CAR carrageenan

PARAMETER	UNIT	VALUE	REFERENCES
GENERAL			
Common name	-	carrageenan	
CAS name	-	carrageenan	
Acronym	-	CAR	
CAS number	-	9000-07-1	
EC number	-	232-524-2	
HISTORY			
Date	-	600 BC, 400 AD, 1930	
Details	-	Gigartina was first used in China, then in Ireland, and in 1930 the first industrial production begun	
SYNTHESIS			
Monomer(s) structure	-	galactose and 3,6 anhydrogalactose	
Method of production	-	extraction from red seaweeds (*Chondrus crispus; Eucheuma cottonii; Eucheuma spinosum, Gigartina stellata* (red algae))	
Mass average molecular weight, M_w	dalton, g/mol, amu	20,000-913,000; 215,000	Bondu, S; Deslandes, E; Fabre, M S; Berthou, C; Yu, G, Carbohydrate Polym., 81, 448-60, 2010; Cosenza, V A; Navarro, D A; Pujol, C A; Damonte, E B; Stiortz, C A, Carbohydrate Polym., 128, 199-206, 2015.
STRUCTURE			
Cell type (lattice)	-	trigonal	
Cell dimensions	nm	a=b:c=1.373:1.328 (calcium salt, iota)	Chandrasekaran, R, Adv. Food Nutrition Res., 42, 131-210, 1998.
Polymorphs	-	κ (hazy gels), ι (clear gels), λ (no gel formation), δ, β, ω (families)	Janaswamy, S; Chandrasekaran, R, Carbohydrate Polym., 60, 499-505, 2005.
Chain conformation	-	double helix (ι and κ)	Janaswamy, S; Chandrasekaran, R, Carbohydrate Res., 343, 364-73, 2008.
COMMERCIAL POLYMERS			
Some manufacturers	-	Evonic, FMC BioPolymer, Kelco, Rhodia Food, Shemberg	
PHYSICAL PROPERTIES			
Density at 20°C	g cm^{-3}	1.3-1.48	
Color	-	yellowish to colorless	
Odor	-	slight marine	
Melting temperature, DSC	°C	50-70	
Setting point	°C	30-50	
pH		7-10; 9.4-10.5	Cosenza, V A; Navarro, D A; Pujol, C A; Damonte, E B; Stiortz, C A, Carbohydrate Polym., 128, 199-206, 2015.
Glass transition temperature	°C	-7 (K salt)	Kasapis, S; Mitchell, J R, Int. J. Biological Macromol., 29, 315-21, 2001.

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PARAMETER	UNIT	VALUE	REFERENCES
MECHANICAL & RHEOLOGICAL PROPERTIES			
Tensile strength	MPa	3.52	Nogueira, L F B; Maniglia, B C; Pereira, L S; Tapia-Blacido, D R; Ramos, A P, Mater. Sci. Eng. C, in press, 2016.
Young's modulus	MPa	309	Nogueira, L F B; Maniglia, B C; Pereira, L S; Tapia-Blacido, D R; Ramos, A P, Mater. Sci. Eng. C, in press, 2016.
Water absorption, equilibrium in water at 23°C	%	75 (max); usually contains 8-10% water	
CHEMICAL RESISTANCE			
Aliphatic hydrocarbons	-	good	
Aromatic hydrocarbons	-	good	
Esters	-	good	
Greases & oils	-	good	
Halogenated hydrocarbons	-	good	
Ketones	-	good	
Good solvent	-	hot water	
Non-solvent	-	diluted acids, organic solvents	
TOXICITY			
NFPA: Health, Flammability, Reactivity rating	-	1/1/0	
Carcinogenic effect	-	not listed by ACGIH, NIOSH, NTP	
TLV, ACGIH	mg m^{-3}	10	
OSHA	mg m^{-3}	15	
Oral rat, LD_{50}	mg kg^{-1}	5,650 (Na salt)	
PROCESSING			
Typical processing methods	-	compounding	
Applications	-	beer, cosmetics, diet sodas, excipient, shampoo, soy milk, thickening agents due to their pseudoplasticity, toothpaste, vegan alternative to gelatin	