



# Evaluation of Furfural/Urea complexes to improve properties of commercial birch wood (*Betula pendula*)

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Biomass  
Wood  
Energy  
Bioproducts



iufro2019  
Curitiba • Brazil



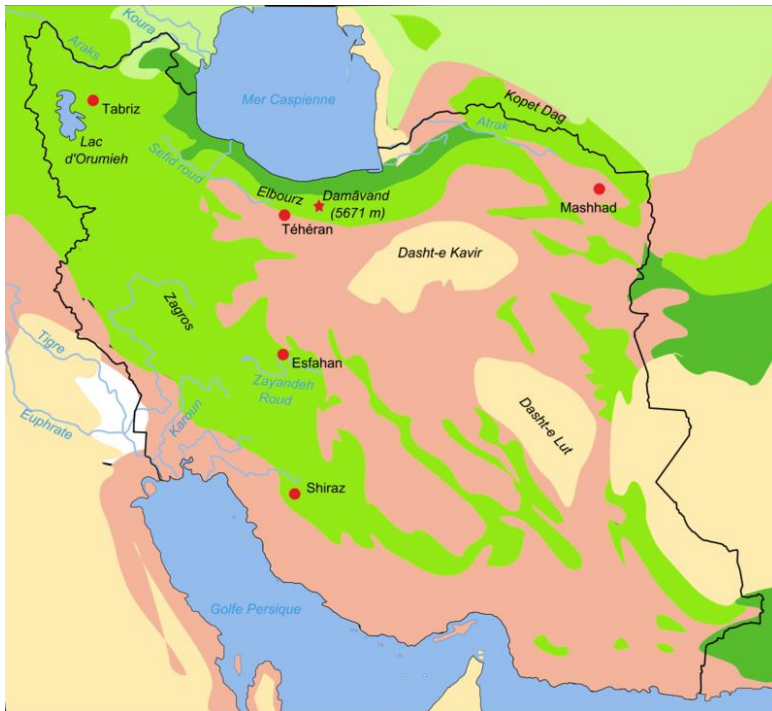
# The context

Iran

Native Beech  
(*Fagus orientalis*)

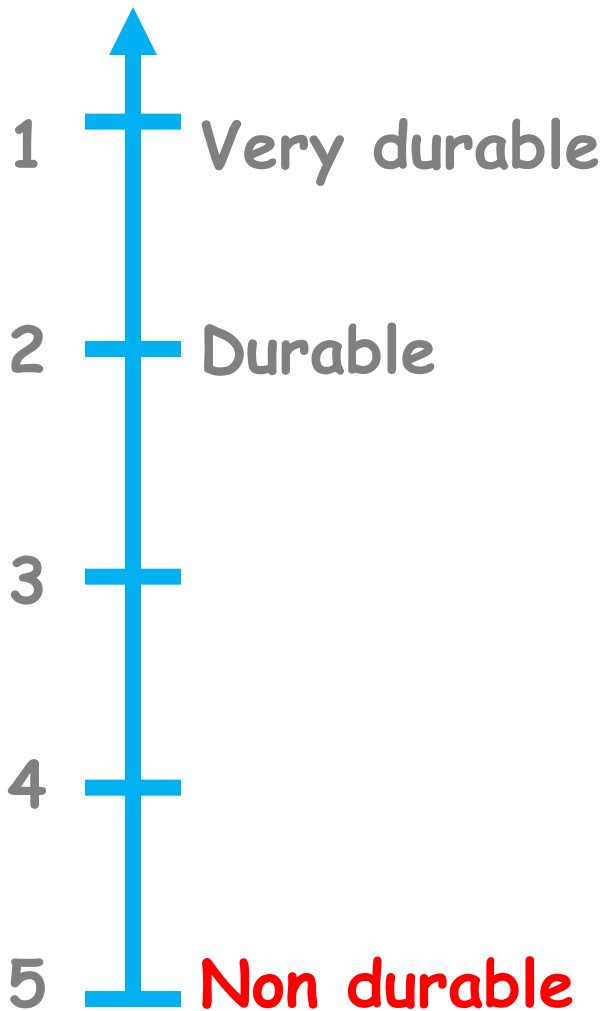
Wood Shortage

Birch (*Betula* sp.)  
from Russia on the  
market





# Birch Durability



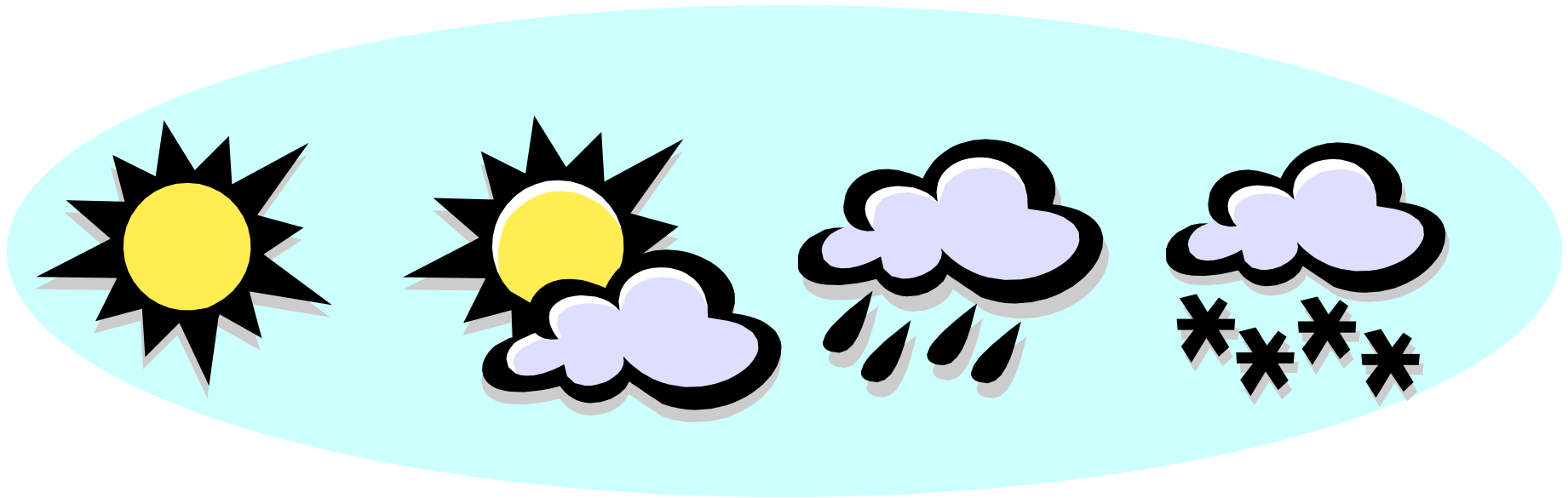
Fungi



Termites



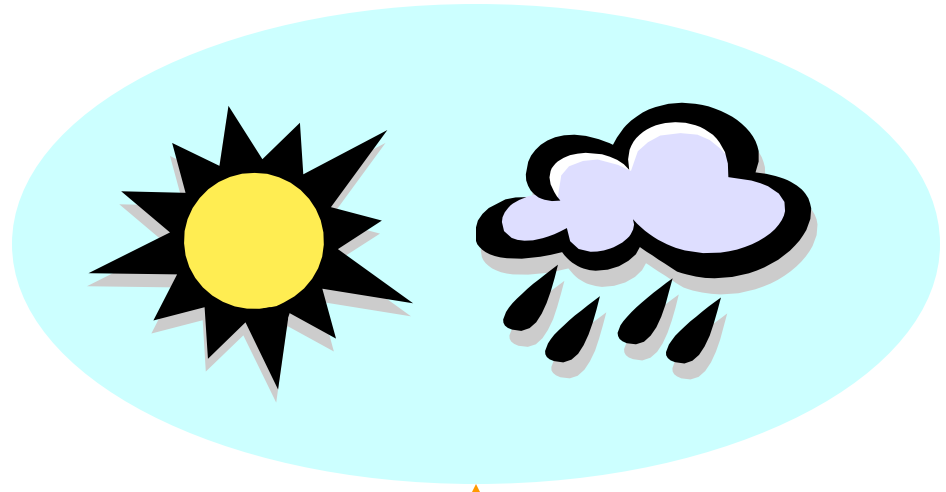
# Wood in service



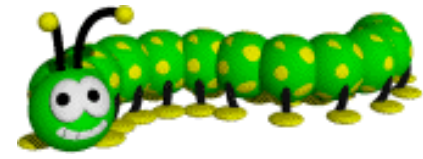
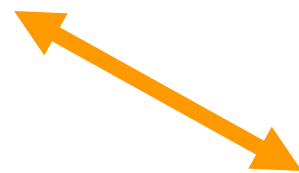
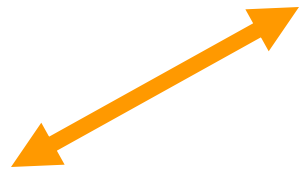
- ★ Temperature
- ★ Humidity
- ★ Light



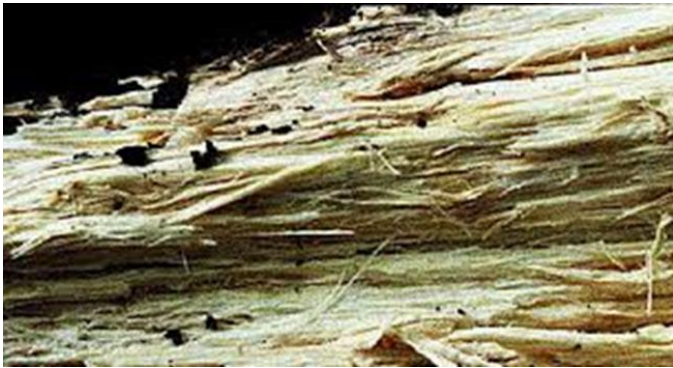
# Use class



Wood in service



# Degradations





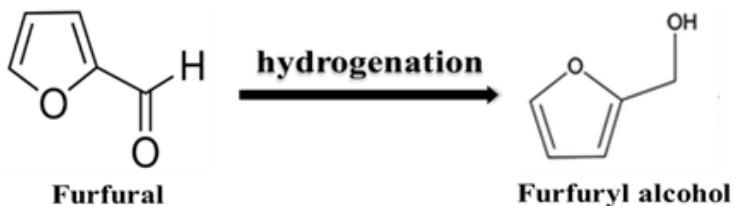
# Wood Treatment

Wood Protection sector under scrutiny in EU

Wood chemical modification is an alternative

Iran : Large amount of waste sugar cane bagasse

Production of **Furfural** - Furfuryl alcohol



**Wood modification**





# Parameters

Birch logs - Wood samples

Wood treatment

Different sample sizes

Different combinations

No.	Treatment	Code
1	Control	C
2	Furfural 20% + Urea 10% + Maleic Anhydride 10%	F <sub>20</sub> +U <sub>10</sub> /M <sub>10</sub>
3	Furfural 40% + Urea 12% + Maleic Anhydride 12%	F <sub>40</sub> +U <sub>12</sub> /M <sub>12</sub>
4	Furfural 60% + Urea 12% + Maleic Anhydride 12%	F <sub>60</sub> +U <sub>12</sub> /M <sub>12</sub>
5	Furfural 70% + Urea 15% + Maleic Anhydride 15%	F <sub>70</sub> +U <sub>15</sub> /M <sub>15</sub>

Vacuum/pressure

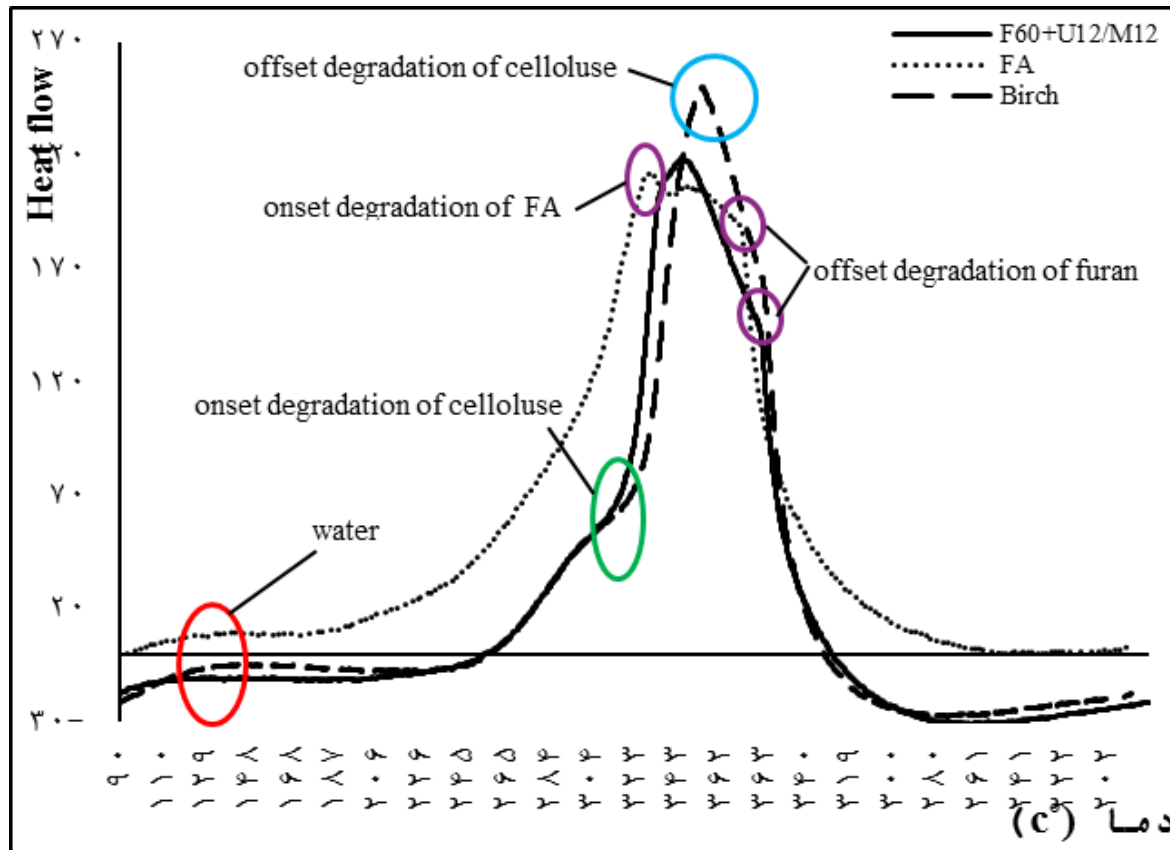
50°C - 12 hrs  70°C - 24 hrs  103°C





# In situ reaction - polymerization

## Differential scanning calorimetry (DSC)





# Treatment and Properties

Anti Swelling Efficiency - 336 hrs in water

Treatment	WPG
C	-----
F20+U10/M10	27.29 ± 3.53
F40+U12/M12	37.35 ± 4.56
F60+U12/M12	43.48 ± 5.81
F70+U15/M15	57.65 ± 8.57

ASE
-----
17.44
17.45
29.69
41.62

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C	-----
F20+U10/M10	27.29 ± 3.53
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F70+U15/M15	57.65 ± 8.57

MOE
15556±1982
18258.3±2215
18018±2223.9
18430±1777.5

Modulus of Elasticity



# Fungal tests EN113

Birch

*Trametes versicolor*

White rot

Treated / Unleached & Leached



Beech control : **Mass Loss > 30%**

Untreated Birch : **Mass Loss > 30%**

Modified Birch : **Mass Loss < 5%**

Any treatment - Unleached & Leached

Controls in the flask : **Mass Loss > 20%**



# Termite tests EN117

Birch / Treated / Unleached & Leached

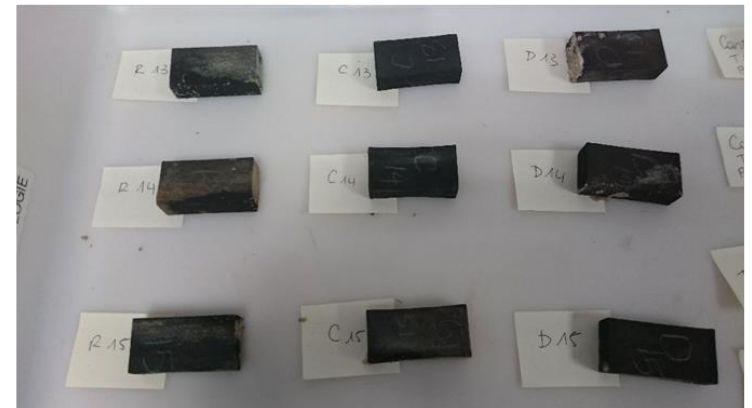
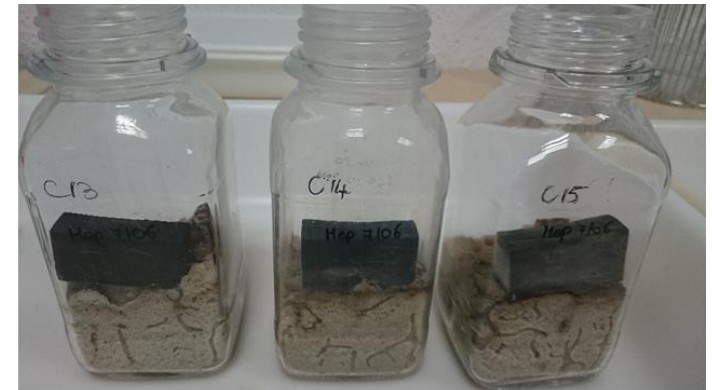
Reticulitermes flavipes

Controls : Rating 4 - Degradation +++

Treated : Any treatment

All termites dead after 8 weeks

Rating 1 max (nibbling)





## Great but....

Birch easily treated / Effective wood modification

Different sample sizes / Different combinations

Improved dimensional stability and biological resistance

But...

**Better like dark wood !**

**Cracks and collapse**

Outdoor weathering in progress



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Henri Curien Partnership  
France / Iran  
MEAE - MESRI / CISSC