EFFECTS OF FUELS ON SCR DESIGN

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KEY SCR DESIGN PARAMETERS

- Required NOx Removal Efficiency
- Required Ammonia Slip
- Operating Temperature
- Fuel Type

GENERAL FUEL TYPES

- Gas – natural gas, process gas
- Fuel Oils – low to high sulfur refined petroleum
- Residual Refinery Products – distillate bottoms
- Refinery Solids - petroleum coke
- Coals – bituminous, anthracite, lignite, PRB

FUEL TYPES - GAS

Natural Gas

- Easiest fuel for SCR applications
- No particulate, no sulfur – no sootblowing or SO_2 conversion limitations
- Allows for high catalyst deNOx activity, small pitch, horizontal and in-duct installations
- Long catalyst lives are typical
- Allowable slip is function of regulations

FUEL TYPES - GAS

Process Gases

- Many fuel gases similar to natural gas
- May have sulfur, fine particulate
- Various components may poison catalysts, such as free silica, sodium, potassium, various upstream catalyst materials
- Unknown components are problematic
- Highly site specific
- Little long-term industry experience on specialty fuels

Low-Sulfur Fuel Oil

- Similar to natural gas if high-grade oil is used
- SO_2 conversion can be relaxed if low-sulfur oil is burned exclusively
- Sootblowing generally not needed if no heavy oils are expected which contain particulate and soot is not typical
- Horizontal and vertical applications, little or no HRSG or APH modifications
- Typified by long catalyst lives, small pitch, high activity catalysts with high allowable slip

Medium to High-Sulfur Fuel Oil

- Presence of significant sulfur will limit allowable SO_2 Conversion
- Sootblowers are generally required, often preferred over sonic horns
- Horizontal configurations possible with low particulate
- Vanadium content may cause increase in SO_2 conversion over time
- Significant ABS corrosion may occur
- Possibility of sulfuric acid plumes depending on SO_2 conversion and sulfur level

Fuel Types – Residual Refinery Products

Distillate Bottoms, Very Heavy Oils

- Characterized by high sulfur, high particulate, high contaminants such as vanadium
- May require sootblowing, possibly vertical configuration
- Strong limits on SO2 conversion or mitigation of impacts on conversion associated with vanadium deposition
- Strong potential for ABS formation on downstream equipment
- Stringent limits on ammonia slip
- Highly fuel specific

Fuel Types – Solid Refinery Products

Petroleum Coke

- Characterized by high sulfur, high particulate, high contaminants such as vanadium
- Sootblowing/sonic horns generally required, vertical configuration preferred
- Strong limits on SO2 conversion or mitigation of impacts on conversion associated with vanadium deposition
- Significant impact on downstream equipment due to sulfuric acid and ABS formation
- Ammonia slip usually held low to help mitigate impacts – similar to coal applications, large catalyst pitch recommended

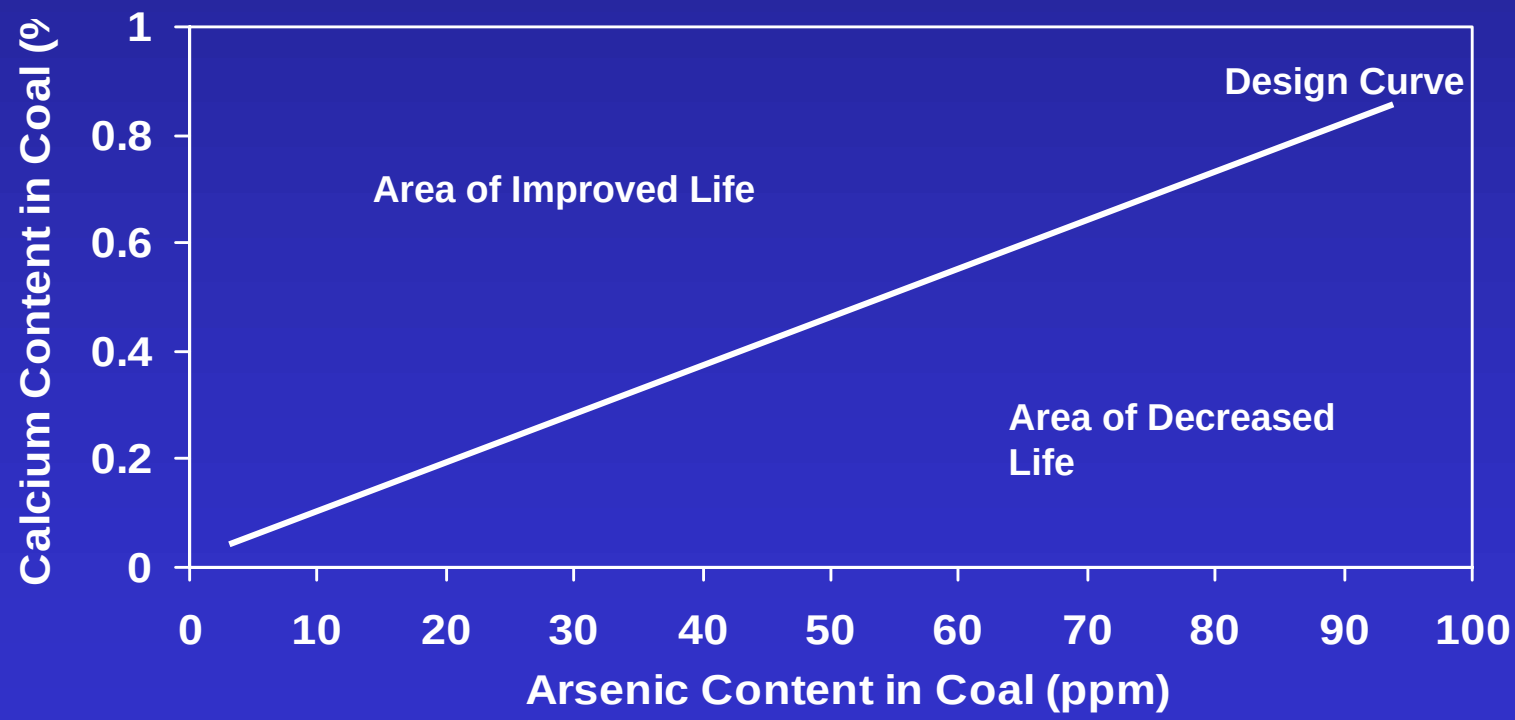
Fuel Types – Coals

Bituminous Coal

- Extensive industry experience
- Characterized by medium to high sulfur levels, arsenic contamination, highly variable ash loadings
- Sootblowing/sonic horns required, vertical configuration required
- SO_2 conversion held to <1% typically
- Significant impact on downstream equipment due to sulfuric acid and ABS formation, APH modifications usually required during life
- Ammonia slip held to < 2 ppm to avoid fouling and ash contamination
- Life strongly impacted by calcium and arsenic levels

Bituminous Coals – Effects of Arsenic and Calcium on Life

Catalyst Life vs. Arsenic and Calcium in Fuel



Fuel Types – Coal

Powder River Basin Coals

- Long-term poisoning mechanism from calcium (different from bituminous coals)
- SO_2 conversion limit may be relaxed depending on specific application
- Sootblowing/Sonic Horns required
- Vertical installations only
- Ammonia slip limits may be relaxed, SO_3 may control ABS formation
- Air preheater modification may be avoided depending on sulfur content
- SCR may improve particulate control device performance
- Ammonia on ash contamination not typically as problematic as with bituminous coals (presence of SO_3 conditioning will increase ammonia uptake).

SUMMARY

DESIGN CHART

Fuel	Config.	Pitch	SO_2 Conversion	Sootblowing	Slip
Natural Gas	any	small	No restriction	Not required	Regulatory restriction only
Process Gas	any	small	Fuel specific restriction	Not typically required	Not normally limited, regulatory restiction only
Fuel Oils	any	small	1-2% depending on fuel sulfur	Not typically required on light oils, may be needed on heavy oils	2 ppm on high sulfur fuel, > 2 ppm on low-sulfur fuel
Petroleum Coke	vertical	Medium to large	1% or less depending on vanadium deposition	Required, sootblower or horns	2 ppm or less typically
Coal Bituminous	vertical	large	Less than 1%	Required, sootblower or horn	2 ppm or less
Coal PRB	vertical	large	1-2%	Required, sootblower or horn	2-5 ppm typical

CONCLUSIONS

- Fuel selection is a controlling factor in overall SCR design
- Highly varied fuel specifications increase the cost of SCR
- Different fuels will have different specific issues such as vanadium deposition, arsenic poisoning, calcium poisoning, high particulate.
- Relative firing times of particular fuels will influence overall design
- Unusual fuels will produce uncertainty in catalyst life and SCR performance