ADHESIVE BASED ON SUGAR FOR WOOD PARTICLEBOARDS

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INTRODUCTION:

Environmentally friendly adhesives are poor used in sector such as sustainable packaging, **furniture**, and general **woodworking;** the main adhesives come from fossil-based resources. The demand for environmentally friendly adhesives has focused on reducing overall solvent content and improving cross-linking in the process and lowering solvent emissions.

Sucrose adhesives are obtained from **renewable resources** and their properties are **promising** but they poses other **challenges** such as improved the **water resistance**, the **cost** or **stability** of adhesive. In this sense, further research is needed to improve the properties of sucrose-based adhesives. The purpose of this study is **to analyze the different experimental variables that could influence the adhesion properties of sucrose-based adhesives for wood applications**.

Materials

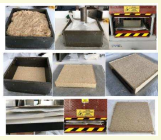
- **Sucrose (S)** (99,5% of purity, labkem) and **Citric acid anhydrous (CA)** (99,8%, labkem) were used to synthesize adhesives for using them as binder in wood panels.
- **Fir fibers** (size particle 1,25-3 mm, 4,2% of moinsture content) were used to obtain small scale samples of wood panels.

Experimental Procedure

▪ **Synthesis and characterization of adhesives**

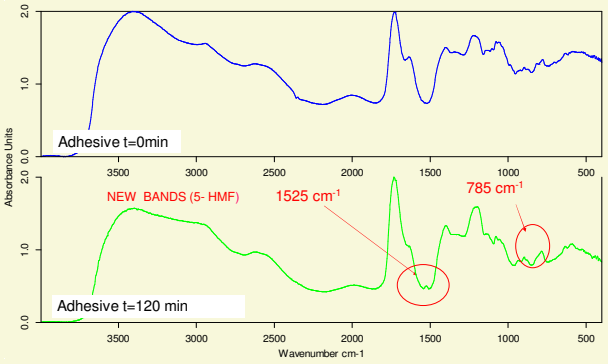
The synthesis was carried out at 100ºC in a round three neck flask with magnetic stirring and air atmosphere. The influence of different experimental variables, such as solid content, magnetic stirring speed, reaction time and CA/S mass ratio, on the final properties of small scale simples of wood panels was analysed **Solid content** (UNE EN ISO 3251) and **Brookfield viscosity (**RVDV-I Prime, SC4-21, 30ºC), of the adhesives were determined. Besides, **ATR-IR Spectroscopy** (Tensor 27, Bruker, single diamond) was used to analyse chemical composition and **Thermo gravimetrical analysis** (TGA Q500, TA Instruments, air atmosphere) to analyse thermal decomposition profile of each adhesive.

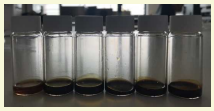
• **Preparation of samples of wood panels**



Cold pressing 6 min, 80 bar, subsequently hot pressing at 200ºC, 10 min and 80 bar Physical and mechanical properties of wood panel samples were evaluated following standard test methods for the determination of **density (**UNE EN 323), **swelling in thickness after immersion in water (**UNE EN 317) and **tensile strength perpendicular to the plane of the board (**UNE EN 319).

ADHESIVE RESULTS: Study of adhesive based on high sucrose and citric acid content





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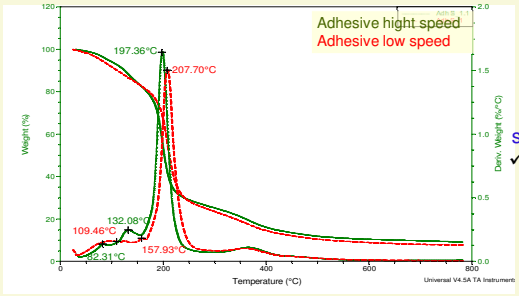


✓ The peak at 132ºC move until 158ºC depending the stirring speed

⇩

Higher stirring speed sooner apear the peak

✓ The predominant decomposition corresponding to citric acid is advanced by 10ºC which later.

✓ New bands are detected at 1525 and 785 cm^{-1} that could correspond due to the formation of 5-HMF

✓ Disappear specific absorption bands of CA and S at 815 cm^{-1} and 1103 cm^{-1}.

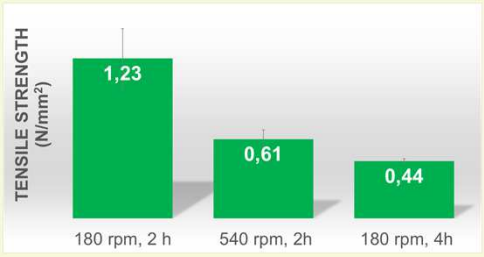
When the boards are made, it is observed that the absence of the peak at 132ºC reflects an improvement in the adhesion of the particle board

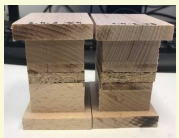
Viscosity values decrease when the solid content decreases in a range from 1623 mPas (adhesive with 83% of solid contents) to 7 mPas (60% of solid contents) at 75/25 (AA/SAC) mass ratio, at 25/75 mass ratio it increases by a 98%

PARTICLE BOARDS RESULTS:

At different stirring speed and time of synthesis

Nomenclature particle board	Density (Kg/m³)	% Apsortion 24h.
180 rpm, 2h	572 ± 5	57 ± 8
540 rpm, 2h	578 ± 8	84 ± 8
180 rpm, 4h	561 ± 4	123 ± 14





At different mass ratio (CA/S) and solid contents

Mass ratio CA/ // % solid content	Density (Kg/m³)	% Absorption 2h.	% Absorption 24h.
75/25, 83%	572 ± 5	51 ± 8	57 ± 8
25/75, 83%	558 ± 6	Break up the sample	Break up the test sample
75/25, 60%	598 ± 6	95 ± 3	104 ± 4
25/75, 60%	603 ± 24	254 ± 43	Break up the sample

FINAL PROPERTIES:

Once the best adhesive has been selected conditions synthesis **(180 r.p.m, 2 hours, 100ºC, 83% solid content and 75/25 mass ratio of AA/SAC)**, a study has been carried out to optimize the amount of adhesives for particle boards from 14% to 30% of adhesive based on solid contents.

Nomenclature of particle boards	% Adhesive	Density (Kg/m³)	% Absorption 24h.
S_14	14	566 ± 6	83 ± 5
S_17	17	572 ± 5	57 ± 8
S_20	20	598 ± 7	58 ± 3
S_25	25	639 ± 7	45 ± 2
S_30	30	642 ± 3	32 ± 1

Increasing the adhesive content in the particle board increases its tensile strength, density and help to decrease the absorption

CONCLUSIONS :

- Positive physical-mechanical property relationship can be established when working at low magnetic stirring speeds.
- The lengthening the reaction time from 2 to 4 hours does not help to improve the results of the mechanical properties.
- The vary of the solid content, there is a considerable difference in the tensile strength values and in the absorption values, this could be due to the fact that applying an adhesive with a higher solid content improves adhesion, There is an improvement in the values by reducing the solids content from 70 to 60% due to the improvement in the impregnation of the fibers, although this improvement is not enough to equal the results obtained with approximately 83% solids.
- An increase in S/CA mass ratio does not improve physical mechanical properties

ACKNOWLEDGMENTS: