

Chemical Processing

PVDF Tackles Bromine Corrosion

A challenge to design and fabricate, the largest-known PVDF-lined vessels now successfully serve at PTA plants

By Diane Dierking, senior editor

When BP, London, decided to expand its purified terephthalic acid (PTA) capabilities in the Far East, the company was faced with the prospect of building two large scrubbers that would be subject to bromine corrosion. BP, working in conjunction with CPF Dualam, Montreal, decided to fabricate these large vessels for bromine service using chemically inert Kynar polyvinylidene fluoride (PVDF), from Atofina Chemicals, Philadelphia, as a primary corrosion barrier.

PTA, a key precursor to polyester, is made by the oxidation of paraxylene. This oxidation process can be catalyzed by highly corrosive bromine. Materials that are resistant to bromine are few: titanium, fiberglass reinforced plastic (FRP) and PVDF. PVDF was considered the best choice because vessels made of FRP have been known to blister and fail prematurely, whereas titanium is very expensive.

BP and Dualam selected Kynar PVDF because it also provides the chemical and permeation resistance necessary at the operating temperatures while being a cost-effective fluoropolymer. Predicting service lives for the vessels is difficult, but they are expected to last as long as titanium vessels, or more than 20 years, depending on service conditions.

Besides its resistance to a variety of chemicals, including halogens and halogenated acids, Kynar PVDF boasts



relatively high tensile strength and low gas permeability in these environments. This minimizes the danger of the vessel lining collapsing under elevated temperature and pressure, positive or negative. Studies show Kynar PVDF permeability ratings to be substantially better than alternative fluoropolymers (Table 1).

The double challenge of building and shipping these large process vessels was laid on the shoulders of CPF Dualam because of its 50 years of experience in the design and fabrication of corrosion-resistant fluid handling equipment, its sophisticated, environmentally controlled shop and its direct access to the year-round Port of Montreal. Of equal importance, however, is the company's intimate knowledge and experience with Kynar fluoropolymer lining materials. The larger of the two scrubbers is the largest fluoropolymer-lined, dual-laminate vessel Dualam has ever built, and has expanded the company's boundaries of vessel fabrication.

Due to their size, the two scrubbers were built in sections inside Dualam's fabrication shop and assembled at the port. The larger of the two scrubbers is a dual-laminate vessel that is 27 ft. (8.2 m) in diameter, 70 ft. (21.3 m) tall and weighs more than 56,000 lb. The smaller scrubber is 22 ft. (6.7 m) in diameter and 68 ft. (20.7 m) tall.

The vessel linings are made entirely of Kynar PVDF

>> Gas Permeability of Fluoropolymers						
	PTFE	PFA	FEP	ETFE	ECTFE	PVDF
Water vapor, g/m ² /day/bar	5	8	1	2	2	2
Oxygen, cm ³ /m ² /day/bar	1,500	—	2,900	350	100	20
Nitrogen, cm ³ /m ² /day/bar	500	—	1,200	120	40	30
Helium, cm ³ /m ² /day/bar	3,500	17,000	18,000	3,700	3,500	600

*Note: Data are based on 100µ film thickness at 23°C.
Source: Data published in 1980 Kunststoffe paper titled "Fluorocarbon Films – Present Situation and Future Outlook."*

Table 1. PVDF exhibits the best gas permeability properties for several common gases.



After assembly at the port, the scrubber is moved for pressure testing.



Steel blinds were made to allow pressure testing of the scrubbers at the port.



One of the scrubbers is moved onto the deck of the ship that will transport the vessels to China.

fabric-backed sheet produced by Symalit AG, Lenzburg, Switzerland. The fabric backing is laminated fiberglass over cloth, which prevents permeants from building up at the Kynar/FRP interface. The construction is fully bonded, meaning 100% of the PVDF surface is bonded to the FRP. This bond is sufficient to withstand full vacuum conditions in a process vessel. External lifting lugs, tailing lugs, platform support brackets and platforms were fabricated from stainless steel, FRP and galvanized steel. A portion of the scrubber packing is also made from Kynar PVDF.

Once assembled, the scrubbers had to be hydrostatically pressure tested — all before being loaded onto the ship. Dualam built reinforced concrete foundations upon which to erect the vessels for testing. Steel plates reinforced with steel

ribs were fabricated for blinding each vessel during testing at the port. The largest vessel required a blind that was 12 ft. in diameter. The vessels are rated for operation at 12 psig; although the vessels passed the pressure testing, some of the steel ribs in the steel plates failed. Design, fabrication and testing took about six months.

The vessels had to be secured on the deck of the ship for transport to China

because they were too big to be stored below deck. The voyage to China took about three weeks. One vessel was delivered to a site in Kaoshiung, Taiwan, and the other to Zhuhai, Guangdong Province, China. Both sites are on the coast, eliminating the need for ground transport of either vessel. The vessels have been operating successfully for about six months. **CP**

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