CIIR chlorobutyl rubber

PARAMETER	UNIT	VALUE	REFERENCES
GENERAL			
Common name	-	chlorobutyl rubber	
CAS name	-	butyl rubber, chlorinated	
Acronym	-	CIIR	
CAS number	-	68081-82-3	
HISTORY			
Person to discover	-	Baldwin, F P; Thomas, R M	Baldwin, F P; Thomas, R M, US Patent 2,926,718, Esso, Mar. 1, 1960
Date	-	1955, 1960	
Details	-	Esso researchers patented vulcanization of chlorinated butyl rubber	
SYNTHESIS			
Monomer ratio	-	0.8-2.5 mol% isoprene	
Chlorine contents	%	0.6-1.4	
Method of synthesis	-	the manufacture of the bromobutyl rubber is a two step process: the polymerization of isobutylene and isoprene to produce butyl rubber, followed by bromination to form bromobutyl rubber; a slurry of fine particles of butyl rubber dispersed in methyl chloride is formed in the reactor after Lewis acid initiation; bromine is added to the butyl solution in highly agitated reaction vessels	
Catalyst	-	aluminum trichloride, alkyl aluminum dichloride, boron trifluoride, tin tetrachloride, and titanium tetrachloride	
Mass average molecular weight, M_w	dalton, g/mol, amu	350,000-450,000	
STRUCTURE			
Trans content	%	50-60 (isoprenyl units)	
COMMERCIAL POLYMERS			
Some manufacturers	-	Exxon; Lanxess; Ravago	
Trade names	-	Chlorobutyl Rubber; Chlorobutyl; Ravaflex	
PHYSICAL PROPERTIES			
Density at 20°C	g cm^{-3}	0.92-0.93	
Color	-	amber	
Odor	-	mild	
Decomposition temperature	°C	>140; >170	
Storage temperature	°C	>500	
Glass transition temperature	°C	-73 to -39	
Permeability to oxygen, 25°C	cm^3 mm m^{-2} day^{-1} mm Hg^{-1}	0.958	

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MECHANICAL & RHEOLOGICAL PROPERTIES			
Tensile strength	MPa	9.2-20.6	
Tensile stress at yield	MPa	0.71-1.04	
Elongation	%	330-870	
Elastic modulus	MPa	5.1-9.7	
Tear strength	kN m^{-1}	42-56	
Rebound, 23°C	%	11.2	
Payne effect	Pa	$4x10^6$ (as measured by storage shear modulus)	Scagliusi, S R; Cardoso, E C L; Parra, D F; Lima, L F C P; Lugao, A B, Radiat. Phys. Chem., 84, 42-6, 2013.
Compression set, 24h 70°C	%	20-25	
Shore A hardness	-	52-69	
Mooney viscosity	-	38-55	
CHEMICAL RESISTANCE			
Alcohols	-	good	
Aliphatic hydrocarbons	-	poor	
Greases & oils	-	poor	
Halogenated hydrocarbons	-	poor	
Ketones	-	good	
FLAMMABILITY			
Autoignition temperature	°C	>210	
Limiting oxygen index	% O_2	>300	
Volatile products of combustion	-	CO, CO_2, flammable hydrocarbons, HCl	
TOXICITY			
NFPA: Health, Flammability, Reactivity rating	-	1/1/0; 1/1/0 (HMIS)	
Carcinogenic effect	-	not listed by ACGIH, NIOSH, NTP	
OSHA	mg m^{-3}	5 (respiratory), 15 (total)	
Oral rat, LD_{50}	mg kg^{-1}	>2,000	
ENVIRONMENTAL IMPACT			
Aquatic toxicity, *Daphnia magna*, LC_{50}, 48 h	mg l^{-1}	125-2,100 (tires)	Wik, A; Dave, G, Chemosphere, 58, 645-51, 2005.
PROCESSING			
Typical processing methods	-	calendering, mixing, molding, vulcanization	
Additives used in final products	-	accelerator (MTBS); antioxidant; curing agents (ZnO, Zn stearate); peroxide (e.g. dicumyl); retarder (MgO); sulfur; tackifying resin (phenolic); UV absorber (carbon black)	
Applications	-	conveyor belts, curing bladders, hoses, membranes, pharmaceutical stoppers, seals, tank liners, tire innerlines, tire non-staining sidewalls	
Outstanding properties	-	fast cure, low permeability to air, gases, moisture, low gas transition temperature, processing safety, vibration damping	

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BLENDS			
Suitable polymers	-	NBR, NR, PA12	