# Birch (betula alleghaniensis) (t)

## General information

**Designation**

Betula alleghaniensis

**Typical uses**

Furniture; boxes; baskets; crates; woodenware; cooperage; interior finish; doors. As veneer in plywood: flush doors; furniture; paneling; radio & television cabinets; aircraft.

## 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 | * 0.67 | - | 1.34 | USD/kg |
| Price per unit volume | * 415 | - | 1.02e3 | USD/m^3 |

## Physical properties

| | | | | |
|---|---|---|---|---|
| Density | 620 | - | 760 | kg/m^3 |

## Mechanical properties

| | | | | |
|---|---|---|---|---|
| Young's modulus | * 2.01 | - | 2.24 | GPa |
| Yield strength (elastic limit) | * 3.42 | - | 4.2 | MPa |
| Tensile strength | 5.7 | - | 7 | MPa |
| Elongation | * 0.84 | - | 1.03 | % strain |
| Compressive strength | 6.02 | - | 7.36 | MPa |
| Flexural modulus | 1.83 | - | 2.04 | GPa |
| Flexural strength (modulus of rupture) | * 5.7 | - | 7 | MPa |
| Shear modulus | * 0.208 | - | 0.285 | GPa |
| Shear strength | * 35.1 | - | 42.9 | MPa |
| Rolling shear strength | * 1.3 | - | 3.9 | MPa |
| Bulk modulus | * 1.03 | - | 1.15 | GPa |
| Poisson's ratio | * 0.02 | - | 0.04 | |
| Shape factor | 5.6 | | | |
| Hardness - Vickers | 5.04 | - | 6.17 | HV |
| Hardness - Brinell | * 27.3 | - | 33.3 | HB |

| | | | | | |
|---|---|---|---|---|---|
| Hardness - Janka | | 5.04 | - | 6.17 | kN |
| Fatigue strength at 10^7 cycles | * | 1.71 | - | 2.1 | MPa |
| Mechanical loss coefficient (tan delta) | * | 0.017 | - | 0.021 | |
| Differential shrinkage (radial) | | 0.18 | - | 0.24 | % |
| Differential shrinkage (tangential) | | 0.26 | - | 0.31 | % |
| Radial shrinkage (green to oven-dry) | | 6.6 | - | 8 | % |
| Tangential shrinkage (green to oven-dry) | | 8.6 | - | 10.5 | % |
| Volumetric shrinkage (green to oven-dry) | | 15.1 | - | 18.5 | % |
| Work to maximum strength | * | 12.9 | - | 15.8 | kJ/m^3 |

## Impact & fracture properties

| | | | | | |
|---|---|---|---|---|---|
| Fracture toughness | * | 0.521 | - | 0.637 | MPa.m^0.5 |

## Thermal properties

| | | | | | |
|---|---|---|---|---|---|
| Glass temperature | | 77 | - | 102 | ℃ |
| Maximum service temperature | | 120 | - | 140 | ℃ |
| Minimum service temperature | * | -73 | - | -23 | ℃ |
| Thermal conductivity | | 0.12 | - | 0.14 | W/m.℃ |
| Specific heat capacity | | 1.66e3 | - | 1.71e3 | J/kg.℃ |
| Thermal expansion coefficient | * | 31.2 | - | 41.8 | µstrain/℃ |

## Electrical properties

| | | | | | |
|---|---|---|---|---|---|
| Electrical resistivity | * | 8.73e14 | - | 1.3e15 | µohm.cm |
| Dielectric constant (relative permittivity) | * | 3.87 | - | 4.74 | |
| Dissipation factor (dielectric loss tangent) | * | 0.054 | - | 0.065 | |
| Dielectric strength (dielectric breakdown) | * | 1 | - | 2 | MV/m |

## Magnetic properties

| | |
|---|---|
| Magnetic type | Non-magnetic |

## Optical properties

| | |
|---|---|
| Transparency | Opaque |

## Critical materials risk

| | |
|---|---|
| Contains >5wt% critical elements? | No |

## 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 | 11.6 | - | 12.8 | MJ/kg |

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 | kg/kg |

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, 2010)

| | | | | |
|---|---|---|---|---|
| Water usage | * 665 | - | 735 | l/kg |

## Processing energy, CO2 footprint & water

| | | | | |
|---|---|---|---|---|
| Coarse machining energy (per unit wt removed) | * 0.567 | - | 0.627 | MJ/kg |
| Coarse machining CO2 (per unit wt removed) | * 0.0425 | - | 0.047 | kg/kg |
| Fine machining energy (per unit wt removed) | * 1.4 | - | 1.54 | MJ/kg |
| Fine machining CO2 (per unit wt removed) | * 0.105 | - | 0.116 | kg/kg |
| Grinding energy (per unit wt removed) | * 2.32 | - | 2.56 | MJ/kg |
| Grinding CO2 (per unit wt removed) | * 0.174 | - | 0.192 | kg/kg |

## Recycling and end of life

| | | | | |
|---|---|---|---|---|
| Recycle | ✗ | | | |
| Recycle fraction in current supply | 8.55 | - | 9.45 | % |
| Downcycle | ✓ | | | |
| Combust for energy recovery | ✓ | | | |
| Heat of combustion (net) | * 19.8 | - | 21.3 | MJ/kg |
| Combustion CO2 | * 1.69 | - | 1.78 | kg/kg |
| Landfill | ✓ | | | |
| Biodegrade | ✓ | | | |

## Notes

**Warning**

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

## Links

ProcessUniverse

Reference

Shape

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