Walnut (juglans regia) (l)

General information

Designation

Juglans regia

Typical uses

Cabinet and carved work; gun stocks; rifle butts; bent work; superior joinery; propeller blades; fittings;

Composition overview

Compositional summary

Cellulose/Hemicellulose/Lignin/12%H2O

Material family	Natural	
Base material	Wood (hardwood)	
Renewable content	100	%

Composition detail (polymers and natural materials)

Wood	100	%

Price

Price	* 3.04	-	4.88	USD/lb

Physical properties

Density	0.0224	-	0.0275	lb/in^3

Mechanical properties

Young's modulus	* 1.71	-	2.09	10^6 psi
Yield strength (elastic limit)	* 8.05	-	9.83	ksi
Tensile strength	14.4	-	17.5	ksi
Elongation	* 2.27	-	2.77	% strain
Compressive strength	8.88	-	10.8	ksi
Flexural modulus	1.55	-	1.9	10^6 psi
Flexural strength (modulus of rupture)	18.5	-	22.7	ksi
Shear modulus	* 0.126	-	0.155	10^6 psi
Shear strength	1.04	-	1.28	ksi
Bulk modulus	* 0.145	-	0.162	10^6 psi
Poisson's ratio	* 0.35	-	0.4	
Shape factor	5.1			
Hardness - Vickers	* 6.44	-	7.88	HV
Hardness - Brinell	7.83	-	9.57	ksi
Hardness - Janka	* 1.45e3	-	1.77e3	lbf
Fatigue strength at 10^7 cycles	* 5.55	-	6.8	ksi
Mechanical loss coefficient (tan delta)	* 0.0069	-	0.0084	

Differential shrinkage (radial)		0.18	-	0.23	%
Differential shrinkage (tangential)		0.25	-	0.3	%
Radial shrinkage (green to oven-dry)		4.9	-	5.9	%
Tangential shrinkage (green to oven-dry)		6.8	-	8.3	%
Volumetric shrinkage (green to oven-dry)		12.3	-	15.1	%
Work to maximum strength		0.381	-	0.465	ft.lbf/in^3

Impact & fracture properties

Fracture toughness	*	5.1	-	6.28	ksi.in^0.5

Thermal properties

Glass temperature		171	-	216	°F
Maximum service temperature		248	-	284	°F
Minimum service temperature	*	-99.4	-	-9.4	°F
Thermal conductivity	*	0.173	-	0.214	BTU.ft/hr.ft^2.°F
Specific heat capacity		0.396	-	0.408	BTU/lb.°F
Thermal expansion coefficient	*	1.11	-	6.11	µstrain/°F

Electrical properties

Electrical resistivity	*	6e13	-	2e14	µohm.cm
Dielectric constant (relative permittivity)	*	6.81	-	8.32	
Dissipation factor (dielectric loss tangent)	*	0.08	-	0.097	
Dielectric strength (dielectric breakdown)	*	10.2	-	15.2	V/mil

Magnetic properties

Magnetic type	Non-magnetic

Optical properties

Transparency	Opaque

Bio-data

Food contact	Yes

Restricted substances risk indicators

RoHS (EU) compliant grades?	✓

Durability

Water (fresh)	Limited use
Water (salt)	Limited use
Weak acids	Limited use
Strong acids	Unacceptable
Weak alkalis	Acceptable

Strong alkalis	Unacceptable			
Organic solvents	Acceptable			
Oxidation at 500C	Unacceptable			
UV radiation (sunlight)	Good			
Flammability	Highly flammable			

Primary production energy, CO2 and water

Embodied energy, primary production	4.99e3	-	5.5e3	BTU/lb

Sources

0.5 MJ/kg (Ximenes, 2006); 2 MJ/kg (Ximenes, 2006); 9.1 MJ/kg (Hammond and Jones, 2008); 11.6 MJ/kg (Hubbard and Bowe, 2010); 23.7 MJ/kg (Ecoinvent v2.2); 26 MJ/kg (Ecoinvent v2.2)

CO2 footprint, primary production	0.574	-	0.633	lb/lb

Sources

0.229 kg/kg (Ecoinvent v2.2); 0.412 kg/kg (Ecoinvent v2.2); 0.862 kg/kg (Hammond and Jones, 2008); 0.909 kg/kg (Hubbard and Bowe,

NOx creation	0.00257	-	0.00284	lb/lb
SOx creation	0.00656	-	0.00725	lb/lb
Water usage	* 1.84e4	-	2.03e4	in^3/lb

Processing energy, CO2 footprint & water

Coarse machining energy (per unit wt removed)	* 607	-	671	BTU/lb
Coarse machining CO2 (per unit wt removed)	* 0.106	-	0.117	lb/lb
Fine machining energy (per unit wt removed)	* 4.23e3	-	4.68e3	BTU/lb
Fine machining CO2 (per unit wt removed)	* 0.738	-	0.816	lb/lb
Grinding energy (per unit wt removed)	* 8.26e3	-	9.12e3	BTU/lb
Grinding CO2 (per unit wt removed)	* 1.44	-	1.59	lb/lb

Recycling and end of life

Recycle	✗			
Recycle fraction in current supply	8.55	-	9.45	%
Downcycle	✓			
Combust for energy recovery	✓			
Heat of combustion (net)	* 8.49e3	-	9.16e3	BTU/lb
Combustion CO2	* 1.69	-	1.78	lb/lb
Landfill	✓			
Biodegrade	✓			

Eco-indicators for principal component

Eco-indicator 95	2.99			millipoints/lb
EPS value	62.7	-	69.3	

Notes

Warning

All woods have properties which show variation; they depend principally on growth conditions and moisture content.

Links

ProcessUniverse

Reference

Shape

Walnut (juglans nigra) (l)

General information

Designation

Juglans nigra

Typical uses

Lumber for boxes; pallets; crates; baskets & furniture; veneer; pulpwood; sleepers; slack

Composition overview

Compositional summary

Cellulose/Hemicellulose/Lignin/12%H2O

Material family	Natural	
Base material	Wood (hardwood)	
Renewable content	100	%

Composition detail (polymers and natural materials)

Wood	100	%

Price

Price	* 3.04	-	4.88	USD/lb

Physical properties

Density	0.0199	-	0.0246	lb/in^3

Mechanical properties

Young's modulus	* 1.67	-	2.03	10^6 psi
Yield strength (elastic limit)	* 6.67	-	8.15	ksi
Tensile strength	* 12.2	-	14.9	ksi
Elongation	* 1.99	-	2.43	% strain
Compressive strength	6.82	-	8.34	ksi
Flexural modulus	1.51	-	1.84	10^6 psi
Flexural strength (modulus of rupture)	13.1	-	16.1	ksi
Shear modulus	* 0.123	-	0.151	10^6 psi
Shear strength	1.23	-	1.51	ksi
Bulk modulus	* 0.104	-	0.117	10^6 psi
Poisson's ratio	* 0.35	-	0.4	
Shape factor	5.2			
Hardness - Vickers	* 4.99	-	6.1	HV
Hardness - Brinell	* 7.14	-	8.72	ksi
Hardness - Janka	* 1.12e3	-	1.37e3	lbf
Fatigue strength at 10^7 cycles	* 3.95	-	4.82	ksi
Mechanical loss coefficient (tan delta)	* 0.007	-	0.0086	

Differential shrinkage (radial)	0.19	-	0.22	%
Differential shrinkage (tangential)	0.28	-	0.33	%
Radial shrinkage (green to oven-dry)	5	-	6.1	%
Tangential shrinkage (green to oven-dry)	7	-	8.6	%
Volumetric shrinkage (green to oven-dry)	11.5	-	14.1	%
Work to maximum strength	0.803	-	0.981	ft.lbf/in^3

Impact & fracture properties

Fracture toughness	* 4.28	-	5.28	ksi.in^0.5

Thermal properties

Glass temperature	171	-	216	°F
Maximum service temperature	248	-	284	°F
Minimum service temperature	* -99.4	-	-9.4	°F
Thermal conductivity	* 0.156	-	0.191	BTU.ft/hr.ft^2.°F
Specific heat capacity	0.396	-	0.408	BTU/lb.°F
Thermal expansion coefficient	* 1.11	-	6.11	µstrain/°F

Electrical properties

Electrical resistivity	1.1e14	-	1.34e14	µohm.cm
Dielectric constant (relative permittivity)	* 6.14	-	7.5	
Dissipation factor (dielectric loss tangent)	* 0.071	-	0.086	
Dielectric strength (dielectric breakdown)	* 10.2	-	15.2	V/mil

Magnetic properties

Magnetic type	Non-magnetic

Optical properties

Transparency	Opaque

Bio-data

Food contact	Yes

Restricted substances risk indicators

RoHS (EU) compliant grades?	✓

Durability

Water (fresh)	Limited use
Water (salt)	Limited use
Weak acids	Limited use
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SOx creation	0.00656	-	0.00725	lb/lb
Water usage	* 1.84e4	-	2.03e4	in^3/lb

Processing energy, CO2 footprint & water

Coarse machining energy (per unit wt removed)	* 551	-	609	BTU/lb
Coarse machining CO2 (per unit wt removed)	* 0.0962	-	0.106	lb/lb
Fine machining energy (per unit wt removed)	* 3.68e3	-	4.06e3	BTU/lb
Fine machining CO2 (per unit wt removed)	* 0.641	-	0.709	lb/lb
Grinding energy (per unit wt removed)	* 7.15e3	-	7.9e3	BTU/lb
Grinding CO2 (per unit wt removed)	* 1.25	-	1.38	lb/lb

Recycling and end of life

Recycle	✗			
Recycle fraction in current supply	8.55	-	9.45	%
Downcycle	✓			
Combust for energy recovery	✓			
Heat of combustion (net)	* 8.49e3	-	9.16e3	BTU/lb
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