

Fiberglass Reinforced Polymer Composites for Coal Fired Power Plant SO₂ Scrubbers

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Outline

- Introduction to AOC
- Coal fired power plants & the need for Sulfur Dioxide (SO₂) cleanup
- Brief review of chemistry of sulfur dioxide generation & removal
- Corrosive nature of sulfur dioxide gases
- Definition of Fiberglass Reinforced Polymer (FRP) Composites
- Materials of construction for sulfur dioxide scrubbers
- Use of FRP in sulfur dioxide scrubbers & stacks
- Concluding remarks

History

- The Alpha Corporation and Owens Corning Resin and Coating division formed a joint venture in 1994, Alpha Owens Corning.
- The Alpha Corporation purchased the Owens Corning share of the joint venture in 1998, and AOC, LLC was formed.

History

- AOC is North America's largest resin manufacturer, with 4 U.S. plants, and 1 each in Canada and Mexico.
- Globally, AOC is among the five largest in the world. European customers are serviced by plants located in the U.K., Poland and Slovakia. Asian-Pacific customers are serviced by plants in Thailand, India and Vietnam.

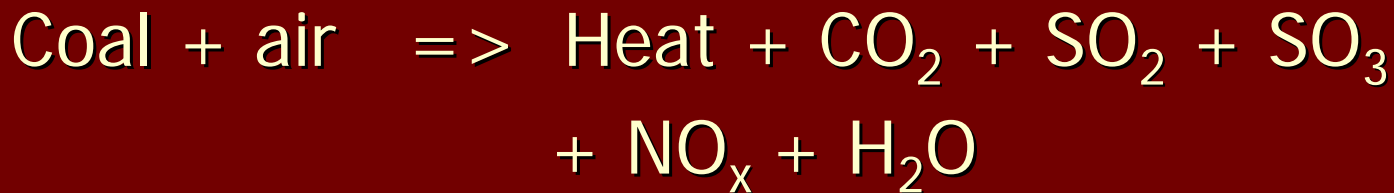
Coal Powered Power Plants

- Coal produces steam that powers steam generators
- Coals contain 2 – 6 % total sulfur
- Sulfur converts to SO_2 during combustion
- SO_2 forms sulfurous acid and sulfuric acid in the atmosphere
- Sulfur acids are deleterious to people and the overall environment if not removed from power plant exhausts

Overall Chemistry of Coal Combustion

Coal combustion

Coal plus oxygen yields heat, carbon dioxide and sulfur oxides



Chemistry of SO₂ Removal

Sulfur oxide gases are mixed with limestone

Limestone forms calcium salts with gases



Corrosive Chemicals in Scrubber Solutions

- Chloride ions (up to 20,000 ppm)
 - Sulfur dioxide and sulfur trioxide
 - Calcium carbonate
 - Nitrogen oxides
- All are corrosive to some materials of construction – *the chloride ion is the most corrosive to metals, especially stainless steels*

Definition of Fiberglass Reinforced Polymer (FRP) Composites

- A matrix of polymer materials that is reinforced by fibers or other reinforcing material.
 - For power plant application the polymer is usually a vinyl ester resin
 - The reinforcing fibers are typically glass fibers (fiberglass)

Examples of FRP in corrosive environments



Made from AOC Vipel® K022 Vinyl Ester

Examples of FRP in corrosive environments



Made from AOC Vipel® K022 Vinyl Ester

Examples of FRP in corrosive environments

Vipel® K022 Vinyl Ester



Vipel® F737 – Seawater pipe – LNG re-gasification



Photo courtesy of PITSA

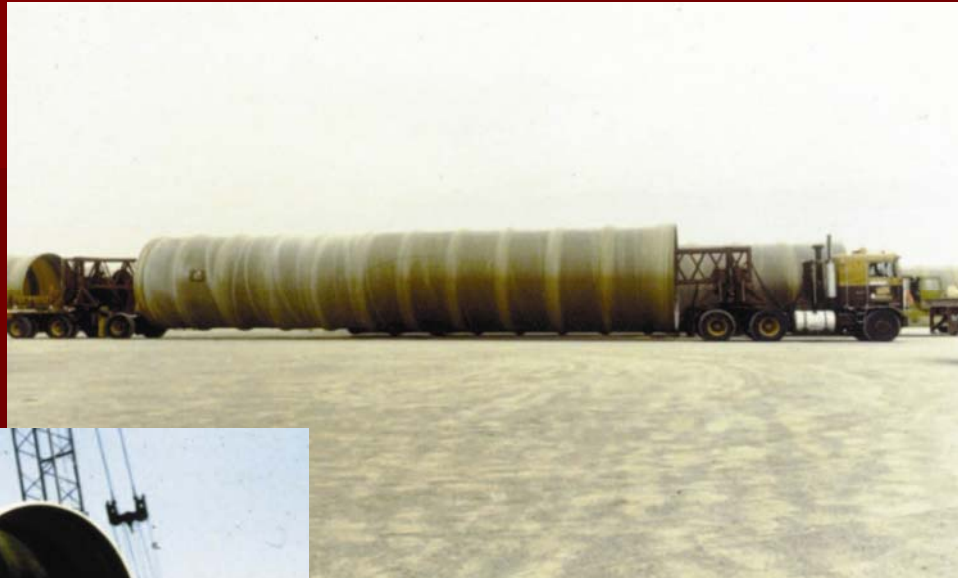
Vipel® F737 – Hydro Power Plant Penstocks - 1979



5620' 10' dia pipe
7808' 12' dia. pipe
Recently
inspected –
excellent
condition



Vipel® F737 – Power Plant Cooling Water - 1978



3000' 16.3' dia pipe –
offshore with 2 – 150 10' dia
dispersion legs
Double O-ring Bell & Spigot
joints
Inspected @ 22 years – like
new!

FRP Composite Scrubbers and Stack Liners

Application for FRP in Power Plant Scrubbers and Stacks

- FRP Piping
- Scrubber Internals
- Scrubber Vessels
- Stack Liners
- Ducting from scrubber to stack

Jet Bubble SO_2 Scrubber

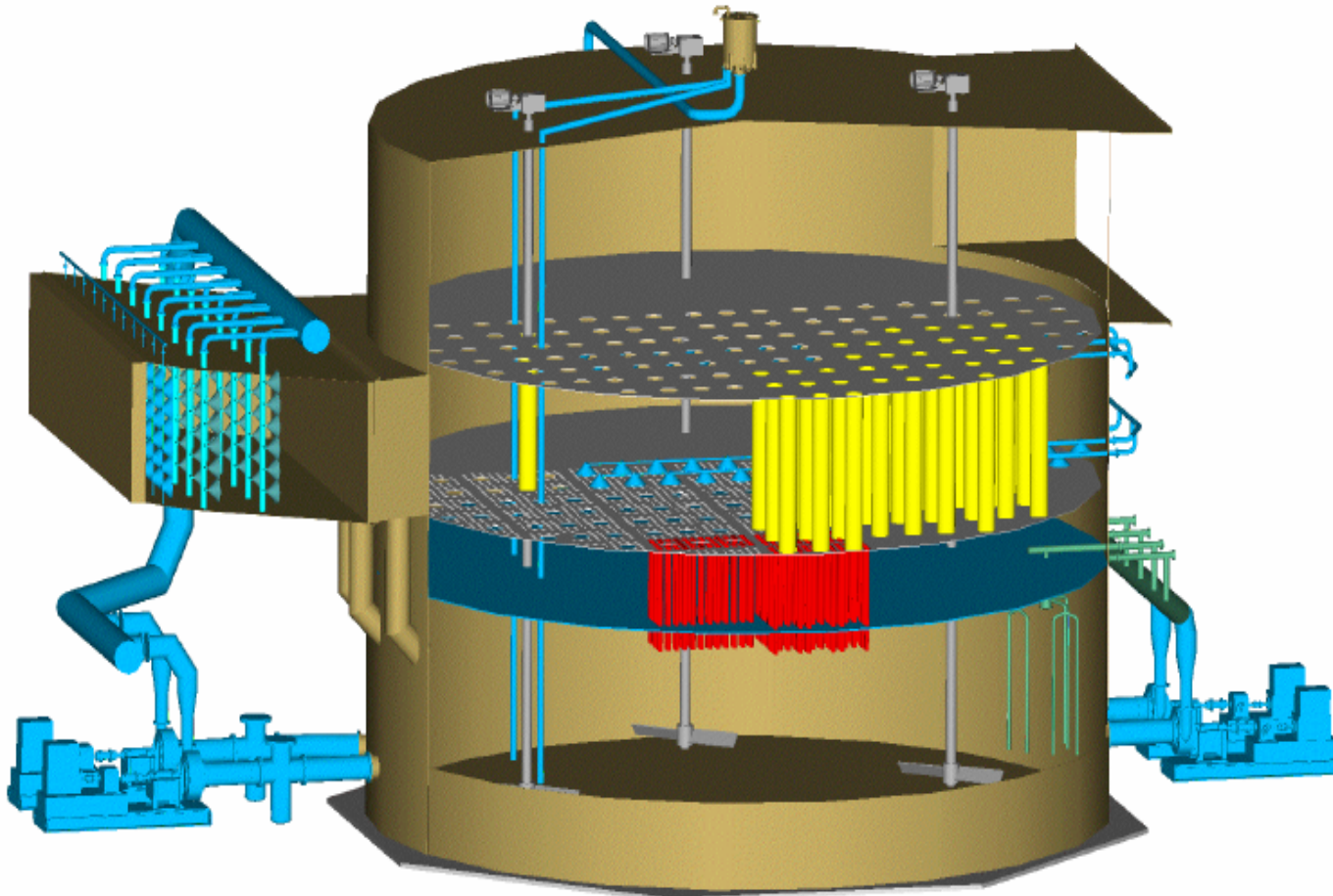
The CT-121 Wet FGD Process



Jet Bubble SO₂ Scrubber

The CT-121 Wet FGD Process

JBR Overview



Vipel® F010 Vinyl Ester Resins Series

Applications

- Caustic piping and storage
- Waste water treatment
- Bleach piping and storage
- Neutralization tanks – Acid tanks
- Sulfonated detergent storage

Examples of FRP in Sulfur Dioxide Scrubbers

Vipel® F010 Vinyl Ester



Examples of FRP in Sulfur Dioxide Scrubbers

Vipel® F010 Vinyl Ester



Stacks & Stack Liners



FRP Composites in Stack Liner for Scrubbing SO₂



Photo courtesy of Fiberglass Structural Engineering

FRP Composites in Stack Liner for Scrubbing SO₂



FRP Composites in Stack Liner for Scrubbing SO₂



Photo courtesy of Fiberglass Structural Engineering

FRP Composites in Stack Liner for Scrubbing SO₂



Photo courtesy of Fiberglass Structural Engineering

Vipel® K022 Fire Retardant Vinyl Ester Resins Series

Features

- Corrosion and toughness typical of non-fire retardant vinyl ester series
- ASTM E-84 Class 1 fire
- Superior fire retardancy (by bromination, not additives)

FRP Composites in Stack Liner for Scrubbing SO₂ AOC Vipel® K022-AC



Vipel® K022-AC – Stack Liner



Photo courtesy of Tri-Clor



Photo: Kiewit Energy

Vipel® K022-AC – Stack Liner



Photo courtesy of Tri-Clor

High Temperature Vinyl Ester Resins for Chimney Liners

High Temperature Vinyl Ester Liners for Chimney Liners

Length:

- 236.2 feet (72 meters)

Diameter:

- 55 inches (1400 millimeters)

Operating temperature:

- 150°C (302°F)

One-hour exposures:

- 180°C (356°F)

Resin:

- Vipel[®] F086 - HT vinyl ester



Photo courtesy of Tunetanken A/S

Comparative Liner Costs

Material of Construction for Liner	Installed Cost, \$/ft²
<i>Alloy C-276 over steel</i>	<i>225</i>
<i>Vinyl Ester FRP (Multiple liners possible)</i>	<i>125</i>
<i>Borosilicate Glass Block</i>	<i>125</i>

Conclusions

- Coal fired power plants are one of the largest generators of SO₂ in the world
- Environmental regulations are requiring plants to be fitted with SO₂ removal equipment
- There are a variety of technologies for removing SO₂ ; wet SO₂ scrubbers are corrosive to many materials of construction.
- AOC has developed a Class 1 flame spread vinyl ester that does not require filler: Vipel[®] K022-AC
- Pipes, scrubbers & chimney liners made from FRP have a proven history in the power industry

How To Get Started

AOC can provide:

- Basic resin specifications & assistance with resin selection
- Fabricator referral lists
- Coupon testing & case histories

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