ECTFE/FRP Applications In Chlorine Dioxide, Sodium Hypochlorite, Sodium Chlorate, Sodium Hydroxide, Sulfuric and Hydrochloric Acids Environments

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Abstract

The properties of ECTFE (ethylene chorotrifluoroethylene), and its chemical resistance to chlorine dioxide, sodium hypochlorite, sodium chlorate, sodium hydroxide, sulfuric and hydrochloric acids will be presented. Up to date typical applications in the pulp and paper and sodium chlorate processes will be shown for ECTFE/FRP equipment.

Properties of ECTFE

ECTFE is a copolymer of ethylene and chorotrifluoroethylene offering a unique combination of mechanical properties, thermal and chemical resistance with an outstanding ease of process ability. It offers excellent resistance to abrasion, harsh chemicals, and permeation. It has a melting point of 640°F – 240 °C.

Chemical resistance

Chemical	°F - °C
Chlorine dioxide: 18 %	200 - 93
Chlorine dioxide: 25 %	212 - 100
Chlorine dioxide gas : 100 %	106 - 50
Sodium hypochorite: 5 %	250 - 121
Sodium hypochorite: 50 %	221 - 105
Sodium hydroxide: 5 %	278 - 137
Sodium hydroxide: 50 %	260 - 132
Sodium chlorate: 60 %	203 - 95
Hydrogen peroxide: 66 %	86 - 30
Hydrochloric acid: 37 %	221 - 105
Sulfuric acid: 98 %	250 - 121
0-20% NaOH, 0-12% NaCl, 0-15% NaOCl, 0-4% NaHCO3	180 - 82
Cl2 scrubbed with NaOH resulting in NaOCl	158 - 70

ECTFE/FRP applications for chlorine dioxide, sodium hydroxide and sulfuric acid							
Mill location	Year	Application	Diameter Ft - mm	Height Ft - mm	Chemicals	Temperature °F - °C	Notes
Michigan, USA - location 1	1998	Preretention J - tube	6.5 - 1,890	75 - 22, 860	Chlorine dioxide: 1.2 % in pulp	190 - 88	Inspected in 2000 and 2003
Michigan, USA - location 1	1998	Down flow prerention tube	14 - 4,267	65 - 19,812	Chlorine dioxide: 1.2 % in pulp	190 - 88	Inspected in 2000 and 2003
France	2000	Preretention U - tube	3 - 914	35 - 10,668	Chlorine dioxide in pulp		Inspected in 2003
Michigan, USA - location 2	2004	Preretention J - tube	9 - 2,743	79 - 24,079	Chlorine dioxide: 1.4 % - Sulfuric acid: 5 % in pulp	180 - 83	
New York, USA	2004	Storage tank	20 - 6,096	25 - 7,620	Chlorine dioxide: 1.2 %	45 - 7	Replaced an FRP lined steel tank in service and repairs for 13 years
Alberta, Canada	2004	Caustic extraction tower	4.75 - 1,448	47.5 - 14,478	Sodium hydroxide: 10 % in pulp	165 - 65	Also additions of sulfuric acid. Replaced FRP tower in service & repairs for 13 years

Other applications for piping

- Stainless pipe used for pulp builds up pitch, which, upon restarting after a shutdown could entrain particles detaching from the rough wall inner surface, and contaminate the pulp. One of the Canadian mills is establishing a replacement program with ECTFE/FRP pipe, known for its smooth inner surface, which would solve the problem.
- Piping for chlorine dioxide and pulp injected to bleaching towers is a good candidate for ECTFE/FRP

Sodium Chlorate applications:

ECTFE/FRP is specified & used at sodium chlorate plants worldwide, including:

- Eka Chemicals
- Nexen Chemicals
- Aker Kvaerner Chemetics
- Erco Worldwide

Applications are:

- Electrolyte feed headers
- Electrolyte feed pipes to cell boxes or electrolysers
- Electrolyte outlet headers
- Degasifiers / Gas separators
- Risers
- Hydrogen scrubbers

Properties of ECTFE in sodium chlorate

- Excellent chemical & abrasion resistance
- Low permeation rate compared to other fluoropolymers (See Figures 1 and 2)
- 1-7 % thickness reduction after 8 years in service in electrolyte outlet solution

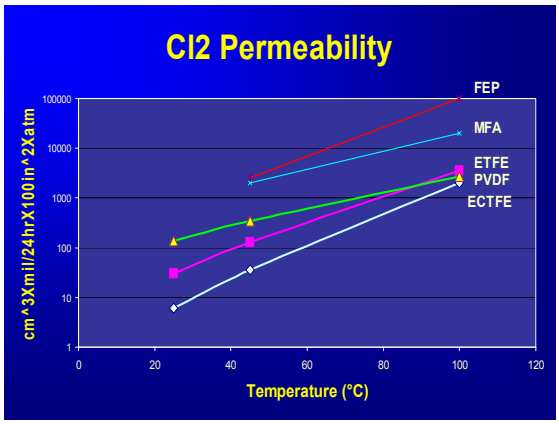

Figure 1

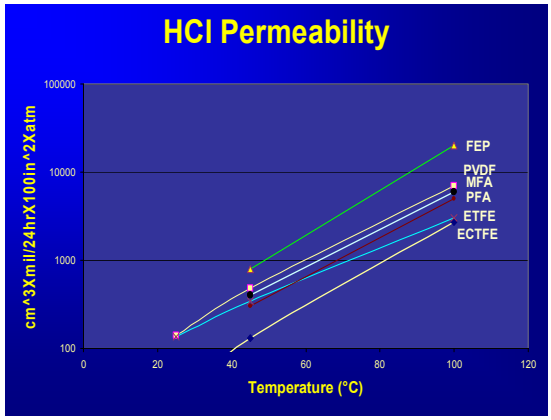

Figure 2

Fabrication of ECTFE/FRP equipment

Piping

- A glass backing is first applied to the ECTFE pipe (as shown in figure 3)
- The pipe is spooled , and the spools are joined by hand welding, or machine butt welding, to fittings, such as tees, elbows, flanges, etc (Figures 4 - 5)
- Finally the FRP reinforcement is applied by wrapping, the ECTFE pipe, either by hand lay up, or by filament winding (Figures 6 - 7 - 8)

Figure 3

Figure 4

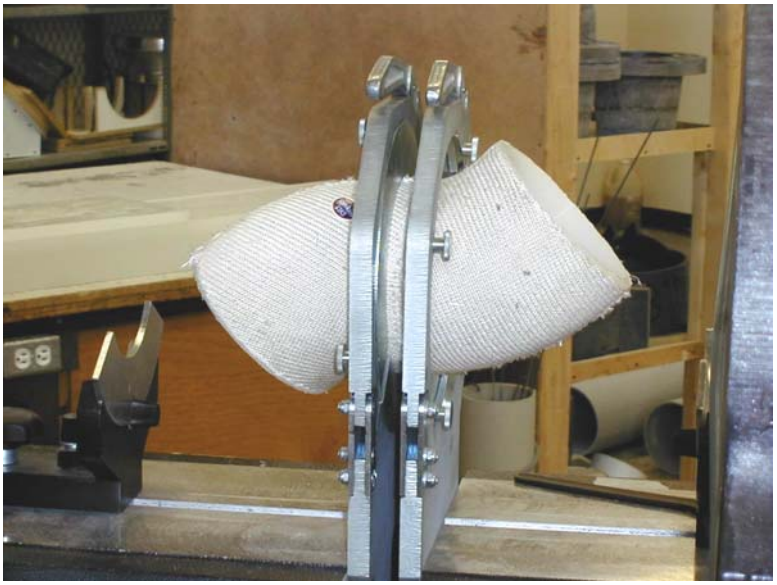

Figure 5

Figure 6

Figure 7

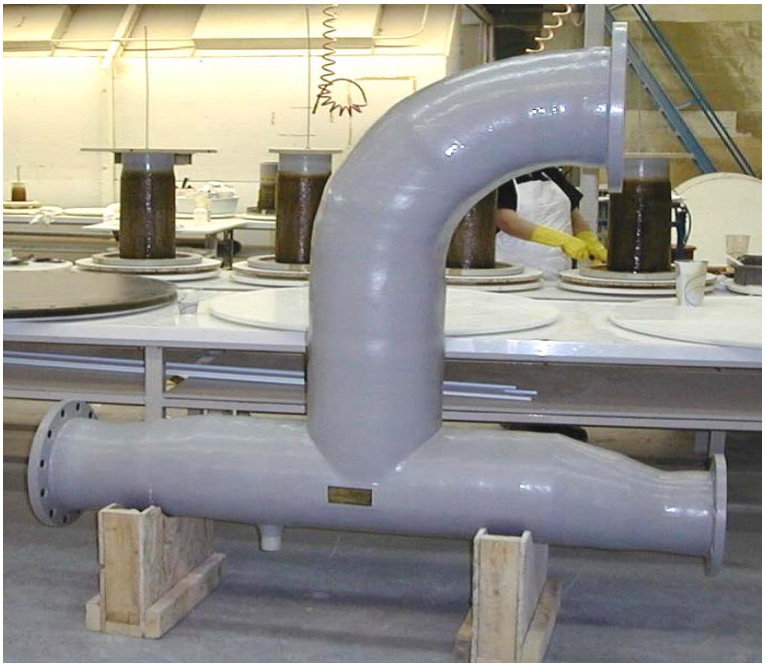

Figure 8

Other ECTFE/FRP shapes than small diameter piping

- Large diameter piping, tanks, towers, scrubbers, etc are first formed in the desired shape using fabric backed sheets, which are joined and welded (Figure 9), then reinforced with FRP.
- Rectangular shapes, such as sodium chlorate electrolytic cells (Figure 10) are fabricated the same way.

Figure 9

Figure 10

Examples of ECTFE/FRP equipment in the manufacturing of sodium chlorate and chlorine

- Sodium chorate electrolytic cells (Figures 10 - 11)
- Ducting over the cells connected to degassers (Figure12)
- Risers in a chlorine plant (Figure 13)

Figure 11

Figure 12

Figure 13

Conclusion

ECTFE/FRP corrosion and high temperature resistance to: chlorine dioxide, sodium hypochlorite, sodium chlorate, sodium hydroxide, hydrochloric and sulfuric acids, supported by case histories, makes it a material of choice for these chemicals used for pulp and paper applications.