PF (fabric and rag filled, impact modified, molding)

General information

Designation

Phenol formaldehyde (Fabric and Rag Filled, Impact Modified, Molding)

Tradenames

Bakelite; Durez; Ferropreg; Fiberite; Norsophen; Plaslok; Plenco; Polychem; Reliapreg; Resinoid; Texolite; Trolitan; Vyncolite

Typical uses

Electrical parts - sockets, switches, connectors, general industrial, water-lubricated bearings, relays, pump impellers, microwave cookware, handles, bottles tops, coatings, adhesives, bearings, foams and sandwich structures.

Composition overview

Compositional summary

PF + fabric filler

Material family					Plastic (thermoset)
Base material					PF (Phenol formaldehyde resin)
% filler (by weight)	*	20	-	40	%
Filler/reinforcement					Rag/cotton/fabric
Filler/reinforcement form					Woven fabric
Additive					Impact modifier
Polymer code					PF-I-NF30

Composition detail (polymers and natural materials)

Polymer	*	40	-	70	%
Impact modifier		10	-	20	%
Rag/cotton/fabric	*	20	-	40	%

Price

Price	*	1.04	-	1.14	USD/lb

Physical properties

Density		0.0495	-	0.0524	lb/in^3

Mechanical properties

Young's modulus		0.901	-	1.1	10^6 psi
Yield strength (elastic limit)	*	4.8	-	6.4	ksi
Tensile strength		6	-	8.01	ksi
Elongation		1	-	4	% strain
Compressive modulus	*	0.901	-	1.1	10^6 psi
Compressive strength	*	20	-	28	ksi
Flexural modulus		0.698	-	1.3	10^6 psi
Flexural strength (modulus of rupture)		10	-	14	ksi
Shear modulus	*	0.34	-	0.415	10^6 psi
Bulk modulus	*	0.925	-	0.971	10^6 psi
Poisson's ratio		0.3	-	0.35	
Shape factor		12			
Hardness - Vickers	*	9.9	-	13.2	HV
Hardness - Rockwell M	*	105	-	115	
Hardness - Rockwell R	*	122	-	134	
Fatigue strength at 10^7 cycles	*	2.4	-	3.2	ksi
Mechanical loss coefficient (tan delta)	*	0.00969	-	0.0111	

Impact & fracture properties

Fracture toughness	*	1.26	-	3.78	ksi.in^0.5
Impact strength, notched 23 °C		0.00257	-	0.011	BTU/in^2
Impact strength, unnotched 23 °C		0.0048	-	0.0053	BTU/in^2

Thermal properties

Glass temperature		338	-	518	°F
Heat deflection temperature 0.45MPa	*	369	-	451	°F
Heat deflection temperature 1.8MPa		325	-	399	°F
Maximum service temperature		288	-	316	°F
Minimum service temperature	*	-45.4	-	44.6	°F
Thermal conductivity		0.218	-	0.29	BTU.ft/hr.ft^2.°F
Specific heat capacity	*	0.327	-	0.341	BTU/lb.°F
Thermal expansion coefficient		18	-	24	µstrain/°F

Electrical properties

Electrical resistivity		3.3e15	-	3e16	µohm.cm
Dielectric constant (relative permittivity)		7.7	-	8.3	
Dissipation factor (dielectric loss tangent)	*	0.05	-	0.08	
Dielectric strength (dielectric breakdown)		200	-	371	V/mil
Comparative tracking index		125	-	225	V

Optical properties

Transparency	Opaque

Magnetic properties

Magnetic type	Non-magnetic

Bio-data

RoHS (EU) compliant grades?	✓

Absorption & permeability

Water absorption @ 24 hrs		0.6	-	0.8	%

Processing properties

Polymer injection molding		Acceptable			
Polymer extrusion		Unsuitable			
Polymer thermoforming		Unsuitable			
Linear mold shrinkage		0.3	-	0.9	%
Melt temperature		331	-	399	°F
Mold temperature		302	-	338	°F
Molding pressure range		2	-	20	ksi

Durability

Water (fresh)	Excellent
Water (salt)	Excellent
Weak acids	Excellent
Strong acids	Limited use
Weak alkalis	Unacceptable
Strong alkalis	Unacceptable
Organic solvents	Excellent
Oxidation at 500C	Unacceptable
UV radiation (sunlight)	Good
Flammability	Slow-burning

Primary production energy, CO2 and water

Embodied energy, primary production	* 4.73e4	-	5.2e4	BTU/lb
CO2 footprint, primary production	* 11.2	-	12.3	lb/lb
NOx creation	* 0.0126	-	0.0139	lb/lb
SOx creation	* 0.0377	-	0.0417	lb/lb
Water usage	* 6.2e4	-	6.86e4	in^3/lb

Processing energy, CO2 footprint & water

Polymer molding energy	* 6.88e3	-	7.61e3	BTU/lb
Polymer molding CO2	* 1.2	-	1.33	lb/lb
Polymer molding water	* 317	-	476	in^3/lb
Coarse machining energy (per unit wt removed)	* 677	-	748	BTU/lb
Coarse machining CO2 (per unit wt removed)	* 0.118	-	0.131	lb/lb
Fine machining energy (per unit wt removed)	* 4.93e3	-	5.45e3	BTU/lb
Fine machining CO2 (per unit wt removed)	* 0.861	-	0.951	lb/lb
Grinding energy (per unit wt removed)	* 9.66e3	-	1.07e4	BTU/lb
Grinding CO2 (per unit wt removed)	* 1.69	-	1.86	lb/lb

Recycling and end of life

Recycle	✗			
Recycle fraction in current supply	0.1			%
Downcycle	✓			
Combust for energy recovery	✓			
Heat of combustion (net)	* 1.1e4	-	1.16e4	BTU/lb
Combustion CO2	* 2.27	-	2.39	lb/lb
Landfill	✓			
Biodegrade	✗			

Geo-economic data for principal component

Principal component	Phenol formaldehyde			
Annual world production	9.35e6	-	1.03e7	ton/yr
Reserves	2.34e8	-	2.59e8	l. ton

Links

ProcessUniverse

Producers

Reference

Shape