Solving Corrosion Problems with VIPEL Composites

Slide 1 Welcome to the seminar on "Solving Corrosion Problems with Fiberglass Composites."

The Solution is AOC VIPEL®, CORROSION RESISTANT RESINS

Slide 2 Shows Corrosion and Abrasion problems to a sucker rod end fitting through oxidation.

Slide 3 Where is the Need?

A. Municipalities

1. Water and Waste Water

2. Transmission lines

B. Residential

C. Industrial 1. Chemical 2. Pulp and Paper 3. Power–Coal, Nuclear, Hydro
4.Electronic/Semiconductor 5. Oil and Gas 6. Pharmaceutical 7. Plating 8. Mining 9. Metal Refining
10.Water and Waste Water 11.Food Processing

Slide 4 What is the Need?

A. Municipal:

1. Water and Waste Water Treatment

(containment vessels, pipes, aerators, walkways, filters, scrubbers,

stacks, covers, pit liners, siding, etc.)

2. Water, gas, and fuel transmission pipe lines – new and refurbished

B. Residential:

1. Transmission pipe lines – water, sewer (new and refurbished)

2. Tanks – water

C. Industrial:

1. Process equipment, tanks, pipes, ducts, stacks, scrubbers, towers,

grating, siding, cooling towers, covers, agitators, etc.

2. Linings and Coatings

Slide 5 Picture of a Field Constructed JBR (Jet Bubbling Reactor) for removing emissions at a coal fired power plant.

Slide 6 Inside view of internals of a JBR.

Slide 7 Filament winding a stack liner on site for a coal fired power plant.

Slide 8 FRP liner inside concrete stack for coal fired power plant.

Slide 9 Engineering Seminar

Slide 10 Installing a tank lining using fiberglass mat and resin.

Slide 11 AOC developed the first underground gasoline storage tanks in the early 1960's.

Slide 12 Terminology

Corrosion: The deterioration of a material that results from a chemical or electrical reaction with its environment.

Composite: The joining together of parts or materials to function as a single unit.

Resin*+Reinforcement + catalyst=Composite

*Resin is a mixture of a polymer r+ monomer

Slide 13 Terminology

FRP - FIBERGLASS REINFORCED PLASTIC

RTP - REINFORCED THERMOSET PLASTIC

GRP - GLASS REINFORCED PLASTIC

Slide 14 Composites

RESIN - CONTROLS CORROSION AND FIRE RETARDANCY

REINFORCEMENT - CONTROL STRENGTH (GLASS FIBERS)

CATALYST - CONTROLS CURE

Slide 15 Shows the difference between a thermoset resin and thermoplastic resin. The thermoset resin is permanent; whereas, the thermoplastic can be re-melted and used again.

Slide 16 Polyester resin being poured out onto glass mat.

Slide 17 Engineering Seminar TERMINOLOGY, **CORROSION RESISTANT RESINS,** FABRICATION FOR CORROSION RESISTANCE, TESTING FOR CORROSION RESISTANCE, FLAME RETARDANCY
RESIN SELECTION, FABRICATION PROCESSES, PROPERTIES / STANDARDS, ADVANTAGES

Slide 18 Generic Types of resin technologies

Bisphenol-A Epoxy Vinyl Ester / AOC VIPEL F010/F007

Bisphenol-A Epoxy FR-VE / VIPEL K022 and K023

High Cross Linked Bisphenol-A Epoxy VE / VIPEL F080

Epoxy Novolac Vinyl Esters / VIPEL F085 and F086

Epoxy Novolac FR-VE / VIPEL K095

Elastomeric, Bisphenol-A Vinyl Ester / VIPEL F017

Bisphenol-A Fumarate Polyester / VIPEL F282

Chlorendic Polyester / VIPEL K190

Isophthalic Polyester / VIPEL F701, F764, F737, F738

Isophthalic FR Polyester/ VIPEL K733

Terephthalic Polyester / VIPEL F774

Slide 19 Diagram of a pulp mill and the color represents resin technologies used in the fiberglass composites.

Slide 20 Chemical resistance of resin technologies using a PH bar graph. PH (measures the negative log of the hydrogen ion) which enables us to see if the solution is acid or base.

Slide 21 Chemical Resistance of VIPEL chemical resistant resins

AOC VIPEL F010/K022

AOC VIPEL F007

AOC VIPEL F080

AOC VIPEL F083

AOC VIPEL F085/F086

AOC VIPEL F282

AOC VIPEL F701/K733

AOC VIPEL K190

Slide 22 Shows potential operating temperatures of generic resin technologies. Consult AOC Technical Service for recommendations.

Slide 23 Engineering Seminar, CORROSION INDUSTRY BACKGROUND, CORROSION RESISTANT RESINS **FABRICATION FOR CORROSION RESISTANCE,** TESTING FOR CORROSION RESISTANCE, FLAME RETARDANCY, RESIN SELECTION, FABRICATION PROCESSES, PROPERTIES / STANDARDS, ADVANTAGES

Slide 24 Standard Construction of corrosion resistant laminate – Minimum thickness 100 mils – Construction (10 mil veil, 90 mils of 3 plies of 1.5 oz. ECR mat, followed by reinforcement (filament winding or following ASTM PS 15-69 for hand layup. Fiberglass standards will be at the end of this seminar.

Slide 25 Fiberglass Composition by weight.

Slide 26 The two most common surfacing veils used are "C veil" and Nexus.

Slide 27 The purpose and use of veils

1. Provides resin rich corrosion barrier and prevents cracking/crazing of resin rich barrier.

2. Types of veils depends upon resin, corrosion environment, and fabrication techniques.

3. Use of multiple veils depends upon corrosion and resin.

Slide 28 Flexural strength retention using various veils and combinations of veils in 15% HF at 130F for 12 months.

Slide 29 A picture of glass mat and chopped strand.

Slide 30 A picture of filament winding strand and woven roving.

Slide 31 A picture of Biaxial and Uniaxial stitched roving.

Slide 32 Microscopic view of fiberglass encapsulated in resin.

Slide 33 Engineering Seminar, CORROSION INDUSTRY BACKGROUND, CORROSION RESISTANT RESINS, FABRICATION FOR CORROSION RESISTANCE, **TESTING FOR CORROSION RESISTANCE**, FLAME RETARDANCY, Resin SELECTION, FABRICATION PROCESS, PROPERTIES / STANDARDS, ADVANTAGES

Slide 34 Evaluation of Corrosion Resistance

ASTM C 581 STANDARD CONSTRUCTION, CORROSION BARRIER IS TESTED, EVALUTATION OF TEST COUPONS, BARCOL HARDNESS, FLEXURAL STRENGTH, FLEXURAL MODULUS, APPEARANCE, WEIGHT AND THICKNESS

Slide 35 ASTM C581 Standard construction test coupon – 10 mil glass veil – 2 plies 1.5 oz. glass mat – 10 mil glass veil and resin coat all edges.

Slide 36 Coupons are tested in a designated solution at a given temperature under reflux for 12 months.

Slide 37 Coupons are removed and rinsed clean before mechanical and visual testing is performed.

Slide 38 Coupons are checked for flexural strength properties. Ideal results are to have coupon with 80-90% strength retention over 12 months.

Slide 39 Generic resin performance in hot wet chlorine

Slide 40 is a picture of a laminate with two silver strips to check for conductivity.

Slide 41 Engineering Seminar, CORROSION INDUSTRY BACKGROUND, CORROSION RESISTANT RESINS FABRICATION FOR CORROSION RESISTANCE, TESTING FOR CORROSION RESISTANCE, **FLAME RETARDANCY**, RESIN SELECTION, FABRICATION PROCESSES, PROPERTIES / STANDARDS, ADVANTAGES

Slide 42 Picture of ASTM E-84 fire test chamber.

Slide 43 Shows how the ASTM E-84 fire test chamber is calibrated. Asbestos cement is rated a zero flame spread and zero smoke; and red oak which is rated at 100 flame spread and 100 smoke. All materials burned are compared against these two materials. To achieve a class 1 FR rating the material must be equal to or less than 25 flame spread.

Slide 44 Antimony oxide is a SYNERGIST FOR HALOGENATED RESINS , but DOES NOT WORK WITH NON-HALOGENATED RESINS

Slide 45 Resin selection, CORROSION INDUSTRY BACKGROUND, CORROSION RESISTANT RESINS, FABRICATION FOR CORROSION RESISTANCE, TESTING FOR CORROSION RESISTANCE, FLAME RETARDANCY, **RESIN SELECTION**, FABRICATION PROCESSES, PROPERTIES / STANDARDS, ADVANTAGES

Slide 46 AOC Resin Selection Guide

Slide 47 is the information needed before selecting a resin.

CHEMICALS, CONCENTRATION (MAX./ MIN.), TEMPERATURE (OPERATING-MAX./ MIN.), UPSETS FLAME RETARDANCY, ABRASION, INSULATION, MANUFACTURING PROCESS

Slide 48 For a Successful application you need to obtain the following information.

RESIN SELECTION, DESIGN / ENGINEERING, WRITING SPECIFICATIONS, FABRICATION, INSPECTION

Slide 49 Inspection of FRP Equipment

WHEN SHOULD IT BE DONE? DURING AND AFTER FABRICATION, WHEN RECEIVED AND INSTALLED AFTER A PERIOD OF USE, CHANGING SERVICE
CHANGING TESTS

BARCOL HARDNESS (12 MINUS HI AND 10 LOW), VISUAL – (AIR BUBBLES, VOIDS, BLISTERS, CRACKING / CRAZING (MECHANICAL –THERMAL), ACOSTICAL EMISSION

Slide 50 Engineering Seminar

CORROSION INDUSTRY BACKGROUND, CORROSION RESISTANT RESINS,FABRICATION FOR CORROSION RESINS, TESTING FOR CORROSION RESISTANCE, FLAME RETARDANCY, RESIN SELECTION, **FABRICATION PROCESSES**, PROPERTIES / STANDARDS, ADVANTAGES

Slide 51 Typical FRP Fabrication Techniques

HAND LAY-UP
SPRAY-UP
FILAMENT WINDING
CONTINUOUS PULTRUSION
RESIN TRANSFER MOLDING
LININGS
PRESS MOLDING

Slide 52 A picture of hand lay-up.

Slide 53 Wetting out glass mat with resin using a roller.

Slide 54 A diagram of a spray-up application.

Slide 55 A picture of a chopper gun.

Slide 56 A diagram of filament winding.

Slide 57 A picture of filament winding a tank in south central Oklahoma.

Slide 58 Glass strands going though a resin wet-out bath.

Slide 59 A diagram of continuous pultrusion.

Slide 60 Glass and resin being pulled through a heated die.

Slide 61 A pultruded panel.

Slide 62 A diagram of resin transfer molding.

Slide 63 A picture of a fan stack part being made by the resin transfer method for a cooling tower.

Slide 64 A diagram of compression molding.

Slide 65 A picture of a flake glass coating or hand lay-up lining.

Slide 66 Lining the inside of a stack.

Slide 67 Engineering Seminar, CORROSION INDUSTRY BACKGROUND, CORROSION RESISTANT RESINS FABRICATION FOR CORROSION RESISTANCE, TESTING FOR CORROSION RESISTANCE,FLAME RETARDANCY, RESIN SELECTION, FABRICATION PROCESSES, PROPERTIES / STANDARDS, ADVANTAGES

Slide 68 Shows a comparison FRP, Al. Steel. Concrete and PVC relating to specific gravity.

Slide 69 Shows the comparative difference of FRP, AL, Steel, Concrete and PVC to coefficient of thermal expansion.

Slide 70 shows the difference of thermal conductivity of FRP, AL, Steel. Concrete and PVC

Slide 71 Industry Specifications for FRP Equipment

ASME RTP-1, the standard for reinforced thermoset plastic corrosion resistant equipment code; and ASME B31.3 process piping code.

ASTM D3299 – Above Ground Vertical Filament Wound Tanks

ASTM D4097 – Above Ground Vertical Contact Molded Tanks

ASTM D2996 – Filament Wound pipe

ASTM D2310 – Machine-made Pipe

ASTM D3982 – Contact Molded Duct and Hoods

ASTM D4024 – Reinforced Thermosetting Plastic (RTP) Flanges

ASTM D6041 – Contact Molded Pipe and Fittings

ASTM D5364 - Chimney Liners

This is available at http://www.asme.org/catalog/.

Slide 72 Engineering Seminar, CORROSION INDUSTRY BACKGROUND, CORROSION RESISTANT RESINS FABRICATION FOR CORROSION RESISTANCE, TESTING FOR CORROSION RESISTANCE, FLAME RETARDANCY, RESIN SELECTION, FABRICATION PROCESSES, PROPERTIES / STANDARDS, ADVANTAGES

Slide 73 Advantages

No Electrochemical Corrosion, High Strength and Stiffness for Low Weight, Tailored Mechanical Properties, Tailored Corrosion Resistance

Slide 74 FRP Advantages versus Steel

Slide 75 Thank you for specifying:

AOC VIPEL® THE PROVEN CORROSION FIGHTER, Corrosion@aoc-resins.com, www.corrosionresins.com
Douglas Raine: douglas@fgbt.org