Table 6 — TFE/P Resistance to Automotive Media

(Compound C)

		Aged Properties		
	Shore A	Tensile Strength	Elongation at Break	Volume Change
		(psi)	(%)	(%)
Aged 336 hrs at 324F in 50/50 water/ethylene gylcol and rust inhibitor	84	2860	195	3.3
Aged 72 hrs at 212F in Dowtherm 209	79	2530	157	0.0
Aged 72 hrs at 400F in SF CD engine oil	74	1850	160	10.0
Aged 72 hrs at 300F in glycol brake fluid	72	1900	180	9.0

AFLAS GENERAL PERFORMANCE INDICATORS

AFLAS PERFORMANCE INDICATORS

Tensile Strength, psi	2000-3200
50% Modulus, psi	300-2800
Hardness, Shore A	60-95+
Elongation, %	55-400
Tear, Die C (ppi)	to 300
Compression Set (70 hrs @ 392°F)	30%
High Temperature Service (depends on media exposure)	400° long term 600°F short term
Low Temperature Brittle Point	−55°F
Electrical Resistance (vulcanized polymer)	
Volume Resistivity @ 70°F (ohms·cm)	3.0×10^{16}
Volume Resistivity @ 400°F (ohms·cm)	1.7×10^{13}
Polymer Specific Gravity	1.55
Polymer Soluble in Freon TF and THF	

MEDIA RESISTANCE GUIDELINES

Acids	E
Animal and Vegetable Oils	E
Bases	E
Brake Fluids	E
Hydraulic Fluids (incl. phosphate esters, Mil-H-5606, water/glycol, etc.)	E
Steam/Water/Brine	E
Radiation	E
Weathering/Ozone	E
Alcohol	G to E
Amines	G to E
Oils and Lubricants (incl. synthetics, SF CD, etc.)	G to E
Oxidizing Agents	G to E
Sour (H_2S) Oil and Gas with Corrosion Inhibitors	G to E
Benzene, Xylene, etc.	F to G
Fuels	F to G
Ketones	F
Chloroform	P

E-Excellent G-Good F-Fair P-Poor

try include: heat exchanger gaskets; hose inner-liners; O-rings and seals of various types including mechanical seal energizers; pipe gaskets; diaphragms for pumps and valves; and possible future use as a chemical tank liner (a new lower molecular weight TFE/P variety is under development for this purpose). Examples of chemical resistance applicable to this industry are shown in Table 5.

Automotive. Many additives used in today's high temperature rated engine oils or lubricants have changed the nature of their attack on previously used elastomers. This can be seen in the new SF rated engine oils, and also in corrosion inhibited engine coolants. Resistance of the TFE/P elastomer to these fluids and other fluids used in the automotive industry are shown in Table 6. Of particular note is the fact that the TFE/P elastomer is not embrittled nor does it exhibit surface stress cracking in either the SF engine oils or the corrosion inhibited engine coolant. In addition to being resistant to the ethylene glycol engine coolants, the TFE/P elastomer is resistant to coolants such as Dowtherm 209. The elastomer is also unique in it's ability to resist both glycol base brake fluids and mineral oil.

Aerospace/Defense. The unique capability of this elastomer to resist all types of hydraulic fluids used in aircraft — commercial and military — as well as lubricants and jet fuel can be very helpful due to cross contamination concerns. The elastomer is also resistant to oxidizers and fuels used in rocket propulsion systems and to cleansers used to remove chemical warfare agents.

General Industry. The applications in this area are very diverse and include elastomeric parts used in steel mills, aluminum smelters, magnet wire production, pulp and paper mills, semiconductor production, and office equipment such as copying machines and computer printers. The types of parts involved include conventional seals, gaskets, roll covering, squeegees used to remove chemicals, and hose inner-liners.

Summary

TFE/P is a new type of elastomer with a unique combination of high temperature, chemical, and electrical resistance properties. Particularly notable is it's resistance to a broad range of chemicals. These properties are being used to advantage in the oilfield, chemical processing, pollution control, automotive/truck/construction equipment, and aerospace industries.

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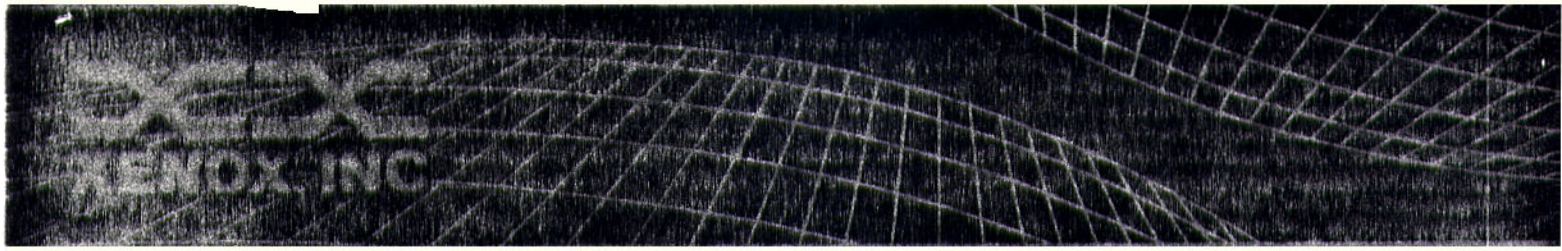

INDICATORS OF AFLAS CHEMICAL RESISTANCE

The following chart provides an indication of the chemical resistance of Aflas. Since temperature, concentrations, mixtures, and elastomer compound selection can affect performance, this chart provides guidelines only.

Unless otherwise noted, the tests were run on a 75 Shore A carbon black filled Aflas 150P formulation with the following properties:

Original Properties of Test Formulation

Shore A Hardness	Tensile Strength (psi)	Elongation @ Break
75	2500	120%

Where available, the chart shows the change in hardness (in Shore A points) and volume as well as the percentage of original tensile strength and elongation retained after immersion in the test fluid under the time and temperature conditions denoted. In other instances, volume change only is shown.

AFLAS GENERAL PERFORMANCE INDICATORS

AFLAS PERFORMANCE INDICATORS	MEDIA RESISTANCE GUIDELINES
Tensile Strength, psi.....2000-3200	Acids.....E
50% Modulus, psi.....300-2800	Animal and Vegetable Oils.....E
Hardness, Shore A.....60-95+	Bases.....E
Elongation, %.....55-400	Brake Fluids.....E
Tear, Die C (ppi).....to 300	Hydraulic Fluids (incl. phosphate esters, Mil-H-5606, water/glycol, etc.).....E
Compression Set (70 hrs @ 392°F).....30%	Steam/Water/Brine.....E
High Temperature Service 400°F long term (depends on media exposure)...600°F short term	Radiation.....E
Low Temperature Brittle Point.....-55°F	Weathering/Ozone.....E
Electrical Resistance (vulcanized polymer)	Alcohol.....G to E
Volume Resistivity @ 70°F (ohms·cm).....3.0×10^{16}	Amines.....G to E
Volume Resistivity @ 400°F (ohms·cm).....1.7×10^{13}	Oils and Lubricants (incl. synthetics, SF CD, etc.).....G to E
Polymer Specific Gravity.....1.55	Oxidizing Agents.....G to E
Polymer Soluble in Freon TF and THF	Sour (H_2S) Oil and Gas with Corrosion Inhibitors.....G to E
	Benzene, Xylene, etc.....F to G
	Fuels.....F to G
	Ketones.....F
	Chloroform.....P
	E = Excellent G = Good F = Fair P = Poor

CHEMICAL	Test Condition		Property Retention After Test			
	Temp °F	Time Days	Retained Tensile Strength (%)	Retained Elongation (%)	Hardness Change Shore A (Points)	Volume Change (%)
Acetic Acid	73	7				71.0
Acetic acid/10% Sodium chlorite	212	1	67	105	-16	24.0
Acetone	73	7				50.0
Acetyle acetone	73	3				54.0
Aeroshell Grease #7*	176	2				8.0
Amine Corrosion Inhibitors (see Oil-field Media)						
Ammonia (28%)	158	3				3.2
	73	90				1.0
Ammonium hydroxide (28%)	73	7				1.0
	73	180				2.5
	158	3	82	116	-1	3.2
Aniline	73	7				.7
ASTM Oil #1	212	3				1.8
	350	3				4.1
ASTM Oil #3	212	3				7.9
	350	3	70	100	-9	13.0
Benzene	73	7				31.0
Benzene/Methanol 30/70	73	7				12.0
50/50	73	7				21.0
Bleaching powder 10% ($CaCl_2O$)	212	7	112	89	-2	0.0
Bromine	73	7	54	136	Not measured	6.2
Bromine 32%/ Hydrochloric acid 18%/Sulfuric acid 25%	212	1	66	112	-8	6.0
Calcium hypochlorite 10%	212	7				0
Caproic acid	73	7				16.8
Carbon tetrachloride	73	7				86.0
Castrol 325*	176	2				6.0
Chlorine solution (saturated)	Test in progress					
Chlorine solution (Sat.)/ 35% Sodium chloride/ 10% Sodium hypochlorite	212	2.5	69	78	-9	5.9
Chloroform	73	7				112.0
Chromic acid (62%)	73	7	90	98	-2	1.7
Chromic acid (46%)/ Sulfuric acid (25%)	73	7	115	117	-1	2.6
Cyclohexane	73	7				13.0
Cyclohexanone	73	7				22.0
Diesel Fuel #2	212	3	75	103	-18	9.0
95 Shore A Compound	302	3	70	121	-5	20.2
Diethyl ether	73	1				42.0
Dioctyl Cebacate	212	3				8.8
	350	3				20.0
Dioxane	73	3				57.0
Dowtherm 209*	212	3				6.3
Ethyl acetate	73	7				88.0

CHEMICAL	Test Condition		Property Retention After Test			
	Temp °F	Time Days	Retained Tensile Strength (%)	Retained Elongation (%)	Hardness Change Shore A (Points)	Volume Change (%)
Ethyl benzene	73	7				22.0
Ethyl benzoate	73	7				26.7
Ethylene Chlorohydrin	73	7				0.0
Ethylene glycol/Water/ Nalcool 2000* 50/50/ 4 oz. per gallon	100H/150P blend compound					
	324	14	106	106	+2	1.1
Exxon Caloria HT43*	500	4	58	164	-8	11.0
Freon TF	Dissolves Aflas 150P					
Fuel B	73	7				58.0
Gasoline	73	7				25.0
Hydrochloric acid (37%)	73	7	100	107	-1	.2
	73	180				4.5
	158	3	57	112	-2	7.0
Hydrochloric acid (20%)	158	3	58	85	-6	7.4
Hydrofluoric acid (50%)	73	7	63	117	+1	1.5
	73	180				4.1
Hydrogen peroxide (30%)	212	7	105	99	0	-1.1
Isomyl alcohol	73	7				0.0
Iso-Octane	73	7				19.0
Kerosene	73	7				2.0
KF/HF (1/1.8)	185	3	94	111	-3	.4
Lacquer thinner	73	7				53.3
Light oil	73	7				5.0
Lithium Bromide (58%)	320	11	106	106	+1	-0.3
Lithium chromate	392	11	99	110	+1	-0.3
Methyl alcohol	73	7				0.2
Methyl cellosolve	73	7				1.4
Methyl chloroform	73	7				125.0
Methyl ether ketone	73	7				58.0
Mil-H-5606	212	3				12.0
Mil-L-7808	212	3				6.0
Mobil 1 5W-30*	400	3	82	111	-6	8.4
Mobil Super 10W-40*	400	3	84	107	-6	10.1
N-hexane	73	7				24.0
Naptha	73	7				4.0
Nitric acid fuming	73	7	42	126	-7	19.0
	73	180				15.0
Nitric acid (98%)	73	30				21.0
Nitric acid (60%)	73	7	94	95	-1	0.0
	73	180				5.1
	158	3	44	107	-3	10.0
Nitric acid (20%)	73	7	105	114	-1	0.0
	158	3	42	90	-13	25.0
Nitrobenzene	73	7				5.6
OILFIELD MEDIA						
Amine corrosion inhibitors (mineral/black filled compound)	NOTE: Aflas remained elastomeric and did not embrittle in Oilfield Media tests					
1% KW44* in water	212	3	90	150	-1	1.8
10% KW44* in water	212	3	81	144	-4	6.8
1% NACE A in water	324	14	56	194	-4	7.7
Sour gas, wet (35% H_2S, 50% CH_4, 15% CO_2, 10 ml H_2O)	400	4	69	86	-3	3.0

CHEMICAL	Test Condition		Property Retention After Test			
	Temp °F	Time Days	Retained Tensile Strength (%)	Retained Elongation (%)	Hardness Change Shore A (Points)	Volume Change (%)
Sour oil, wet with 5% NACE B corrosion inhibitor (47.5% ASTM #1 oil, 47.5% H_2O, 5% NACE B: Mixed gas 35% H_2S 15% CO_2, 50% CH_4 under pressure)	350	6	40	111	-15	8.6
Skydrol 500*	176	2				14.6
Skydrol 500B*	212	3				14.0
Skydrol 500 B4*	176	2				17.2
Sodium chloride (35%)/ Sodium hypochlorite (10%) Saturated chlorine solution	212	2.5	69	78	-9	5.9
Sodium chlorite (10%)	212	7	80	93	-12	22.0
Sodium hydroxide 50%	73	7	108	116	+2	1.2
	212	3	101	116	-1	1.1
Sodium hydroxide 20%	73	7	85	104	-1	-0.3
	212	3	95	117	-3	2.0
Sodium hypochlorite (10%)	212	7	100	95	-1	1.0
Sour (H_2S) gas and oil (See Oilfield Media)						
Stauffer 7700*	350	3	80	120	-10	18.0
Steam (90 Shore A cmpd)	320	7	91	84	-3	4.6
	392	10	73	97	-4	1.6
	392	30	62	100	-5	1.3
	550	4	65	145	-1	1.6
Sulfur dioxide (5%)	104	2	69	84	-4	7.8
Sulfuric acid fuming	73	7	76	98	-2	4.2
	73	180				7.4
Sulfuric acid (96%)	73	7	98	99	-3	0.4
	73	180				2.3
	212	3	99	101	-3	4.4
Sulfuric acid (60%)	73	7	103	98	-1	0.1
	212	3	107	104	+1	0.4
Sulfuric acid (20%)	73	7	102	105	-1	0.5
	212	3	99	98	-3	0.4
Toluene	73	7				41.0
Trichloroethylene	73	7				95.0
Trichlorotrifluoroethane	73	7				249.0
Wagner 21B* brake fluid	300	3	87	120	-8	9.0
Water	212	3	89	117	0	1.1
Xylene	73	7				30.0

* Tradename or proprietary fluid