Chemfluor® References

Chemfluor® Fluoropolymer Resins

Three types are used in Flexible Components hose assemblies:

- **PTFE** (sometimes referred to as TFE) (Polyetrafluoroethylene)
- **FEP** (Copolymer of tetrafluoroethylene and hexafluoropropylene)
- **PFA** (Copolymer of tetrafluoroethylene and perfluoroalkyl)

The various types of fluoropolymer are ideal as hose materials because of the following characteristics:

- Insolubility and inertness to chemical attack
- Purity
- High thermal stability and upper service temperature
- High melting points
- Low coefficient of friction
- Low water absorptivity
- Low dielectric constant and dissipation factor
- Excellent weatherability
- Flame resistance

Purity

Flexible Components Chemfluor® PTFE, PFA and FEP resins are either approved by the Food and Drug Administration or the pharmaceutical industry (Pharmacopeia VI). See below for specific details.

Chemical Resistance

The following materials are the only ones that need consideration when conveyed through a Flexible Components Chemfluor® hose. There are only 17 materials named. Only three* are absolutely not to be used with Chemfluor® PTFE, FEP, or PFA. The other 14 are to be considered questionable with either high temperatures and simultaneous impact resistance or temperature and pressure in combination.

- Elemental Sodium*
- Elemental Potassium*
- Elemental Lithium*
- Fluorine (F_2) *(Fluorine is absorbed into the Chemfluor® resin)*
- Chlorine Tri-fluoride (ClF_3) *(can be sensitive to impact ignition)*
- Bromine Tri-fluoride
- Iodine Pentafluoride
- Oxygen Difluoride
- Chlorine Difluoride
- 80% Sodium Hydroxide
- 80% Potassium Hydroxide
- Borane (B_2H_6) *(Only at 400°F to 500°F)*
- Aluminum Chloride *(at elevated temperatures)*
- Ammonia (NH_3)
- Amines ($R\text{-}NH_2$) *(at elevated temperatures)*
- Imine (R-NH)
- 70% Nitric Acid – slow oxidative attack only under pressure at 480°F

Industry Approval and Compliance References

FDA/USDA Approvals

Chemfluor® PTFE, PFA and FEP resins used by Flexible Components comply with the following FDA and USDA requirements:

Articles Intended for Food Contact

Reference: 21CFR177.1550 Perfluorocarbon Resins

Covers Chemfluor® PTFE and FEP resins, which may be safely used as articles or components of articles intended to contact food in compliance with this regulation.

USDA Acceptance

The Department of Agriculture (USDA) has accepted Chemfluor® PTFE and FEP fluoropolymer resins that comply with 21CFR177.1550 as components of materials in direct contact with meat or poultry food products prepared under federal inspection.

US Pharmacopeia Class VI

Samples of Chemfluor® PTFE, FEP and PFA (white/natural and black anti-static PTFE and PFA) have been tested in accordance with USP protocol, and all meet the requirements for Class VI plastics. USP testing was done to support the use of these fluoropolymers in pharmaceutical processing and food processing applications. While USP Class VI certification is not required for pharmaceutical processing, many pharmaceutical customers seeking ISO-9000 certification have requested it.

Colorants in Polymers

Reference: 21CFR178.3297 Colorants for Polymers

This regulation permits certain colorants for use in polymers intended for food contact. Included are TiO_2, iron oxides, all-gas channel black (carbon black) and ultra marine colorants.

Chemical Resistance Ratings

Three Chemfluor® Fluoropolymer Hose Products in 362 Environments

The ratings in the charts are based on the results of both laboratory and field tests. They reflect the relative capabilities of various Chemfluor® fluoropolymer resins to withstand specific chemicals. All ratings are based on room temperature. Although we believe these ratings to be thoroughly reliable, no guarantee is expressed or should be implied. It is suggested that the user conduct tests using the conditions of the application prior to specifying a particular hose.

28-Day Immersions at 73°

E = Excellent **G = Good** **F = Fair** **U = Not Recommended**

No.	Environmental % Conc. * w = Water alc. = Alcohol Environment, Conc. 0/0[1]	Chemfluor FEP	Chemfluor PFA	Chemfluor PTFE
1	Acetaldehyde	E	E	E
2	Acetamide, 67% in w	E	E	E
3	Acetate Solvents	E	E	E
4	Acetic Acid, 10% in w	E	E	E
5	Acetic Acid, 50-60% in w	E	E	E
6	Acetic Acid, Glacial, 100%	E	E	E
7	Acetic Anhydride	E	E	E
8	Acetone	E	E	E
9	Acetonitrile	E	E	E
10	Acetyl Bromide	E	E	E
11	Acetyl Chloride	E	E	E
12	Acetylene Gas	E	E	E
13	Acrylonitrile	E	E	E
14	Adipic Acid, 100% in alc	E	E	E
15	Air	E	E	E
16	Alcohols General	E	E	E
17	Aliphatic Hydrocarbons	E	E	E
18	Alkyl Alcohol	E	E	E
19	Alum, 5% in w	E	E	E
20	Aluminum Chloride, 53% in w	E	E	E
21	Aluminum Fluoride, 0.1% in w	E	E	E
22	Aluminum Hydroxide, 2% in w	E	E	E
23	Aluminum Nitrate, 39% in w	E	E	E
24	Aluminum Sulfate, 50% in w	E	E	E
25	Aluminum Salts	E	E	E
26	Amines	E	E	E
27	Ammonia Gas	E	E	E
28	Ammonia, Anhydrous Liquid	E	E	E
29	Ammonium Acetate, 45% in w	E	E	E
30	Ammonium Bifluoride, 50% in w	E	E	E
31	Ammonium Carbonate, 50% in w	E	E	E
32	Ammonium Chloride, 23% in w	E	E	E
33	Ammonium Hydroxide, 5-10% in w	E	E	E
34	Ammonium Hydroxide, 30% in w	E	E	E
35	Ammonium Nitrate, 54% in w	E	E	E
36	Ammonium Persulfate, 30% in w	E	E	E
37	Ammonium Phosphate, 21% in w	E	E	E
38	Ammonium Salts	E	E	E
39	Ammonium Sulfate, 30% in w	E	E	E
40	Amyl Acetate	E	E	E
41	Amyl Alcohol	E	E	E
42	Amyl Chloride	E	E	E
43	Aniline	E	E	E
44	Aniline Hydrochloride	E	E	E
45	Antimony Salts	E	E	E
46	Antimony Trichloride	E	E	E
47	Aqua Regia	G	E	E
48	Aromatic Hydrocarbons	E	E	E
49	Arsenic Acid, 20% in w	E	E	E
50	Arsenic Salts	E	E	E
51	ASTM Reference No. 1 Oil	E	E	E
52	ASTM Reference No. 2 Oil	E	E	E
53	ASTM Reference No. 3 Oil	E	E	E
54	Barium Carbonate, 1% in w	E	E	E
55	Barium Chloride, 27% in w	E	E	E
56	Barium Hydroxide, 5% in w	E	E	E
57	Barium Salts	E	E	E
58	Barium Sulfate, <1% in dilute acids	E	E	E
59	Barium Sulfide	E	E	E
60	Beer	E	E	E
61	Benzaldehyde	E	E	E
62	Benzene	E	E	E
63	Benzenesulfonic Acid	E	E	E
64	Benzoic Acid	E	E	E
65	Benzyl Alcohol	E	E	E
66	Bleach Liquor, 22% in w	E	E	E
67	Borax, 6% in w	E	E	E
68	Boric Acid, 4% in w	E	E	E
69	Bromine, Anhydrous Liquid	U	U	U
70	Butadiene	E	E	E
71	Butane	E	E	E
72	Butyl Acetate	E	E	E
73	Butyl Alcohol	E	E	E
74	Butyric Acid	E	E	E
75	Calcium Bisulfite, 1% in w	E	E	E
76	Calcium Carbonate, 25% in dilute acids	E	E	E
77	Calcium Chlorate, 30% in w	E	E	E
78	Calcium Chloride, 30% in w	E	E	E
79	Calcium Hydroxide, 10% in glycerol	E	E	E
80	Calcium Hypochlorite, 20% in w	E	E	E
81	Calcium Nitrate, 55% in w	E	E	E
82	Calcium Oxide, 3% in w	E	E	E
83	Calcium Salts	E	E	E
84	Calcium Sulfate, 1% in w	E	E	E
85	Carbon Dioxide, Wet/Dry	E	E	E
86	Carbon Disulfide	E	E	E
87	Carbonic Acid	E	E	E
88	Carbon Monoxide	E	E	E
89	Carbon Tetrachloride	E	E	E
90	Castor Oil	E	E	E
91	Cellosolve	E	E	E
92	Cellosolve Acetate	E	E	E
93	Chlorine, Dry Gas	E	E	E
94	Chlorine, Wet Gas	E	E	E
95	Chloroacetic Acid, 20% in w	E	E	E
96	Chlorobenzene, Mono, Di, Tri	E	E	E
97	Chloroform	E	E	E
98	Chlorosulfonic Acid	E	E	E
99	Chromic Acid, 10-20% in w	E	E	E
100	Chromic Acid, 50% in w	E	E	E
101	Chromium Salts	E	E	E
102	Citric Acid, 10-20% in w	E	E	E
103	Coconut Oil	E	E	E
104	Copper Salts	E	E	E
105	Corn Syrup	E	E	E
106	Cottonseed Oil	E	E	E
107	Cresol (m, o, or p)	E	E	E
108	Cresylic Acid	E	E	E

28-Day Immersions at 73°

E = Excellent **G = Good** **F = Fair** **U = Not Recommended**

Environmental % Conc. *
w = Water alc. = Alcohol

No.	Environment, Conc. 0/0[1]	Chemfluor FEP	Chemfluor PFA	Chemfluor PTFE
109	Cupric Chloride, 40% in w	E	E	E
110	Cupric Cyanide, 10% in dilute bases	E	E	E
111	Cupric Nitrate, 70% in w	E	E	E
112	Cupric Sulfate, 13% in w	E	E	E
113	Cyclohexane	E	E	E
114	Cyclohexanone	E	E	E
115	Detergent Solutions	E	E	E
116	Diacetone Alcohol	E	E	E
117	Dibutyl Phthalate	E	E	E
118	Dichlorobenzene	E	E	E
119	Diesel Fuel	E	E	E
120	Diethylamine, 2.5% in w	E	E	E
121	Diethylene Glycol	E	E	E
122	Diethyl Ether	E	E	E
123	Dimethylformamide	E	E	E
124	Dimethylsulfoxide	E	E	E
125	Dioctyl Phthalate	E	E	E
126	Dioxane	E	E	E
127	Ether	E	E	E
128	Ethyl Acetate	E	E	E
129	Ethyl Alcohol (Ethanol)	E	E	E
130	Ethyl Benzoate	E	E	E
131	Ethyl Chloride	E	E	E
132	Ethyl Ether	E	E	E
133	Ethylamine, 70% in w	E	E	E
134	Ethylene Bromide	E	E	E
135	Ethylene Chlorohydrin	E	E	E
136	Ethylene Diamine	E	E	E
137	Ethylene Dichloride	E	E	E
138	Ethylene Glycol	E	E	E
139	Ethylene Oxide	E	E	E
140	Fatty Acids	E	E	E
141	Ferric Chloride, 43% in w	E	E	E
142	Ferric Nitrate, 60% in w	E	E	E
143	Ferric Salts	E	E	E
144	Ferric Sulfate, 5% in w	E	E	E
145	Ferrous Chloride, 40% in w	E	E	E
146	Ferrous Salts	E	E	E
147	Ferrous Sulfate, 5% in w	E	E	E
148	Fluoborate Salts	E	E	E
149	Fluoboric Acid, 48% in w	E	E	E
150	Fluorine Gas	G	G	G
151	Fluosilicic Acid, 25% in w	E	E	E
152	Formaldehyde, 37% in w	E	E	E
153	Formic Acid, 25% in w	E	E	E
154	Formic Acid, 40-50% in w	E	E	E
155	Formic Acid, 98% in w	E	E	E
156	Freon 11	F	E	E
157	Freon 12	F	E	E
158	Freon 22	F	E	E
159	Freon 113	F	E	E
160	Fruit Juice	E	E	E
161	Fuel Oil	E	E	E
162	Furfural	E	E	E
163	Gallic Acid, 17% in acetone	E	E	E
164	Gasoline, Automotive	E	E	E
165	Gelatin	E	E	E
166	Glucose, 50% in w	E	E	E
167	Glycerol, (Glycerin)	E	E	E
168	Glycolic Acid, 70% in w	E	E	E
169	Heptane	E	E	E
170	Hexane	E	E	E
171	Hydrazine	E	E	E
172	Hydrobromic Acid, 20-50% in w	E	E	E
173	Hydrobromic Acid, 100% in w	E	E	E
174	Hydrochloric Acid, 10% in w	E	E	E
175	Hydrochloric Acid, 37% in w	E	E	E
176	Hydrocyanic Acid	E	E	E
177	Hydrofluoric Acid, 10% in w	E	E	E
178	Hydrofluoric Acid, 25% in w	E	E	E
179	Hydrofluoric Acid, 40-48% in w	E	E	E
180	Hydriodic Acid, 55-58% in w	E	E	E
181	Hydrogen Gas	E	E	E
182	Hydrogen Peroxide, 3% in w	E	E	E
183	Hydrogen Peroxide, 10% in w	E	E	E
184	Hydrogen Peroxide, 30% in w	E	E	E
185	Hydrogen Peroxide, 90% in w	E	E	E
186	Hydrogen Sulfide	E	E	E
187	Hydroquinone, 7% in w	E	E	E
188	Hypochlorous Acid, 25% in w	E	E	E
189	Iodine, 50 ppm in w	E	E	E
190	Isobutyl Alcohol	E	E	E
191	Isooctane	E	E	E
192	Isopropyl Acetate	E	E	E
193	Isopropyl Alcohol	E	E	E
194	Isopropyl Ether	E	E	E
195	Jet Fuel, JP8	E	E	E
196	Kerosene	E	E	E
197	Ketones	E	E	E
198	Lacquer Solvents	E	E	E
199	Lactic Acid, 3-10% in w	E	E	E
200	Lactic Acid, 85% in w	E	E	E
201	Lard, Animal Fat	E	E	E
202	Lead Acetate, 35% in w	E	E	E
203	Lead Nitrate, 27% in w	E	E	E
204	Lead Salts	E	E	E
205	Lemon Oil	E	E	E
206	Limonene-D	E	E	E
207	Linoleic Acid	E	E	E
208	Linseed Oil	E	E	E
209	Lubricating Oils, Petroleum	E	E	E
210	Magnesium Carbonate, 1% in w	E	E	E
211	Magnesium Chloride, 35% in w	E	E	E
212	Magnesium Hydroxide, 10% in dilute acids	E	E	E
213	Magnesium Nitrate, 50% in w	E	E	E
214	Magnesium Sulfate, 25% in w	E	E	E
215	Maleic Acid, 30% in w	E	E	E
216	Malic Acid, 36% in w	E	E	E
217	Manganese Salts	E	E	E
218	Manganese Sulfate, 34% in w	E	E	E
219	Mercuric Chloride, 6% in w	E	E	E
220	Mercuric Cyanide, 8% in w	E	E	E
221	Mercurous Nitrate, 10% in dilute acids	E	E	E
222	Mercury	E	E	E
223	Mercury Salts	E	E	E
224	Methane Gas	E	E	E
226	Methyl Acetate	E	E	E
225	Methyl Alcohol (Methanol)	E	E	E
227	Methyl Bromide	E	E	E
228	Methyl Chloride	E	E	E
229	Methyl Ethyl Ketone	E	E	E
230	Methyl Isobutyl Ketone	E	E	E
231	Methylene Chloride	E	E	E
232	Methyl Methacrylate	E	E	E
233	Milk	E	E	E
234	Mineral Oil	E	E	E
235	Mineral Spirits	E	E	E
236	Molasses	E	E	E
237	Monoethanolamine	E	E	E
238	Motor Oil	E	E	E
239	Naphtha	E	E	E
240	Naphthalene	E	E	E

Chemical Resistance Ratings (continued)

28-Day Immersions at 73°

E = Excellent **G = Good** **F = Fair** **U = Not Recommended**

No.	Environmental % Conc. * w = Water alc. = Alcohol Environment, Conc. 0/0[1]	Chemfluor FEP	Chemfluor PFA	Chemfluor PTFE
241	Natural Gas	E	E	E
242	Nickel Chloride, 40% in w	E	E	E
243	Nickel Nitrate, 75% in w	E	E	E
244	Nickel Salts	E	E	E
245	Nickel Sulfate, 25% in w	E	E	E
246	Nitric Acid, 10% in w	E	E	E
247	Nitric Acid, 35% in w	E	E	E
248	Nitric Acid, 68-71% in w	G	E	E
249	Nitrobenzene	E	E	E
250	Nitromethane	E	E	E
251	Nitrous Acid, 10% in w	E	E	E
252	Nitrous Oxide	E	E	E
253	Oils, Animal	E	E	E
254	Oils, Essential	E	E	E
255	Oils, Hydraulic (Phosphate Ester)	E	E	E
256	Oils, Hydrocarbon	E	E	E
257	Oils, Vegetable	E	E	E
258	Oleic Acid	E	E	E
259	Oleum, 25% in w	E	E	E
260	Ortho Dichlorobenzene	E	E	E
261	Oxalic Acid, 12% in w	E	E	E
262	Oxygen	E	E	E
263	Ozone, 300pphm	E	E	E
264	Palmitic Acid, 100% in ether	E	E	E
265	Paraffins	E	E	E
266	Perchloric Acid, 67% in w	E	E	E
267	Perchloroethylene	E	E	E
268	Phenol, 5-10% in w	E	E	E
269	Phenol, 91% in w	E	E	E
270	Phosphoric Acid, <10% in w	E	E	E
271	Phosphoric Acid, 25% in w	E	E	E
272	Phosphoric Acid, 85% in w	E	E	E
273	Phosphorous Trichloride Acid	E	E	E
274	Photographic Solutions	E	E	E
275	Phthalic Acid, 9% in alc	E	E	E
276	Phthalic Anhydride, 9% in alc	E	E	E
277	Picric Acid, 1% in w	E	E	E
278	Plating Solutions	E	E	E
279	Potassium Carbonate, 55% in w	E	E	E
280	Potassium Chloride, 20% in w	E	E	E
281	Potassium Cyanide, 33% in w	E	E	E
282	Potassium Dichromate, 5% in w	E	E	E
283	Potassium Hydroxide, <10% in w	E	E	E
284	Potassium Hypochlorite, 70% in w	E	E	E
285	Potassium Iodide, 56% in w	E	E	E
286	Potassium Nitrate, 10% in w	E	E	E
287	Potassium Oxide, 50% in w	E	E	E
288	Potassium Permanganate, 6% in w	E	E	E
289	Potassium Salts	E	E	E
290	Potassium Sulfate, 10% in w	E	E	E
291	Potassium Sulfide, 20% in w	E	E	E
292	Propane Gas	E	E	E
293	Propyl Alcohol (Propanol)	E	E	E
294	Propylene Glycol	E	E	E
295	Propylene Oxide	E	E	E
296	Pyridine	G	G	E
297	Salicylic Acid, 1% in w	E	E	E
298	Silicone Oils	E	E	E
299	Silver Nitrate, 55% in w	E	E	E
300	Skydrol 500A	E	E	E
301	Soap Solutions	E	E	E
302	Sodium Acetate, 55% in w	E	E	E
303	Sodium Benzoate, 22% in w	E	E	E
304	Sodium Bicarbonate, 7% in w	E	E	E
305	Sodium Bisulfate, 3% in w	E	E	E
306	Sodium Carbonate, 7% in w	E	E	E
307	Sodium Chlorate, 45% in w	E	E	E
308	Sodium Chloride, 20% in w	E	E	E
309	Sodium Cyanide, 30% in w	E	E	E
310	Sodium Dichromate, 70% in w	E	E	E
311	Sodium Fluoride, 3% in w	E	E	E
312	Sodium Hydroxide, 10-15% in w	E	E	E
313	Sodium Hydroxide, 30-40% in w	E	E	E
314	Sodium Hypochlorite, 5.5% in w	E	E	E
315	Sodium Hypochlorite, 12.2% in w	E	E	E
316	Sodium Nitrate, 3.5% in w	E	E	E
317	Sodium Perborate, 25% in w	E	E	E
318	Sodium Peroxide, 20% in w	E	E	E
319	Sodium Phosphate, 30% in w	E	E	E
320	Sodium Salts	E	E	E
321	Sodium Sulfate, 5% in w	E	E	E
322	Sodium Sulfide, 45% in w	E	E	E
323	Sodium Sulfite, 10% in w	E	E	E
324	Stannic Chloride, 50% in w	E	E	E
325	Stannous Chloride, 45% in w	E	E	E
326	Stearic Acid, 5% in alc	E	E	E
327	Styrene Monomer	E	E	E
328	Sulfur Chloride	E	E	E
329	Sulfur Dioxide, Gas Dry	E	E	E
330	Sulfur Dioxide, Gas Wet	E	E	E
331	Sulfur Trioxide, Wet	G	G	G
332	Sulfuric Acid, 10% in w	E	E	E
333	Sulfuric Acid, 30% in w	E	E	E
334	Sulfuric Acid, 95-98% in w	E	E	E
335	Sulfurous Acid	E	E	E
336	Tannic Acid, 75% in w	E	E	E
337	Tanning Solutions	E	E	E
338	Tartaric Acid, 56% in w	E	E	E
339	Tetrahydrofuran	E	E	E
340	Thionyl Chloride	E	E	E
341	Tin Salts	E	E	E
342	Titanium Salts	E	E	E
343	Toluene	E	E	E
344	Trichloroacetic Acid, 90% in w	E	E	E
345	Trichloroethane	E	E	E
346	Triethanolamine	E	E	E
347	Trichloroethylene	E	E	E
348	Trichloropropane	E	E	E
349	Tricresyl Phosphate	E	E	E
350	Trisodium Phosphate	E	E	E
351	Turpentine	E	E	E
352	Urea, 20% in w	E	E	E
353	Uric Acid	E	E	E
354	Vinegar	E	E	E
355	Vinyl Acetate	E	E	E
356	Water, Brine	E	E	E
357	Water, De-ionized	E	E	E
358	Water, Distilled	E	E	E
359	Xylene	E	E	E
360	Zinc Chloride, 80% in w	E	E	E
361	Zinc Salts	E	E	E
362	Zinc Sulfate, 30% in w	E	E	E