AK alkyd resin

PARAMETER	UNIT	VALUE	REFERENCES
GENERAL			
Common name	-	alkyd resin	
Acronym	-	AK	
CAS number	-	63148-69-6; 68333-62-0	
RTECS number	-	WZ6250000	
HISTORY			
Person to discover	-	Berzelius; Kienle	Hofland, A, Prog. Org. Coat., in press, 2011.
Date	-	1847, 1920s, 1976	
Details	-	Berzelius condensed glycerol tartrate; in 1920s, Kienle developed alkyd resins; in 1976 artist's alkyd paints were introduced by Winsor & Newton	Ploeger, R; Scalarone, D; Chiantore, O, J. Cultural Heritage, 9, 412-19, 2008.
SYNTHESIS			
Monomer(s) structure	-	polyol and dicarboxylic acid or anhydride	
Monomer(s) molecular weight(s)	dalton, g/mol, amu	>1000	
Oil or fatty acids contents	%	>70 (very long oil); 56-70 (long oil); 46-55 (medium oil); 35-45 (short oil)	Ploeger, R; Scalarone, D; Chiantore, O, J. Cultural Heritage, 9, 412-19, 2008.
Formulation example	wt%	glycerol – 25.9, oil – 33.3, phthalic anhydride – 40.8	Atimuttigul, V; Damrongsakkul, S; Tanthapanichakoon, W, Korean J. Chem. Eng., 23, 4, 672-77, 2006; Ikhuoria, E U; Maliki, M; Okieimen, F E; Aigbodion, A I; Obaze, E O; Bakare, I O, Prog. Org. Coat., 59, 134-37, 2007.
Method of synthesis	-	the mixture of oil, glycerol, and catalyst is heated to a required temperature and phthalic anhydride is added to accomplish esterification	Atimuttigul, V; Damrongsakkul, S; Tanthapanichakoon, W, Korean J. Chem. Eng., 23, 4, 672-77, 2006.
Temperature of polymerization	°C	210-260	Atimuttigul, V; Damrongsakkul, S; Tanthapanichakoon, W, Korean J. Chem. Eng., 23, 4, 672-77, 2006.
Time of polymerization	h	5	Atimuttigul, V; Damrongsakkul, S; Tanthapanichakoon, W, Korean J. Chem. Eng., 23, 4, 672-77, 2006.
Pressure of polymerization	Pa	atmospheric	Atimuttigul, V; Damrongsakkul, S; Tanthapanichakoon, W, Korean J. Chem. Eng., 23, 4, 672-77, 2006.
Catalyst	-	LiOH; Mn and Co compounds (drying catalyst)	Atimuttigul, V; Damrongsakkul, S; Tanthapanichakoon, W, Korean J. Chem. Eng., 23, 4, 672-77, 2006; Ikhuoria, E U; Maliki, M; Okieimen, F E; Aigbodion, A I; Obaze, E O; Bakare, I O, Prog. Org. Coat., 59, 134-37, 2007; Erich, S J F; Laven, J; Pel, L; Huinink, H P; Kopinga, K, Prog. Org. Coat., 55, 105-11, 2006.
Number average molecular weight, M_n	dalton, g/mol, amu	2,300-2,400; 3,754-6,611 (hyperbranched resins); 2550-4677 (hyperbranched resins)	Murillo, E A; Vallejo, P P; Lopez, B L, Prog. Org. Coat., 69, 235-40, 2010.
Mass average molecular weight, M_w	dalton, g/mol, amu	23,900-30,300; 8,125-19,537 (hyperbranched resins)	
Polydispersity, M_w/M_n	-	>10; 2.16-295 (hyperbranched resins); 1.94-2.58	Vallejo, P P; Lopez, B L; Murillo, E A, Prog. Org. Coat., 87, 213-21, 2015.

PARAMETER	UNIT	VALUE	REFERENCES
STRUCTURE			
Cross-sectional surface area of chain	nm^2	0.34	Swarup, S; Nigam, A N, J. Appl. Polym. Sci., 39, 1727-31, 1990.
Number of carbon atoms per entanglement		440	Swarup, S; Nigam, A N, J. Appl. Polym. Sci., 39, 1727-31, 1990.
PHYSICAL PROPERTIES			
Density at 20°C	$g\ cm^{-3}$	1.10-1.25	
Color	-	yellow to white	
Refractive index, 20°C	-	1.467-1.493	
Gloss, 60°, Gardner (ASTM D523)	%	85-95 (coating); 85.2-90.9	Vallejo, P P; Lopez, B L; Murillo, E A, Prog. Org. Coat., 87, 213-21, 2015.
Odor	-	none	
Decomposition temperature	°C	150-250 (peroxide decomposition); 250-400 (oxidative decomposition); >400 (volatilization)	Lazzari, M; Chiantore, O, Polym. Degrad. Stab., 65, 303–13, 1999.
Glass transition temperature	°C	8-10; 2 (uncrosslinked); 20-40 (naturally exposed for 25 years)	Erich, S J F; Adan, O C G; Pel, L; Huinink, H P; Kopinga, K, Chem. Mater., 18, 4500-4, 2006; Ploeger, R; Scalarone, D; Chiantore, O, Polym. Deg. Stab., 94, 2036-41, 2009.
Hansen solubility parameters, δ_D, δ_P, δ_H	$MPa^{0.5}$	20.42, 3.44, 4.56 (long oil); 18.50, 9.21, 4.91 (short oil)	
Dielectric constant at 100 Hz/1 MHz	-	3.5-5	
Speed of sound	$m\ s^{-1} \times 10^{-3}$	1.29-1.35	
MECHANICAL & RHEOLOGICAL PROPERTIES			
Pencil hardness		2B-H	Bora, M M; Gogoi, P; Deka, D C; Kakati, D K, Ind. Crops Prod., 52, 721-8, 2014.
CHEMICAL RESISTANCE			
Acid dilute/concentrated	-	poor	
Alcohols	-	very good	
Alkalis	-	poor-good	Huang, Q H; Liu, C; Chen, S; Bai, G; An, Q; Cao, J; Zheng, S; Liang, Y; Xiang, B, Prog. Org. Coat., 87, 189-96, 20015.
Aliphatic hydrocarbons	-	good	
Aromatic hydrocarbons	-	good	
Esters	-	good-fair	
Greases & oils	-	good-fair	
Halogenated hydrocarbons	-	fair-poor	
Good solvent	-	acids	
Non-solvent	-	carbon tetrachloride, methyl acetate, methanol	
FLAMMABILITY			
Ignition temperature	°C	40	

PARAMETER	UNIT	VALUE	REFERENCES
WEATHER STABILITY			
Activation wavelengths	nm	330	
Products of degradation	-	chalking, oxidation of double bonds	
Stabilizers	-	UVA: 2-hydroxy-4-methoxybenzophenone; 2,4-dihydroxy-benzophenone; 2-benzotriazol-2-yl-4,6-di-tert-butylphenol; 2-(2H-benzotriazole-2-yl)-4,6-di-tert-pentylphenol; N-(2-ethoxyphenyl)-N'-(4-isododecylphenyl)oxamide; HAS: decane-dioic acid, bis(2,2,6,6-tetramethyl-1-(octyloxy)-4-piperidinyl) ester, reaction products with 1,1-dimethylethylhydroperoxide and octane; 2,4-bis[N-butyl-N-(1-cyclohexyloxy-2,2,6,6-tetra-methylpiperidin-4-yl)amino]-6-(2-hydroxyethylamine)-1,3,5-triazine; bis(1,2,2,6,6-pentamethyl-4-piperidyl) sebacate and methyl 1,2,2,6,6-pentamethyl-4-piperidyl sebacate; 2-dodecyl-N-(2,2,6,6-tetramethyl-4-piperidinyl)succinimide; polymer of 2,2,4,4-tetramethyl-7-oxa-3,20-diaza-dispiro [5.1.11.2]-hene-icosan-21-on and epichlorohydrin; Screener: TiO2; Phosphite: phosphoric acid, (2,4-di-butyl-6-methylphenyl)ethylester	
BIODEGRADATION			
Colonized products		paints and coatings (triglycerides highly crosslinked and with nondegradable linkages are not biodegradable)	Shogren, R L; Petrovic, Z; Liu, Z; Erhan, S Z, J. Polym. Environ. 12, 3, 173-78, 2004.
Typical biodegradants	-	esterase action is responsible for the microbial degradation of alkyd resins	
Stabilizers	-	azole+iodopropargyl butylcarbamate, octylisothiazolinone, silver nanoparticles	
TOXICITY			
NFPA: Health, Flammability, Reactivity rating	-	1/2/0	
Carcinogenic effect	-	not listed by ACGIH, NIOSH, NTP	
Mutagenic effect	-	none known	
Oral rat, LD_{50}	mg kg^{-1}	>2000	
Skin rabbit, LD_{50}	mg kg^{-1}	non-irritant	
PROCESSING			
Typical processing methods	-	compounding/mixing, grinding, sand milling, molding	
Additives used in final products	-	Fillers: calcium carbonate, clay, glass fiber, iron oxides, litho-pone, mica, silica, titanium dioxide, zinc oxide	
Applications	-	adhesives, artist's paints, coatings, electrical applications, fibers, paints, pavement marking, printing inks, putties, var-nishes	
BLENDS			
Suitable polymers	-	acrylics, epoxy, melamine, melamine-formaldehyde	
ANALYSIS			
FTIR (wavenumber-assignment)	cm^{-1}/-	O-H – 2500-3500, carbonyl – 1731-1701, C=C – 1648 (olefinic unsaturations), 1600-1500 (aromatic ring), C-O-H – 1406, C-O – 1275	Suarez, P A Z; Einloft, S; de Basso, N R; Fernandes, J A; da Motta, L; do Amaral, L C; Lima, D G, e-Polymers, 58, 1-8, 2008.
NMR (chemical shifts)	ppm	CH=CH – 5.30, CH_2OCOR – 4.21, CH_3, CH_2, CH – 0.5-3	Murillo, E A; Vallejo, P P; Lopez, B L, Prog. Org. Coat., 69, 235-40, 2010.