PFPE perfluoropolyether

PARAMETER	UNIT	VALUE	REFERENCES
GENERAL			
Common name	-	perfluoropolyether; poly(perfluoropropylene oxide-co-perfluoromethylene oxide)	
IUPAC name	-	trifluoromethyl-poly[oxy-2-trifluoromethyl-1,1,2-trifluoroethylene]-poly[oxy-difluoromethylene]-trifluoromethyl ether	
ACS name	-	1-propene, 1,1,2,3,3,3-hexafluoro-, oxidized and polymerized	
Acronym	-	PFPE	
CAS number	-	69991-67-9; 60164-51-4	
HISTORY			
Person to discover	-	Arbogast, F L	Arbogast, F L, US Patent 3,412,148, DuPont, Nov. 19, 1968.
Date	-	1968	
SYNTHESIS			
Monomer(s) structure	-	hexafluoropropylene oxide, C_3F_6O	
Monomer(s) CAS number(s)	-	428-59-1	
Monomer(s) molecular weight(s)	dalton, g/mol, amu	166.02	
Mass average molecular weight, M_w	dalton, g/mol, amu	870-1210 (vapor phase soldering); 1,500-6,250 (cosmetics); 1,500-7,500 (lubricants); 17,500-374,000 (Fomblin polymers)	Sanguineti, A; Guarda, P A; Marchionni, G; Ajroldi, G, Polymer, 36, 19, 3697-3703, 1995.
Polydispersity, M_w/M_n	-	1.11-1.32 (Fromblin polymers)	Sanguineti, A; Guarda, P A; Marchionni, G; Ajroldi, G, Polymer, 36, 19, 3697-3703, 1995.
Polymerization degree (number of monomer units)	-	10-60 (oil)	
Chain-end groups	-	OH (lubricants)	
COMMERCIAL POLYMERS			
Some manufacturers	-	DuPont; Solvay	
Trade names	-	Krytox; Fluorolink, Fomblin, Galden	
PHYSICAL PROPERTIES			
Density at 20°C	g cm^{-3}	1.79-1.92; 2.13-2.20 (Algoflon)	
Color	-	colorless	
Refractive index, 20°C	-	1.293-1.302	
Odor	-	odorless	
Pour point	°C	-25 to -62	
Boiling point	°C	200-260 (MW: 870-1210)	
Decomposition temperature	°C	350 (air); 470 (nitrogen)	
Thermal expansion coefficient, 25-99°C	10^{-4} $°C^{-1}$	9.5-10.9	
Thermal conductivity	W m^{-1} K^{-1}	0.0831-0.0934 (38°C); 0.0692-0.0883 (260°C)	
Specific heat capacity	J K^{-1} kg^{-1}	960-1,000 (23°C); 1,210-1,260 (204°C)	
Heat of vaporization	kJ kg^{-1}	63	
Maximum service temperature	°C	-75 to 350; 250 (fuel cells); 270 (heat transfer fluids)	
Long term service temperature	°C	288 (in the presence of certain metal oxides)	

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Surface tension	mN m^{-1}	16-25	Tao, Z; Bhushan, B, Wear, 259, 1352-61, 2005.
Volume resistivity	ohm-m	1E13	
Electric strength K20/P50, d=0.60.8 mm	kV mm^{-1}	15.7	
Coefficient of friction	-	0.2-0.23	Tao, Z; Bhushan, B, Wear, 259, 1352-61, 2005.
Contact angle of water, 20°C	degree	144-147; 85-99 (lubricants)	Gallo Stampino, P; Molina, D; Omati, L; Turri, S; Levi, M; Cristiani, C; Dotelli, G, J. Power Sources, in press, 2011; Tao, Z; Bhushan, B, Wear, 259, 1352-61, 2005.
CHEMICAL RESISTANCE			
Alcohols	-	insoluble	
Aromatic hydrocarbons	-	insoluble	
Greases & oils	-	insoluble	
Halogenated hydrocarbons	-	insoluble	
Ketones	-	insoluble	
Good solvent	-	fluorinated solvents	
FLAMMABILITY			
Ignition temperature	°C	400 (in gaseous oxygen at pressure of 13 MPa)	
TOXICITY			
NFPA: Health, Flammability, Reactivity rating	-	1/0/0	
Carcinogenic effect	-	not listed by ACGIH, NIOSH, NTP	
Mutagenic effect	-	did not cause genetic damage in cultured bacterial cells	
Oral rat, LD_{50}	mg kg^{-1}	15,000; >37,400	
Skin rabbit, LD_{50}	mg kg^{-1}	non-irritating; >17,000	
ENVIRONMENTAL IMPACT			
Aquatic toxicity, *Daphnia magna*, LC_{50}, 48 h	mg l^{-1}	no effect; >1,000	
Aquatic toxicity, *Rainbow trout*, LC_{50}, 48 h	mg l^{-1}	no effect; >1,000	
PROCESSING			
Additives used in final products	-	pigments, mineral powders, emulsifiers, thickeners, surfactants	
Applications	-	cosmetics (emollients, hair conditioners, hand and body care, lotions, shaving products, skin protectants and feel improvers, water and oil repellents); fuel cells; lubricants (antilock brakes, bearings working at high temperatures, gasoline tank floats, missile catapult system, oxygen and chlorine valves, space rockets); proton exchange membrane fuel cells, solar industry; vapor phase soldering)	
Outstanding properties	-	biological inertness, chemical resistance, high solubility of respiratory gases, thermal and electrical resistance	

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PARAMETER	UNIT	VALUE	REFERENCES
BLENDS			
Compatible polymers	-	compatible with most common elastomers and plastics	