Influence of Hemicellulose Extraction on Suitability for Oriented Strand Board (OSB) Production

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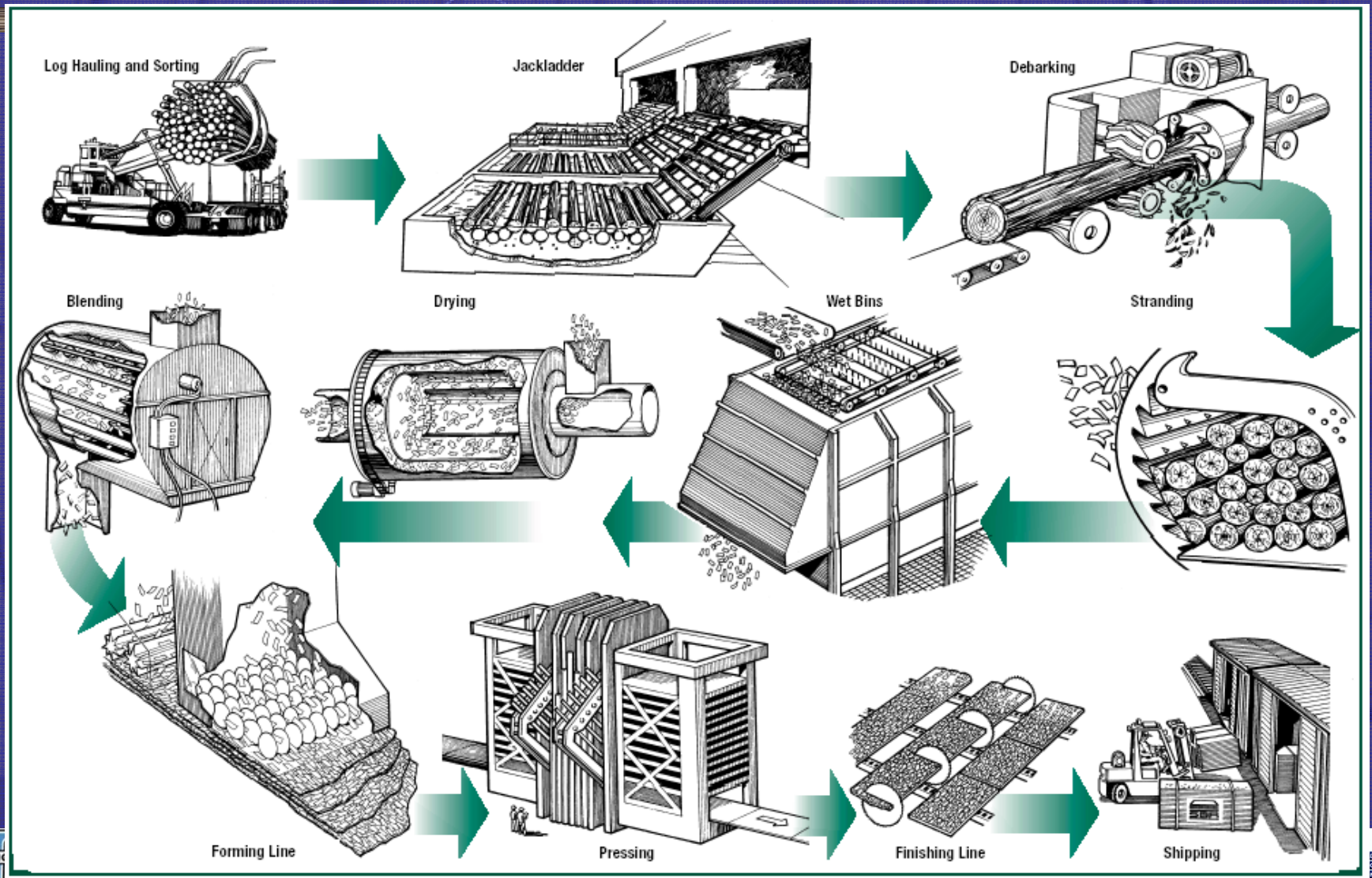
Outline

- Background
- Objectives
- Experimental procedures
- Results and discussions
- Conclusions

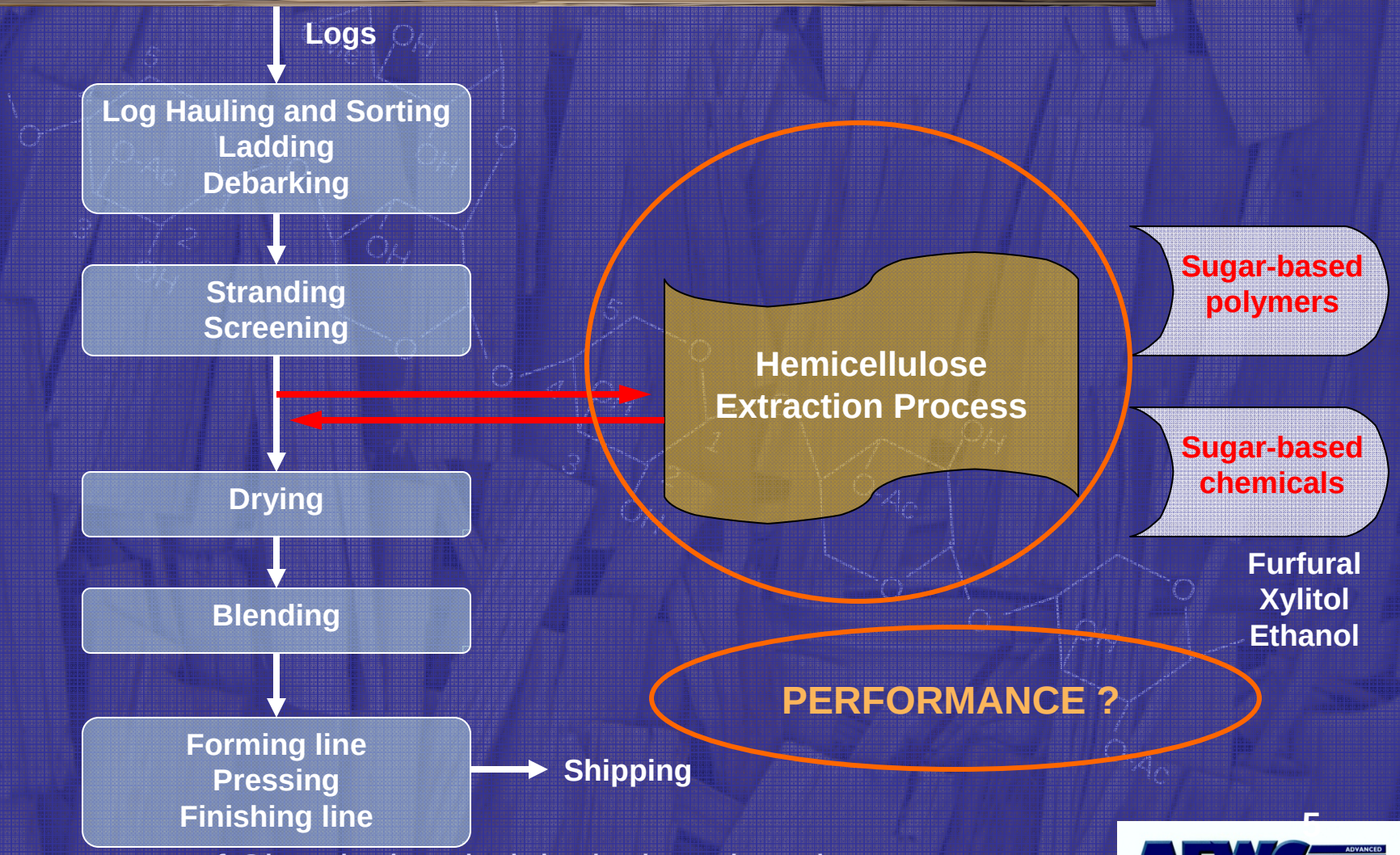
Background

- OSB Process
- Wood components
- Chemical composition and wood strength

OSB Process


Log Hauling and Sorting
Jackladder
Debarking
Blending
Drying
Wet Bins
Stranding
Forming Line
Pressing
Finishing Line
Shipping

Modified OSB Process



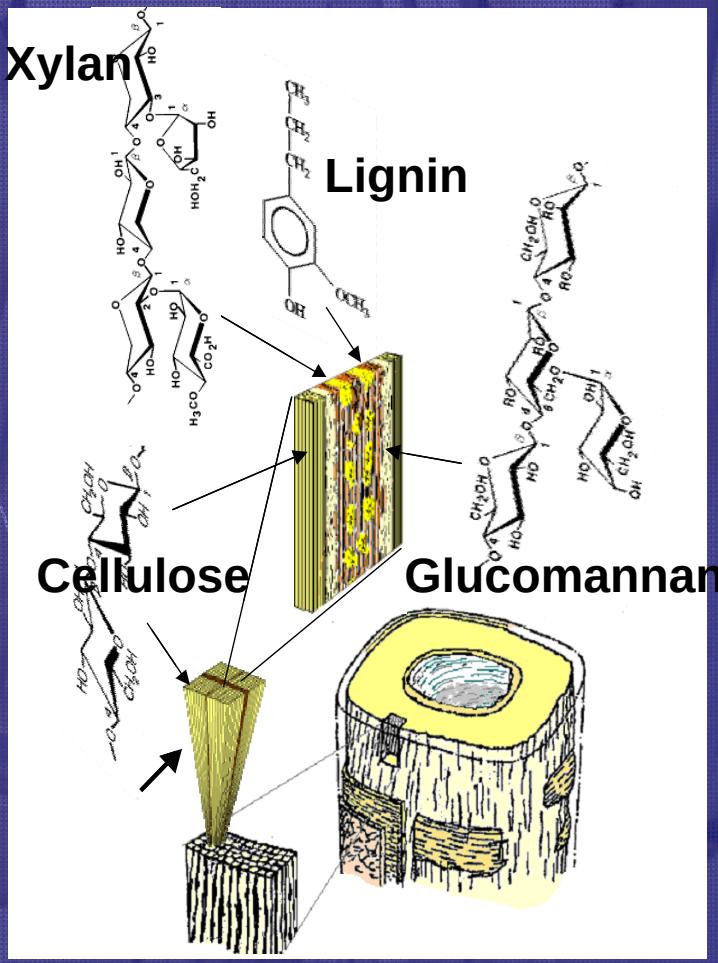
Wood Components

Hardwood (% o. d. wood)	
Cellulose[a]	41.0 – 51.0
Lignin[a]	21.5 – 31.0
Hemicelluloses[a]	20.0 - 34.5
Ash[b]	0.2 - 1.0

Softwood (% o. d. wood)	
Cellulose[a]	33.0 – 42.0
Lignin[a]	27.0 – 32.0
Hemicelluloses[a]	26.0 – 33.0
Ash[b]	0.1 – 0.5

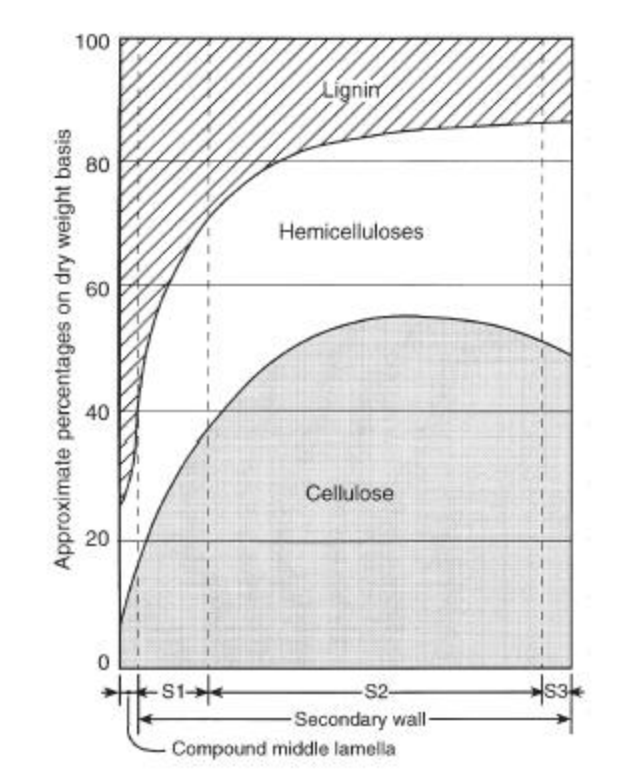
[a] Sjostron, E., 1993

[b] Rowell, R., 2005

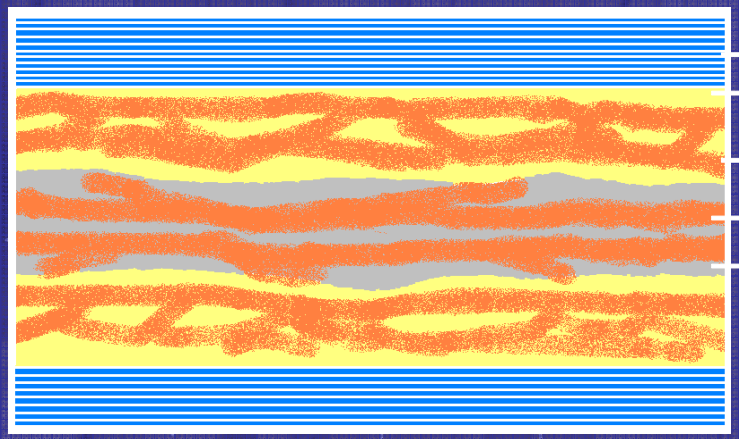


(M. Åkerholm and L. Salmén, STFI 2004)

Wood Components



(*Sweet et al. Holzforschung 53 (1999) 311-317*)



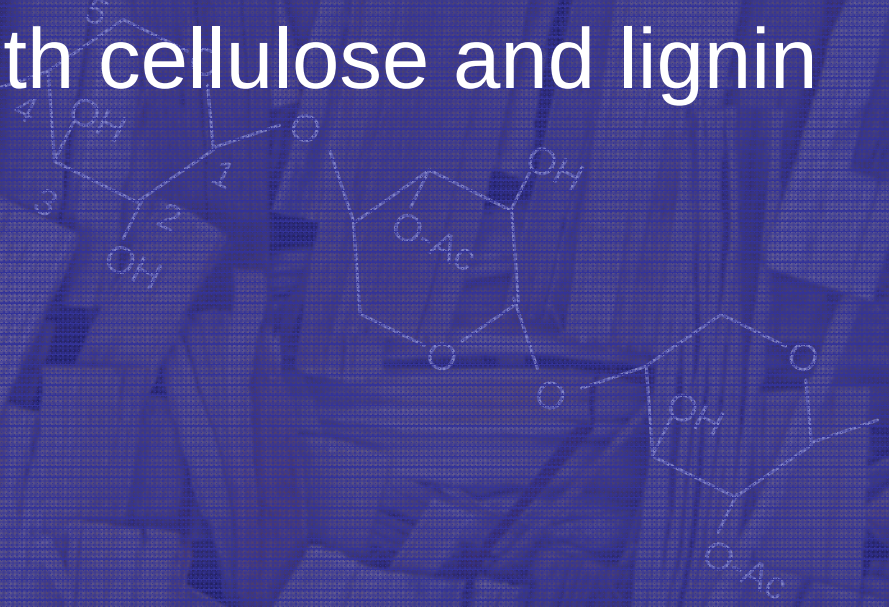
(*Lawoko et al. Biomacromolecules 6(6) 3467-3473, 2005*)

Chemical composition and wood strength

- **Molecular level depends on individual components of the cell wall**
- **Cellulose greatest polymeric chain and higher DP**
- **Lignin is a nature's adhesive. Hydrophobic polymer.**
- **Cellulose and lignin are the main structural wood components. Hydrogen bonds are important for providing rigidity.**
- **Hemicelluloses are a series of carbohydrate molecules with lower DP than cellulose. They exhibit hydrogen bonding.**
- **Early degradation of hemicelluloses affect the wood strength (Curling at al., Forest Products Journal, Vol. 52, No 78, 2002)**

Issues to be considered

- Mechanical properties of OSB must be maintained after hemicellulose extraction
- The extraction process must minimize degradation of both cellulose and lignin



Objective

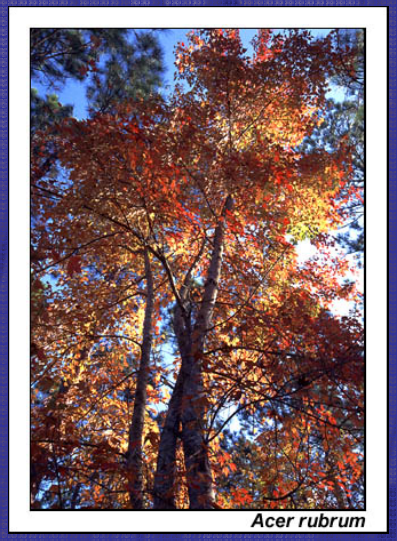
- Determine how specific variables in the OSB strand extraction process (namely, pH, temperature, time and strand thickness) affect hemicellulose yields and characteristics of cellulose and lignin in the wood

Experimental

Procedure

Wood material preparation

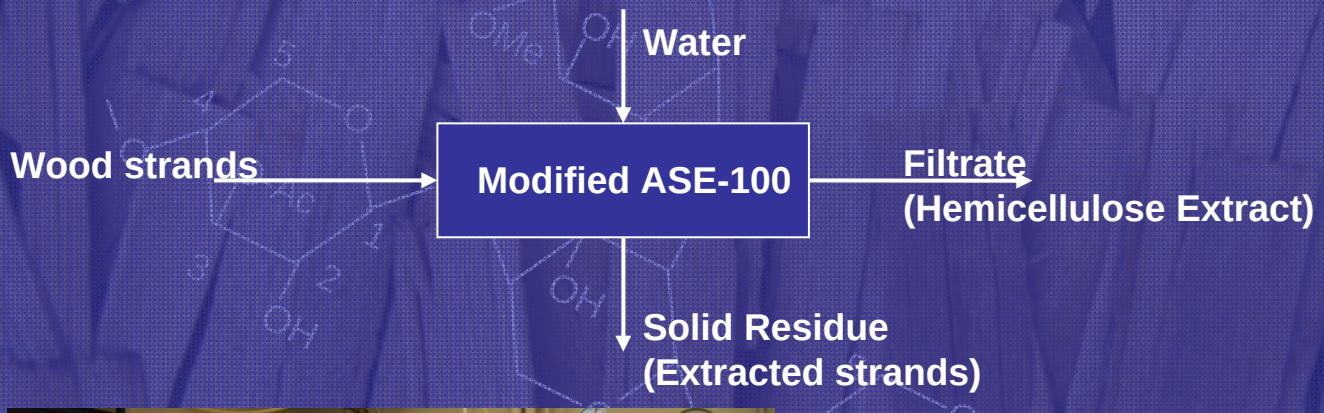
- Red Maple tree (hardwood)
- Stranding process at AEWC Center
- Wood material air-dried



Acer rubrum

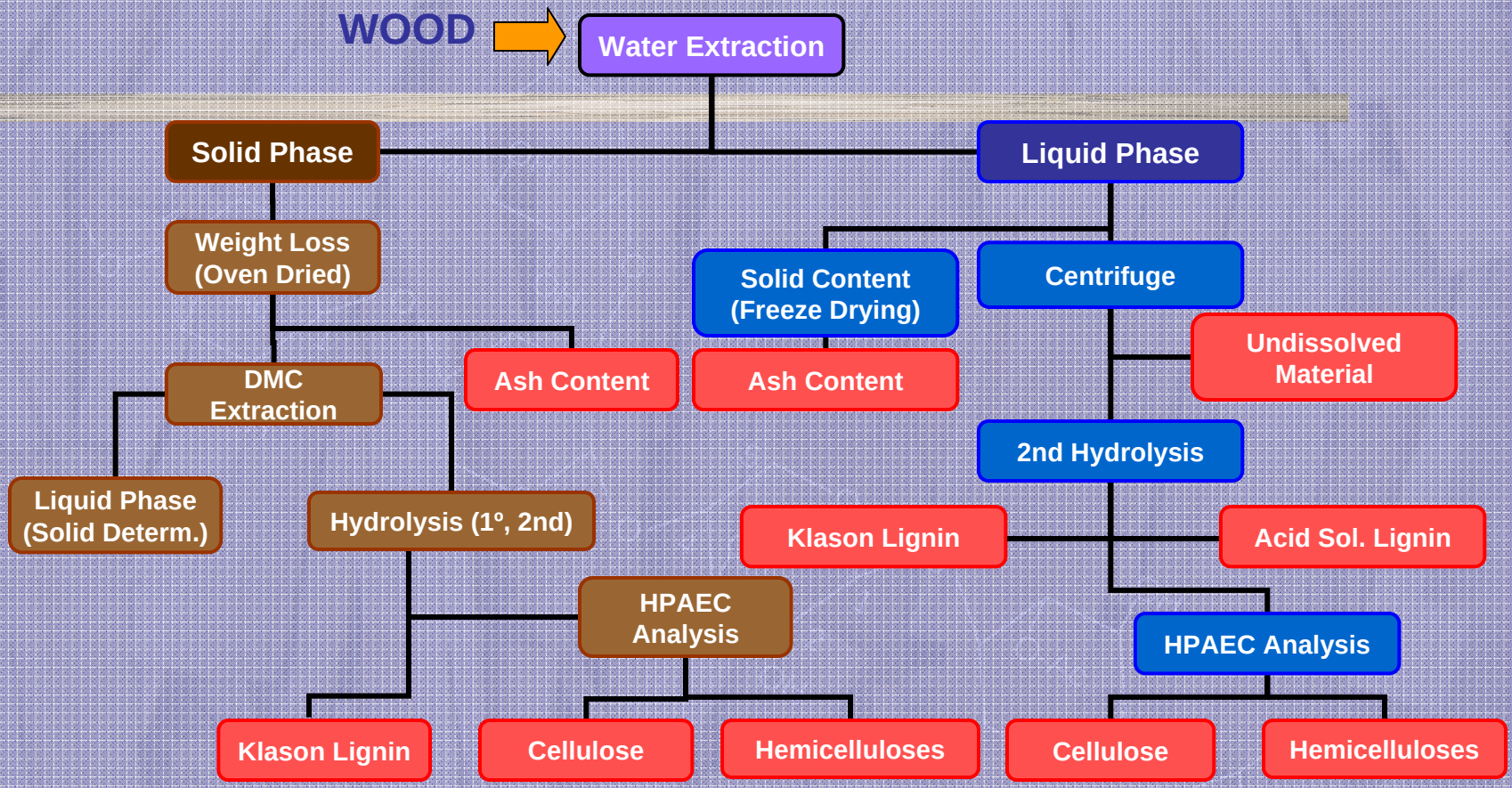
Experimental Procedures

Lab Extraction



Temperature: 140 – 170ºC

Time: 15 – 90 min



Chemical analysis procedure

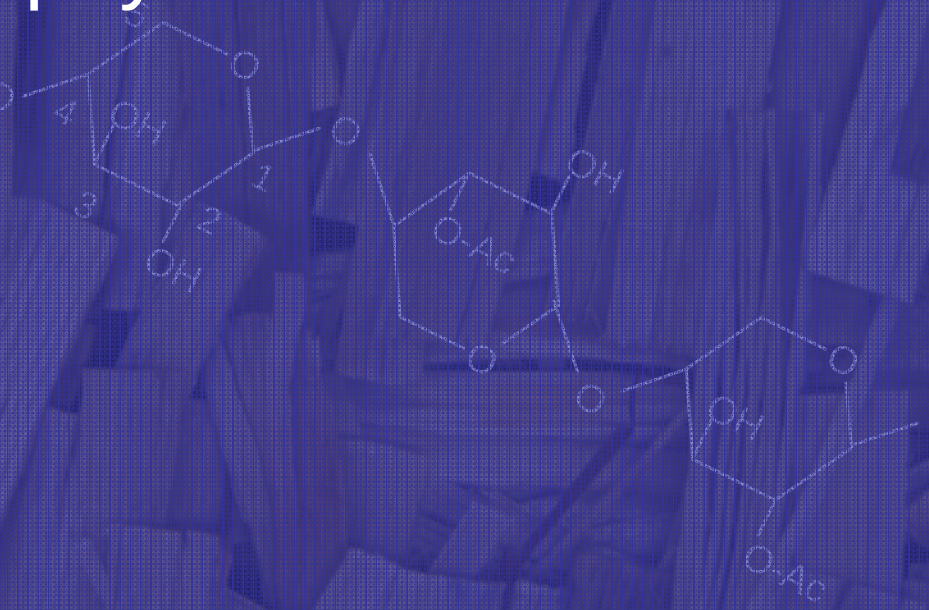
Yield Determination

$$\text{Yield}^{sp}\ (\%) = \frac{\text{solid residue (o.d.) after extraction}}{\text{wood (o.d.) before extraction}} * 100$$

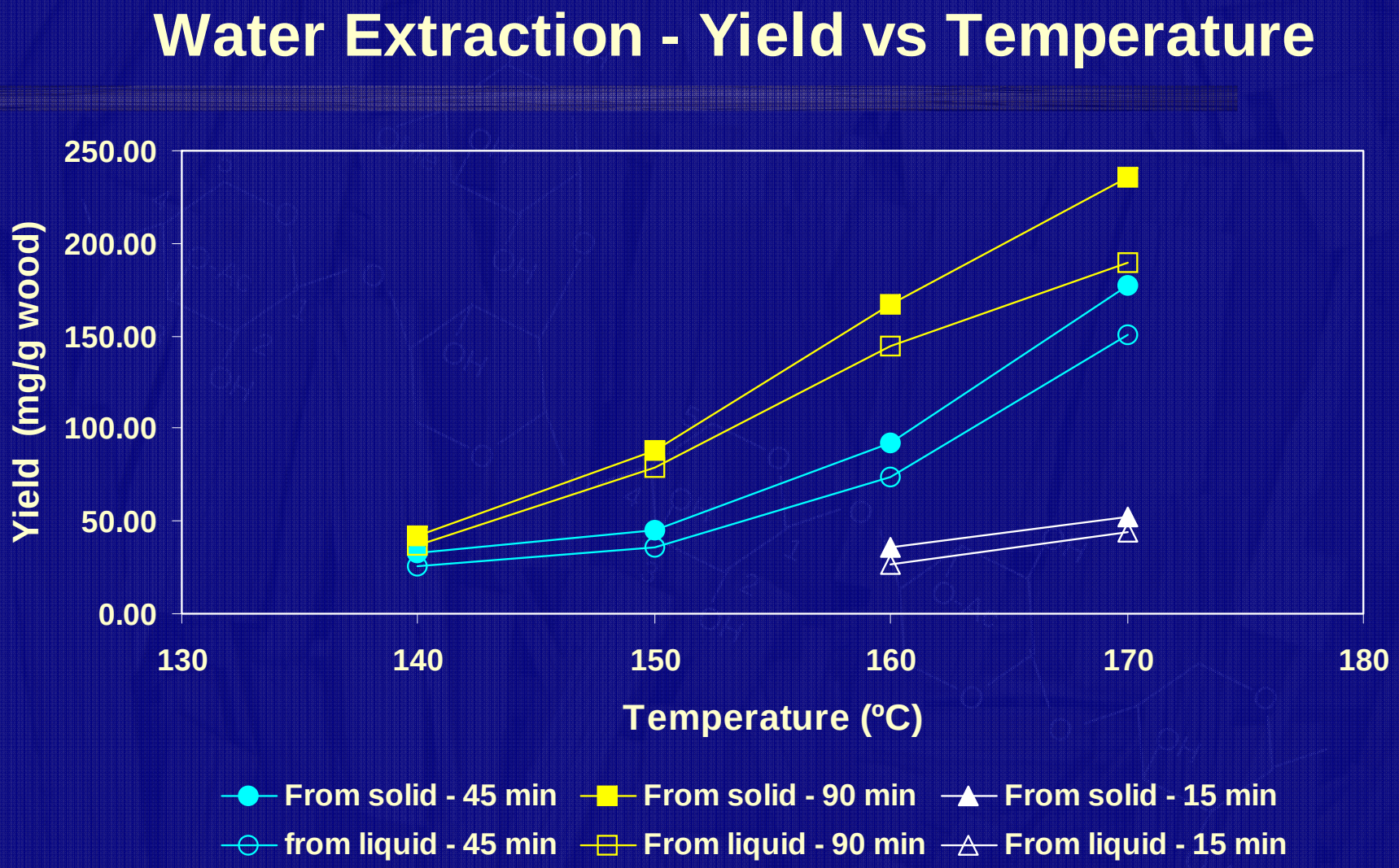
$$\text{Yield}^{lp}\ (\%) = \frac{\text{S.C.}_{fd} * \text{Total weight extract}}{\text{wood (o.d.) before extraction}} * 100$$

Results

- Water extraction yield
- Mass Balance
- OSB panels and physical/mechanical properties



Results: Water extraction yield



Severity Factor (Ro)

- **Proposed for Overend and Chornet, 1987)**

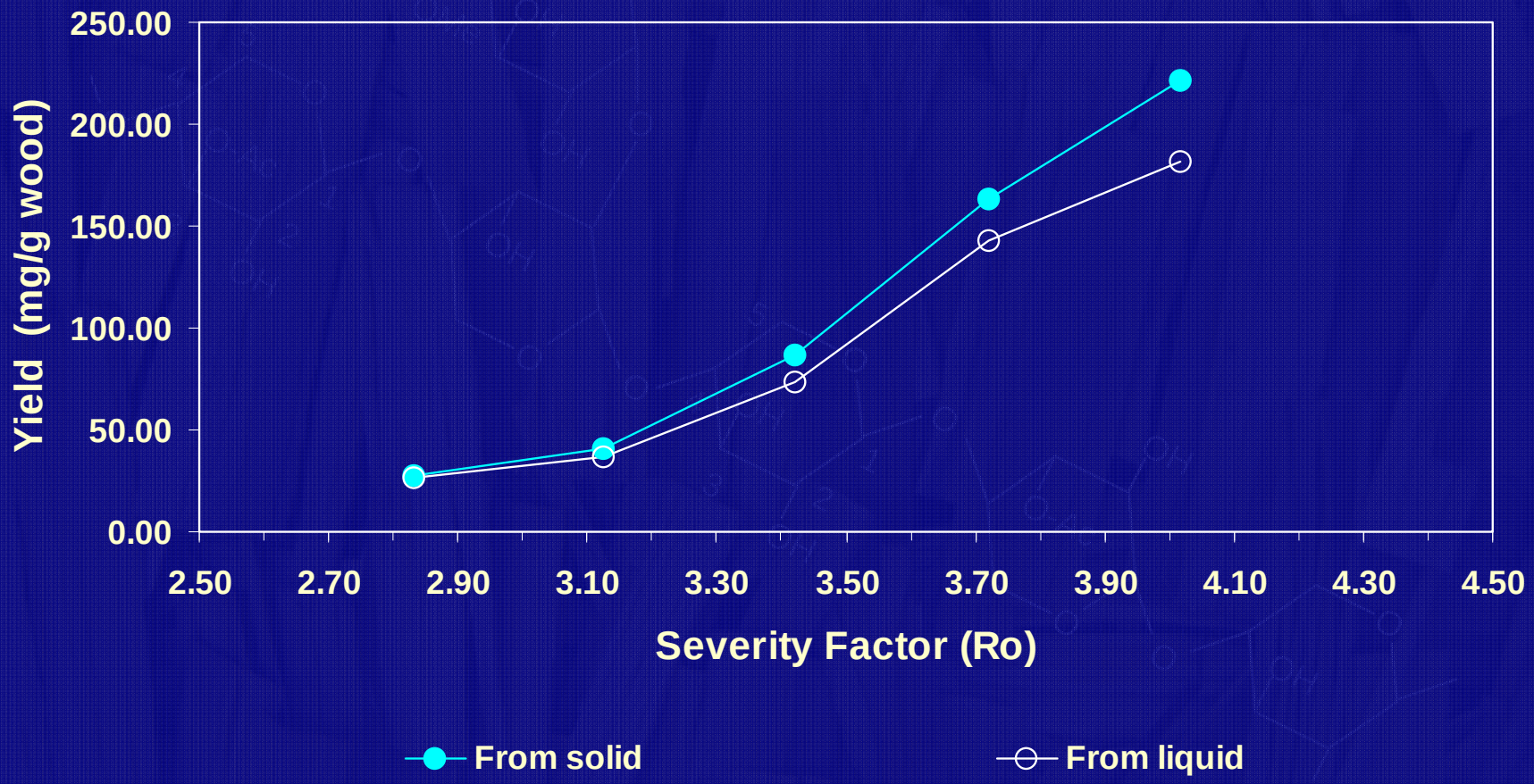
$$R_O = t \cdot \exp\left(\frac{T[^oC] - 100}{14.75}\right)$$

Where,

t: Time (minutes)

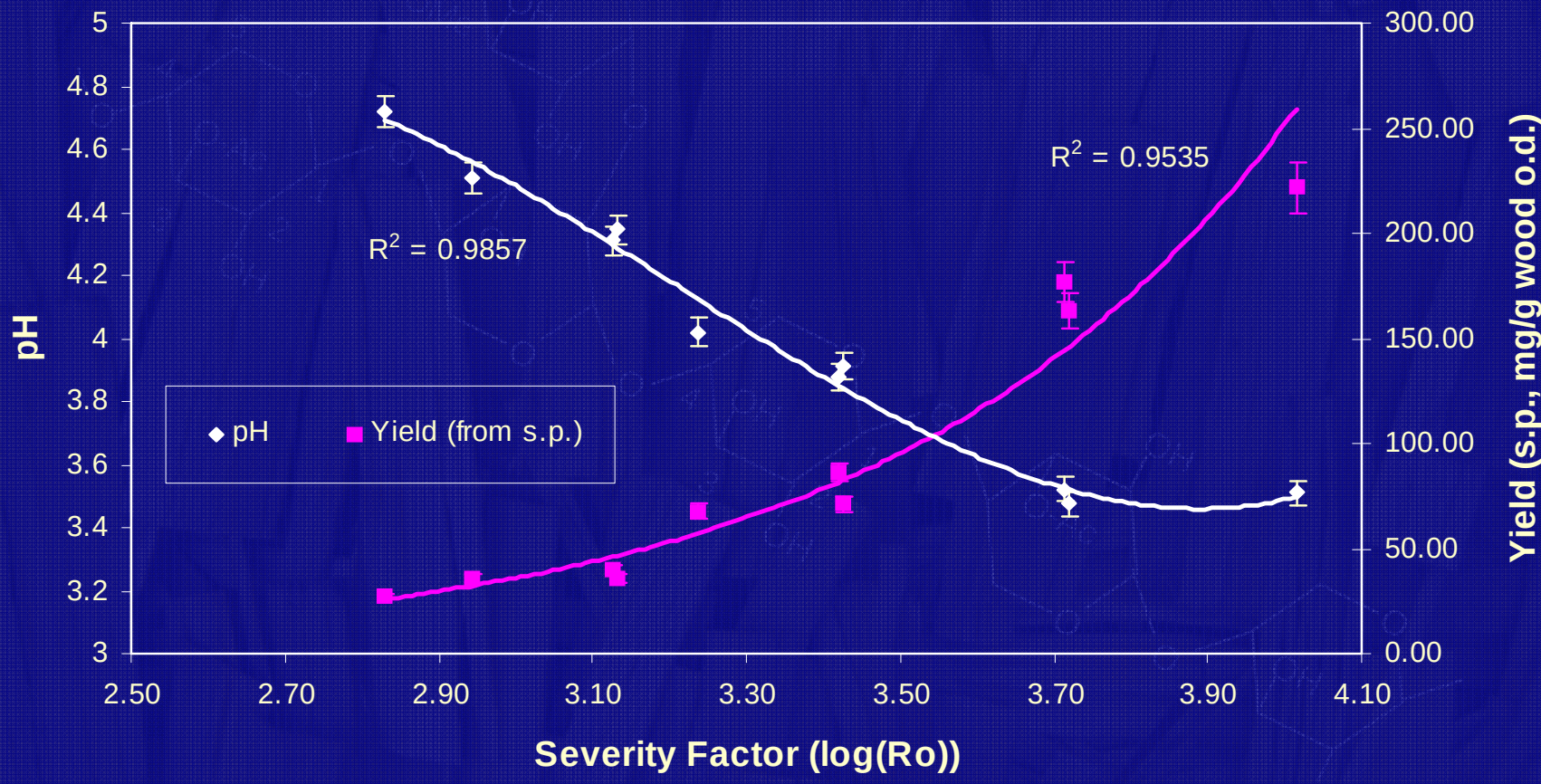
T: Temperature (ºC)

Results: Water extraction yield

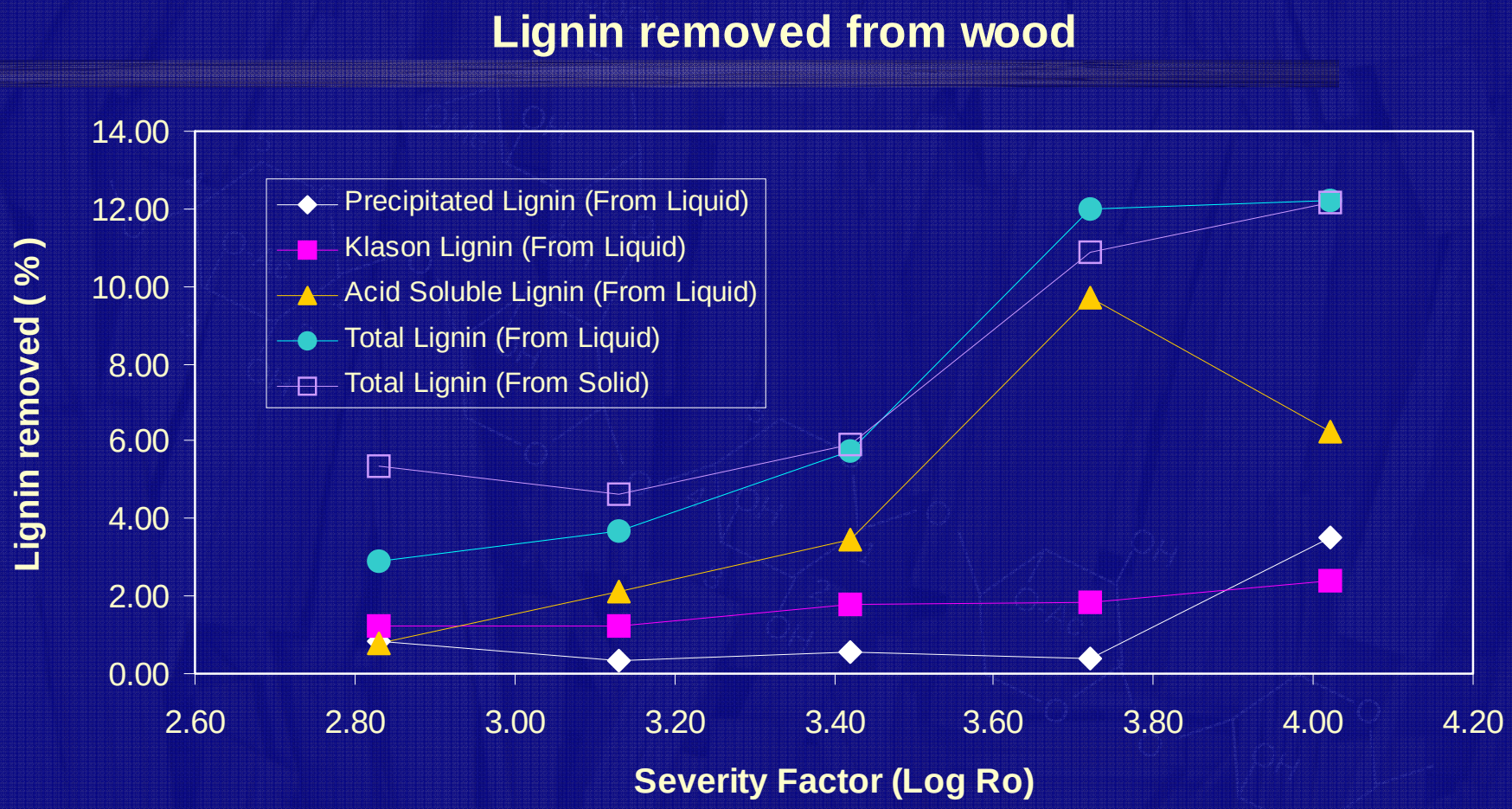


Results: Water extraction yield

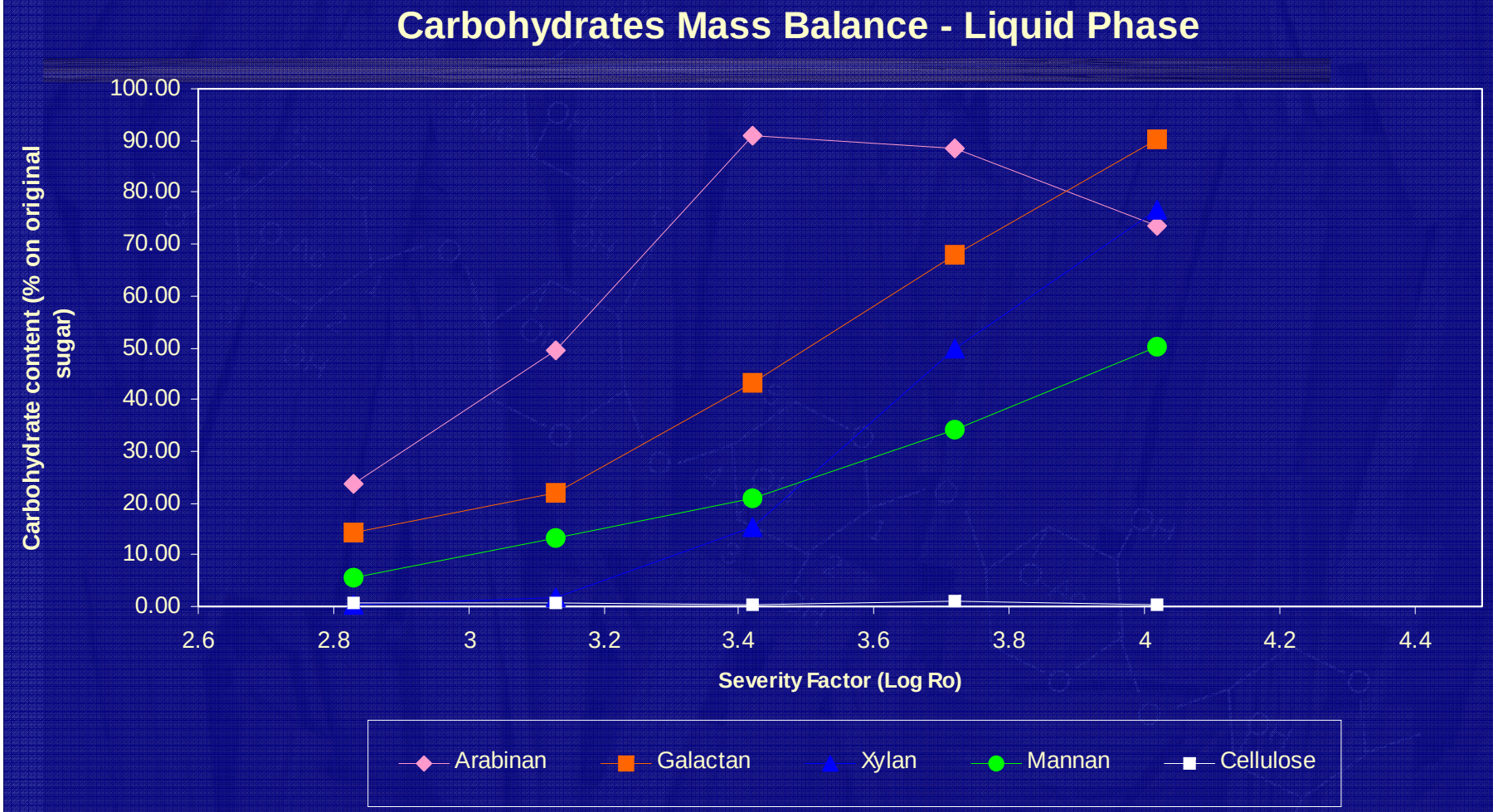
Severity Effect on pH Extraction



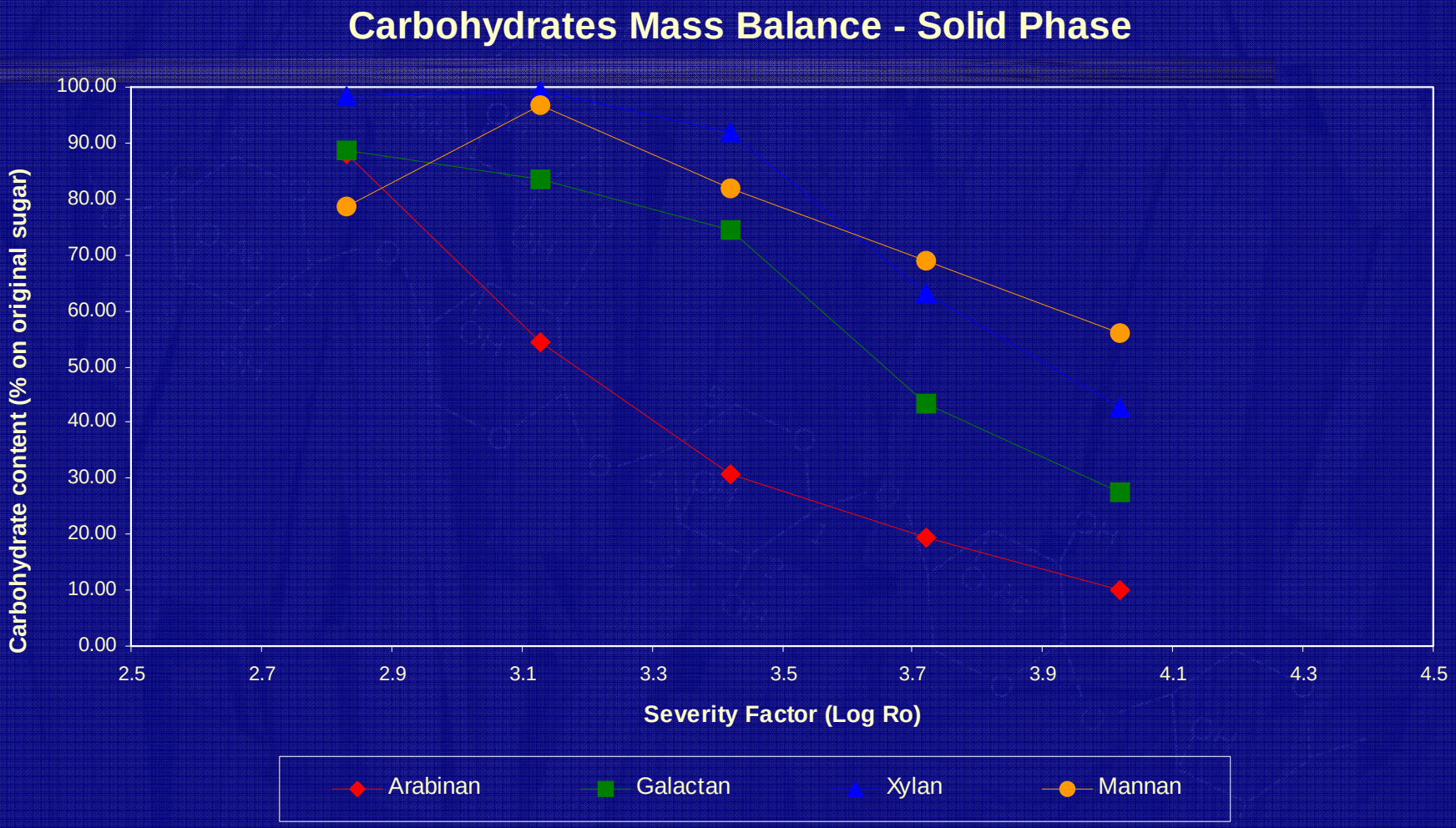
Results: Mass balance



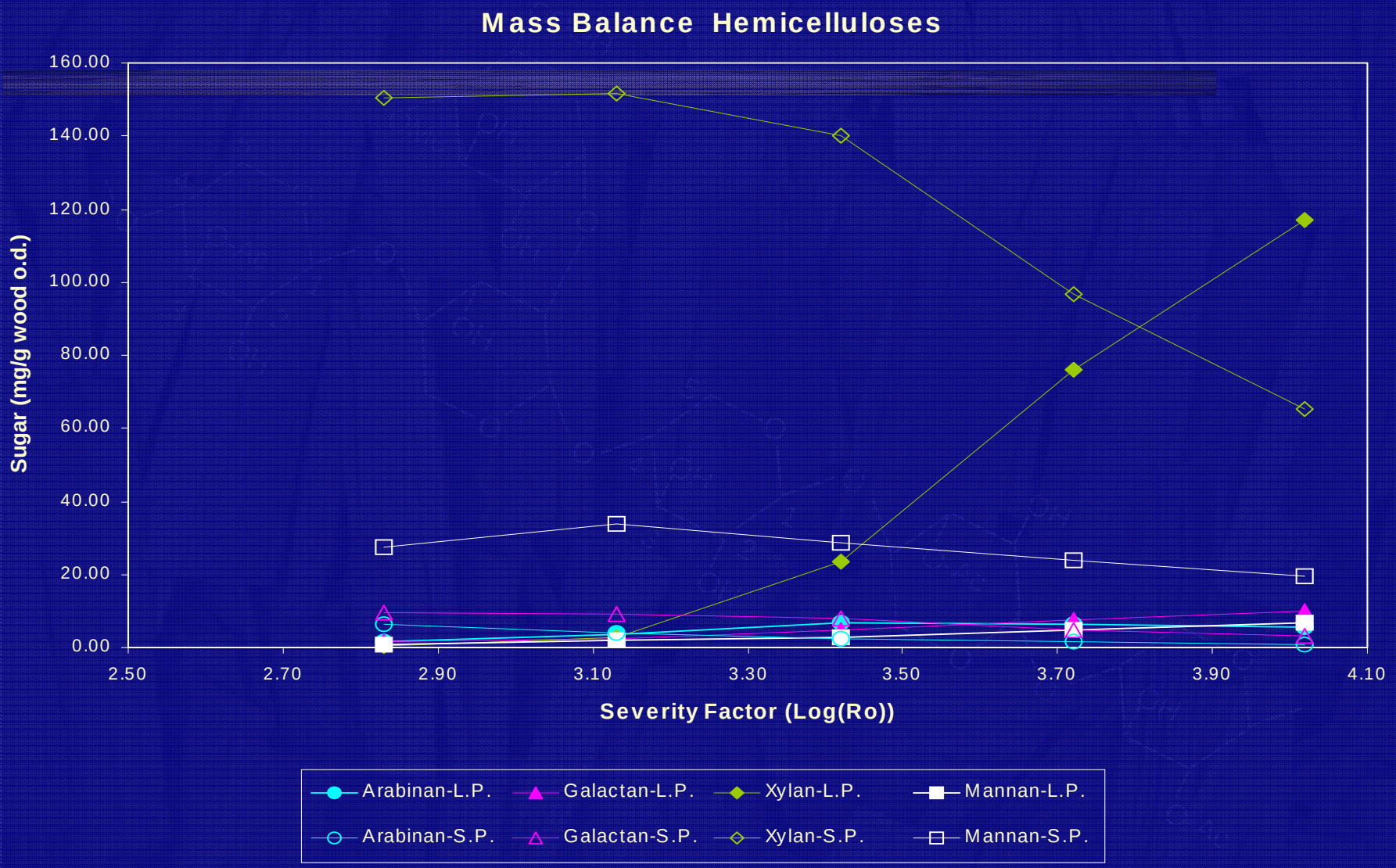
Results: Mass balance



Results: Mass balance

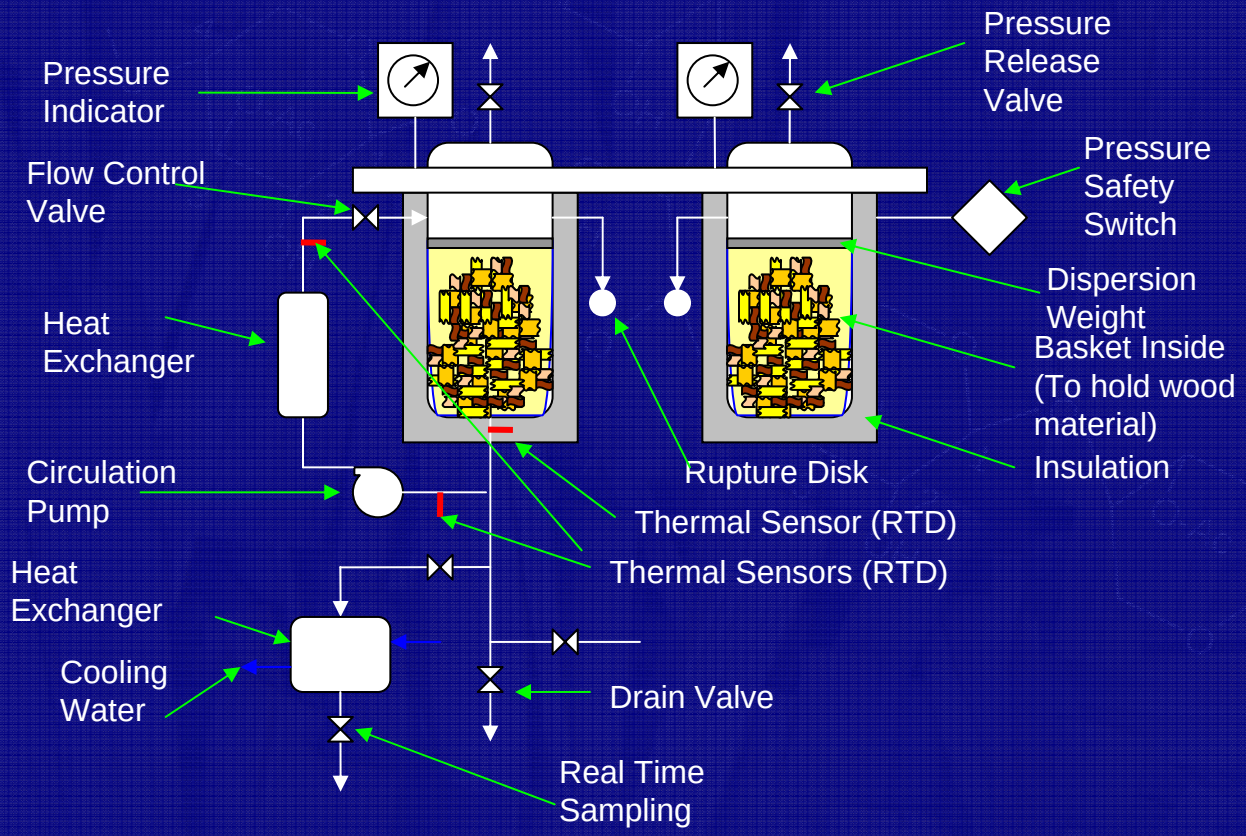


Results: Mass balance



Results: OSB Panels

Manufacture of OSB Panels



Conditions:

Temperature: 160ºC

Time: 45 – 90 min

Batch: 500 grs.

(Preheating: 50 min)

L / S: 6

Water extraction

Pilot scale

Manufacture of OSB Panels

Panel manufacturing was done at AEWC Center following internal procedures:

Weight: 1.28 kg

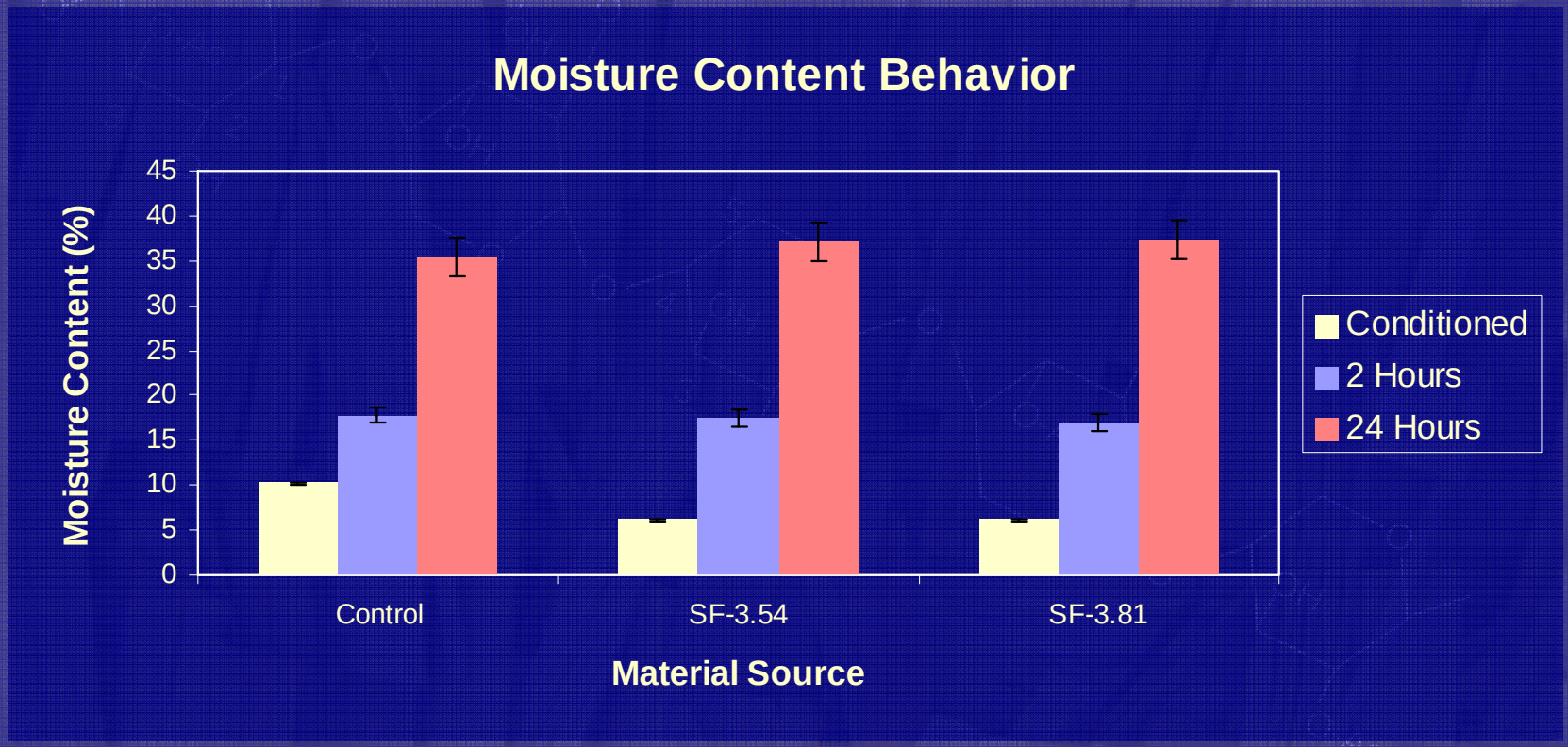
Adhesive: pDMI, 4% o.d.w.

Density: 38pcf, at 0% MC

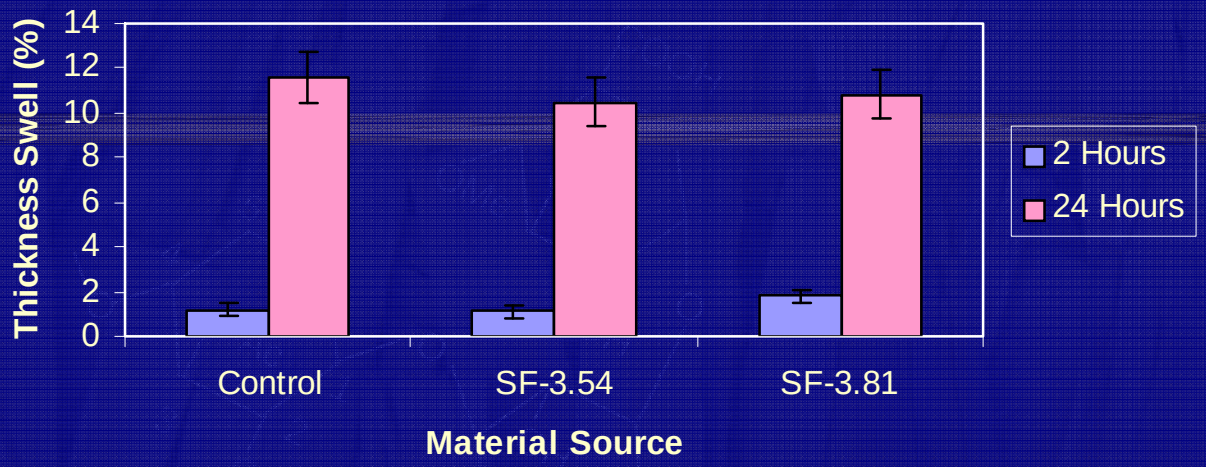
Results: OSB Panels

Physical Properties

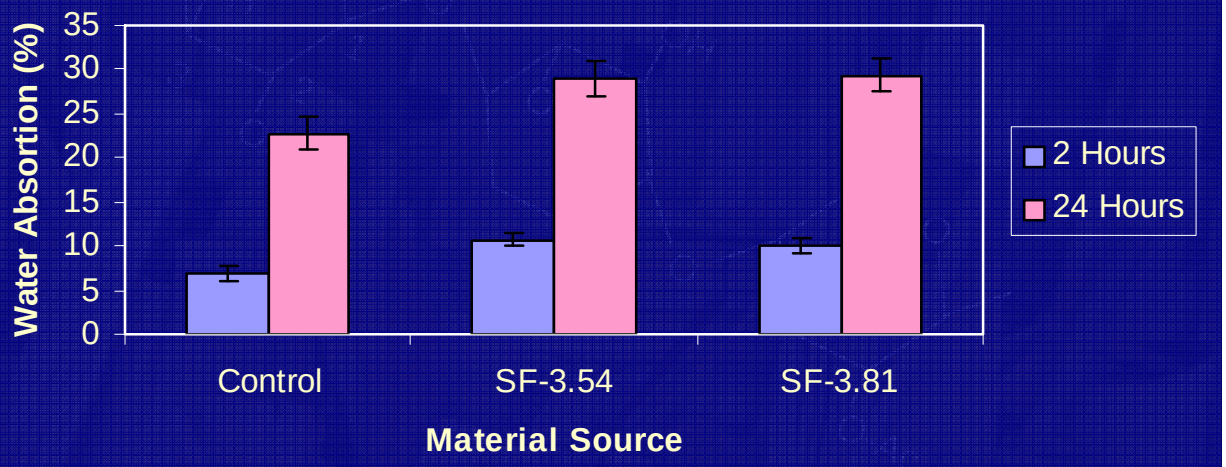
Tests were done following ASTM D 1037 specifications.



Thickness Swell Behavior



Water Absorption Behavior



Results: OSB Panels

Mechanical Properties

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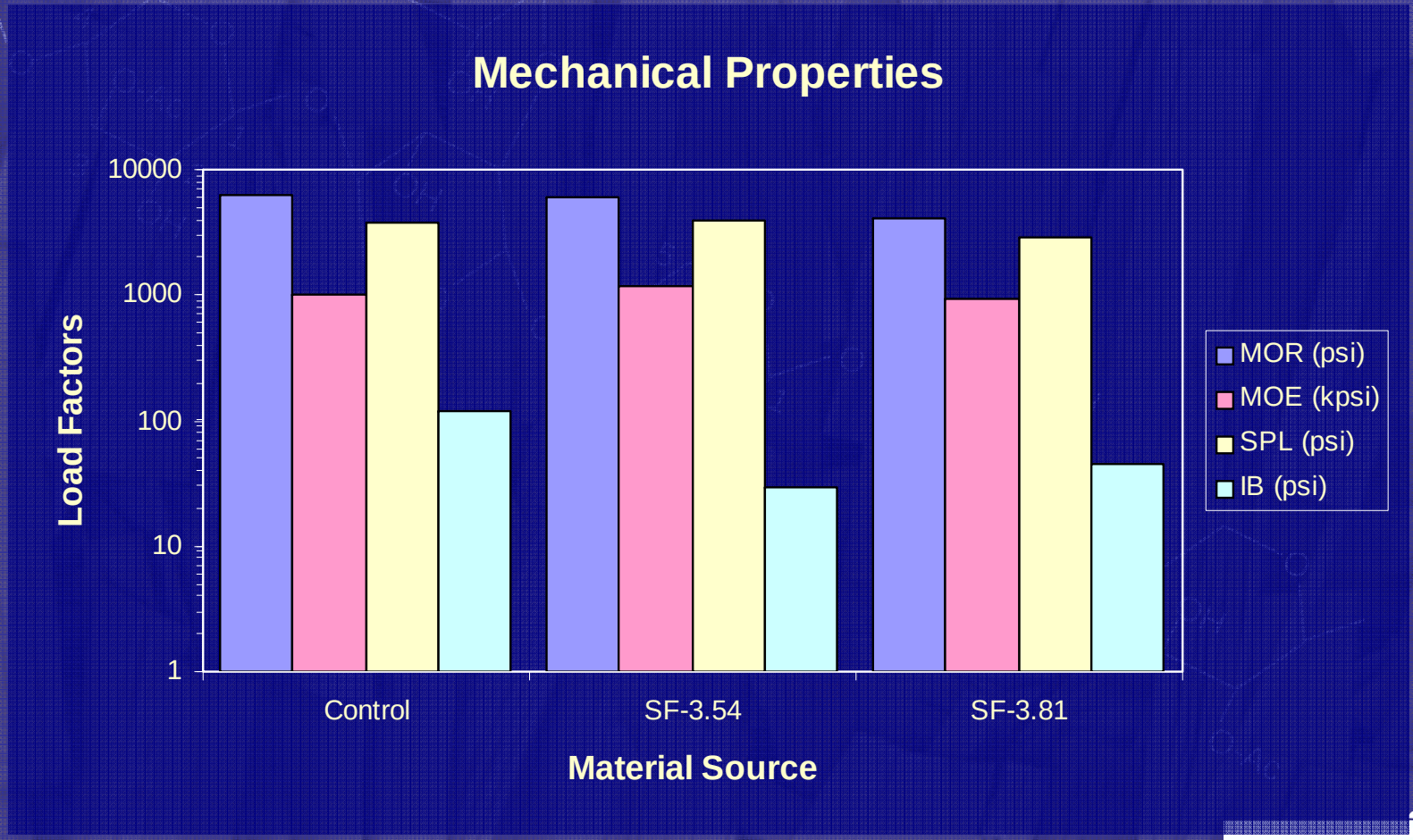
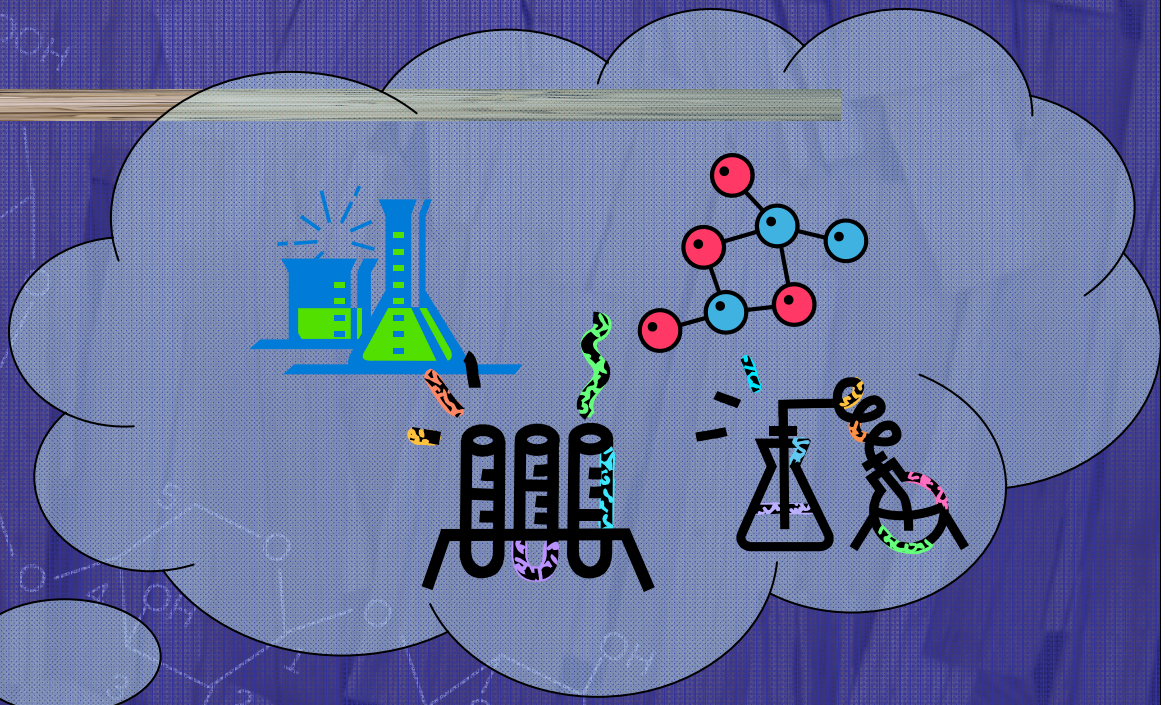


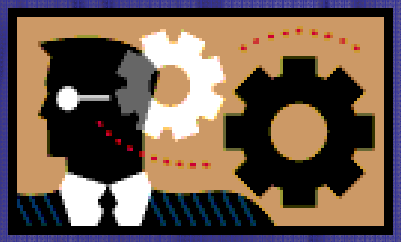
Conclusions

Extraction with pure water

- **Degradation of cellulose is not significant**
- **Xylan contribute significantly more to the total hemicellulose yield.**
- **Continued hydrolysis of carbohydrates**
- **Further research is necessary to understand changes in physical and mechanical properties of OSB**

Questions ?

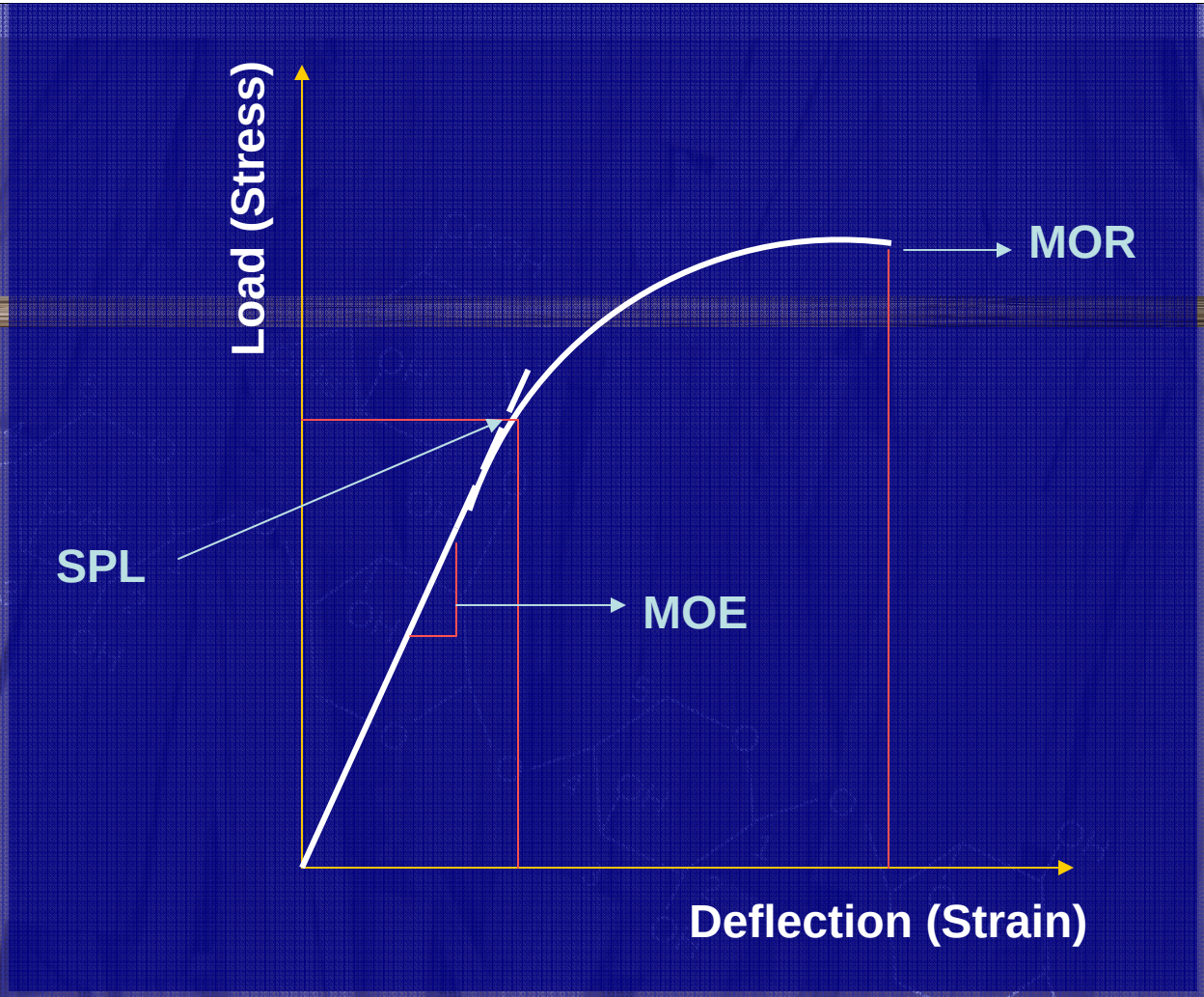




Comments ?

Mass Balance

Cellulose	= [Glucan – Mannan/1.7]/(wood weight)
Hemicellulose	= Total Sugar/(wood weight) - Cellulose
Xylan	= [Xylose*(132/150)+UA*0.6*(132/176)]



MOR: Modulus of Rupture (Maximum Load)

MOE: Modulus of Elasticity

SPL: Stress at Proportional Limit