Oak (quercus rubra) (t)

General information

Designation

Quercus rubra

Typical uses

Lumber; sleepers; mine timbers; fenceposts; veneer; pulpwood; fuelwood; flooring; furniture; general millwork; boxes; pallets & crates; agricultural implements; caskets; woodenware; handles; railroad cars;

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	*	0.912	-	1.22	USD/lb

Physical properties

Density		0.0231	-	0.0282	lb/in^3

Mechanical properties

Young's modulus	*	0.306	-	0.341	10^6 psi
Yield strength (elastic limit)	*	0.435	-	0.531	ksi
Tensile strength		0.725	-	0.885	ksi
Elongation	*	0.7	-	0.86	% strain
Compressive strength		0.909	-	1.11	ksi
Flexural modulus		0.278	-	0.31	10^6 psi
Flexural strength (modulus of rupture)	*	0.725	-	0.885	ksi
Shear modulus	*	0.0316	-	0.0434	10^6 psi
Shear strength	*	4.81	-	5.85	ksi
Rolling shear strength	*	0.177	-	0.532	ksi
Bulk modulus	*	0.157	-	0.174	10^6 psi
Poisson's ratio	*	0.02	-	0.04	
Shape factor		5.7			
Hardness - Vickers		5.16	-	6.31	HV
Hardness - Brinell	*	3.29	-	4.02	ksi
Hardness - Janka		1.16e3	-	1.42e3	lbf

Fatigue strength at 10^7 cycles	* 0.218	-	0.265	ksi
Mechanical loss coefficient (tan delta)	* 0.016	-	0.021	
Differential shrinkage (radial)	0.14	-	0.18	%
Differential shrinkage (tangential)	0.28	-	0.34	%
Radial shrinkage (green to oven-dry)	3.6	-	4.4	%
Tangential shrinkage (green to oven-dry)	7.7	-	9.5	%
Volumetric shrinkage (green to oven-dry)	12.3	-	15.1	%
Work to maximum strength	* 0.109	-	0.133	ft.lbf/in^3

Impact & fracture properties

Fracture toughness	0.333	-	0.408	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	* 0.0641	-	0.078	BTU.ft/hr.ft^2.°F
Specific heat capacity	0.396	-	0.408	BTU/lb.°F
Thermal expansion coefficient	* 17.5	-	23.4	µstrain/°F

Electrical properties

Electrical resistivity	* 3.63e14	-	5.42e14	µohm.cm
Dielectric constant (relative permittivity)	* 3.93	-	4.8	
Dissipation factor (dielectric loss tangent)	* 0.054	-	0.067	
Dielectric strength (dielectric breakdown)	* 25.4	-	50.8	V/mil

Magnetic properties

Magnetic type	Non-magnetic

Optical properties

Transparency	Opaque

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,

Water usage	* 1.84e4	-	2.03e4	in^3/lb

Processing energy, CO2 footprint & water

Coarse machining energy (per unit wt removed)	* 244	-	270	BTU/lb
Coarse machining CO2 (per unit wt removed)	* 0.0426	-	0.0471	lb/lb
Fine machining energy (per unit wt removed)	* 605	-	668	BTU/lb
Fine machining CO2 (per unit wt removed)	* 0.106	-	0.117	lb/lb
Grinding energy (per unit wt removed)	* 1.01e3	-	1.11e3	BTU/lb
Grinding CO2 (per unit wt removed)	* 0.175	-	0.194	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	✓			

Notes

Warning

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

Links

ProcessUniverse
Reference
Shape