Typical Catalyst Operation Window

SCR Catalysts Operating Window

- Precious Metal Catalyst
- Base Metal Catalyst
- Zeolite Catalyst

NOx Conversion % vs Temperature

Temperature: 400°F to 600°F
Boiler with SNCR

AMMONIA/UREA INJECTION ZONES (LOWER TEMPERATURE OPTIONS)

ECONOMIZER

STACK

AMMONIA OR UREA FROM SUPPLY SYSTEM

AMMONIA/UREA INJECTION ZONE (HIGH TEMPERATURE OPTION)

AIR

FURNACE

FUEL
Selective Non-Catalytic Reduction

**Ammonia**

- \[ \text{NH}_3 \]
- \[ \text{NH}_3 + \text{OH} \rightarrow \text{NH}_2 + \text{H}_2\text{O} \]
- \[ \text{NH}_2 + \text{NO} \rightarrow \text{N}_2 + \text{H}_2\text{O} \]

**Urea**

- \[ \text{NH}_2\text{CONH}_2 \]
- \[ \text{NH}_3 + \text{HNCO} \]
- \[ \text{HNCO} + \text{OH} \rightarrow \text{NCO} + \text{H}_2\text{O} \]
- \[ \text{NCO} + \text{NO} \rightarrow \text{N}_2\text{O} + \text{CO} \]
- \[ \text{N}_2\text{O} + \text{H} \rightarrow \text{N}_2 + \text{OH} \]
- \[ \text{N}_2\text{O} + \text{OH} \rightarrow \text{N}_2 + \text{HO}_2 \]
- \[ \text{N}_2\text{O} + \text{M} \rightarrow \text{N}_2 + \ldots \]

**Products**

- \[ \text{N}_2 \]
- \[ \text{N}_2\text{O} \]
# SCR vs. SNCR

<table>
<thead>
<tr>
<th></th>
<th>SNCR</th>
<th>SCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOx Reduction</td>
<td>20-50%</td>
<td>50-95%</td>
</tr>
<tr>
<td>Hardware</td>
<td>Simple</td>
<td>More Complex</td>
</tr>
<tr>
<td>Capital Cost</td>
<td>Low (1)</td>
<td>High (5-10)</td>
</tr>
<tr>
<td>Reagent Utilization</td>
<td>Typ. 30%</td>
<td>Almost 100%</td>
</tr>
<tr>
<td>O&amp;M</td>
<td>Reagent</td>
<td>Reagent/Catalyst</td>
</tr>
<tr>
<td>Designability</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>NH3 slip</td>
<td>5-20 ppm</td>
<td>&lt;10 ppm</td>
</tr>
</tbody>
</table>
Typical packed scrubber

Exhaust gases
Mist eliminator
Spray bars
Packing
Scrubber inlet gas
Slurry tank

Liquor flow and pH monitoring
Recirculation liquid pumping system and liquor make-up
Carbon Adsorber – Fixed Bed Schematic
Catalytic Oxidizer/Incinerator

Auxiliary Fuel Burners

Catalyst Bed

Waste Gas

Optional Heat Recovery

Stack
Recuperative TO
Catalytic Recuperative
Regenerative TO

Natural Gas Burner

Heat Exchange Media

Process Inlet
RTO Operation
How a Cyclone Works
Baghouse Cleaning Methods

Mechanical Shaker

Fabric-filter baghouse

baghouse enclosure

shaker mechanism

filter bag

clean air outlet

dusty air inlet

collection hopper

trapped dust on inner bag surface

cell plate (point of attachment for open bag ends)
Baghouse Cleaning Methods

Reverse Air

SINGLE BAG SCHEMATIC

- EXHAUST
- REPRESSURING VALVE
- FILTERING MODE
- COLLECTION HOPPER
- COLLAPSING (BAG CLEANING MODE)
- Dust laden air
- Tubesheet
- Filter Bag
- Bag clamp
- Reverse air cleaning
Clean Air
Clean Air Plenum
Pulse Pipe
Pulse Jet
Bag
Cage
Venturi
Solenoids
Dust-Laden Air
Inlet Baffle

Pulse Jet Baghouse
Electrostatic Precipitator
Venturi Scrubber
What is a DPF

Soot Collects Along the Inlet Walls

Particulate Matter or Soot Entering

Cells Fill Up: Physical

Clean Exhaust Out
Diesel Particulate Filter is integrated in the exhaust piping.

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