Wood endurance increase by means of retification

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Abstract

Retification allows materials to acquire new qualitative characteristics. This process involves reduced pyrolysis of wood that makes the wood more stable and more mycosis-resistant, but slightly impairs its mechanical properties.
The tests were carried out on three major healthful wood types (poplar, fir, and spruce) used in constructions, but hard to apply common products for wood conservation. Test samples of wood retified at different temperatures were exposed to basiodimicite fungi. The test results proved to be stunning. This interesting property can successfully be used for increasing the endurance of materials, originally not resistant to biological effects. The treatment process optimization has improved both the procedure itself and the wood endurance.

1. Introduction

Wood retification is heat treatment at 200º - 260ºC in the oxygen-unsaturated atmosphere. The treatment combines a series of physical, mechanical, and chemical wood transformations that impart unique endurance to the treated material.
Wood represents a complex material in terms of its elements heterogeneity, their anisotropy, and hydroscopic and biological properties. Under special heat treatment, or retification, that represents a reduced low-temperature pyrolysis (200º - 260º C), the water absorption capacity of wood noticeably decreases, the volume stability improves, and the resistance to microorganism damage enhances.

The aim of the present investigation is to present the results obtained during the treatment of three major wood types, the two soft (poplar and fir), and the one hard (spruce) ones.

2. Description of the treatment process

Retification is a heat treatment at the temperature of 200º - 260º C and short time deficiency of air.
The term «retified wood» implies the material obtained by retification of natural wood, i.e. as a result of chemical transformation (creation of new bonds) on molecular level wood components crystallize. This thermal process occurs under specific conditions of pressure, temperature, and at an accurately set level of temperature. The physicochemical composition of natural and treated wood is shown in Table 1.
During the high-temperature treatment, a portion of water contained in wood is extracted. Under these conditions and in an inert atmosphere carbon monoxides and dioxides are released, thus, resulting in the alteration of wood constituents. This is a complicated and multilateral process of heat wood treatment that leads to numerous reactions that occur at different stages of the treatment. However, real-life control of temperature, duration, gas pressure and cooling atmosphere facilitates the thermal condensation reaction of certain constituents of internal wood structure without any losses of main ingredients (cellulose and lignin).
Wood becomes much more moisture-proof during the first minutes of retification; the material releases 4% of moisture into the external atmosphere. The weight decline is accounted for by the fact that water filling up the cracks of pentosan derivatives (semichemical pulp) provides the stability of the dimensions.
The stability of the dimensions appears due to furfural polymers derived from the destruction of sugars that are less hydroscopic than hemocellulose.

3. Improvement of biological damage resistance.

In order to control the improvement of material endurance, three major samples of retified material (Bravery test, 1979) were tested.
The test checked the resistance to the following mycosis:

- Coriolus Versicolor,
- Gloeophyllum trabeum,
- Coniophora puteana.

The poplar samples were also tested for the resistance to Chaetomium globosum Kunze.

12 retified wood samples (30x10x5 mm) were placed into containers with fungi crops for 6 months. At the same time, samples of untreated wood were exposed to the same conditions.

The results of the tests are represented in Tables 2 – 4.

4. Comments

- In all cases the loss of weight by the retified wood samples is considerably less (<1%).
- The samples have demonstrated the resistance to biological damage in accordance with standards.
- In all cases, the moisture of retified wood was much less, than that of natural wood; and this fact is especially important for the poplar samples.
- Putrefactive processes did not affect the poplar samples.

5. Conclusion

Retification imparts the treated wood with exceptional resistance to biological damage. The low moisture level of all retified wood samples has influenced the improvement of this characteristic, since the absorption level of wood significantly diminishes. Notwithstanding the fact that the hemicellulose content decreases, the potential for destructive processes development is much less than in natural wood.

This increase in wood endurance becomes possible due to chemical and physical modifications of wood during the treatment. This fact suggests that the «new» material possesses interesting properties, and offers ample prospects for the application of soft wood types under environment conditions.

Table 1. Physicochemical analysis of natural and retified wood:

Fir	Natural	Treatment 1	Treatment 2
Simple analysis C% O% H%	 49.06 44.96 6.22	 53.62 40.44 5.93	 54.34 39.29 5.91
Remains	8.51	14.97	8.4
Lignin	23.93	32.69	39.07
Pentosan	8.76	2.9	2.56

Spruce	Natural	Treatment 1	Treatment 2
Simple analysis C% O% H%	 50.47 43.85 6.21	 53.62 40.06 5.88	 55.10 38.40 5.82
Remains	14.72	12.70	8.02
Lignin	26.06	34.97	40.59
Pentosan	8.48	3.81	2.49

Poplar	Natural	Treatment 1	Treatment 2
Simple analysis C% O% H%	 47.47 46.83 6.26		
Remains	2.63	4.89	9.21
Lignin	20.53	36.2	25.44
Pentosan	17.25	16.28	11.54

Table 2. Results obtained during the fir samples test (2 retification treatments)

	Treatment 1				Treatment 2			
	Retified samples		Reference samples		Retified samples		Reference samples	
	PM%	H%	PM%	H%	PM%	H%	PM%	H%
Coniophora Puteana	0	52	22.04	60	0.68	54	23.81	60
Gloephyllum trabeum	0	33	15.01	114	0.02	31	18.3	89
Coriolus versicolor	0.04	76	16.13	162	0.06	98	16.21	150

Table 3. Results obtained during the spruce samples test (2 retification treatments)

	Treatment 1				Treatment 2			
	Retified samples		Reference samples		Retified samples		Reference samples	
	PM%	H%	PM%	H%	PM%	H%	PM%	H%
Coniophora Puteana	0	59	36.02	75	0	50	34.76	73
Gloephyllum trabeum	0.28	40	0	101	0.6	28	0	95
Coriolus versicolor	0.23	53	8.76	224	0.58	40	9.92	210

Table 4. Results obtained during the poplar samples test (2 retification treatments)

	Treatment 1				Treatment 2			
	Retified samples		Reference samples		Retified samples		Reference samples	
	PM%	H%	PM%	H%	PM%	H%	PM%	H%
Coniophora Puteana	0.4	29	31.8	117	0.2	35	46.2	142
Gloephyllum trabeum	0.4	30	37.7	61	0.3	54	35	73
Coriolus versicolor	0.1	36	40.7	156	0.0	74	37.9	187