SCR and Advanced Ammonia Slip Catalyst

Alec Miller
Business Manager, Process Technology
JM Stationary Emissions Control LLC

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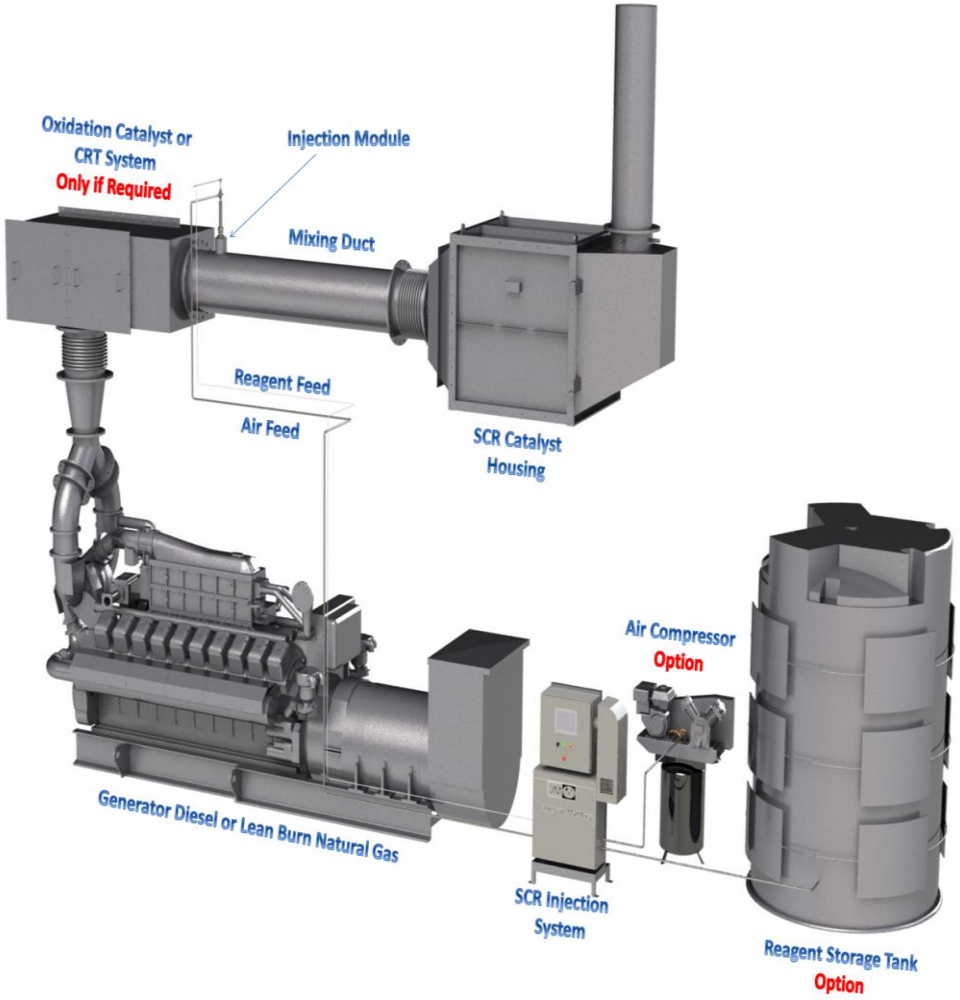
Johnson Matthey

EMISSION CONTROL TECHNOLOGIES

SCR System Configuration & Ammonia Injection

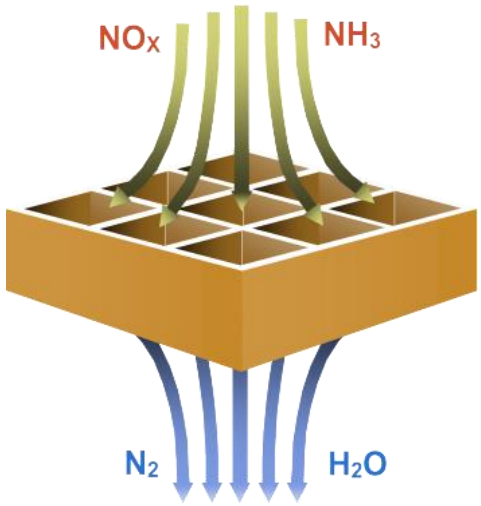
Engines



Turbines / Boilers

SCR uses NH_3 as the reductant to remove NOx from lean exhaust

Reaction stoichiometry: one molecule NH_3 reacts with one molecule of NOx

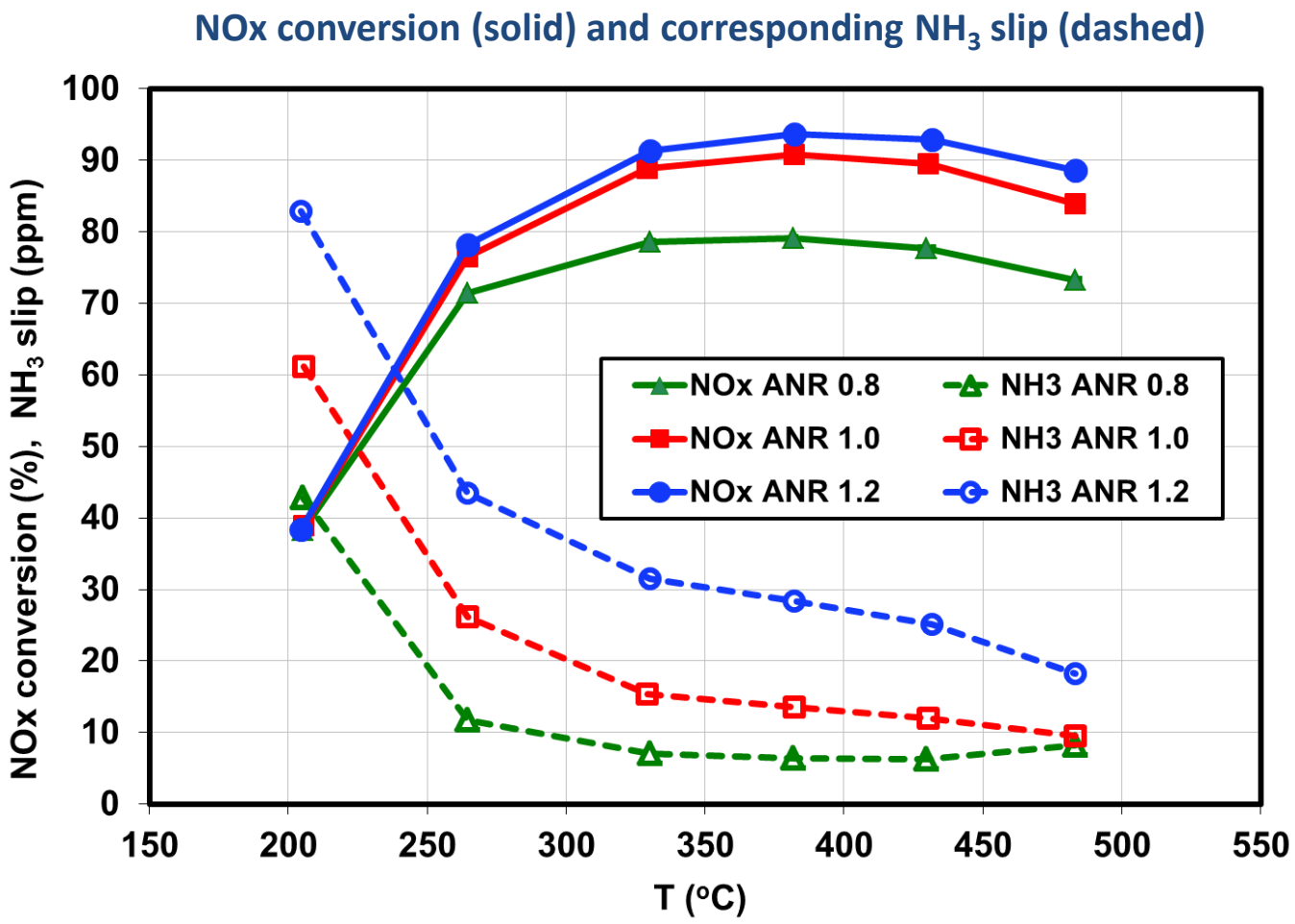


Relevant chemical reactions:

$4\ NH_3 + 4\ NO + O_2 \rightarrow 4\ N_2 + 6\ H_2O$	*standard SCR reaction (fast)*
$4\ NH_3 + 2\ NO_2 + 2\ NO \rightarrow 4\ N_2 + 6\ H_2O$	*fast SCR (very fast)*
$4\ NH_3 + 5\ O_2 \rightarrow 4\ NOx + 6\ H_2O$	*undesired reaction (above 425°C)*
$4\ NH_3 + 4\ NO + 3\ O_2 \rightarrow 4\ \mathbf{N_2O} + 6\ H_2O$	*undesired reaction (**GHG**)*

Note: there are other reaction pathways but these reactions dominate in lean exhaust

Relationship between NOx conversion, NH_3 slip, ammonia NOx ratio (ANR)



At ANR 0.8 max NOx conversion is 80% (1:1 stoichiometry) and because there is insufficient NH_3 NH_3 slip is low

At ANR 1.0 the max NOx conversion achieved here is higher, but with higher NH_3 slip

At ANR 1.2 excess NH_3 enables even higher NOx conversion, but with much higher NH_3 slip

Increase NH_3 → increase NOx conversion but increase NH_3 slip

Advanced ammonia slip catalyst (ASC) technology significantly improves overall SCR performance

Even the optimal catalyst cannot achieve maximum NOx conversion with non-uniform NH_3 distribution

Non-uniform NH_3 distribution can be a result of:

- Flue gas mal distribution
- Control system / Injection system
  - Location of sample ports, CEMS system, AIG Configuration or tuning
- Fluctuating load or inlet NOx values
  - NH3 Injection won't match NOx

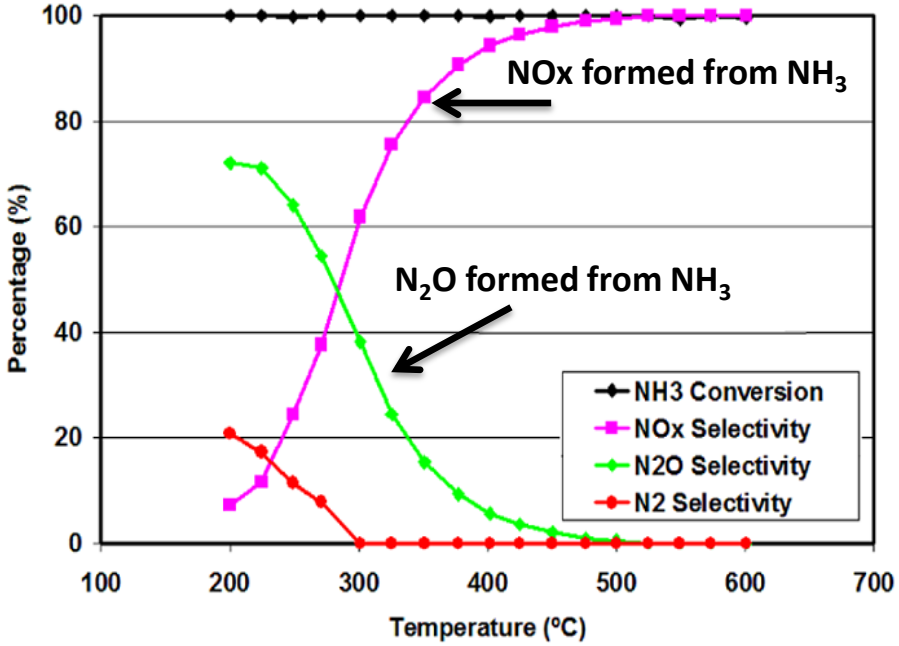
Non-uniform NH_3 distribution can result in localized ANRs:

- ANR < 1 results in incomplete NOx conversion
- ANR >1 results in NH_3 slip

Ammonia Slip Catalyst (ASC) can compensate for non-uniform NH_3 distribution
ASC allows operation at higher ANR boosting NOx conversion with low NH_3 slip

Advanced dual-function ASC is very selective to N_2

(selectivity = fraction of specific product)

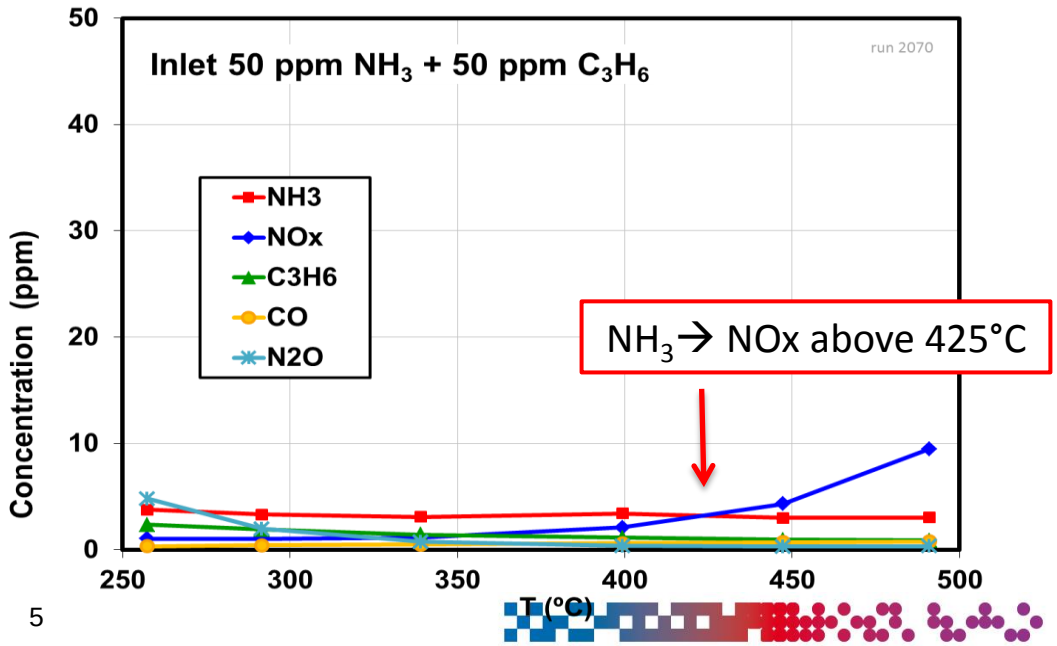


Previous generation ASC:

- 20 ppm NH_3 fed to reactor
- Very active for NH_3 conversion
- N_2O formed at low T, NOx formed at high T
- **Not selective to N_2**

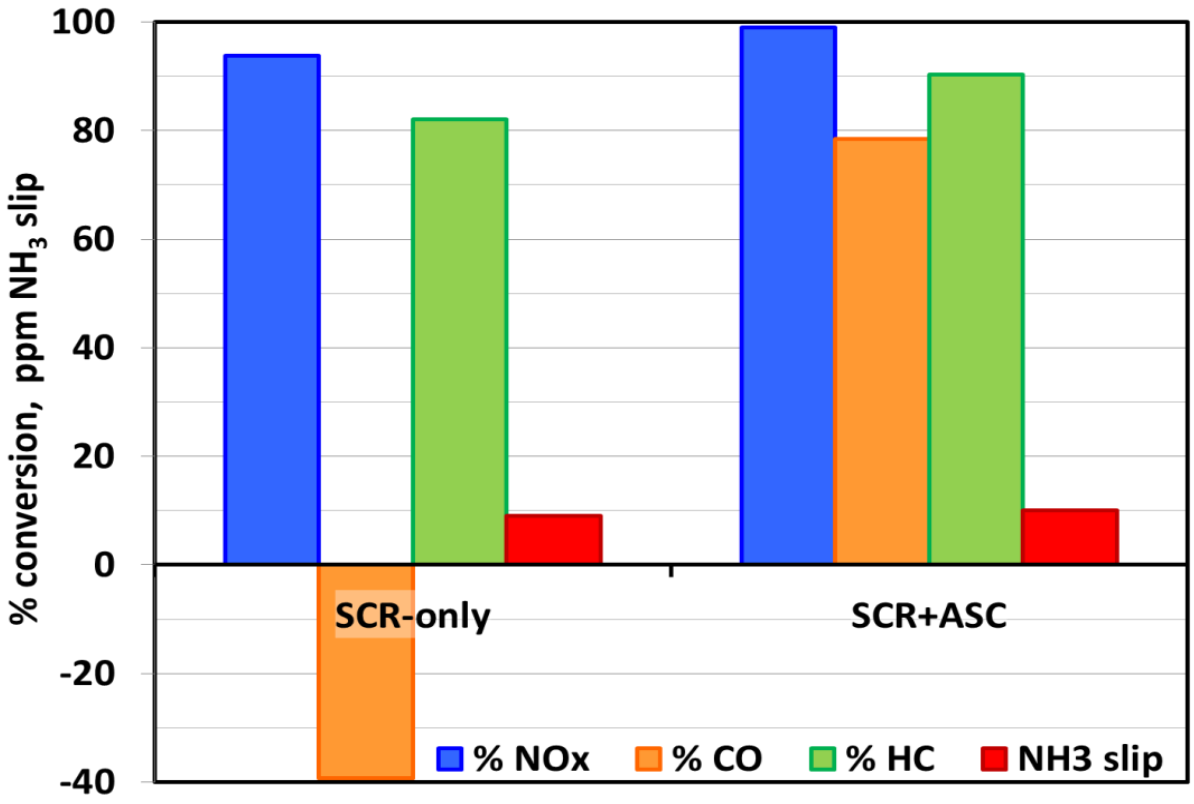
Advanced dual-function ASC:

- 50 ppm NH_3 + 50 ppm HC fed to ASC
- Very active for NH_3 conversion
- NH_3 exiting ASC is very low
- Formation of NOx, N_2O is very low
- **Highly selective to N_2**



Additional benefits of adding ASC to SCR catalyst system

- Allows operation at higher ANR increasing NOx conversion at low NH_3 slip
- ASC improves HC conversion
- Incomplete combustion of HC over V-SCR results in formation of CO
- ASC provides CO conversion
- In some applications, use of ASC can eliminate the need for an oxidation catalyst



Engine data: equal volumes SCR and SCR+ASC

Thank You