SÜD-CHEMIE

Catalysis & Energy

Catalysts for Industrial exhaust gas treatment

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- Catalysts for Industrial Exhaust gas treatment
Air Pollution & Regulatory standards

Development of Air Pollution Regulations

Major drivers:
1. Protection of human health,
2. Protection of all living organisms,
3. Protection of ozone layer / Stop of Climate change

Started in 1979: Convention on Long-Range Trans-Boundary Air Pollution

Most popular: UNFCCC “Framework Convention on Climate Change” incl. Kyoto Protocol, COP 21

Major Air pollutants

Technologies for Emission Control

- Absorption of Pollutants in Liquids or Solids, e.g. water, acidic or basic chemicals (e.g. calcium hydroxide for sulphur dioxide) using dry or wet scrubbers.
- Adsorption of Pollutants e.g. on activated carbon or zeolites
- Mechanical Separation like filters, electrostatic precipitator or cyclones
- Catalytic or Thermal Oxidation
- Catalytic and Non-Catalytic Reduction
## Industrial Air Pollution Emission Standards

<table>
<thead>
<tr>
<th>Industries</th>
<th>SOx</th>
<th>NOx</th>
<th>PM</th>
<th>CO</th>
<th>VOC/TOC</th>
<th>NH₃</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mg / Nm³</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pesticides</td>
<td>200</td>
<td>20-50</td>
<td>100</td>
<td>20</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Pharma-Incinerator</td>
<td>200</td>
<td>50</td>
<td>100</td>
<td>20</td>
<td></td>
<td></td>
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<tr>
<td>Dyes &amp; Dyes Intermediate</td>
<td>200</td>
<td>50</td>
<td>100</td>
<td>20</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Waste Incinerators</td>
<td>200</td>
<td>400</td>
<td>50</td>
<td>50 - 100</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Petro-chemicals</td>
<td>50 – 1700</td>
<td>250 – 450</td>
<td>10 – 100</td>
<td>100 – 200</td>
<td>0.1 - 150</td>
<td></td>
</tr>
<tr>
<td>Power plants</td>
<td>100-600</td>
<td>100-600</td>
<td>30-100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cement Plant</td>
<td>100</td>
<td>600-800</td>
<td>30-100</td>
<td></td>
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</tbody>
</table>

**Our offering**

- Oxidation Catalysts
- Reduction (SCR) Catalysts
- Oxidation Catalysts
Catalysts for Exhaust gas treatment

Catalyst lower the activation energy at which the reaction takes place

Pollutants/Impurities from exhaust stream are removed catalytically through oxidation or reduction

Oxidation
• Volatile Organic Compounds
• Carbon Monoxide
• Hydrocarbons
• Soot
• Ammonia
• Hydrogen

Reduction
• N₂O
• NOₓ

Adsorption
• Hydrocarbons
• H₂S
Oxidation catalysts
VOC AND CO-OXIDATION

Compared to thermal oxidation, catalytic incineration enables oxidation to occur at lower temperatures, helping lower operating costs and reduce stress on equipment.

ADVANTAGES

• Superior mechanical properties
• Low oxidation temperature
• Wide range of operating temperatures
• Low operational pressure drop
• High thermal durability
• Low catalyst volume required
• Long operational life time
Chemical Off-Gas Application

- Acrylic Acid (AA)
- Polyethylene Terephthalate (PET)
- Phthalic Anhydride (PA)
- Acrylonitrile (AN)
- Phenol/Acetone
- Maleic Anhydride (MA)
- Methyl Methacrylate (MMA)
- Formaldehyde (FA)
- Urea Production (H2 removal in CO2)
- Purified Terephthalic Acid (PTA)
- CO2 Purification
- PO/SM – Propylene oxide/Styrene monomer
- Cyclohexanone
Reduction catalysts
NO\textsubscript{x} and N\textsubscript{2}O REDUCTION

Standard SCR: \(4 \text{NH}_3 + 4 \text{NO} + \text{O}_2 \rightarrow 4 \text{N}_2 + 6 \text{H}_2\text{O}\)
Fast SCR: \(4 \text{NH}_3 + 2 \text{NO} + 2 \text{NO}_2 \rightarrow 4 \text{N}_2 + 6 \text{H}_2\text{O}\)
NO\textsubscript{2} SCR: \(4 \text{NH}_3 + 2 \text{NO}_2 + \text{O}_2 \rightarrow 3 \text{N}_2 + 6 \text{H}_2\text{O}\)

**EnviCat® NO\textsubscript{x} Blue**
- Low T NO\textsubscript{x} conversion (T: 200 – 450°C)
- Available as ceramic or metallic honeycomb monoliths, Pellets

**EnviCat® NO\textsubscript{x} Yellow**
- Medium T NO\textsubscript{x} conversion (T: 250 – 450°C)
- Available as ceramic or metallic honeycomb monoliths

**EnviCat® NO\textsubscript{x} Red**
- High T NO\textsubscript{x} conversion (T: 325 – >600°C)
- Available as ceramic or metallic honeycomb monoliths, pellets

**ADVANTAGES:**
- High-performance operation through a broad temperature range
- Reduced ammonia slip with EnviCat® NOx Blue and Red catalyst series
- Achieve high levels of NH3 conversion with only low formation of N2O or NOx
- High selectivity
Reduction catalysts
NITROUS OXIDE REDUCTION

$N_2O$ has a life time of 120 years and global warming potential (GWP) is 280 times more than CO2

EnviCat® $N_2O$ series of catalysts are offered in varieties to be effective in both nitric acid production and in secondary nitric acid installations.

**ADVANTAGES**

- **Drop-in catalyst solution**
- **Long-life**
- **High activity improves conversion of $N_2O$ (up to 100%)**
- **Helps increase yields in nitric acid plants**
- **Variety of shapes depending upon need**
Selective Catalytic Oxidation (SCO) of NH₃

• Our EnviCat® series of catalysts selectively oxidize NH₃ to Nitrogen without creating NOx

$$4 \text{NH}_3 + 3 \text{O}_2 \rightarrow 2 \text{N}_2 + 6 \text{H}_2\text{O}$$

Sulphur/H₂S removal Catalysts

• Our EnviCat®/ Actisorb/ HDMax series of catalysts and Adsorbents remove sulfur compounds from exhaust gas
Design considerations

- Systems are designed based on
  - Inlet concentration
  - Conversion requirements
  - Temperature limitations
  - Space velocity
  - Pressure drop
  - Durability
  - Safety
  - Dust
  - Catalyst poisons

Types of Catalysts/Carriers
SÜD-CHEMIE Offers

- Wide range of Environmental Catalysts for Off-Gas treatment.

- State-Of-Art Facility in India and World Wide

- Customized solutions and after sales services

- Technical support, feasibility study

Thank You