The Curing Behavior of Urea-Formaldehyde Adhesive in the Presence of Chemicaly Treated Narrow-Leaved Ash (*Fraxinus angustifolia* Vahl. ssp. *Pannonica* Soo & Simon)

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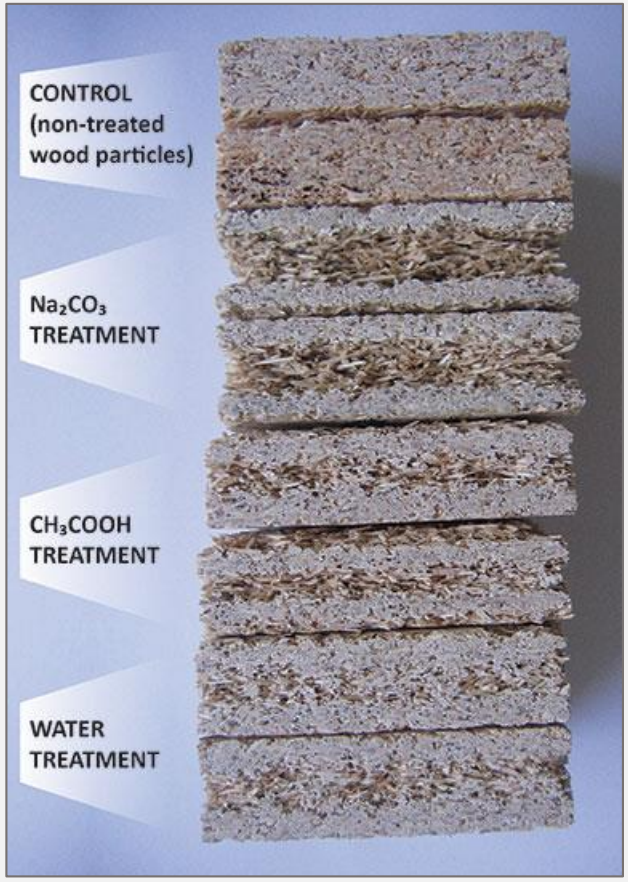
PRE-INTRO

- Previous research has showed that the pre-treatments applied on the wood particles resulted in different physical and mechanical properties of experimental particleboards.
- (Dr Jasmina Popović doctoral dissertation)



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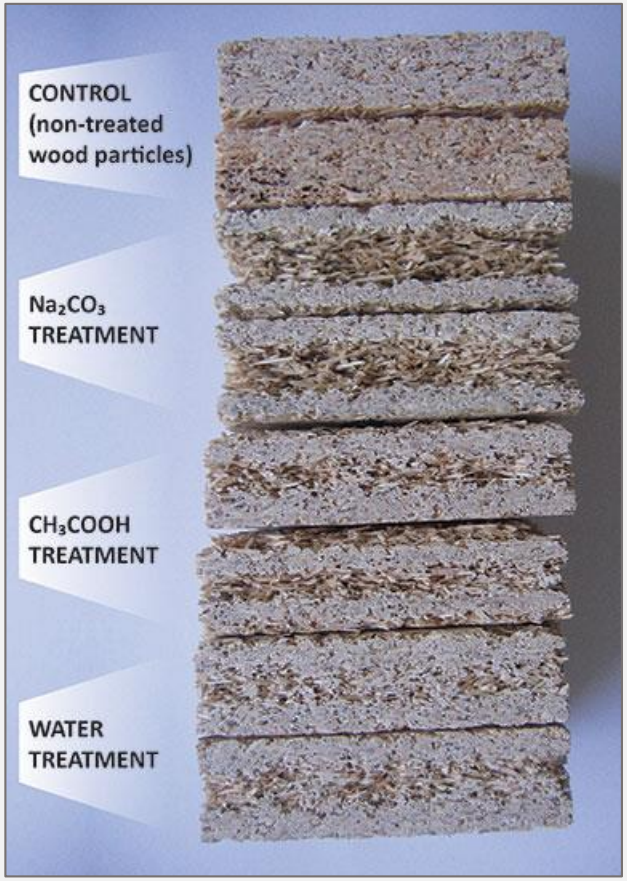
In comparison to control series:

- Bending properties severely decreased
- Internal bond – hardly detectable

- No significant difference for BS and MOE
- Internal bond significantly decreased

- MOE increased
- Internal bond significantly decreased



INTRODUCTION

- The general idea behind this study was to find out how much the pretreatments could affect the cure of the ureaformaldehyde adhesive?

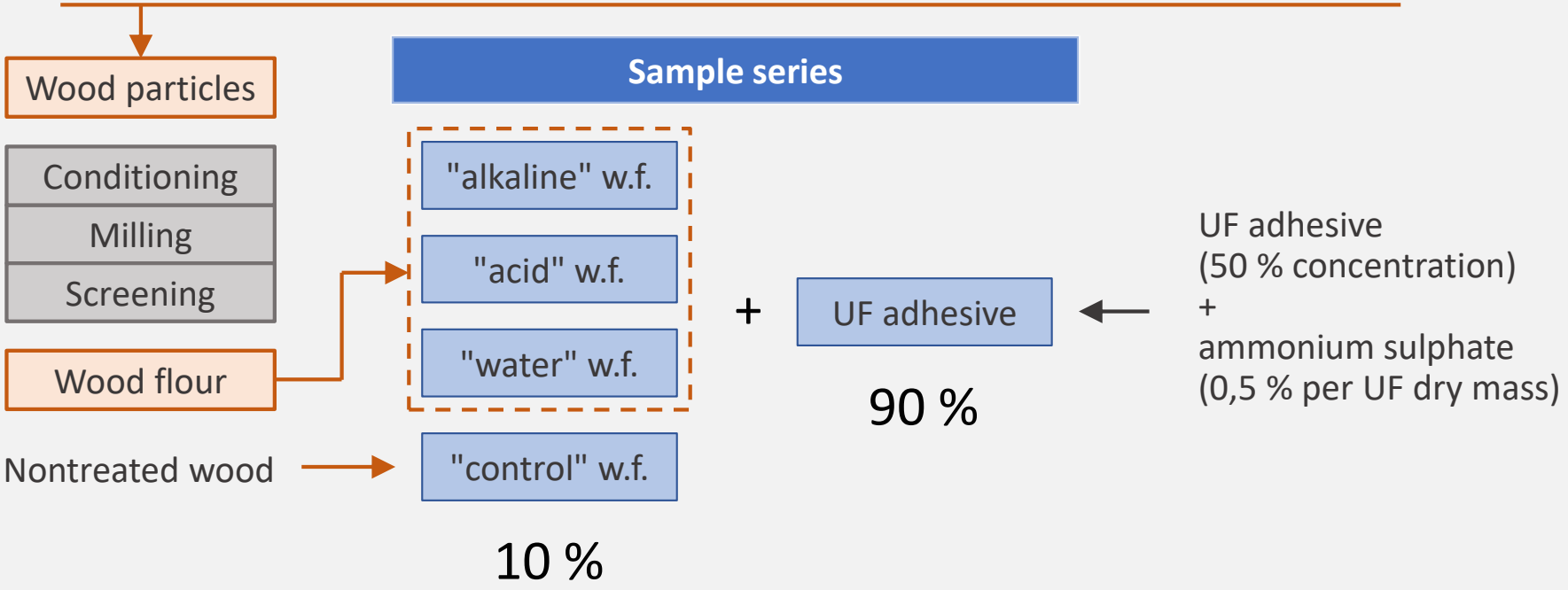
- Hence, the *differential scanning calorimetry* was used to monitor the reaction of UF adhesive mixed with the non-treated and treated wood flour.

MATERIALS

- Narrow leaved ash:
  - *Fraxinus angustifolia* Vahl. ssp. *Pannonica* Soo & Simon
  - origin: Forest administration area "Morovic" (Forest holding Sremska Mitrovica, Serbia)
  - wood particles for the pretreatments (fraction: 0.5 – 1.0 mm)
  - wood flour for DSC measurements (fraction: < 0.5 mm).
- Commercial UF adhesive:
  - dry content = 66.92 % (EN 827);
  - density = 1.27 kg/m^3 (measured with areometer);
  - viscosity = 415 mPa·s (Brookfield - EN 12092) and
  - pH value = 8.05 (EN 1245).
- Ammonium sulphate ($(NH_4)_2SO_4$) was used as a hardener.
- Chemicals for the treatment solutions:
  - Sodium carbonate (anhydrous) (Na_2CO_3) (99.9%) AnalaR NORMAPUR (Belgium)
  - Acetic acid (glacial) (CH_3COOH) (99.5%) Zorka Pharma - Hemija d.o.o. (Serbia)

TREATMENTS AND SAMPLE SERIES

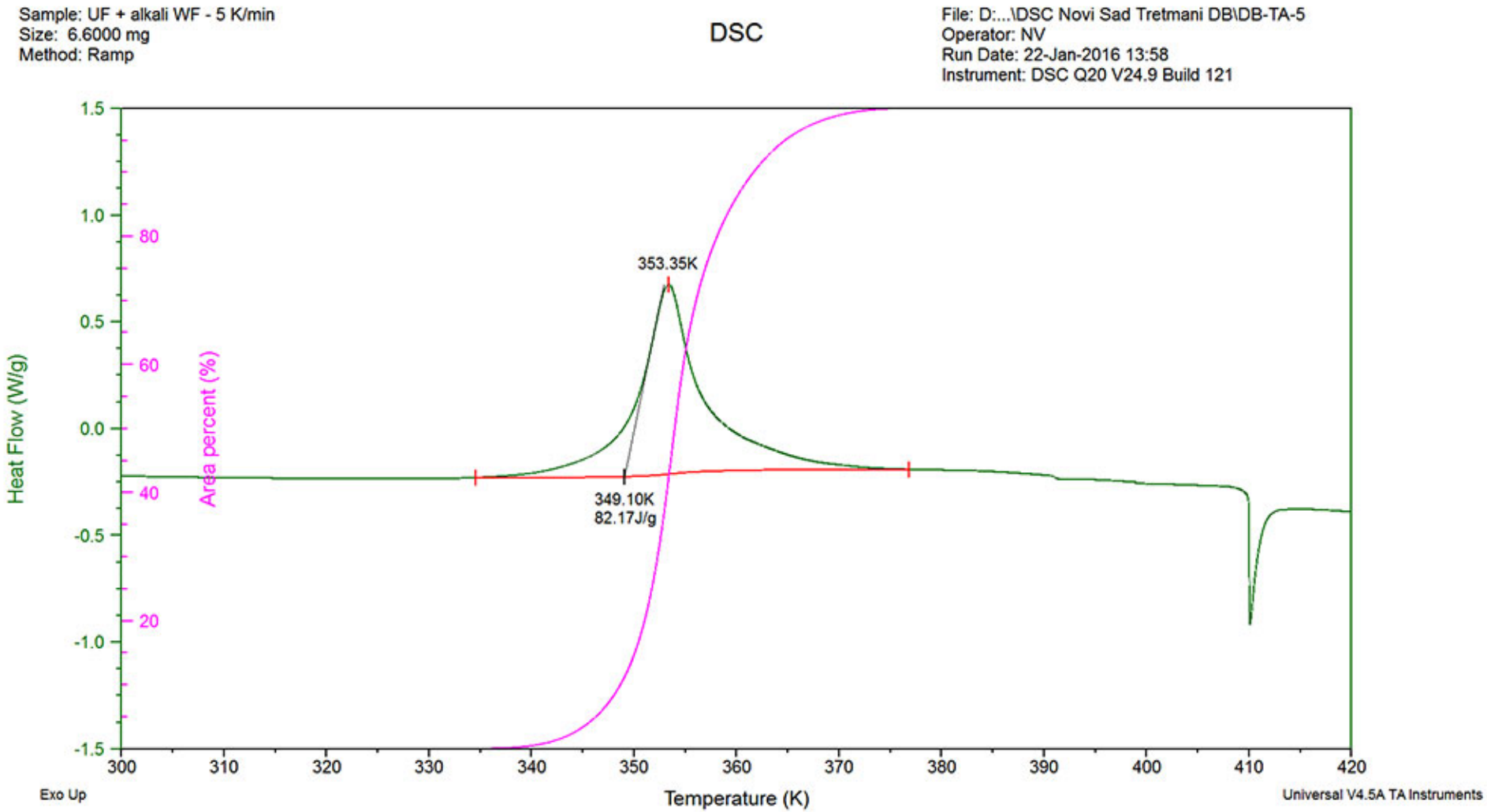
Treatments →	Alkaline	Acid	Water
Chemicals	Sodium carbonate	Acetic acid	/
The addition of chemicals (by weight per dry weight of particles)	0.03 g/g	0.06 g/g	/
Time	60 min		
Temperature	100 °C		
Dry wood / reactant sol.	1 : 5		



DSC MEASUREMENTS

- non-isothermal regime,
- 3 different constant heating rates: 5, 10 and 20 °C/min
- temperature range: 30 °C to 180 °C
- hermetically sealed aluminum pans (with approximately 5 mg of samples)

DSC MEASUREMENTS



ISOCONVERSION KINETIC MODELS

- KAS: integral method - linear

$$\ln\left(\frac{\beta}{T^2}\right) = \ln\left(\frac{R \cdot A}{E_a \cdot g(\alpha)}\right) - \frac{E}{R \cdot T}$$

$\ln(\beta/T^2)$ vs. $1/T$

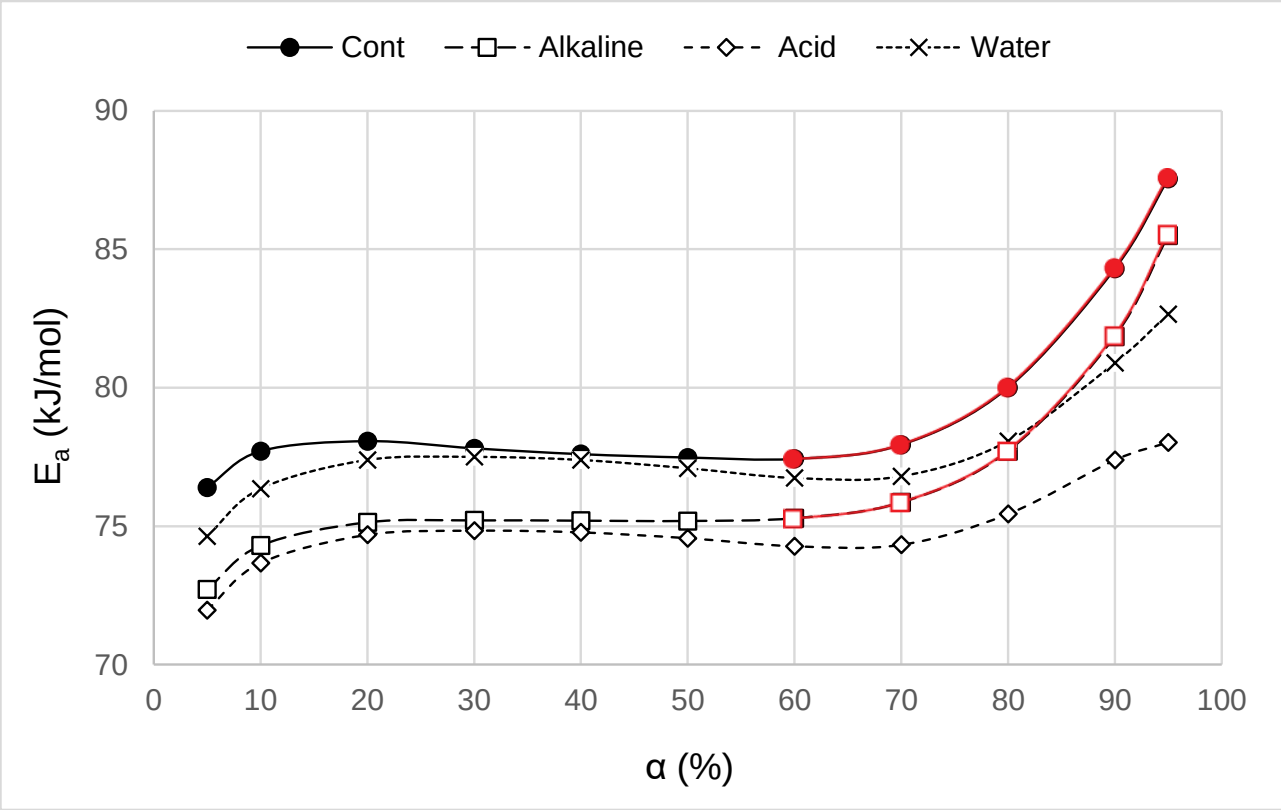
- Friedman: differential method - linear

$$\ln\left(\frac{d\alpha}{dt_\alpha}\right) = \ln\left[A_\alpha \cdot f(\alpha)\right] - \frac{E_\alpha}{R \cdot T_\alpha}$$

$\ln(\beta \cdot d\alpha/dt)$ vs. $1/T$

ISOCONVERSIONAL MODELS

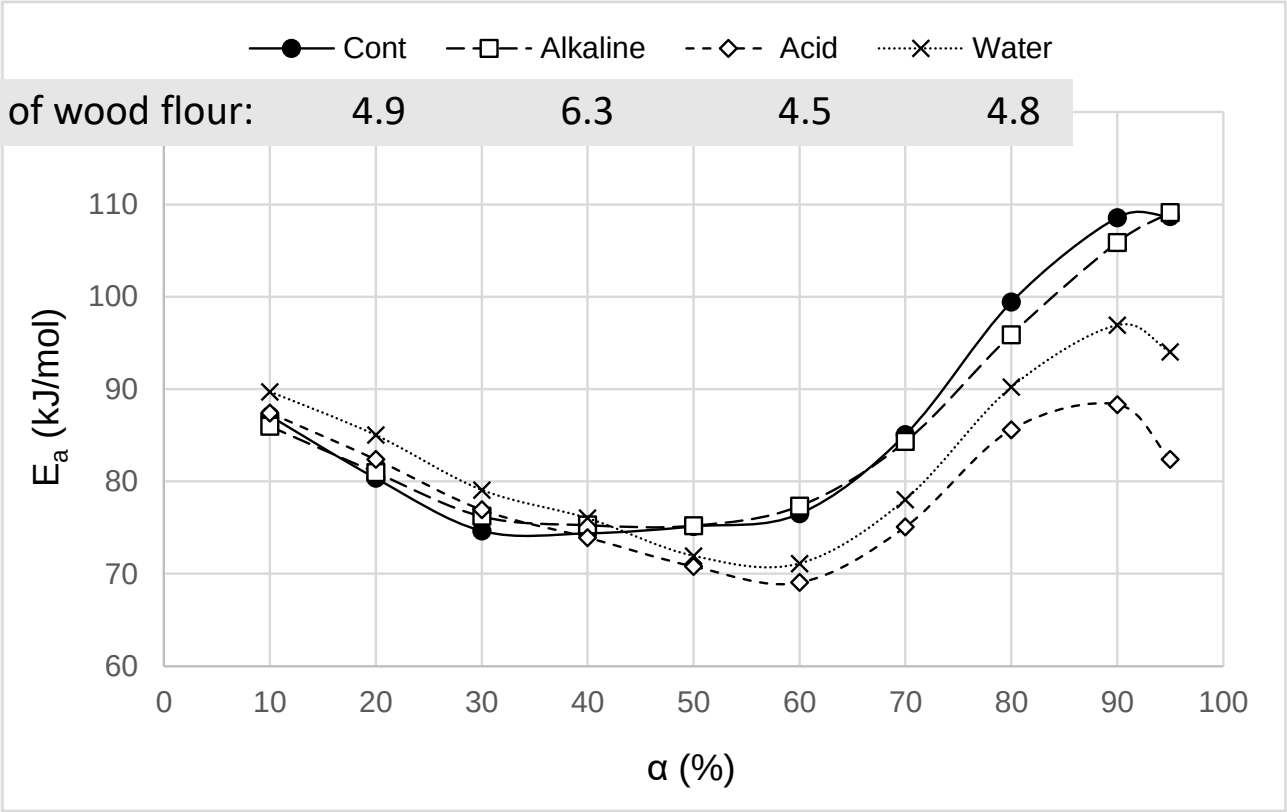
- The application of Kissinger-Akahira-Sunose model



Activation energy in regard to conversion degree

ISOCONVERSIONAL MODELS

- The application of Friedman model

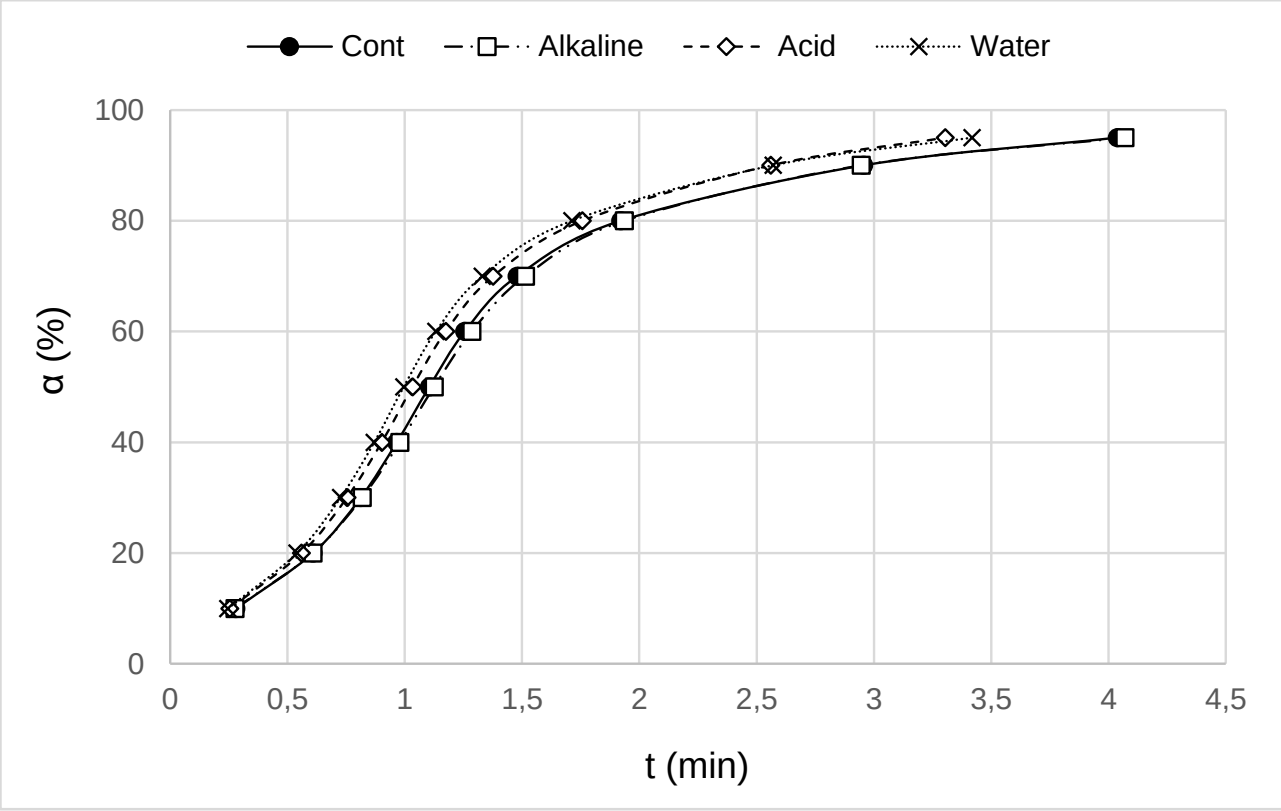


Activation energy in regard to conversion degree

TIME PREDICTION

$$t_\alpha = \int_0^\alpha \frac{e^{\frac{E(\alpha)}{R \cdot T_{iso}}}}{e^{A'(\alpha)}} d\alpha$$

- Transformation of non-isothermal data into isothermal conversion vs. time chart
- Temperature 80 °C



CONCLUSIONS

- DSC experiments were able to detect the effects of pretreatments even for the small load of wood flour per dry adhesive mass (of 10 %).
  - However, a suitable method for producing a homogen mixture with higher load of wood flour should be devised.
- The influence of the wood flour pH on the UF adhesive cure may only hold for the treated series.
  - However, with superior mechanical properties found earlier on control particleboard samples, we may assume that the altered sorptive characteristics at the particle surface, in contact with adhesive, have played more important role in the adhesion, rather than their chemical alteration, also depicted in this experiment.

THANK YOU

COST FP1303