



## 2nd U.S. - China NOx SO2 Control Workshop

# Selective Catalytic Reduction 选择性催化还原介绍 ( SCR )

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2005-08-04





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# Introduction of Corning and Cormetech

## 康宁(Corning)和Cormetech简介





# 美国康宁公司 Corning, Inc (GLW)

- 创建时间： 1851  
Established: 1851
- 总部： 美国纽约州康宁镇  
Headquarters: Corning, New York
- 员工数： 全球25,000人  
Employee: 25,000
- 2004 收入： 38亿美金  
2004 Revenue \$3.8 Billion



《财富》500强公司





# Market Segments and Additional Operations

## 市场领域分布

### SEGMENTS

Display  
Technologies  
显示科技

- LCD Glass Substrates

Environmental  
Technologies  
环保科技

- Automotive Emissions Control
- Diesel Emission Control
- Molten Metal Filters
- Selective Catalytic Reduction Catalysts

Telecommunicatio  
n电信科技

- Optical Fiber and Cable
- Hardware and Equipment

Life Sciences  
生命科学

- Microarray Products
- Drug Discovery and Genomics
- Cell and Molecular Biology
- General Laboratory Products

### ADDITIONAL OPERATIONS

- Semiconductor Optics
- Photonic Materials
- Technical Materials
- Mirrors and Windows
- Ophthalmic Products
- Steuben
- Dow Corning Corporation



CORMETECH

# Science and Technology 科研投入

- 2000年超过5亿美元的研发投入  
More than \$500 million spent on research and development in 2000
- 超过1600位的科学家和工程师分布于全球的康宁网络  
More than 1600 scientists and engineers

- 每年超过100项的发明专利  
100+ patents a year
- 2000年美国国家科技奖章  
2000 National Medal of Technology
- 位于纽约、法国、俄罗斯、日本和英国的机构  
Facilities located in New York, France, Russia, Japan, and England



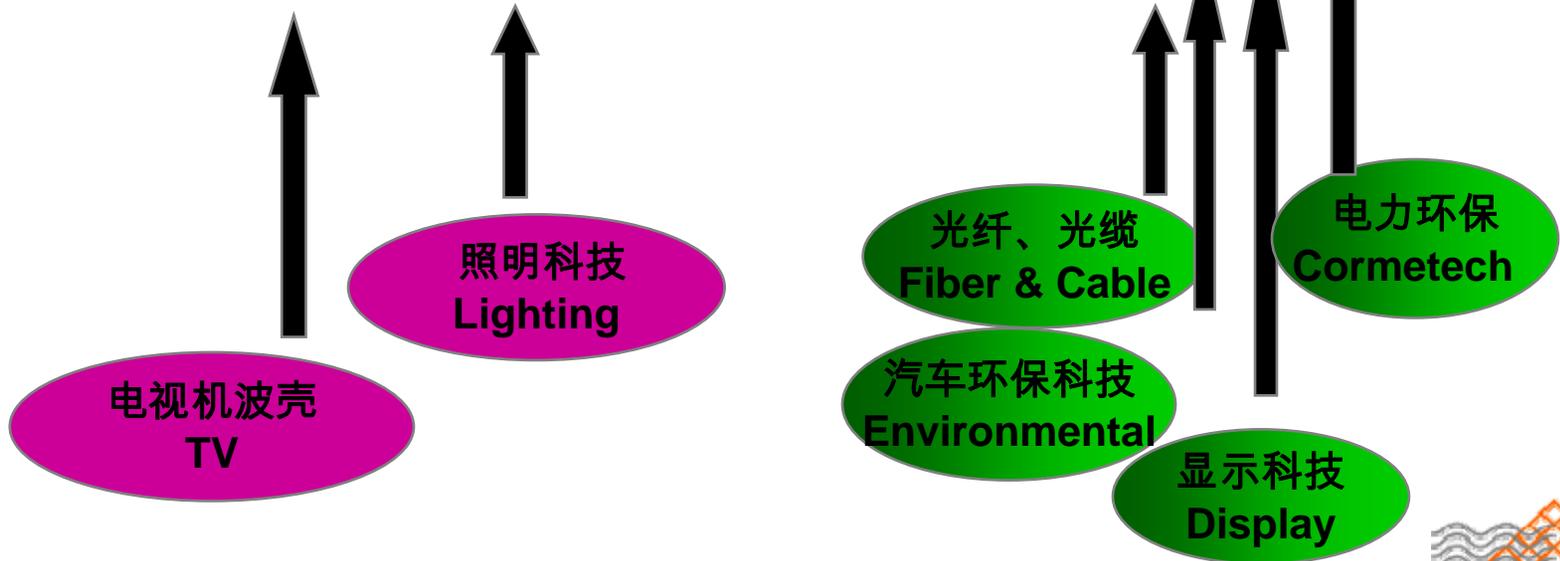


# Corning Has Built a Long-Term Partnership with China 与中国建立长期的合作

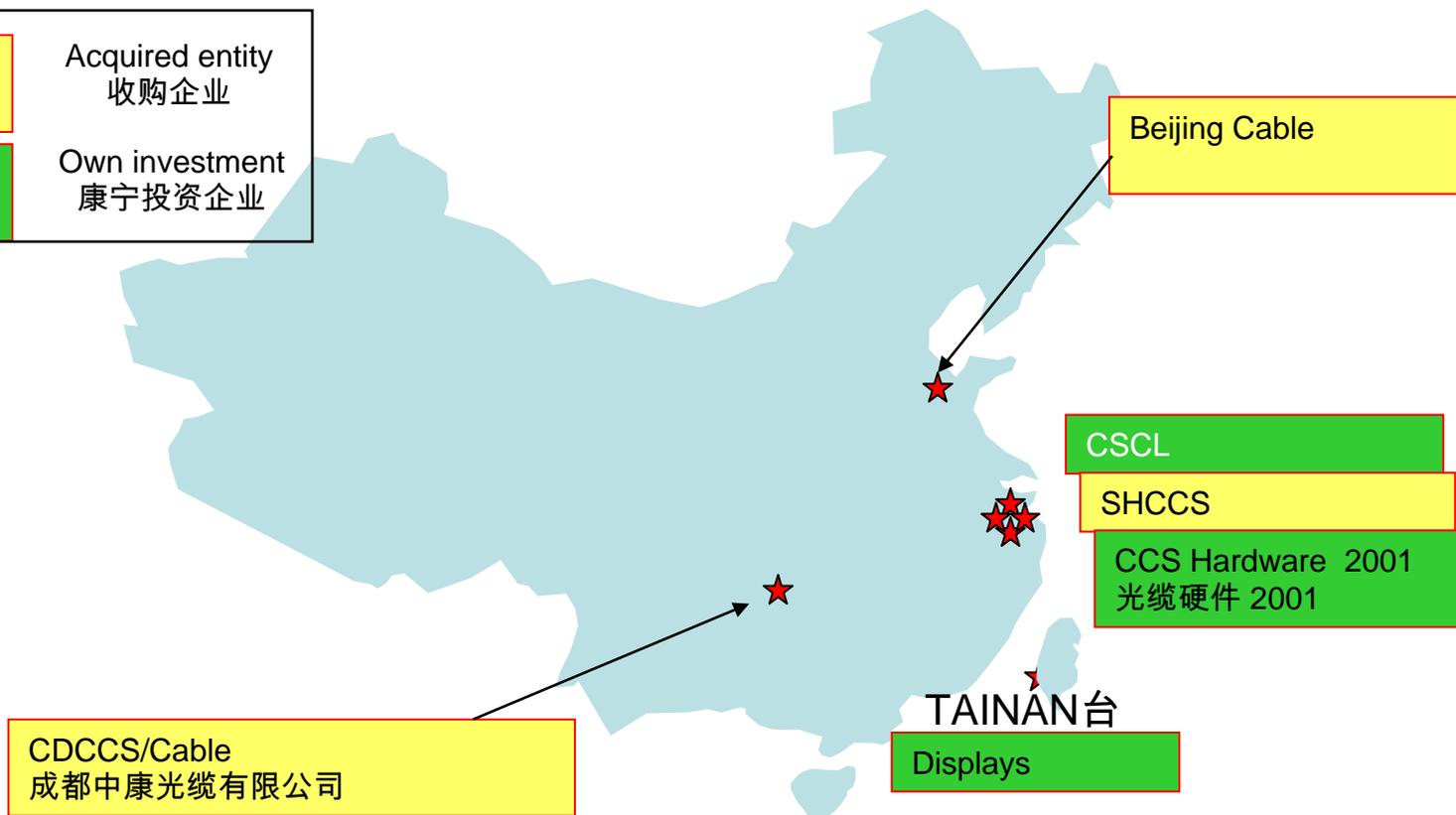
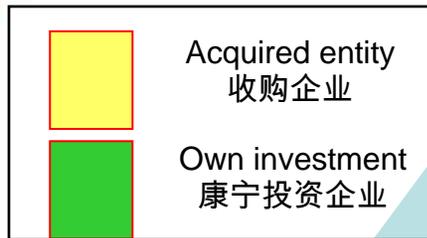
1980

1990

2000

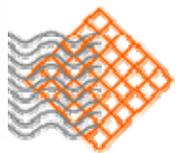


# Corning Has Invested Over \$1000m in China 康宁在华投资超过10亿美元





# Cormetech, Inc.



CORMETECH



# 关于Cormetech

- **Established in 1989, a joint equity venture between Corning and Mitsubishi**  
康宁公司(Corning)和三菱公司(Mitsibutshi)50:50的合资企业,成立于1989年.
- **Manufacturing facilities in North Carolina & Tennessee**  
在北卡罗莱那州和田那西州都有生产基地.
- **Manufactures SCR Catalyst for the Electric Power Generation, Petroleum Refining and Chemical industries**  
为发电厂,石化行业生产SCR催化剂



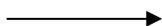
CORMETECH

# Where Cormetech Products Go Cormetech 产品系列

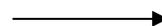


催化材料

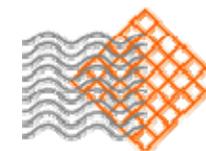
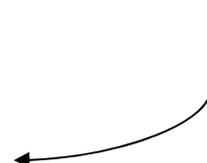
150 mm x 150 mm x up to 1300 mm



催化材模块



催化反应器



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# Cormetech Experience Since 1989

## Cormetech业绩

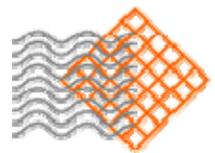
- Utility Boilers 电站锅炉 128 units 台机组
- Utility Boilers \_ Demonstration 电站锅炉 - 示范工程 4 units 台机组
- Combustion Turbines 燃气轮机 535 units 台机组
- Refinery & Industrial Boilers 炼油和工业锅炉 144 units 台机组
- Stationary Diesel Engines 柴油机 12 units 台机组
- Total Experience 总数 **823 units 台机组**
- **Cormetech also has an operational SCR unit in China Nanhai Refinery**
- **Cormetech 在中国南海油田有运行的 S C R 业务**





# Why SCR?

## 为什么选用SCR系统?



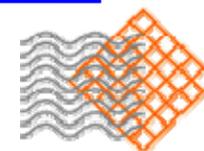
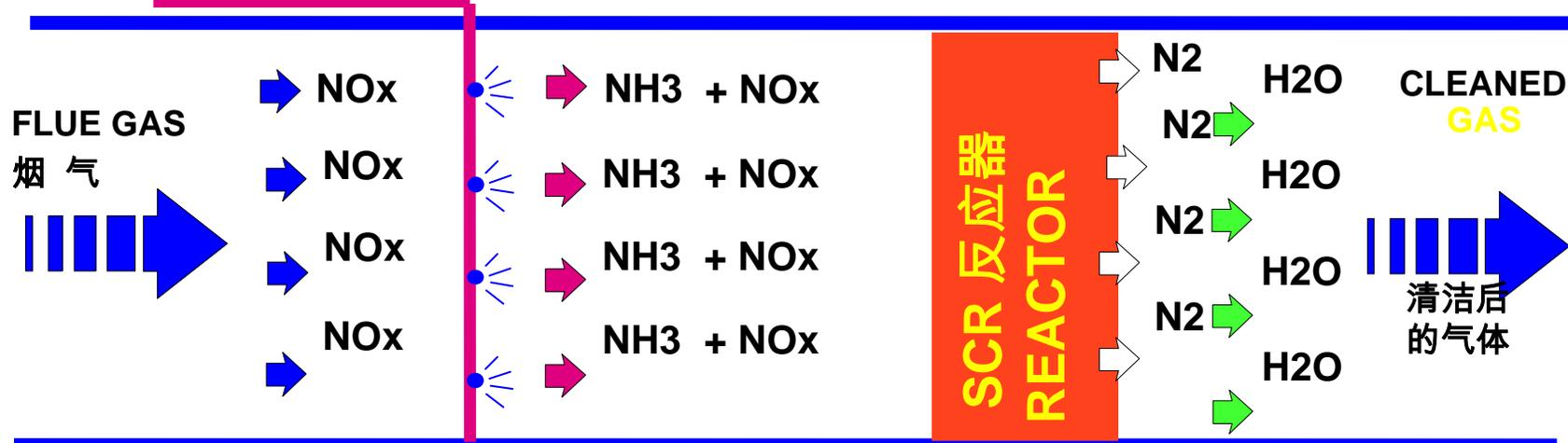
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# SCR Reaction Chemistry

## SCR化学反应方程式

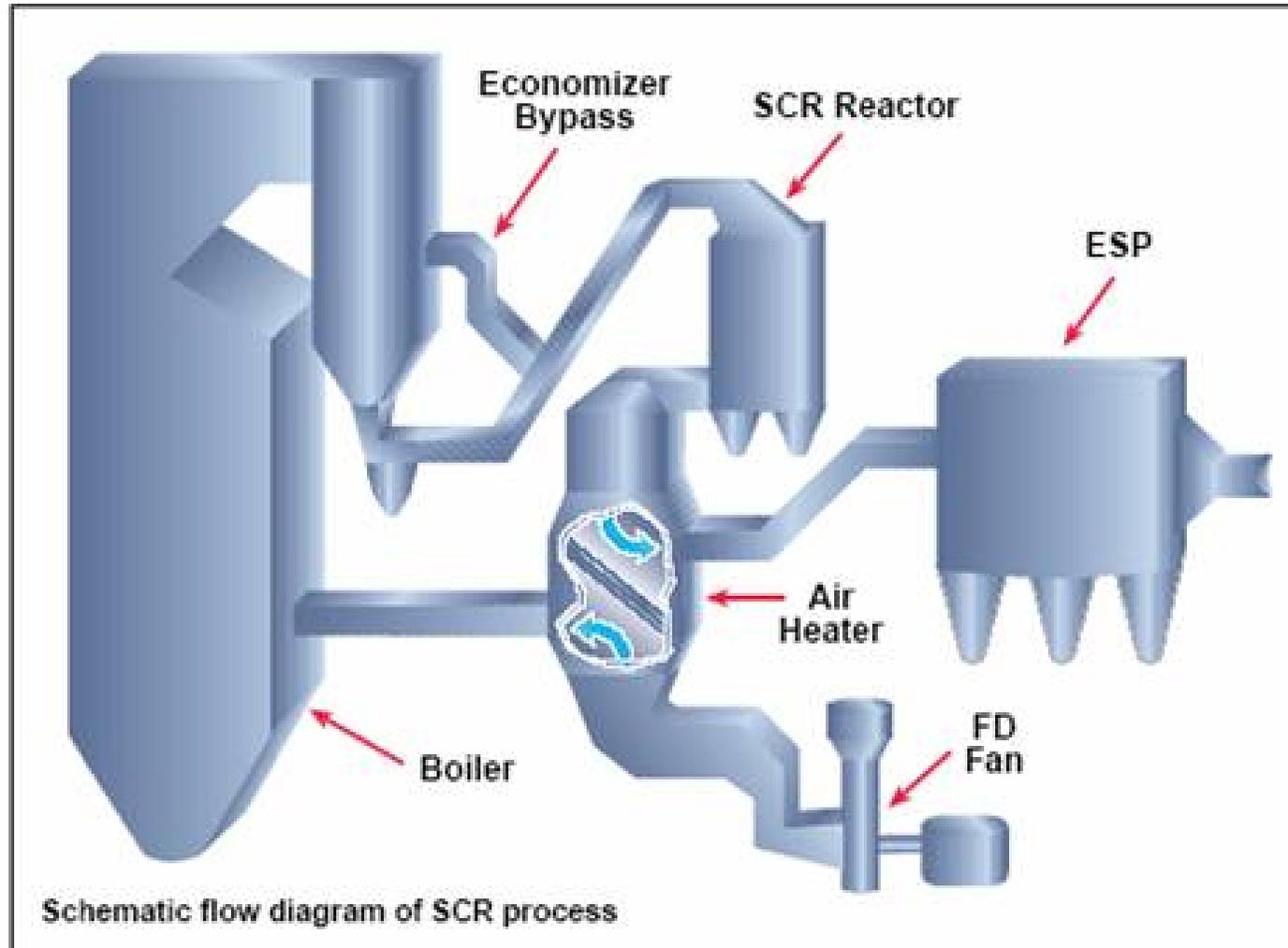


NH3 INJECTION 加氨



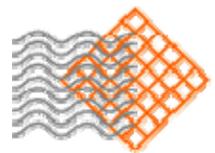
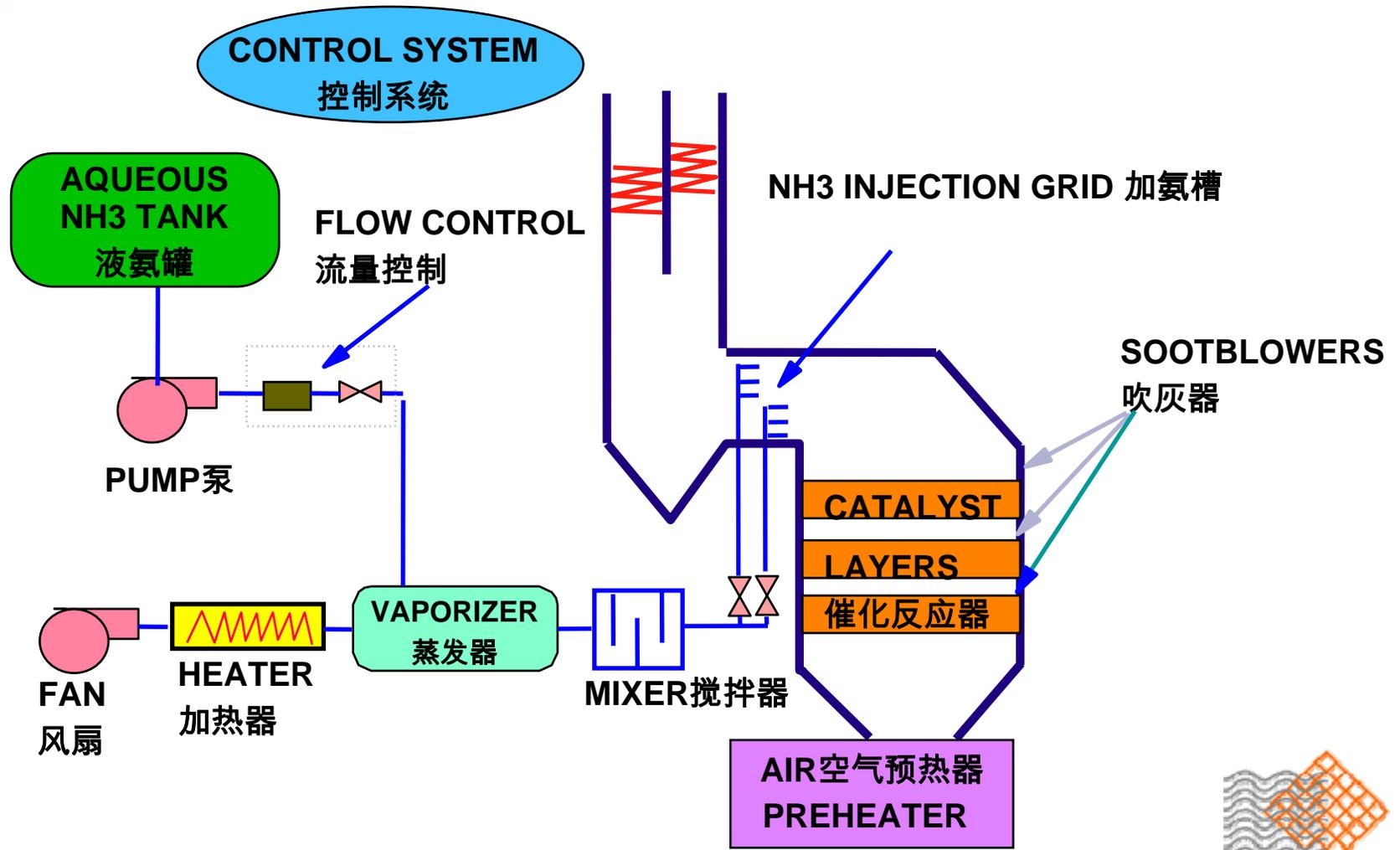
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# SCR overview 示意图



# SCR Components

## SCR组成

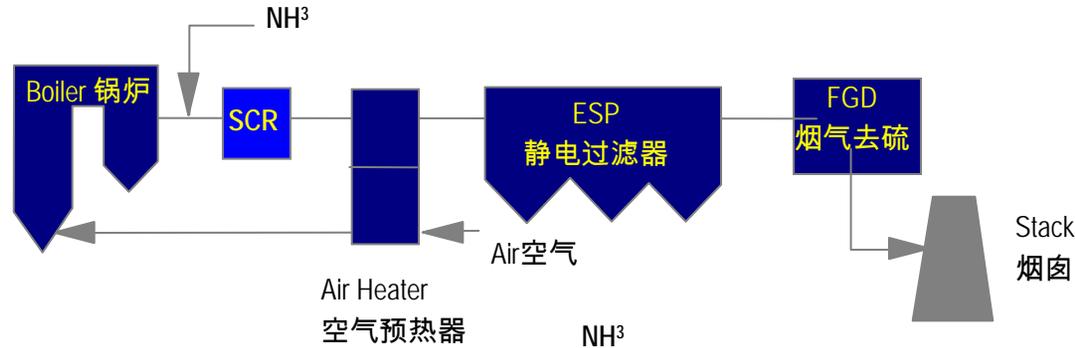


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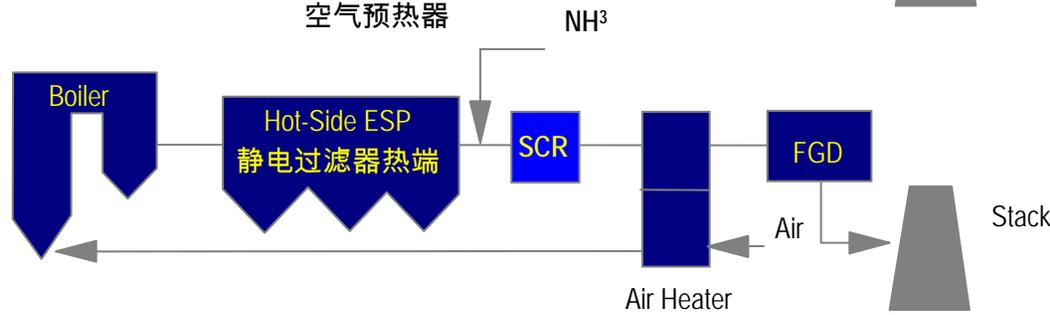
# SCR Configuration Options

## SCR 的布置

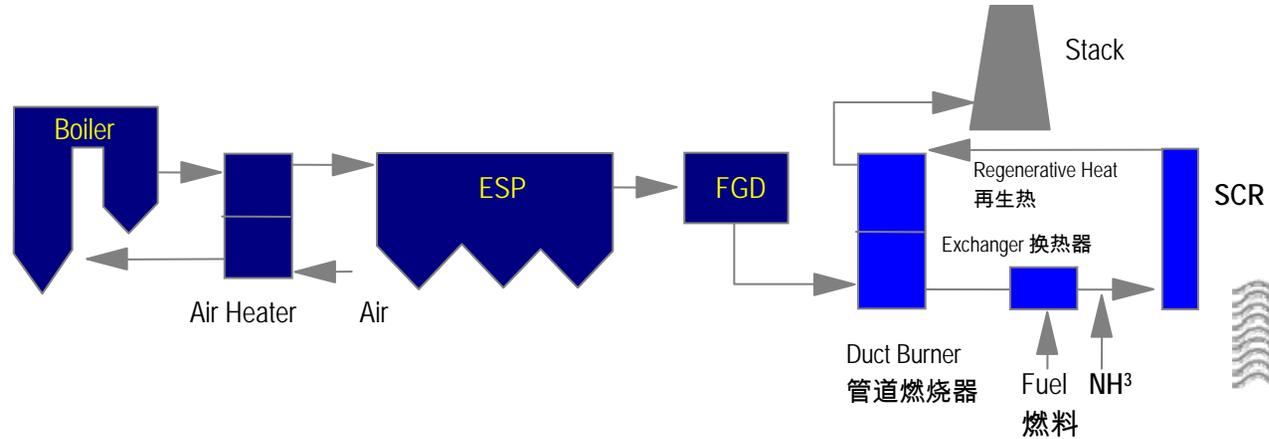
High Dust  
高灰分



Low Dust  
低灰分



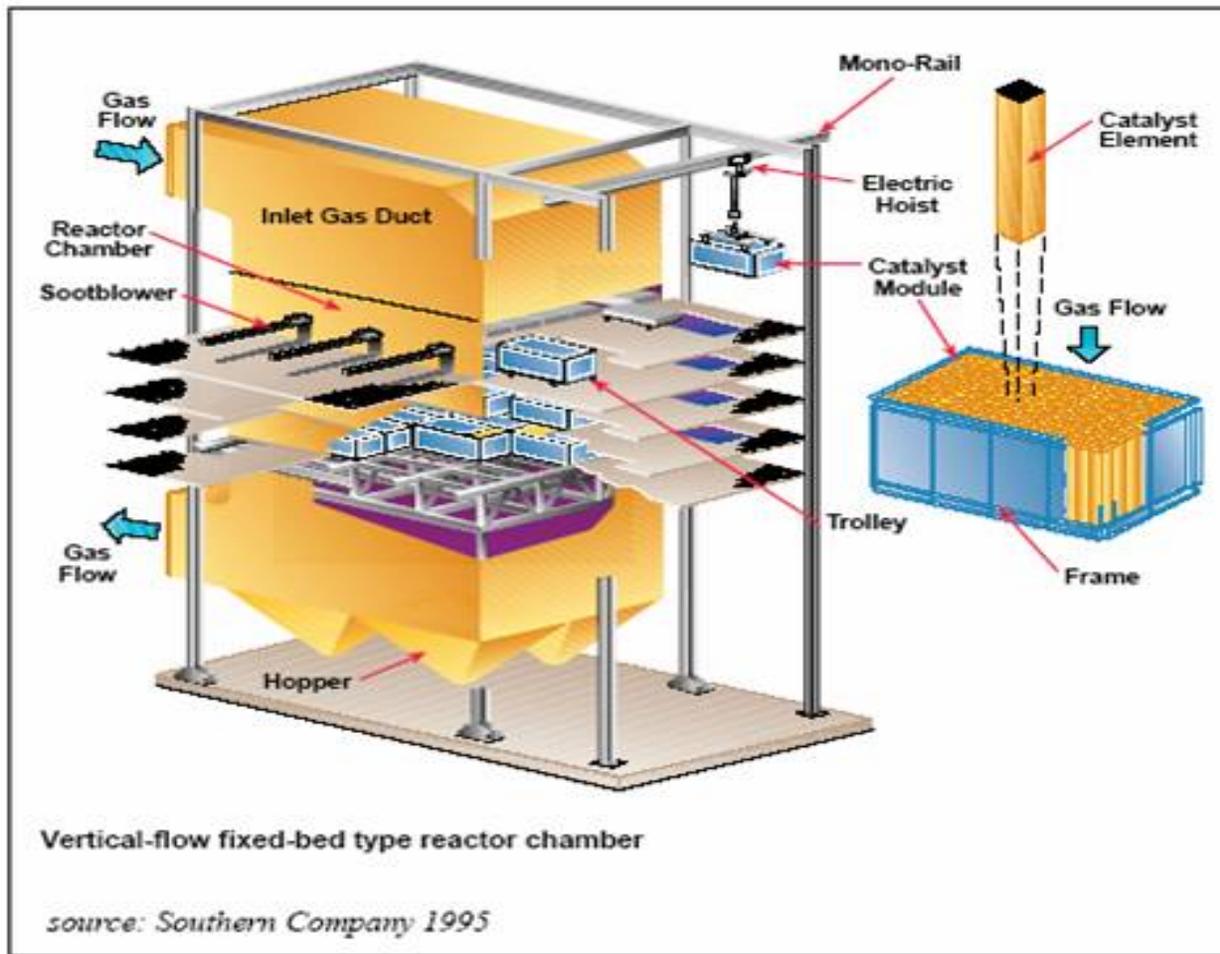
Tail End  
尾端



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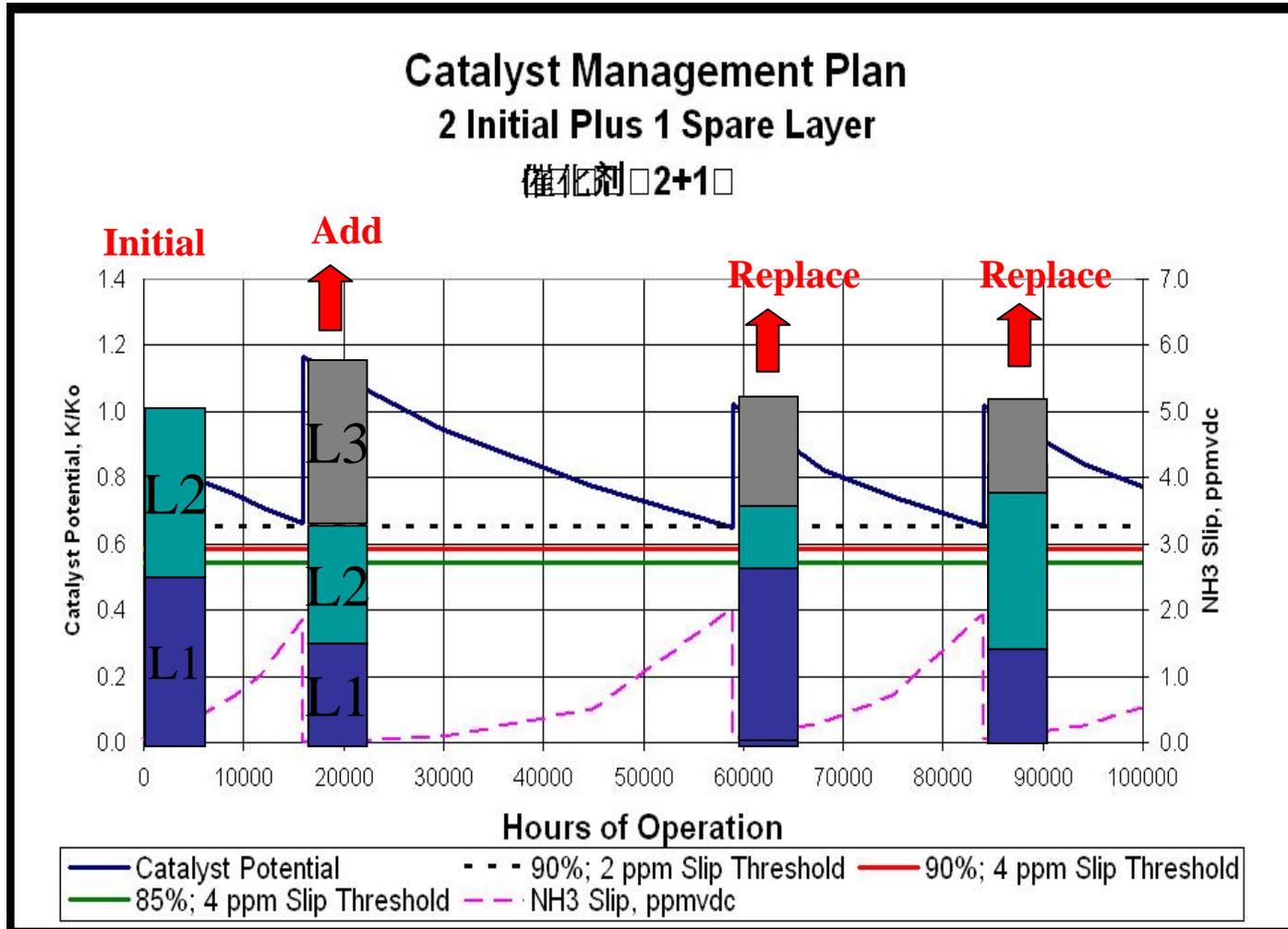
# Erection of Catalyst

## 催化剂安装图



# Catalyst Management Plan

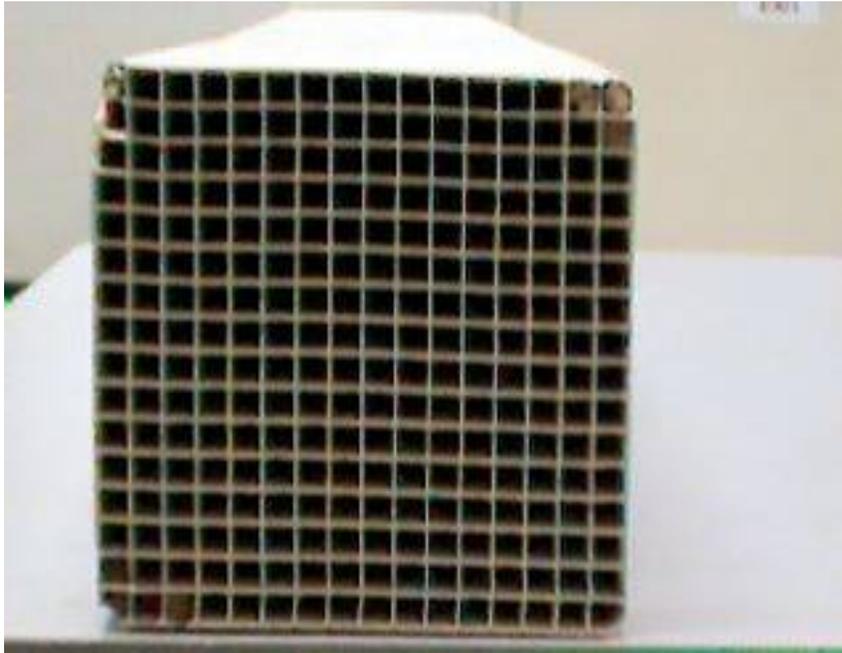
## 催化剂寿命管理





# Catalyst Sampling

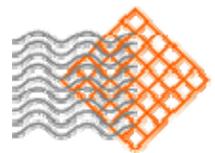
## 催化剂取样





# 为什么要用蜂窝式催化剂？

## Why honeycomb?



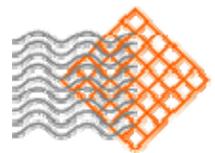
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# Types of Catalyst

## 催化剂的类型

- Honeycomb 蜂窝式
  - Homogenous 均匀分布
  - Coated 涂层
- Plate 平板式
  - Coated 涂层





# Comparison of Catalyst Types

## 催化剂的比较

### Honeycomb 蜂窝式

- 每个单元丰富的表面积意味着在同等效能下，需用较少量的催化剂和较小型的SCR反应器  
Large surface area per unit
- 高防毒性能意味着较低的初始用量或较长期的催化剂寿命  
High poison resistance
- 丰富大量的经验和业绩  
Vast experience base

### Plate 平板式

- 每个单元较低的表面面积意味着需要使用更多的催化剂来满足性能要求  
Low surface area per unit
- 较低的防毒转换能力增加了初始用量或导致催化剂寿命缩短  
Lower resistance to poisoning
- 有限的业绩  
Much lower deployment experience



## Advantages of Cormetech High Performance Honeycomb Catalyst versus Plate Catalyst Cormetech蜂窝式催化剂和板式催化剂比较

Product 产品	Pitch, mm 孔径	Geometric Surface Area, $m^2/m^3$ 比表面积	Relative Volume required* 需要的体积
Plate Catalyst 板式	5.5 – 7.0	307 – 353	176% - 153%
Cormetech Honeycomb CM-69HP 蜂窝式	6.9 (22-cell)	539	100%

\*At Constant NOx Conversion Efficiency (90%), Ammonia Slip (2 ppmvd @ 3% O2) and SO2 Oxidation rate (0.9%)



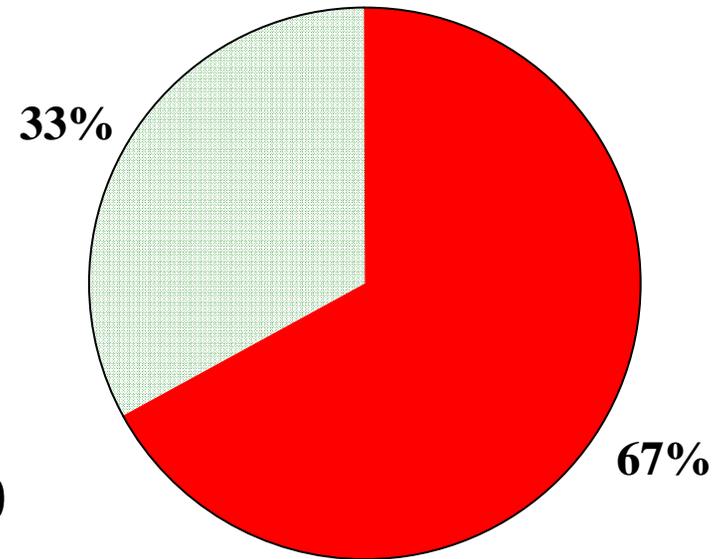


# Catalyst Market Share in Japan

## 日本的催化剂市场份额

### Coal-Fired Boilers 燃煤锅炉

- Honeycomb catalyst has operated over 100,000 hours without replacement.  
蜂窝式催化剂运行超过100,000小时无替换
- Demonstrates excellent resistance to poisoning, erosion, and plugging.  
优异的防毒、防腐、防堵塞表现



■ 蜂窝式HC    □ 平板式 Plate



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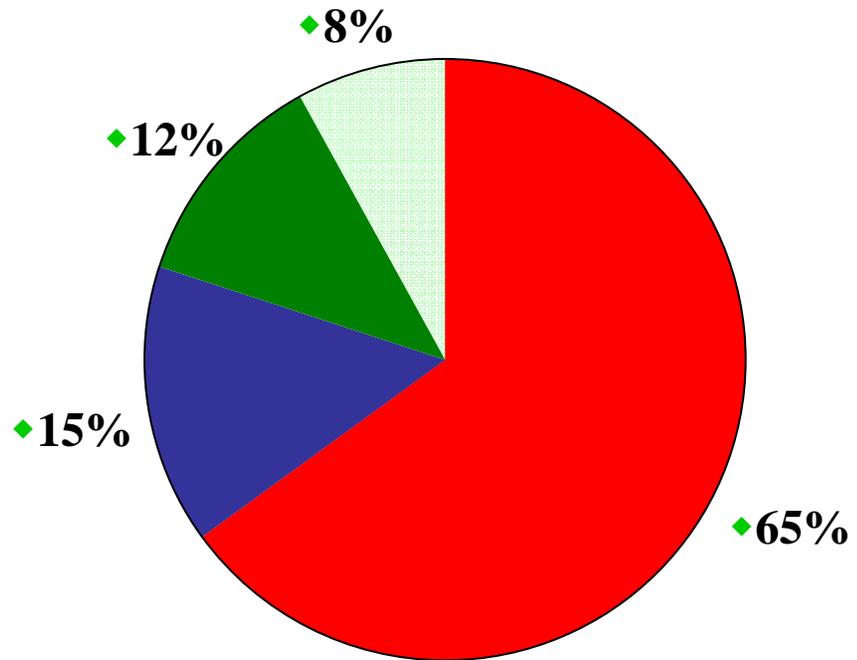
# Catalyst Market Share in Germany

## 德国的催化剂市场份额

### Coal-Fired Boilers

### 燃煤锅炉

- Honeycomb dominates due to efficient cell structure and superior performance life.
- 蜂窝式催化剂由于有效的结构和超群的性能最终占据了市场主导地位





# Avoid Erosion

## 抗腐蚀的催化剂边缘硬化

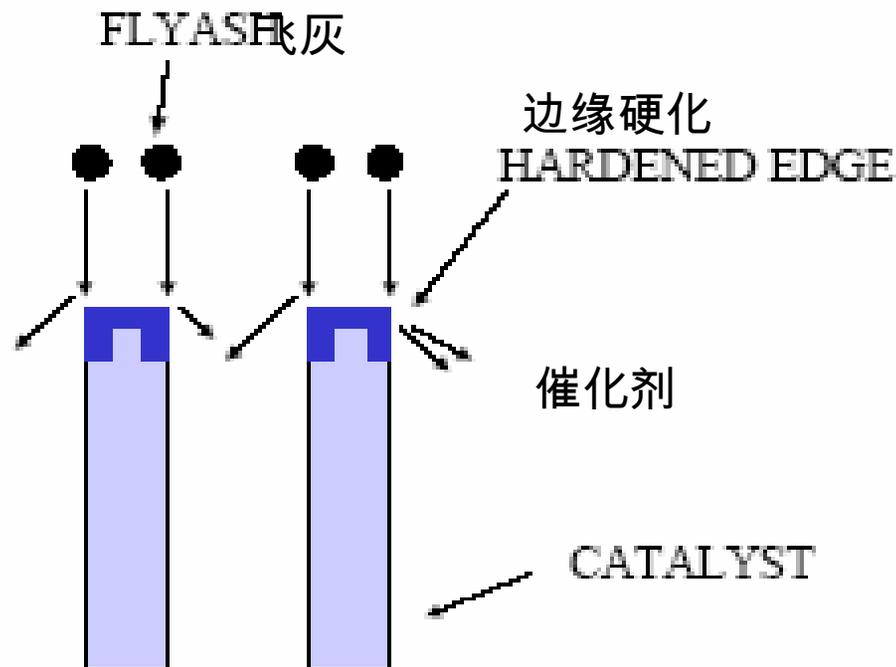


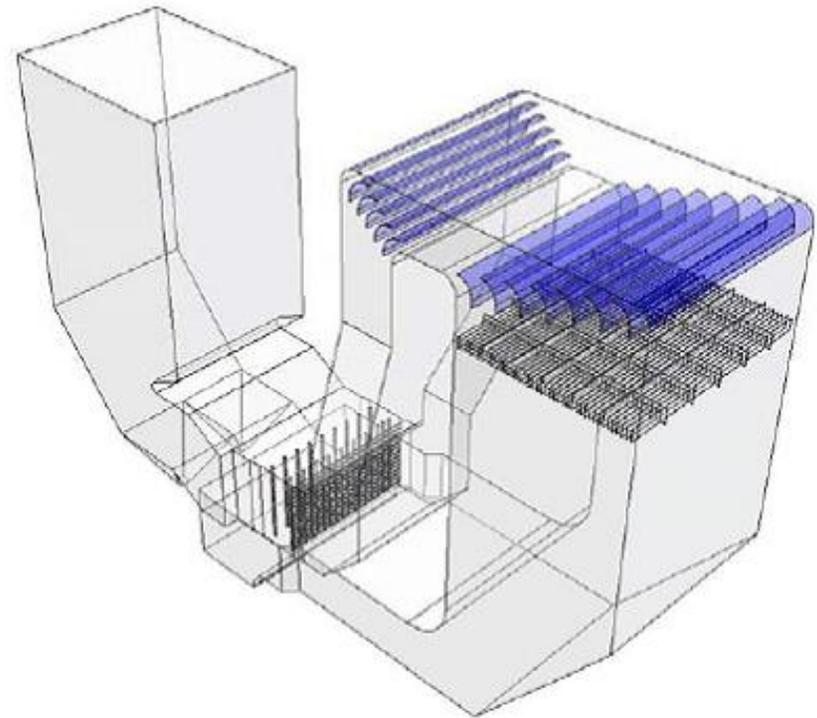
Figure 14  
Honeycomb Catalyst with Hardened Edge





# Avoid Ash Deposition Plugging 防止催化剂堵塞

- Choose correct pitch size  
选择合适的催化剂孔径
- Correct design: 设计正确的布置
- Installing deflection devices  
安装导流装置



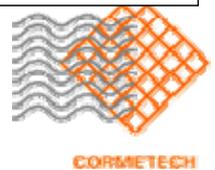
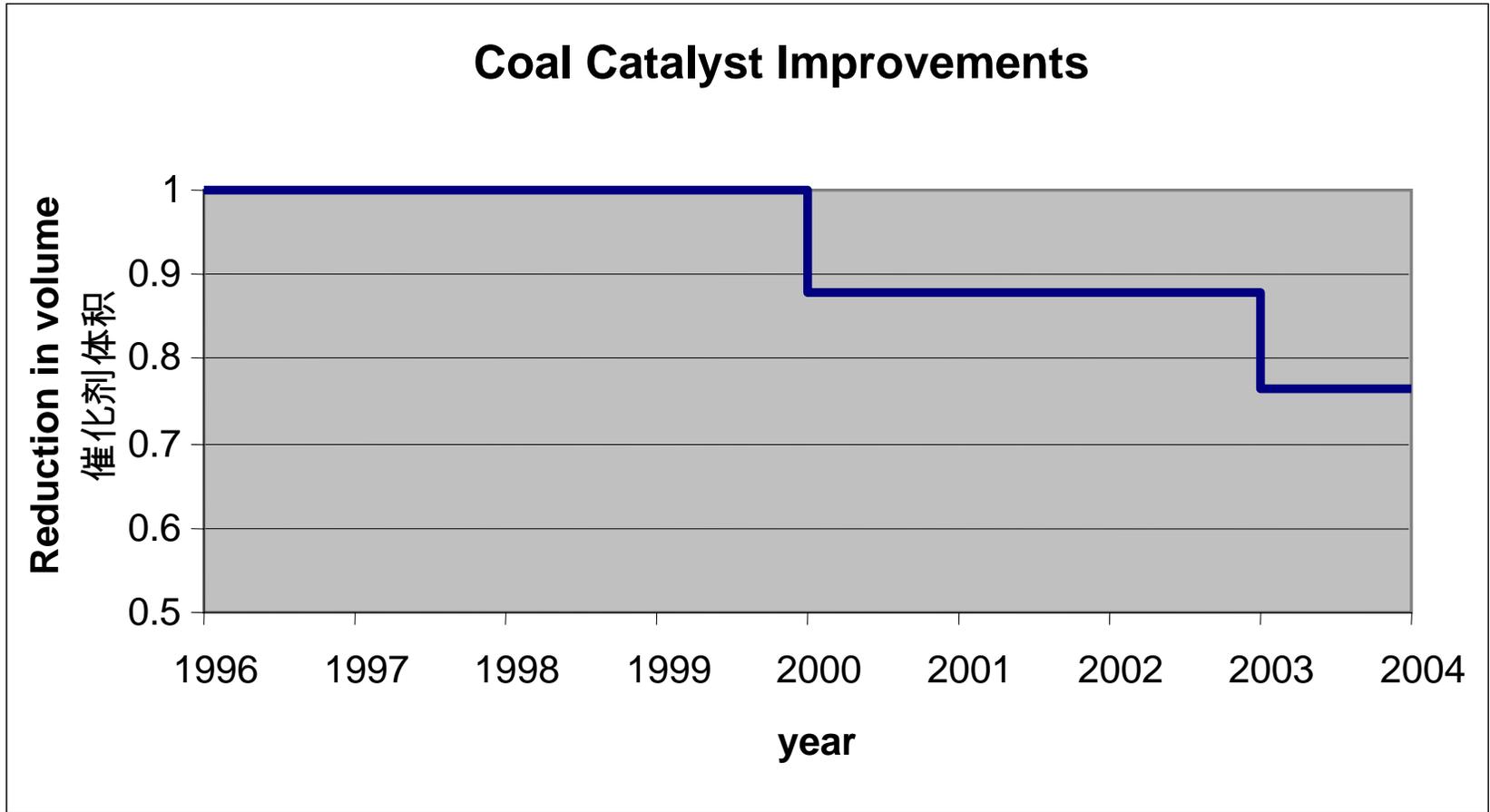


# 为什么选择Cormetech? Why Cormetech?





# An Example Of Leadership: Product Development 产品发展

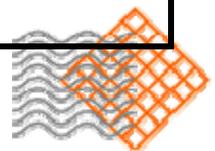




## Advantages of Cormetech High Performance Catalyst Cormetech 高效催化剂的优势

在相同体积前提下Cormetech产品带来的压降仅为竞争对手的80%

Product 产品	Pitch, mm 孔径	Opening, mm	Geometric Surface Area, 表面积 m <sup>2</sup> /m <sup>3</sup>	Relative Volume required 需要的相对 体积	Relative SO <sub>2</sub> Oxidation Rate 相对SO <sub>2</sub> 氧 化率
Competitor 竞争对手	7.4 (20-cell)	6.3	445	100%	100%
CM-71HP Cormetech	7.1 (21-cell)	6.4	502	100%	35%
CM-69HP Cormetech	6.9 (22-cell)	6.3	539	100%	25%



CORMETECH

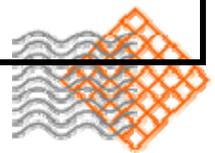


# Advantages of Cormetech High Performance Catalyst

## Cormetech 高效催化剂的优势

At Constant Conversion Efficiency, Slip and SO<sub>2</sub> Oxidation rate  
在相同的转化率,逃逸率和SO<sub>2</sub>氧化率的前提下

Product 产品	Pitch, mm 孔径	Opening, mm	Geometric Surface Area, 表面积 m <sup>2</sup> /m <sup>3</sup>	Relative Volume Required at const. SO <sub>2</sub> Oxidation 相对面积	Relative Pressure Drop at const. SO <sub>2</sub> Oxidation 相对压降
Competitor 竞争对手	7.4 (20-cell)	6.3	445	100%	100%
CM-71HP Cormetech	7.1 (21-cell)	6.4	502	83%	69%
CM-69HP Cormetech	6.9 (22-cell)	6.3	539	75%	61%

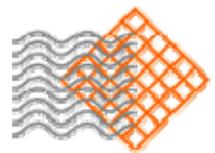


CORMETECH



# Cormetech is a World-Leader in SCR 领先地位

- Efficiency: Up to 95%  
效率: 高达95%
- Experience: Over 820 installations worldwide  
业绩: 全球超过820台
- Leadership: Largest capacity  
领先者: 产能最大
- Scale: Capability up to 1300 MW  
单机容量: 最大1300MW
- Vast experience for high CaO coal application  
大量高Cao含量煤的应用业绩
- SO<sub>2</sub> oxidation: as low as 0.2%  
SO<sub>2</sub> 氧化率: 最低0.2%

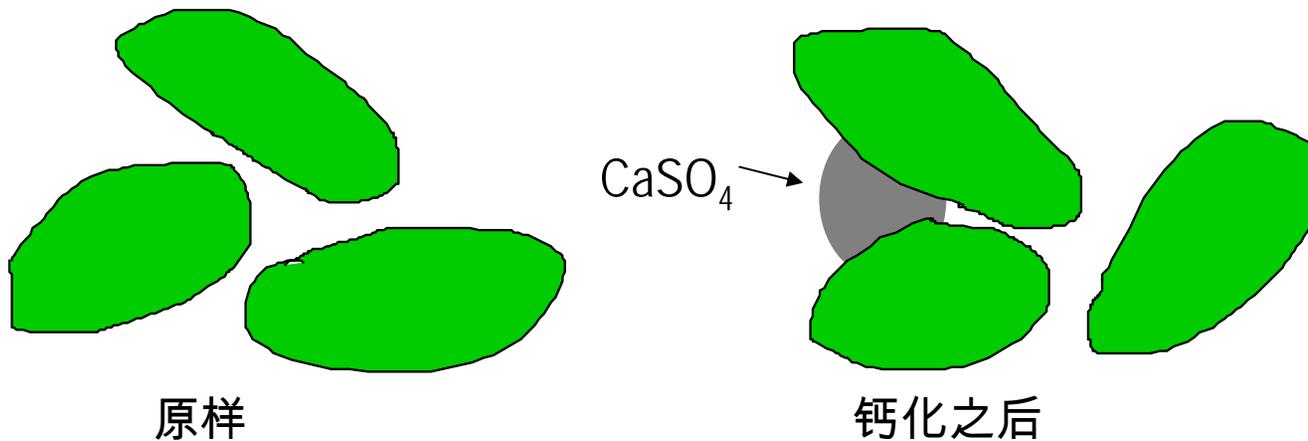


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# Alkaline Earth Metals [Ca, Mg]

## 碱金属的硫化合物

- Primarily Ca. CaO in flyash reacts with SO<sub>3</sub> to form CaSO<sub>4</sub>  
主要是飞灰中的钙氧化物与三氧化硫反应生成硫酸钙
- CaSO<sub>4</sub> causes catalyst surface pore plugging (typically 20 - 30 micron depth)  
硫酸钙覆盖在催化剂表面的毛细孔上(一般20-30微米深)



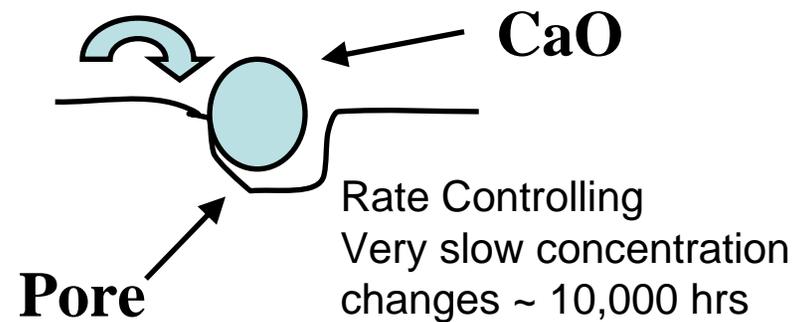


# CaO reaction with SO<sub>3</sub>

## CaO与SO<sub>3</sub>反应机理

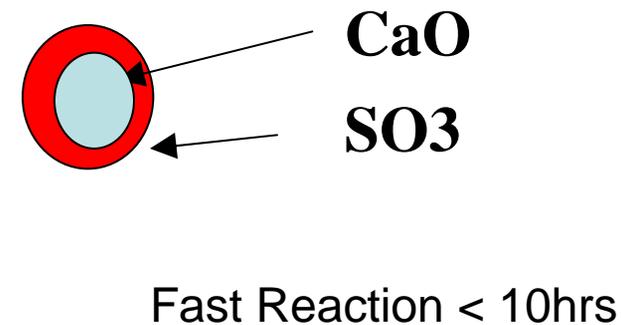
- **Step 1**

- CaO is caught in macro pore on catalyst
- Phenomenon is dependent on probability and quantity of CaO



- **Step 2**

- SO<sub>3</sub> diffusion
- function of mass transfer & concentration

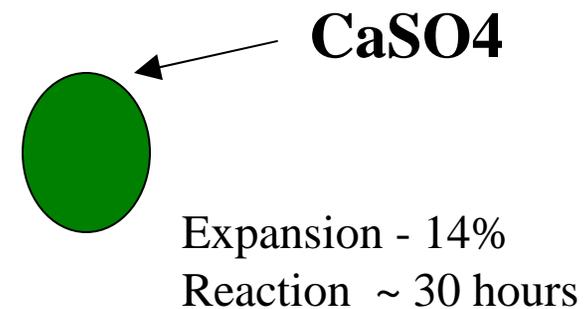


# CaO reaction with SO<sub>3</sub>

## CaO与SO<sub>3</sub>反应机理

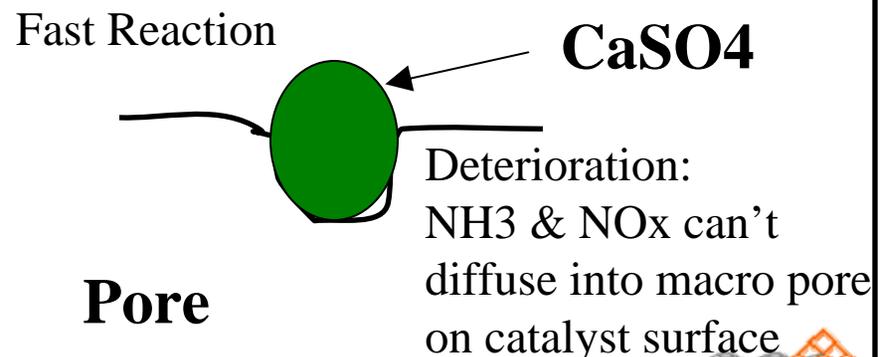
- Step 3

- Diffusion through ash
- function of diffusion through ash and SO<sub>3</sub> concentration



- Step 4

- $\text{CaO} + \text{SO}_3 \longrightarrow \text{CaSO}_4$
- function of concentrations of SO<sub>3</sub> and CaO





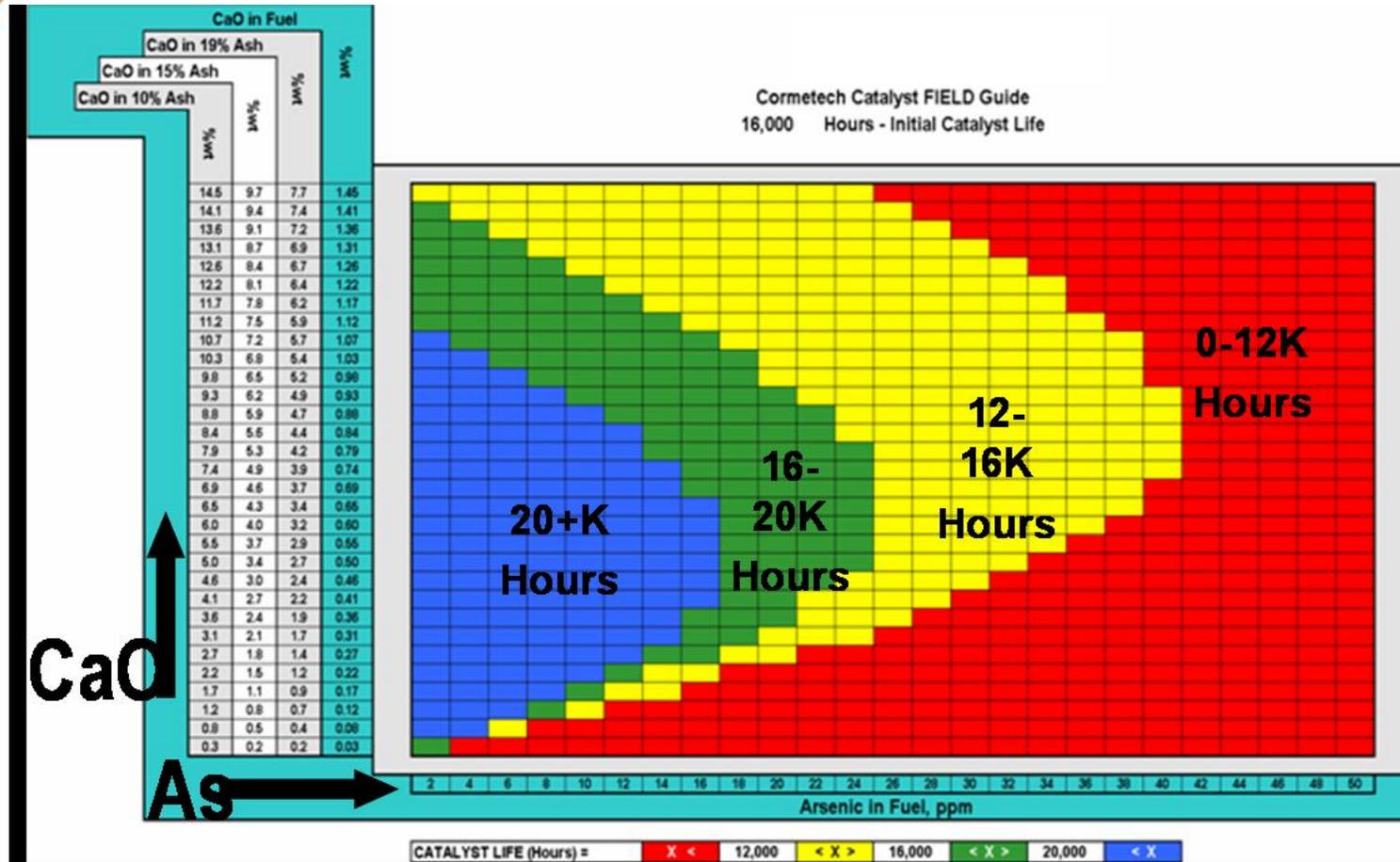
## Counter-measures 处理方法

- Understand reactions  
了解问题原因
- Select appropriate catalyst formulation  
选择合适的催化剂配方
- Account for in deactivation assumptions  
设计时假设一定程度催化剂老化



# As & CaO Relationship

## 砷与氧化钙的相互作用





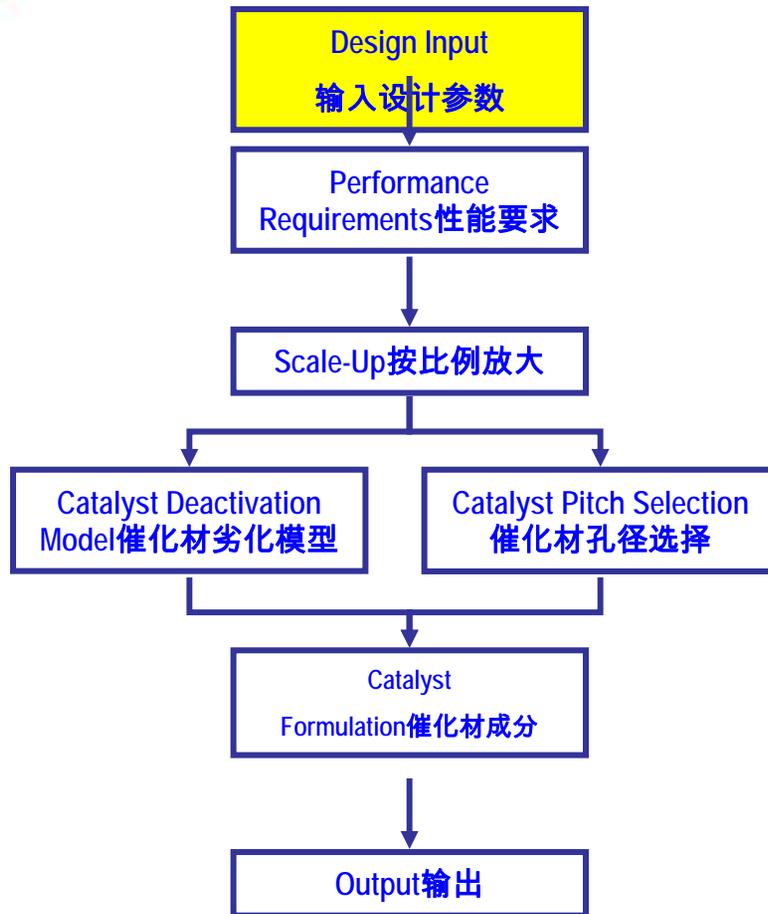
# How to select catalyst

## 如何选择催化剂



# Catalyst Design Process

## 催化反应器设计



### Design Inputs 设计参数输入

- ◆ Flue Gas Flow Rate 烟气流量
- ◆ NO<sub>x</sub> Inlet 进入的NO<sub>x</sub>浓度
- ◆ Flue Gas Constituents 烟气组成
- ◆ Fuel Type & Analyses 燃料类型和分析
- ◆ Reactor Size & Geometry 反应器大小和尺寸
- ◆ Unit Type (PC, Cyclone, etc.) 锅炉类型 (粉煤, 旋风式等, etc.)





# Fuel & Ash Analyses

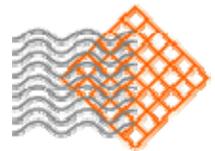
## 燃料和灰分分析

- Fuel燃料

- C, wt%
- H, wt%
- N, wt%
- O, wt%
- S, wt%
- Ash, wt%
- Cl, ppm
- F, ppm
- As(砷), ppm
- Na, ppm
- K, ppm
- V, ppm

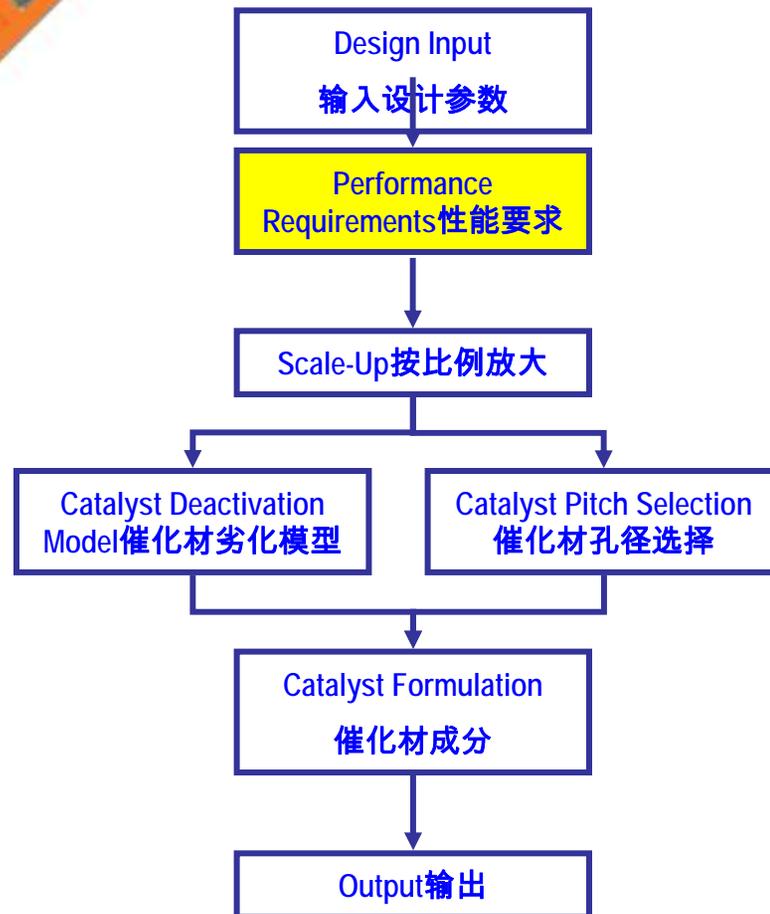
- Ash Analysis

- Particle size distribution 颗粒尺寸分布
- SiO<sub>2</sub>, wt%
- Al<sub>2</sub>O<sub>3</sub>, wt%
- Fe<sub>2</sub>O<sub>3</sub>, wt%
- Total & Free CaO, wt% 总&游离氧化钙
- MgO, wt%
- TiO<sub>2</sub>, wt%
- MnO, wt%
- V<sub>2</sub>O<sub>5</sub>, wt%
- Na<sub>2</sub>O, wt%
- K<sub>2</sub>O, wt%
- P<sub>2</sub>O<sub>5</sub>, wt%
- SO<sub>3</sub>, wt%
- LOI未燃碳氢物比率, wt%
- As, ppm
- Loading, gr/acf 粒/立方英尺



# Catalyst Design Process

## 催化反应器设计



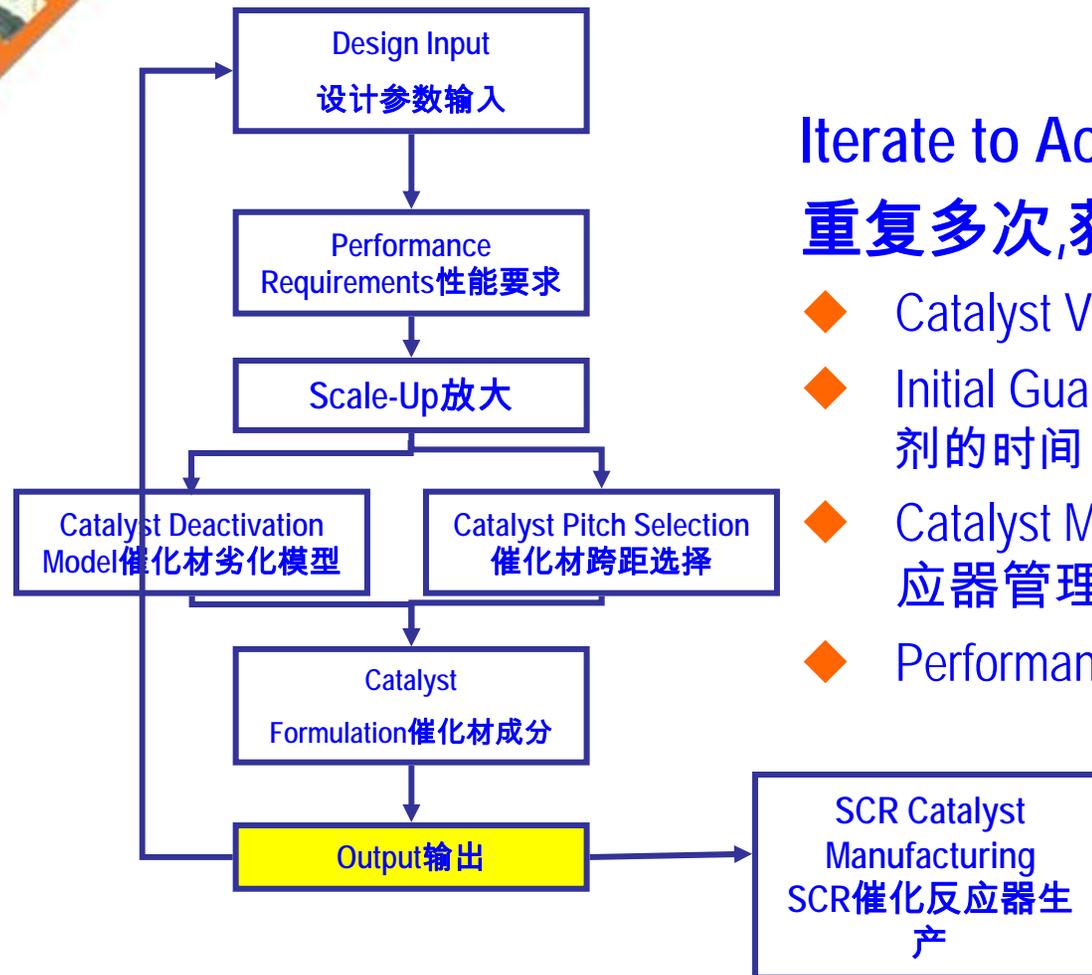
## Performance Requirements 性能要求

- ◆ NO<sub>x</sub> Removal Efficiency  
NO<sub>x</sub>去除效率
- ◆ Ammonia Slip氨泄漏
- ◆ Pressure Drop压降
- ◆ SO<sub>2</sub> Oxidation Limit  
SO<sub>2</sub>氧化极限
- ◆ Initial Guaranteed Life  
首次增加催化剂的时间



# Catalyst Design Process

## 催化反应器设计



Iterate to Achieve Design Result  
重复多次,获得设计结果

- ◆ Catalyst Volume 催化反应器体积
- ◆ Initial Guaranteed Life 首次增加催化剂的时间
- ◆ Catalyst Management Plan 催化反应器管理计划
- ◆ Performance Level 性能水平

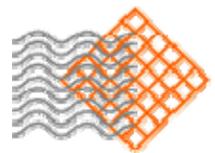




# Thank You

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# Questions?



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