VE vinyl ester resin

PARAMETER	UNIT	VALUE	REFERENCES
GENERAL			
Common name	-	vinyl ester resin	
CAS name	-	vinyl ester resin; benzene, ethenyl-, polymer	
Acronym	-	VE	
CAS number	-	36425-15-7; 68002-44-8; 926021-66-1; 877997-30-3; 855482-93-8; 848485-23-4; 208520-04-1	
HISTORY			
Person to discover	-	Robertson, F	Robertson, F, US Patent 1,921,326, Carbide and Carbon Chemicals, Aug.8, 1933.
Date	-	1933	
SYNTHESIS			
Styrene content	%	27-41.5	
Method of synthesis	-	free radical polymerization	Yang, G; Liu, H; Bai, L; Jiang, M; Zhu, T, Microporous Mesoporous Mater., 112, 351-56, 2008.
Molecular weight between crosslinks	g mol^{-1}	300-900	La Scala, J J; Logan, M S; Sands, J M; Palmese, G R, Composite Sci. Technol., 68, 1869-76, 2008.
COMMERCIAL POLYMERS			
Some manufacturers	-	AOC; Ashland; Dow, Reichhold	
Trade names	-	Vipel; Hetron; Derakane; Dion	
PHYSICAL PROPERTIES			
Density at 20°C	g cm^{-3}	1.03-1.15	
Thermal expansion coefficient, 23-80°C	10^{-4} $°C^{-1}$	0.11	
Glass transition temperature	°C	55-145	Rosu, L; Cascaval, N; Rosu, D, Polym. Test., 28, 296-300, 2009; La Scala, J J; Logan, M S; Sands, J M; Palmese, G R, Composite Sci. Technol., 68, 1869-76, 2008.
Heat deflection temperature at 0.45 MPa	°C	108-115	
Heat deflection temperature at 1.8 MPa	°C	93-166	
Dielectric constant at 100 Hz/1 MHz	-	3.4-3.5/3.3-3.4	
Dissipation factor at 100 Hz	E-4	25-36	
Dissipation factor at 1 MHz	E-4	16-23	
Volume resistivity	ohm-m	1E14	
Surface resistivity	ohm	1E13	
Electric strength K20/P50, d=0.60.8 mm	kV mm^{-1}	120	
MECHANICAL & RHEOLOGICAL PROPERTIES			
Tensile strength	MPa	16-95	
Tensile modulus	MPa	3,000-3,800	
Tensile stress at yield	MPa	77-88	

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PARAMETER	UNIT	VALUE	REFERENCES
Elongation	%	2.5-9	
Flexural strength	MPa	60-163	La Scala, J J; Logan, M S; Sands, J M; Palmese, G R, Composite Sci. Technol., 68, 1869-76, 2008.
Flexural modulus	MPa	3,200-4,200	La Scala, J J; Logan, M S; Sands, J M; Palmese, G R, Composite Sci. Technol., 68, 1869-76, 2008.
Compressive strength	MPa	82	
Abrasion resistance (ASTM D1044)	mg/1000 cycles	100	
Shrinkage	%	1.65	
Melt viscosity, shear rate=1000 s^{-1}	mPa s	400-800	
Water absorption, equilibrium in water at 23°C	%	0.1	
CHEMICAL RESISTANCE			
Acid dilute/concentrated	-	good/poor	
Alcohols	-	good/poor	
Alkalis	-	good	
Aliphatic hydrocarbons	-	good	
Aromatic hydrocarbons	-	poor	
Esters	-	good	
Greases & oils	-	good	
Halogenated hydrocarbons	-	poor	
Ketones	-	poor	
FLAMMABILITY			
Ignition temperature	°C	35	
Limiting oxygen index	% O_2	23	
TOXICITY			
Oral rat, LD_{50}	mg kg^{-1}	>4,000	
Skin rabbit, LD_{50}	mg kg^{-1}	>2,000	
PROCESSING			
Typical processing methods	-	lay-up, spray-up, filament winding, pultrusion, sheet and bulk molding, vacuum-assisted resin transfer molding	
Applications	-	aircraft, coatings, pipes, tanks, windmill blades	
Outstanding properties	-	chemical resistance, corrosion resistance	
BLENDS			
Suitable polymers	-	PU	