

Adhesives Based on Lignin, Tannin and Liquefied Wood

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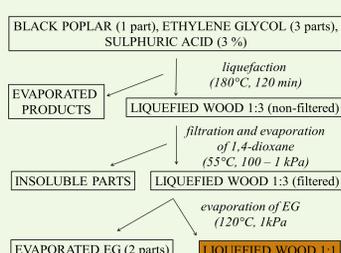
Wood industry is significant consumer of adhesives. The largest amount of adhesives is consumed in wood based-composites, where mainly aminoplastic adhesives: urea- and melamine- formaldehyde (UF and MF), phenolic adhesives: phenol- and resorcinol-formaldehyde (PF and RF) or isocyanate adhesives are used. Majority of these wood adhesives are on formaldehyde basis, and thus, harmful to health and environment.

Nowadays, there are many efforts placed on development of new bio-based adhesives, which could at least partially substitute the formaldehyde adhesives. The proposed solutions of this paper are focused on different adhesive formulations based on lignin, tannin and liquefied wood. Main disadvantage of these adhesives are lower strength and durability properties and higher consumption of energy for curing.

Adhesive preparation

Tannin / Lignin

Adhesive name	Tannin : lignin : hexamine dry weight ratio
T0	0 : 100 : 6
T20	20 : 80 : 6
T40	40 : 60 : 6
T60	60 : 40 : 6
T80	80 : 20 : 6
T100	100 : 0 : 6



Liquefied Wood

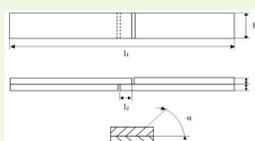


Bonding parameters

Tannin / Lignin



- Solid beech wood, 5 mm thick lamellas, 10 % MC
- Adhesive spread: 200 g/m²
- Press temperature: 170 °C
- Pressing time: 12 min



Liquefied Wood

- Solid beech wood, 5 mm thick lamellas, 10 % MC
- Adhesive spread: 200 g/m²
- Press temperatures: 150, 160, 170, 180, 190 and 200 °C
- Pressing time: 6, 9, 12, 15 and 18 min

Specimen preparation

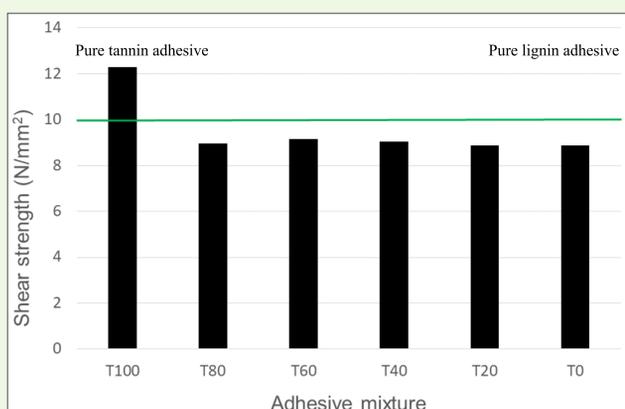


Shear strength testing



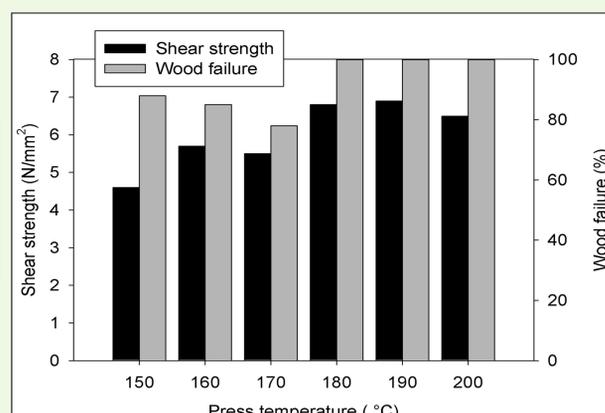
Shear strength results

Tannin / Lignin



Sequence number	Duration and condition	Adhesive strength in N/mm ² Durability classes			
		C1	C2	C3	C4
1	7 days in standard atmosphere 25°C, 65% RH	≥10	≥10	≥10	≥10
2	7 days in standard atmosphere 2 h in water at 20±5 °C	≥7	≥7	≥7	≥7
3	7 days in standard atmosphere 2 h in water at 20±5 °C 2 h in water at 20±5 °C		≥4		
4	7 days in standard atmosphere 2 h in boiling water				≥4

Liquefied Wood



Conclusions:

- Optimal press temperature and pressing time for bonding of beech wood with liquefied wood was 180°C and 12 minutes.
- Liquefied wood did not satisfy the requirements for durability class C1 (10 N/mm²).
- High wood failure (100%) was determined despite relatively low shear strength of bonded specimens.
- Pure tannin adhesives satisfy the requirements for durability class C1, whereas other adhesive mixtures made of tannin and lignin did not.
- There is certain potential for the use of tannin as well as lignin and liquefied wood for novel bio-adhesives made from renewable resources.

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