

Description

Image



Caption

Styrene Butadiene Rubber is the most popular synthetic rubber in tyres.

The material

Styrene Butadiene Copolymer Rubber (SBR) is the synthetic rubber that is most widely used and has the highest production volume. It is nearly always compounded with reinforcing fillers such as carbon black.

Strengths: When filled, its strength approaches natural rubber (NR) and polychloroprene. Similar chemical and physical properties to NR and somewhat better abrasion resistance.

Limitations: Weaker and lower fatigue resistance than natural rubber (it does not undergo strain-induced crystallation) especially when unfilled. Like NR: prone to oxidation, degrades in ozone, swells readily in hydrocarbon fluids with loss of properties.

Composition (summary)

Copolymer of 23% styrene ($\text{CH}_2\text{CH}(\text{C}_6\text{H}_5)_n$) and 77% butadiene ($\text{CH}_2\text{CH}=\text{CHCH}_2)_m$ reinforced with typically 30% Carbon Black

General properties

Density	70.5	-	71.8	lb/ft ³
Price	* 1.77	-	2.04	USD/lb
Date first used	1932			

Mechanical properties

Young's modulus	5.51e-4	-	8.7e-4	10 ⁶ psi
Shear modulus	* 1.74e-4	-	2.9e-4	10 ⁶ psi
Bulk modulus	* 0.218	-	0.29	10 ⁶ psi
Poisson's ratio	0.48	-	0.496	
Yield strength (elastic limit)	2.32	-	3.77	ksi
Tensile strength	2.32	-	3.77	ksi
Compressive strength	* 2.78	-	4.53	ksi
Elongation	320	-	550	% strain
Fatigue strength at 10 ⁷ cycles	* 0.928	-	1.51	ksi
Fracture toughness	* 0.892	-	0.978	ksi.in ^{0.5}
Mechanical loss coefficient (tan delta)	* 0.08	-	0.14	

Thermal properties

Glass temperature	-83.2	-	-61.6	°F
Maximum service temperature	158	-	230	°F

Minimum service temperature	-58	-	-40	°F
Thermal conductor or insulator?	Poor insulator			
Thermal conductivity	0.231	-	0.52	BTU.ft/h.ft ² .F
Specific heat capacity	0.346	-	0.382	BTU/lb.°F
Thermal expansion coefficient	88.9	-	100	µstrain/°F

Electrical properties

Electrical conductor or insulator?	Poor insulator			
Electrical resistivity	1e10	-	1e16	µohm.cm

Optical properties

Transparency	Opaque			
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Processability

Moldability	3	-	4	
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Durability: water and aqueous solutions

Water (fresh)	Excellent
Water (salt)	Excellent
Soils, acidic (peat)	Excellent
Soils, alkaline (clay)	Excellent
Wine	Excellent

Durability: acids

Acetic acid (10%)	Excellent
Acetic acid (glacial)	Limited use
Citric acid (10%)	Excellent
Hydrochloric acid (10%)	Excellent
Hydrochloric acid (36%)	Limited use
Hydrofluoric acid (40%)	Acceptable
Nitric acid (10%)	Limited use
Nitric acid (70%)	Unacceptable
Phosphoric acid (10%)	Excellent
Phosphoric acid (85%)	Excellent
Sulfuric acid (10%)	Excellent
Sulfuric acid (70%)	Unacceptable

Durability: alkalis

Sodium hydroxide (10%)	Excellent
Sodium hydroxide (60%)	Excellent

Durability: fuels, oils and solvents

Amyl acetate	Unacceptable
Benzene	Unacceptable
Carbon tetrachloride	Unacceptable
Chloroform	Unacceptable
Crude oil	Unacceptable
Diesel oil	Unacceptable
Lubricating oil	Unacceptable
Paraffin oil (kerosene)	Unacceptable
Petrol (gasoline)	Unacceptable
Silicone fluids	Excellent
Toluene	Unacceptable
Turpentine	Unacceptable
Vegetable oils (general)	Unacceptable

White spirit

Excellent

Durability: alcohols, aldehydes, ketones

Acetaldehyde

Unacceptable

Acetone

Limited use

Ethyl alcohol (ethanol)

Excellent

Ethylene glycol

Excellent

Formaldehyde (40%)

Limited use

Glycerol

Excellent

Methyl alcohol (methanol)

Excellent

Durability: halogens and gases

Chlorine gas (dry)

Unacceptable

Fluorine (gas)

Unacceptable

O₂ (oxygen gas)

Unacceptable

Sulfur dioxide (gas)

Unacceptable

Durability: built environments

Industrial atmosphere

Excellent

Rural atmosphere

Excellent

Marine atmosphere

Excellent

UV radiation (sunlight)

Fair

Durability: flammability

Flammability

Highly flammable

Durability: thermal environments

Tolerance to cryogenic temperatures

Unacceptable

Tolerance up to 150 C (302 F)

Acceptable

Tolerance up to 250 C (482 F)

Unacceptable

Tolerance up to 450 C (842 F)

Unacceptable

Tolerance up to 850 C (1562 F)

Unacceptable

Tolerance above 850 C (1562 F)

Unacceptable

Geo-economic data for principal component

Annual world production

1.01e7 - 1.04e7 ton/yr

Reserves

* 2.85e8 - 2.9e8 l. ton

Primary material production: energy, CO₂ and water

Embodied energy, primary production

* 1.21e4 - 1.34e4 kcal/lb

CO₂ footprint, primary production

* 6.29 - 6.95 lb/lb

Water usage

* 7.63 - 22.9 gal(US)/lb

Eco-indicator 99

342 millipoints/kg

Material processing: energy

Polymer molding energy

* 1.67e3 - 1.84e3 kcal/lb

Grinding energy (per unit wt removed)

* 182 - 200 kcal/lb

Material processing: CO₂ footprint

Polymer molding CO₂

* 1.23 - 1.36 lb/lb

Grinding CO₂ (per unit wt removed)

* 0.126 - 0.139 lb/lb

Material recycling: energy, CO₂ and recycle fraction

Recycle

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Recycle fraction in current supply	0.1		%
Downcycle	✓		
Combust for energy recovery	✓		
Heat of combustion (net)	* 4.68e3	- 4.91e3	kcal/lb
Combustion CO2	* 3.11	- 3.27	lb/lb
Landfill	✓		
Biodegrade	✗		
Toxicity rating	Non-toxic		
A renewable resource?	✗		

Environmental notes

Styrene Butadiene elastomers are thermosets, and thus cannot be recycled. Their disposal creates an environmental problem.

Supporting information

Design guidelines

SBR is much weaker than NR if unfilled, but gains similar strength by compounding with 30-50 wt% carbon black.

Typical uses

Car and truck tires, belt, hose, footwear

Links

Reference

ProcessUniverse

Producers