



COMPOSITE PIPES FOR ETHANOL TRANSMISSION

Rio de Janeiro, 22 de Setembro de 2011.
Antonio Carvalho Filho
IBCOM



BEST RESINS FOR ETHANOL

- TEREPHTHALIC POLYESTER
- VINYL ESTER NOVOLAC



TESTED RESINS

- TEREPHTHALIC POLYESTER (THE BEST)
- DCPD POLYESTER (THE WORST)
- ALL DULY POST-CURED TO MINIMIZE ABSORPTION.
- VINYL ESTER NOVOLAC NOT TESTED (HIGH COST)



TEST METHOD

- **2,0 MM THICK CAST COUPONS OF NEAT RESIN IMMERSED IN ETHANOL AT 30°C.**
- **ABSORPTION “ Δm ” MEASURED AS WEIGHT GAIN**
- **TESTING STOPPED AT SATURATION.**
- **DIFFUSION COEFFICIENT “D” ESTIMATED BY TIME TO SATURATION.**



FORMULAS

- **ABSORPTION**

$$\Delta m = \frac{m - m_0}{m_0} \times 100$$

- **COEFFICIENT OF DIFFUSION**

$$D = \frac{\pi^2}{4} \times \frac{(\text{Thickness})^2}{\text{Time}}$$



TEST RESULTS



RESULTS

	TEREPHTHALIC	DCPD
Δm	11%	14%
D	0,014 mm²/day	0,082 mm²/day
TIME TO SATURATION	> 700 Days	120 Days



CONCLUSION

- **ETHANOL ABSORPTION IS TOO HIGH**
 - ETHANOL SWELLS THE COMPOSITE
 - THE SWOLLEN COMPOSITE LOSES MECHANICAL PROPERTIES AND TEMPERATURE CAPABILITY
 - COMPOSITE PIPELINES CANNOT BE USED FOR ETHANOL TRANSMISSION
- **THE INGRESS OF ETHANOL SHOULD BE PREVENTED**



IMPERMEABLE LINER

- **METALS ARE IMPERMEABLE.**
- **COMPOSITE PIPES WITH A METAL FOIL IN THE LINER WILL PREVENT THE INGRESS OF ETHANOL.**



BENEFITS FROM THE METAL FOIL

- **MAIN BENEFIT**
 - **THE COMPOSITE PIPES ARE GOOD FOR ETHANOL TRANSMISSION**
- **ADDITIONAL BENEFITS:**
 - **DOUBLE WALL PIPES EASILY MADE, IF DESIRED**
 - **ALLOWS THE USE OF LOW COST RESINS**
 - **ELIMINATION OF ANOMALOUS BLISTERS IN SAND CORED PIPES**
 - **CRACKING FROM POOR HANDLING CEASES TO BE A CONCERN**
 - **IN FACT, POOR HANDLING CEASES TO BE A CONCERN**



APPLICATIONS OTHER THAN ETHANOL PIPELINES

- **SOLVENT LADEN INDUSTRIAL EFFLUENTS**
- **SOLVENT TRANSPORTATION AND STORAGE**
- **INDUSTRIAL WASTE MANAGEMENT**
- **SAND CORED SANITATION AND IRRIGATION PIPES**
- **GAS TRANSMISSION**



PROTOTYPE IMPERMEABLE PIPES

- **PROTOTYPE CONSTRUCTION**
 - **TRADITIONAL “VEIL” LINER RETAINED FOR MECHANICAL PROTECTION**
 - **ALUMINUM FOIL APPLIED OVER THE “VEIL” LINER.**
 - **STRUCTURAL LAMINATE APPLIED OVER THE FOIL.**



PROTOTYPE FITTINGS

- **THE METAL FOIL IN THE FITTINGS IS APPLIED BY**
 - METAL “SPRAY”
 - HAND LAY-UP
- **FITTING CONSTRUCTION**
 - “VEIL” LINER FOR MECHANICAL PROTECTION
 - ALUMINUM FOIL
 - HAND LAID-UP STRUCTURAL PLIES



JOINTS

- **RIGID JOINTS**
 - LAMINATED JOINTS PREFERRED. THE PIPE ENDS NEED NOT BE SEALED PRIOR TO LAMINATION OF THE JOINT
 - FLANGED JOINTS USED AS REQUIRED



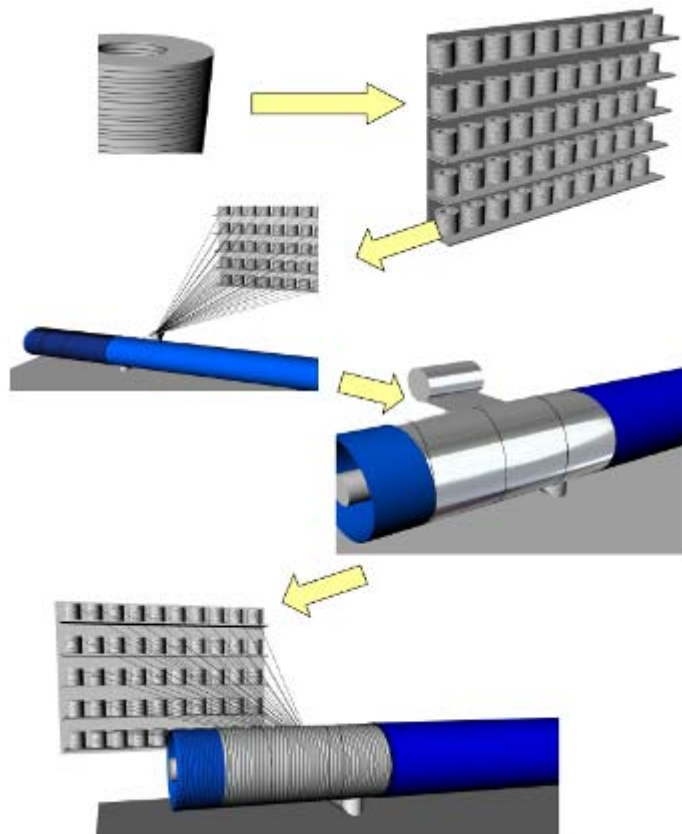
COST

- **THE ALUMINUM FOIL IS THE ONLY ADDED ITEM**
- **COMPOSITE KEEPS ITS COMPETITIVE POSITION**
- **LOWER INSTALLATION AND MAINTENANCE COSTS VERSUS STEEL**
 - **NO NEED OF CATHODIC PROTECTION**
 - **NO COATING REQUIRED**
 - **EASY INSPECTION (DOUBLE WALL IF DESIRED)**

THE PROTOTYPE



THE MANUFACTURING PROCESS







THANK YOU!

Antonio Carvalho Filho
(11) 9 5300 4821
TONY.HDB@GMAIL.COM