6	171	9.4	530	14	7	95.9
67.1	218	9.1	550	26	13	92.2
78.5	255	9.6	530	7	4	97.3
93.2	303	9.3	530	14	7	95.3
98.5	320	9.0	520	12	6	95.9

Table 2. NO_x compliance costs for SCRs on natural gas engines

Annualised operating costs	4000 hours of operation	8000 hours of operation
capital cost recovery - hardware[1]	$3048	$3048
capital cost recovery - catalyst	$7944	$7944
variable operating costs	$1892	$3784
Total annual costs	$12884	$14776
Total tons of NO_x removed	3.35	6.70
Annual cost/ton of NO_x removed	$3846	$2205

[1] *Capital costs are recovered over a five year period*

Emissions reduction: an expanding armoury

RJM Corporation has recently expanded its range of technologies on offer for emissions control at large reciprocating engines, which includes ARIS (see main article), with the launch of the RJM A3 SCR system.

This SCR technology is geared towards achieving up to 98 per rent NO_X reduction in addition to CO and HC reductions on large stationary reciprocating engines at an affordable compliance cost.

The RJM A3 SCR system is specifically designed for dual fuel engines that require a large turn down ratio of reagent flow. The system modulates the urea flow over a turndown rate of 40:1, making it an attractive proposition for reciprocating engines over 3 000 hp.

The technology is designed around RJM's atomiser and controls technology. The atomiser is custom built to the engine requirements and tested using a laser Doppler beam for droplet size and spray quality. The control system is PLC based using Allen Bradley SLC components.

The RJM A3 SCR system is expected to make power production costs for large diesel and gas reciprocating engines more competitive. The overall NO_X removal efficiency of the system coupled with the capital and operating cost savings over competing NO_X reduction technologies are expected to lower compliance costs and significantly reduce production costs.

*ARIS is a trademark of Clean Diesel Technologies, Stamford, CT, USA.

Reprinted from Modern Power Systems August 2002