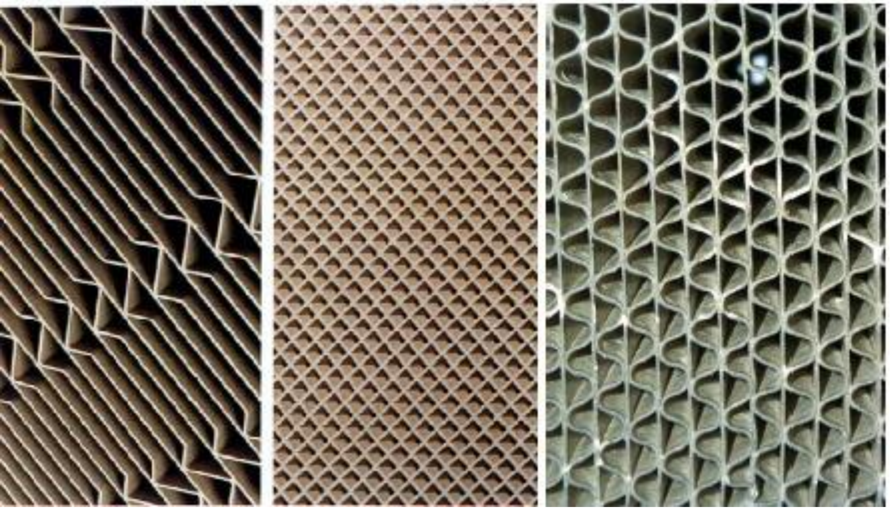

Selecting SCR Catalysts for Integrated Pollution Control

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Parameters Affected by Catalyst Selection

- NOx Removal
- Ammonia Slip
- Pressure Loss
- Catalyst Life
- SO3 Levels
- APH Fouling
- ESP Collection Efficiency
- Mercury Oxidation and Capture
- Scrubber Operation

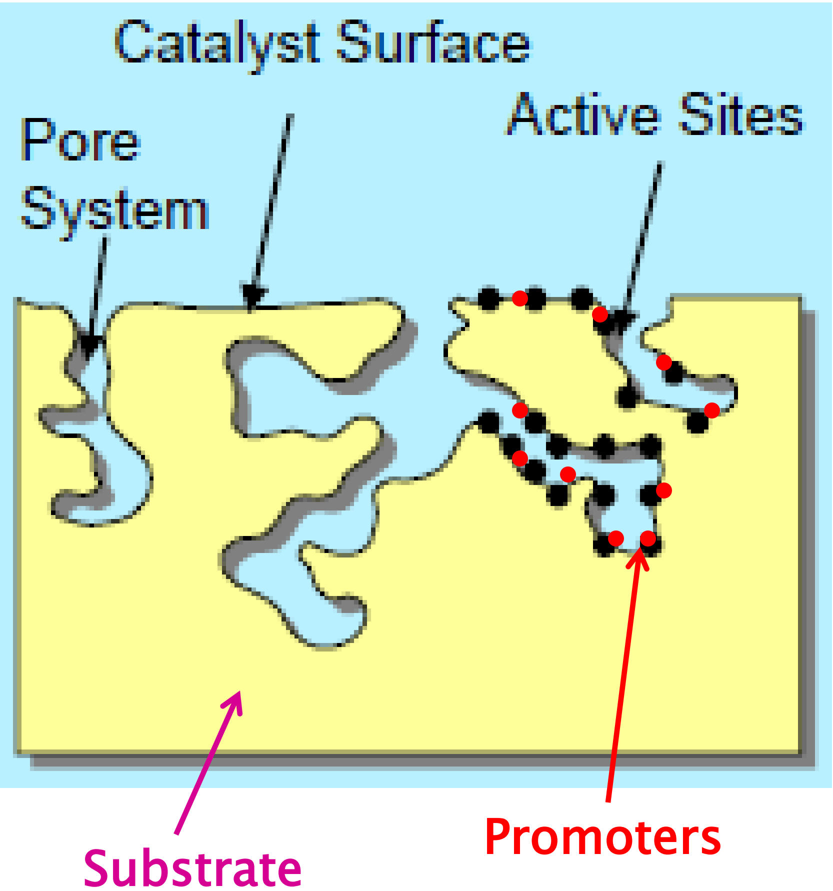
Relative Effects Matrix

Parameter Adjustment	Relative Effect									
	DeNOx	SO3	Slip	Pressure Drop	Catalyst Volume	Catalyst Life	APH Fouling	Mercury Oxidation	ESP Efficiency	Scrubber/ Emissions Perf.
Increased DeNOx w/ constant volume and slip (change formulation)	↑	↑	–	–	–	–	↑	↑	–↑	–↓
Increased Life w/ constant slip and deNOx (volume increase w/ no formulation change)	–	↑	–	↑	↑	↑	↑	↑	–↑	–↓
Decreased Slip w/ no catalyst change – constant DeNOx, and SO3	–	–	↓	–	–	↓	↓	–↑	–↓	–↑
Decreased SO3 with formulation change – constant deNOx, slip, and life	–	↓	–	↑	↑	–	↓	↓	–↓	–↑
Catalyst Design Improvements	↑	↓	↓	↓	↓	↑	↓	↑	–	–

Catalyst Design Parameters

- Chemistry
- Microscopic Physical Parameters
- Macroscopic Physical Parameters

Catalyst Chemistry



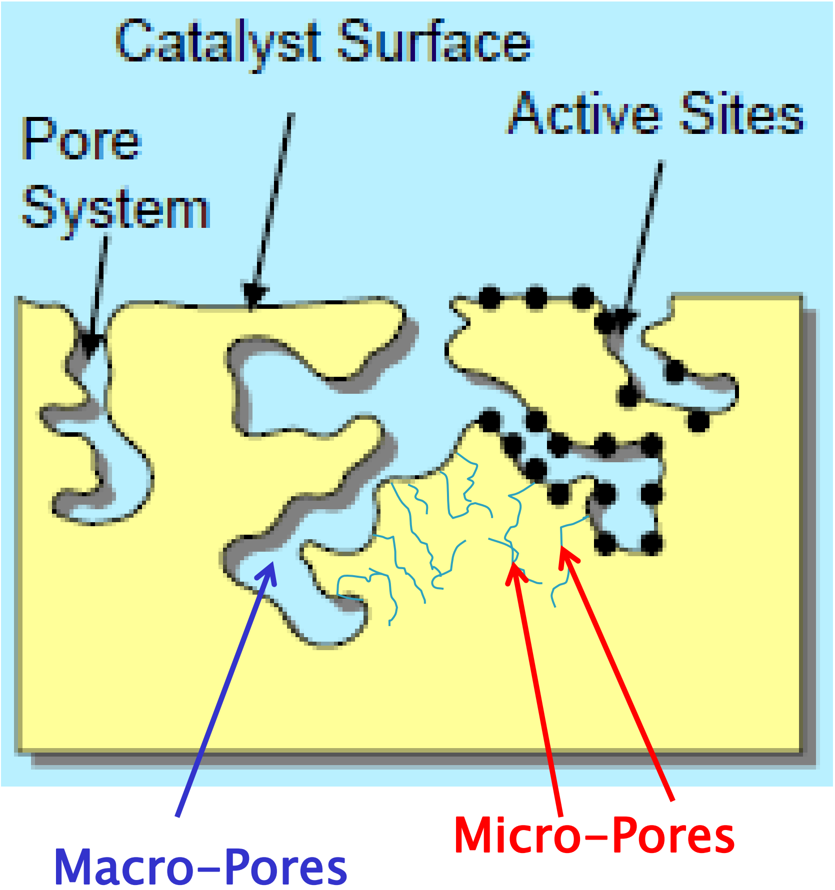
The catalyst formulation refers to the catalyst chemistry– i.e. the chemicals that are present as active catalytic components, promoters, and substrates.

Active catalytic components: “active sites” principally of vanadium (V2O5), but sometimes titania (TiO2) under some conditions.

Promoters: work along with the active catalytic components improving the reaction and limiting side reactions (SO2 conversion), often molybdenum, and tungsten

Substrate: Provides the micro and physical surface to which the catalysts and promoters attach, and provides the macro porosity and physical strength of the catalyst matrix – primarily titania (TiO2)

Microscopic Physical Design



The microscopic physical design refers to the pore volume, pore size distribution, and total surface area of the catalyst (BET).

Macro-pores: relatively large pores providing a major "highway" for the diffusion of reactants and products

Micro-pores: relatively small pores providing a "local" network of paths and chambers giving high surface area

Manipulating the pore size distribution greatly affects the catalyst's performance, especially in terms of SO2 oxidation.

Macroscopic Physical Design

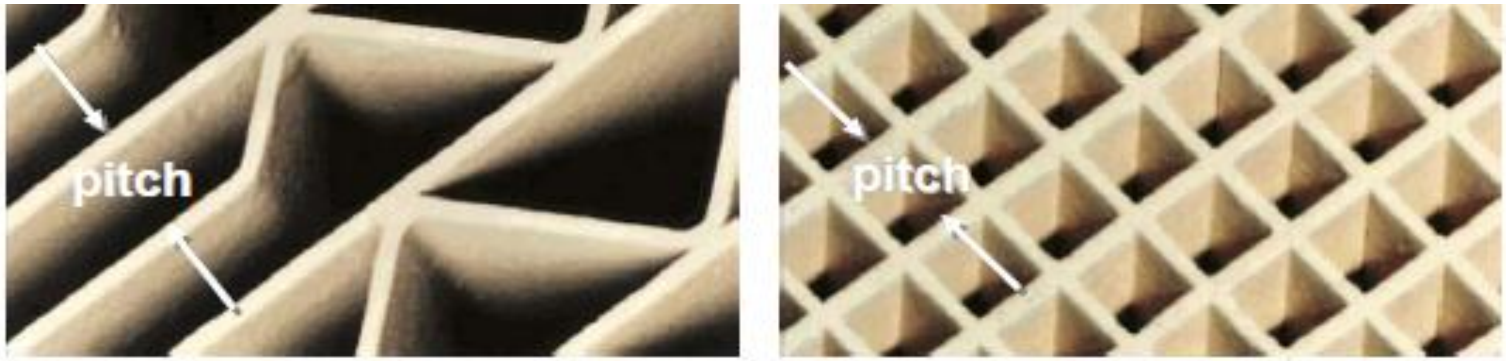


Plate-Type Structure   Honeycomb Structure

Physical Geometry: plate, honeycomb, or corrugated provides the pitch, geometric surface area, open area, and flow path length and dimension – affects overall strength, fouling resistance, etc.

Wall thickness: very important to physical strength and reaction mechanisms – thinner walls generally improve SO2 conversion, but may impact strength parameters.

Substrate selection: impacts “hardness” of catalyst – resistance to abrasion, cracking, delamination, etc. , as well as the ability to create the desired pore structure.

TRENDS AFFECTING CATALYST DESIGN AND SELECTION

Fuel Switching to Higher Sulfur Coal – increases focus on lowering SO3 to avoid APH fouling and wet stack emissions – need for lower SO2 conversion catalysts without a trade-off.

Mercury Control Added to the Mix – Improved mercury oxidation capability of the catalysts needed, as well as improved understanding of the mechanism – guarantees are being demanded.

PRB Coal Combustion – Poor mercury oxidation due to low halogens – strong incentive for new high-oxidation catalysts for PRB flue gases.

Wet Scrubber Installations – Important to limit SO3 to avoid plume issues, especially in light of potential fuel switching.

Catalyst Regeneration – adds an additional variable to the overall catalyst selection process – potential cost savings.

Catalyst Manufacturer "Hot Topics"

- Improve and better predict mercury oxidation without adversely affecting other parameters
- Continue to improve SO2 conversion without affecting deNOx capability
- Reduce volume – improve activity
- Improve poisoning resistance
- Maintain physical strength in light of other changes
- Control costs in light of overall market pressure

QUESTIONS ?