

Analytical Test Results

May 1999

There have been a number of extraction studies done by resin manufacturers and others claiming very low levels of extractables for a variety of fluoropolymer and thermoplastic resins. These studies often are based upon closed loops of extruded piping or tubing with circulating ultra pure water, UPW. Several studies have been done with pellets of a specific fluoropolymer resin being soaked in UPW or some other high purity media. Although useful and helpful to some degree, we believe actual coated and lined vessels exposed to UPW should be more meaningful. We therefore engaged a well-known testing laboratory to perform extraction tests on coated stainless steel vessels. Testing conditions were done at room temperature and over a period of seven days. The analysis of the UPW for leachables was done by IC and ICP-Mass Spectroscopy. The results are noted and provide some comparative information about coated and lined vessels.

WHITE RUBBER

ECTFE

PVDF

PE

PEI

ETFE

ETFE 1020 *High Purity*

Leachable Total Oxidizable Carbon

Leachable Anions by IC

Leachable Cations by IC

Leachable Trace Metals by ICP-MS

Fisher|Moore



Leachable Total Oxidizable Carbon Detection Detection Limit 5 ppb

White Rubber (Pharmaceutical Grade)	5300
ECTFE	*
PVDF	27
PE	46
PEI	16
ETFE	*
ETFE*	*



Leachable Anions by IC Detection Limit Units ppb

		Rubber	ECTFE	PVDF	PE	PEI	ETFE	ETFE*
Fluoride (F ⁻)	0.03	6.1	0.14	4.9	0.85	2.0	0.2	*
Chloride (Cl ⁻)	0.3	130	0.8	14	3.8	1.2	0.6	*
Nitrite (NO ₂ ⁻)	0.3	*	*	*	*	*	*	*
Bromide (Br ⁻)	0.5	*	*	*	*	*	*	*
Nitrate (NO ₃ ⁻)	0.5	*	5.5	*	*	*	*	*
Phosphate (HPO ₄ ²⁻)	0.5	*	4.1	*	*	*	*	*
Sulphate (SO ₄ ²⁻)	0.5	1200	*	*	11	2.2	*	*

* ETFE 1020 - High Purity



Leachable Cations by IC	Detection Limit	Units ppb						
		Rubber	PVDF	ECTFE	PE	PEI	ETFE	ETFE*
Lithium (Li ⁺)	3	*	*	*	*	*	*	
Sodium (Na ⁺)	3	77	*	1.5	0.9	2.4	0.33	*
Ammonium (NH ₄ ⁺)	5	*	*	*	*	*	*	1.1
Potassium (K ⁺)	5	17	*	1.4	*	0.7	*	*



Conditions:

Pre-cleaning Solution	UPW
Leaching Volume	5700ml
Leaching Temperature	Ambient
Sample Weight	--
Surface Area	1555 cm ²
Leaching Time	7 days

Leachable Anions by IC	Detection Limit	Units ppb						
		Rubber	ECTFE	PVDF	PE	PEI	ETFE	ETFE*
Aluminum (Al)	0.05	0.43	0.3	*	0.27	0.1	0.05	*
Barium (Ba)	0.01	1300	0.68	*	0.2	*	*	*
Calcium (Ca)	3.0	*	8.0	*	21	6.0	*	*
Iron (Fe)	0.1	1.4	*	*	0.3	0.1	*	*
Magnesium (Mg)	0.02	64	2.4	0.06	0.6	1.4	0.04	*
Manganese (Mn)	0.03	1.8	*	*	0.05	*	*	*
Sodium (Na)	0.05	85	2.3	1.1	0.93	2.2	0.44	1.4
Zinc (Zn)	0.05	350	1300	13	3.0	0.68	3.0	*

*ETFE 1020 - High Purity