Impregnation of eucalyptus and pine wood in alkaline pulping processes. *Effects of steaming and pressurized impregnation*

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Chip Impregnation for pulping

A proper

- Penetration of liquids
- Diffusion of chemicals

Both are necessary for optimal efficiency of:

- Chemical pulping
- Chemimechanical pulping

Uniformity

The uniformity of the impregnation

determines ↓

the uniformity of the chemical treatment in the first stage of pulping

Is essential for ↓

the homogeneity of the pulp obtained

Distribution of kappa number of a kraft softwood pulp

Kappa number of individual fiber

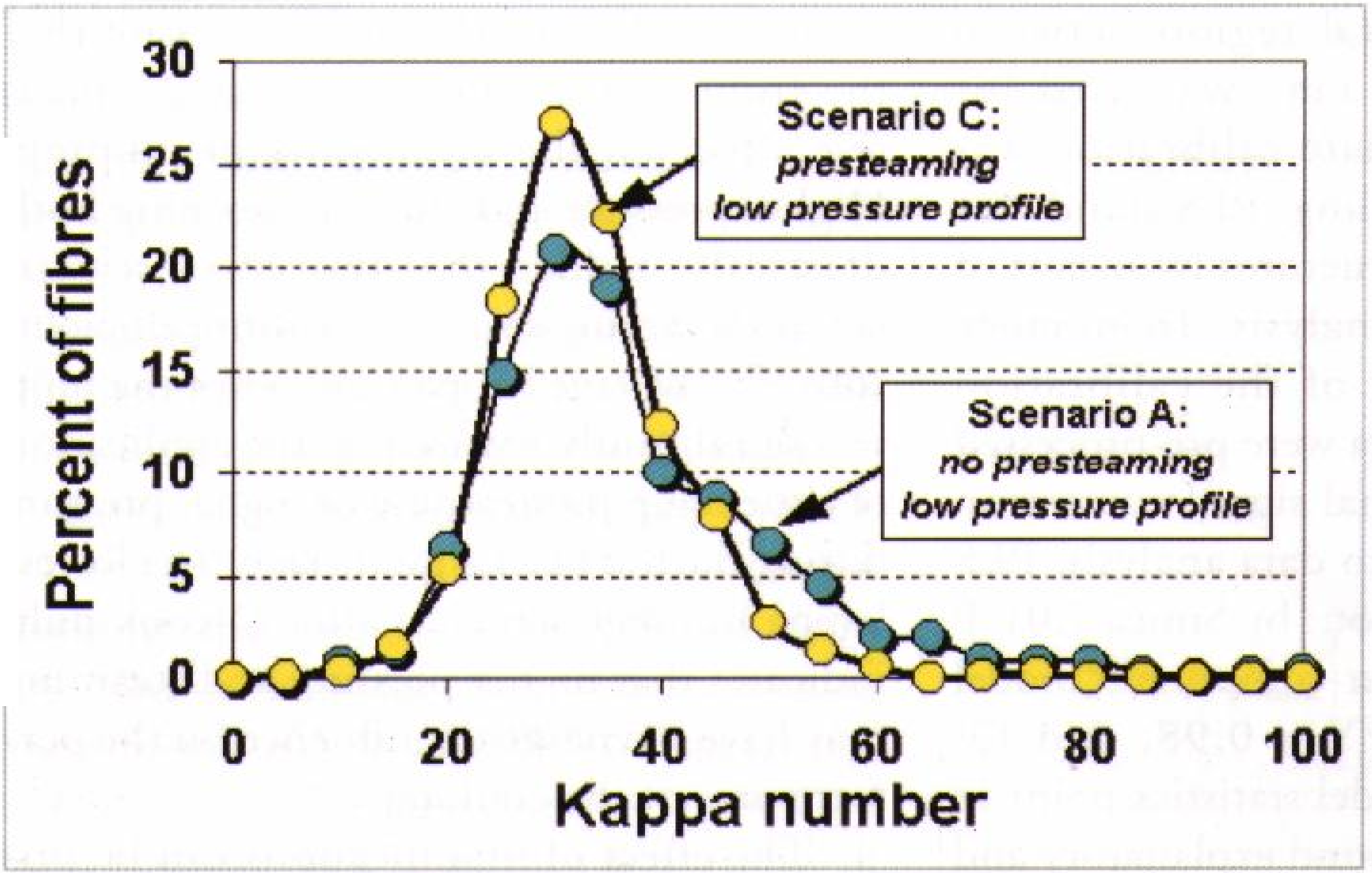
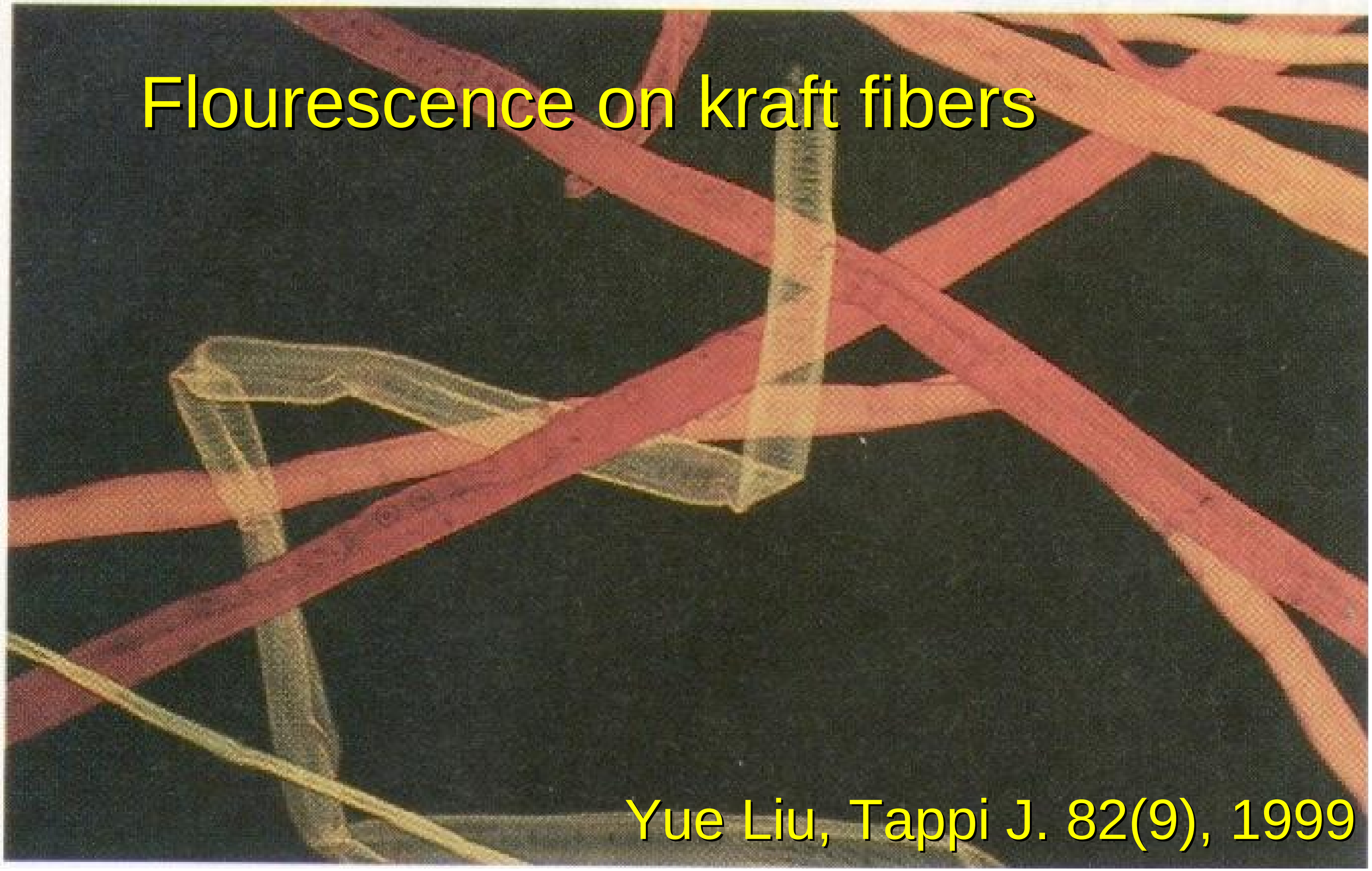


Fig. 6. Fibre kappa distributions: scenario C vs. scenario A.

Malkov, et al Paperi ja Puu – Paper and Timber Vol.85/No. 4/2003

Flourescence on kraft fibers



Yue Liu, Tappi J. 82(9), 1999

3. AO stained kraft fibers with kappa nos. 14, 32, and 82 exhibiting green, yellow-orange, and red-orange colors, respectively

The Malkov work shows:

- A fairly broad distribution of kappa of the softwood kraft pulp.

- Distribution can be notably reduced when a proper impregnation is applied

Benefits of a proper wood impregnation in a kraft pulping

In general it is shown in the literature that

it can lead to:

- Increase in pulping yield
- Reduction in cooking time
- Reduction in bleaching chemical

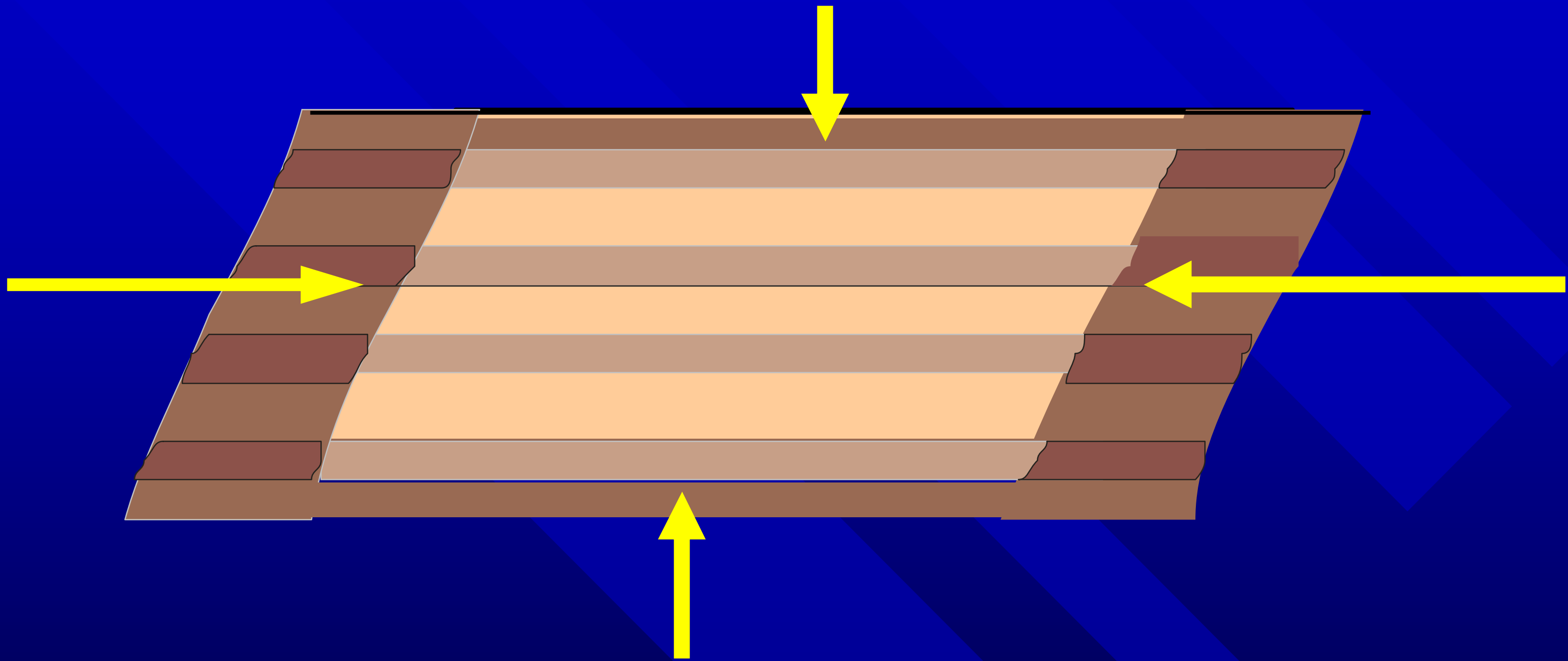
The alkaline impregnation phenomenon is complex.

It implies:

- Air removing
- Penetration in the longitudinal direction
- Diffusion in all directions.
- Chemical reactions and wood swelling
- Chemical modification of wood. Alkali diffusion coefficient is changed

Issues not considered in the literature

Chips treated with alkali shows a impregnation front



The size of the intact core reduces with time.

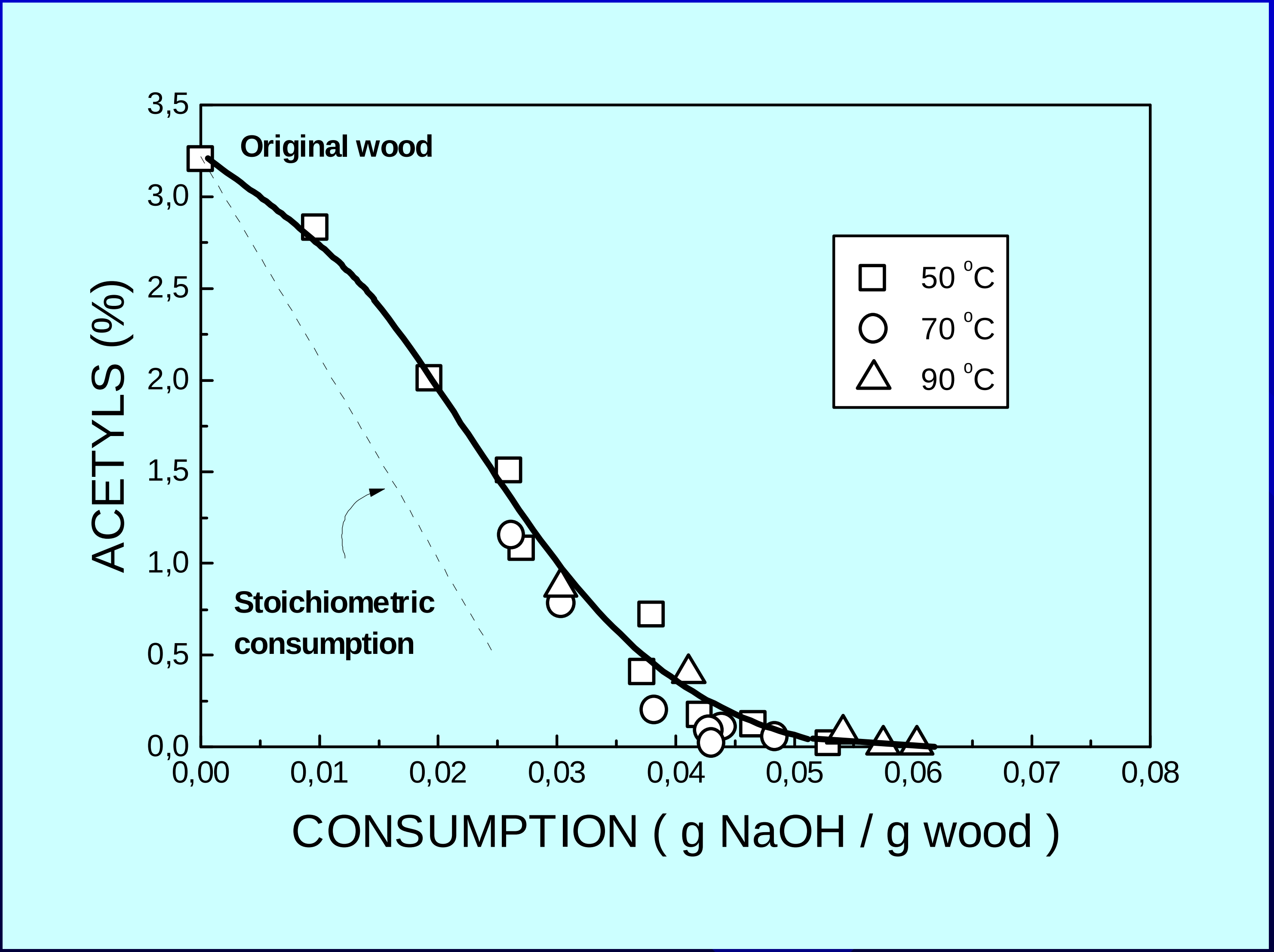
Situation depends on the wood and treatment conditions.

Alkali impregnation of hardwood in transverse direction

For poplar (Zanuttini et al., JPPS 2003) and for eucalyptus wood (Zanuttini et al., Holz un Roh, 2003), it was shown:

At temperatures below 100 ºC, impregnation is a reactive diffusion process.

Consumption could be as high as 6.0 % NaOH / wood



- Deacetylation is the main reaction and is the main responsible for alkali consumption.

Mechanism

At low temperature, it was shown that:

During impregnation, a reactive front is established which separates an intact inner zone from a reacted and swollen outer zone.

Pre-steaming and pressurized impregnation

- Presteaming rapidly heats the wood and the steam produced inside chips is useful to displace the air (Malkov et al 2000).

- When chip is immersed in liquid under pressure, a high liquid uptake takes place (Malkov et al. 2000)

- Presteaming stage and pressurized impregnation <u>should be considered</u> for a impregnation analysis

In this paper:

The pattern of the pressurized alkaline impregnation is analyzed:

pre-steamed wood

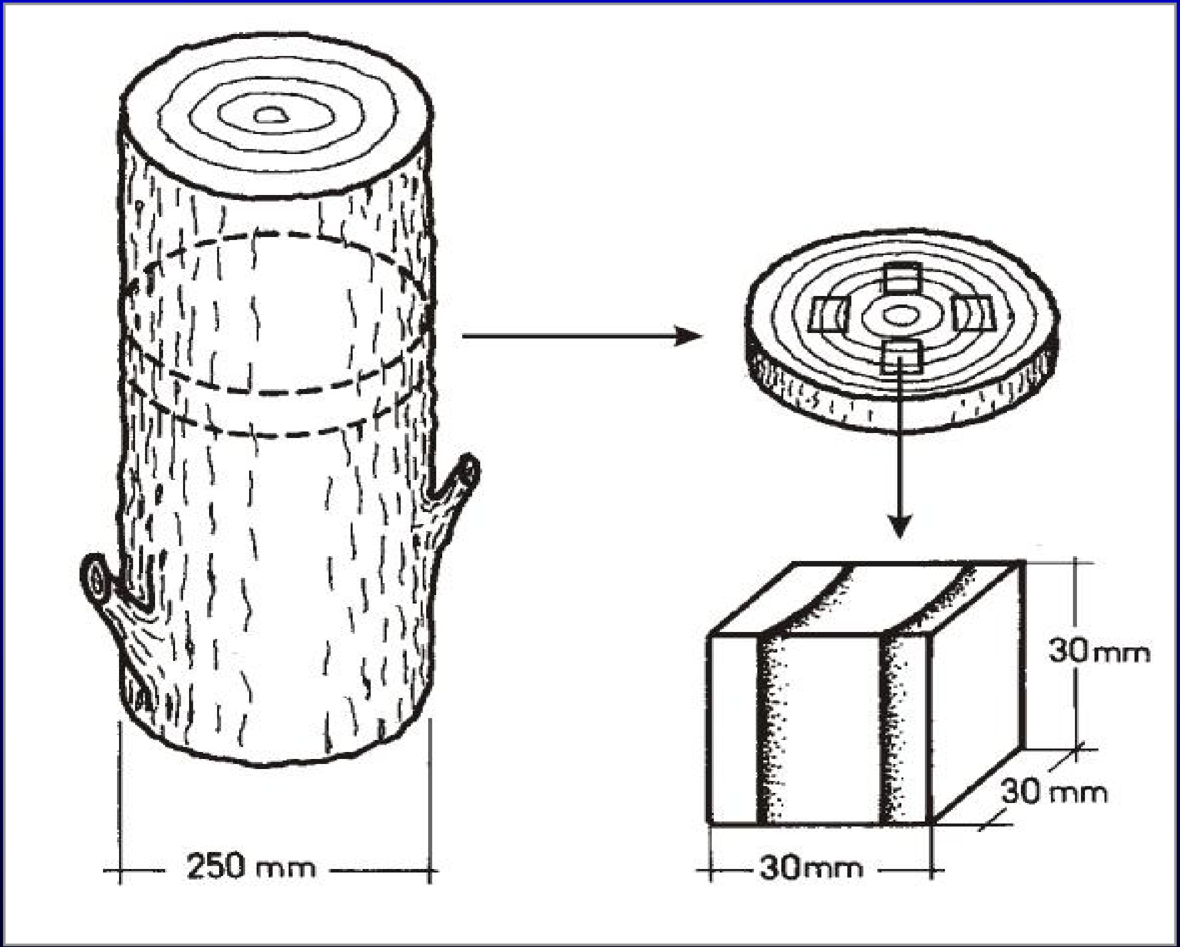
pine and eucalyptus wood

Profiles of:

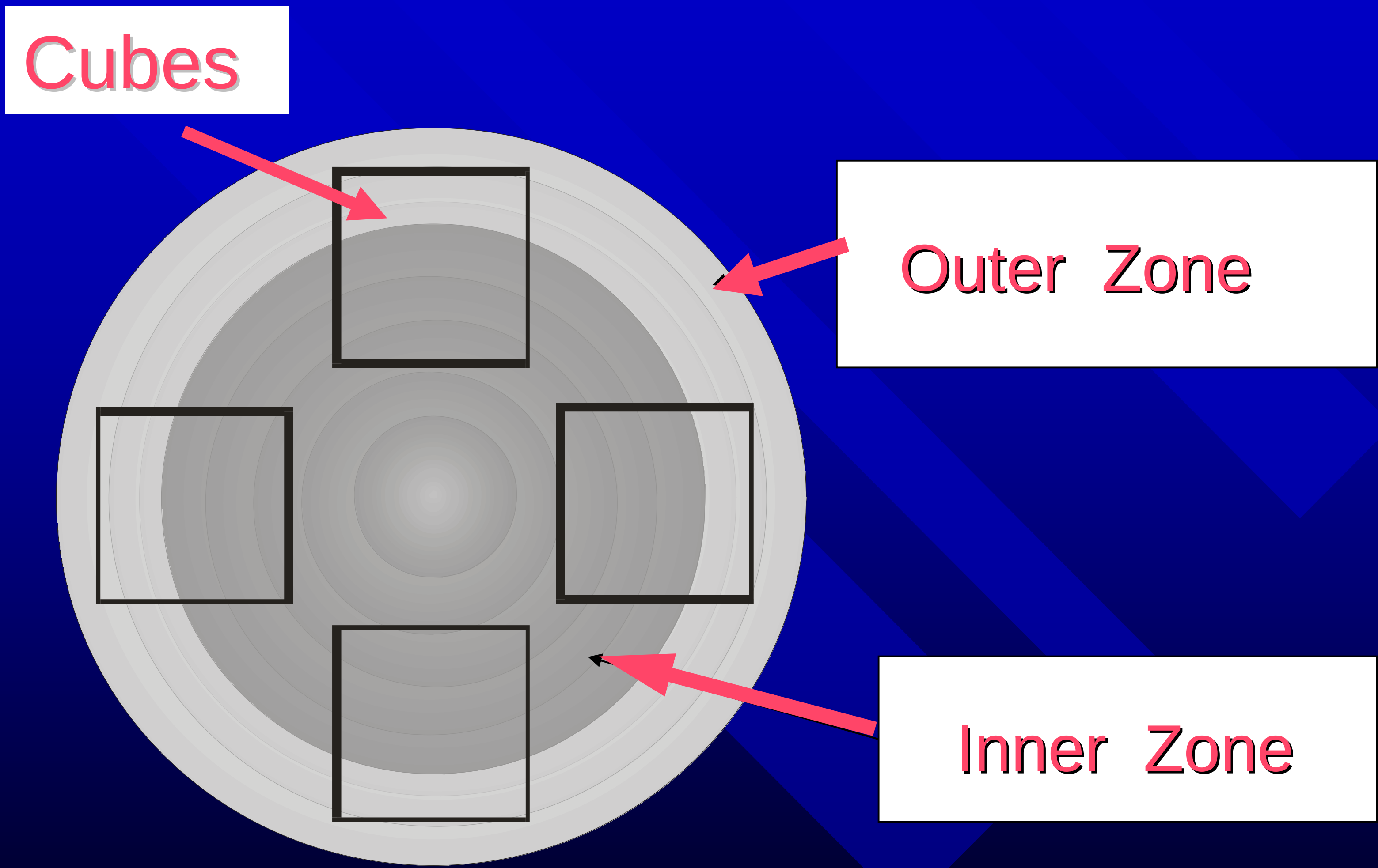
- alkali concentration
- alkali content
- liquid content
- acetyls content

It is shown that the level of impregnation can be predicted for given operation conditions

Experimental



Cubes from eucalyptus wood



Impregnation experiences

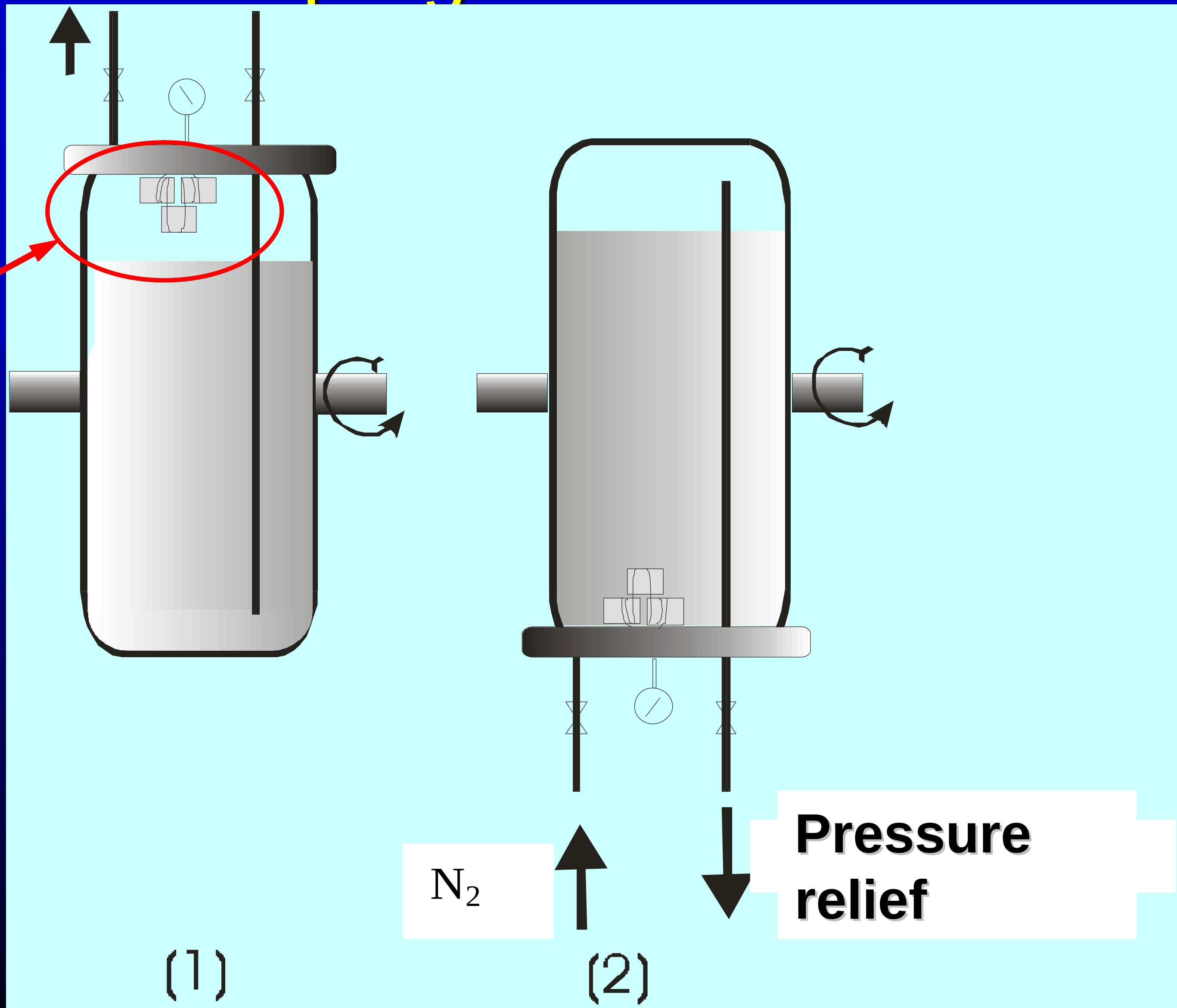
A Weverk digester:

- Steaming of wood samples by the liquor vapor
- Pressurization by Nitrogen

Positions of Weverk digester during impregnation

Wood

Samples

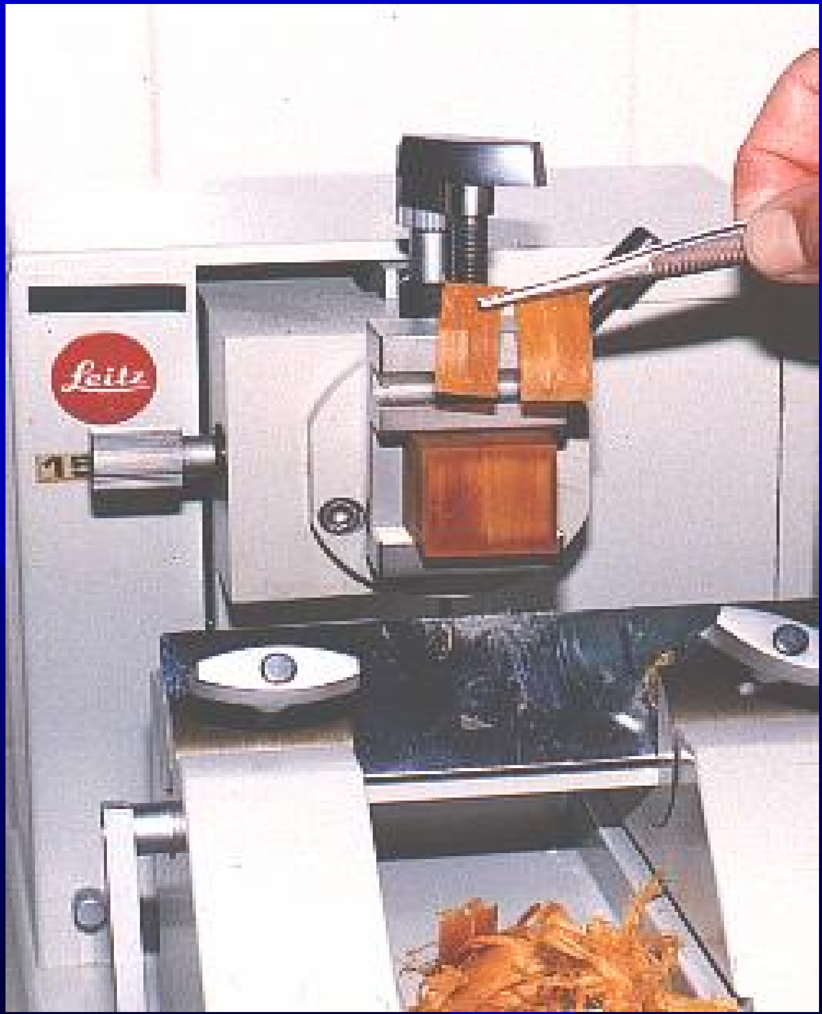


Procedure stages

1) Preheating of liquor at 100 ºC
2) Load of samples (under the digester cover)
3) Heating, air relief and steaming
4) Immersion in the liquor (Position 2) and pressurization up to 6 Bar (N_2)
5) Treatment under digester rotation
6) Relief of digester (wood submerged in the liquid). Flash in wood was avoided (Position 1)
7) Opening of digester and immersion of cubes in liquid Nitrogen by 2 hours.
8) Store at freezer temperature.

Slicing of treated cubes

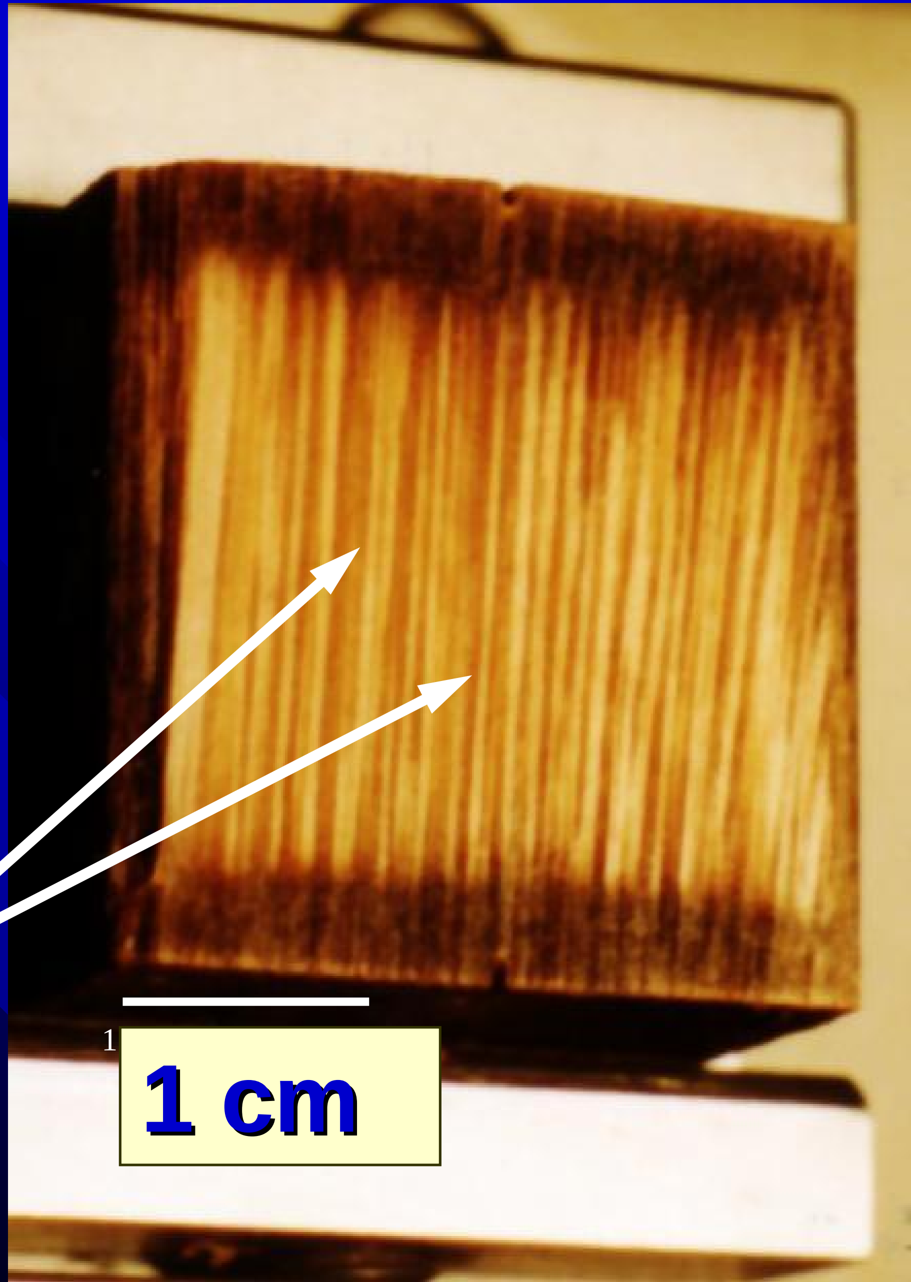
Wood sample is still frozen



Slices are weighed, and chemical analyzed

Tangential face of impregnated wood

Wood vessels



Chemical analysis of slices

- Titration →

- Drying
- Acetyl content by GC chromatography

Results

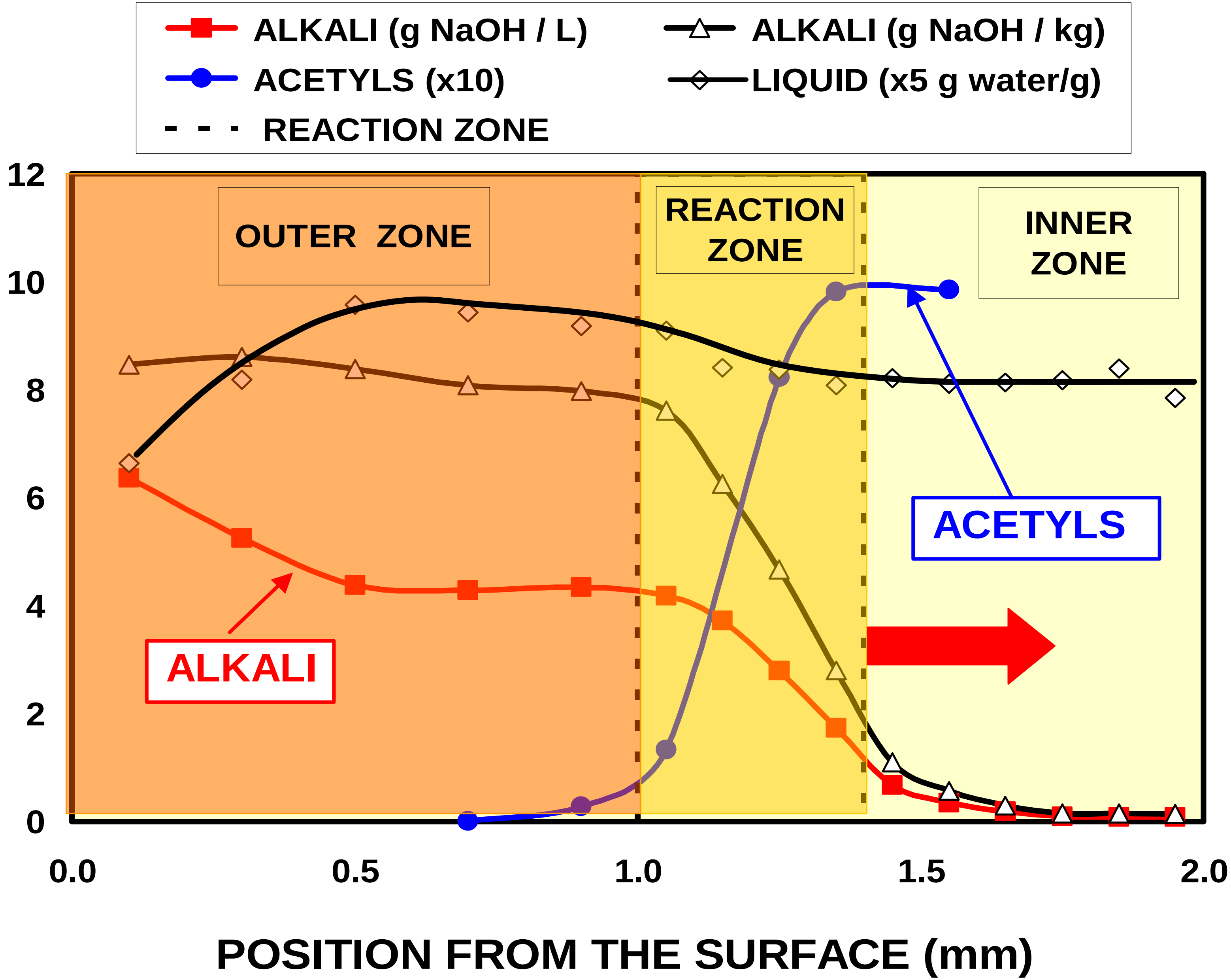
Results

- For Eucalyptus and Pine
- Profiles in radial direction

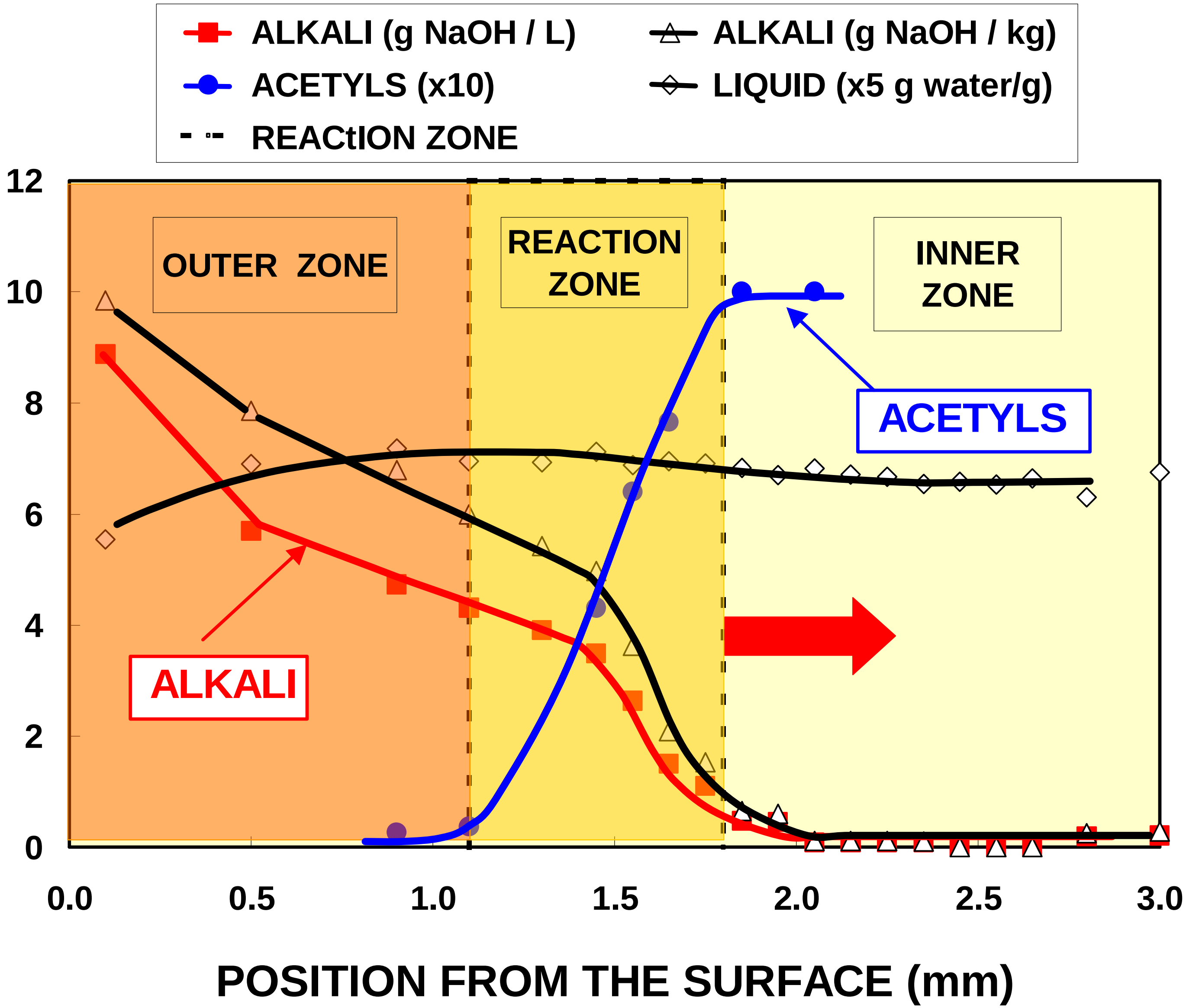
as a function of the position from de interphase

- Liquid content of the internal zone of the wood

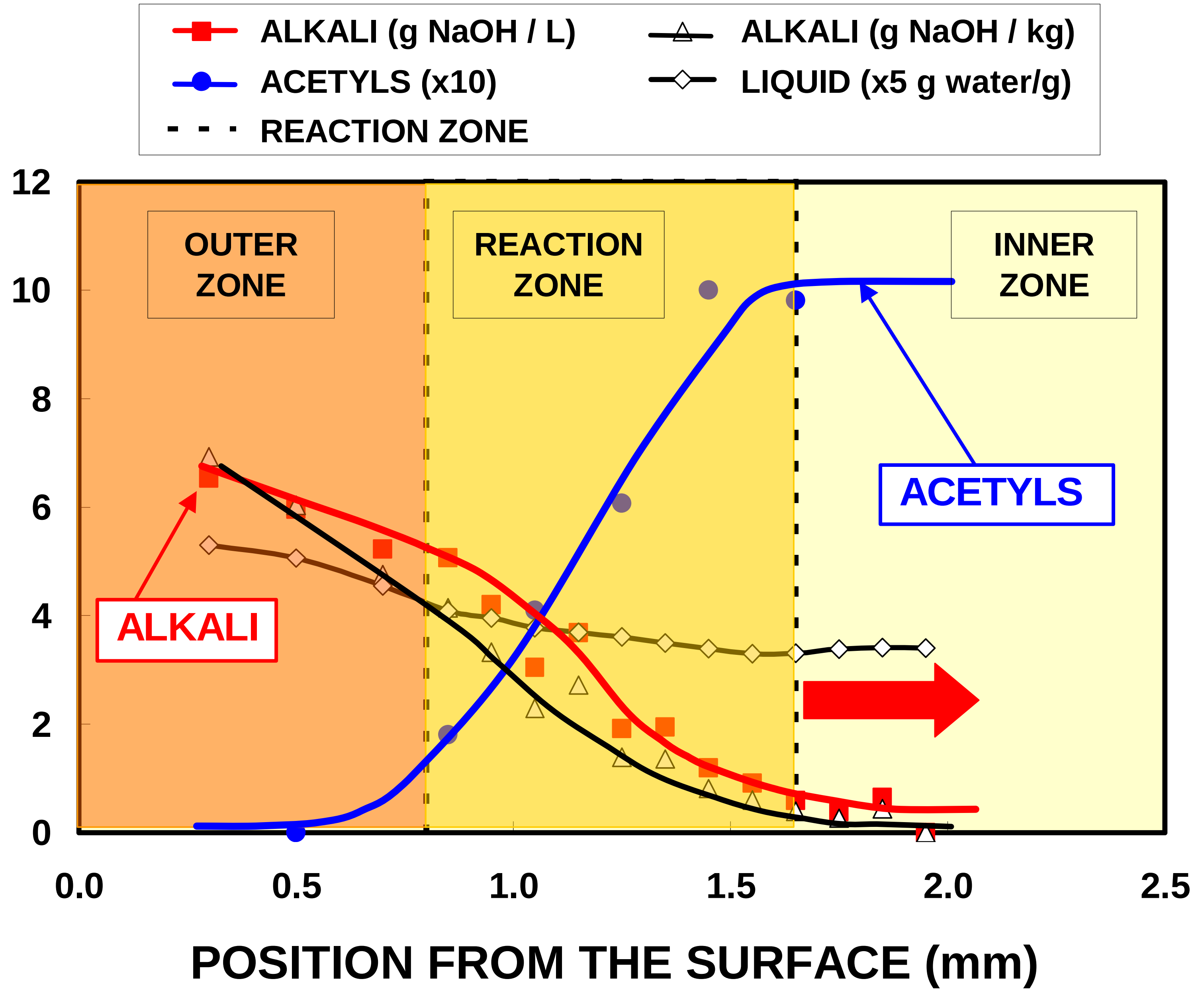
Eucalyptus – 15 minutes



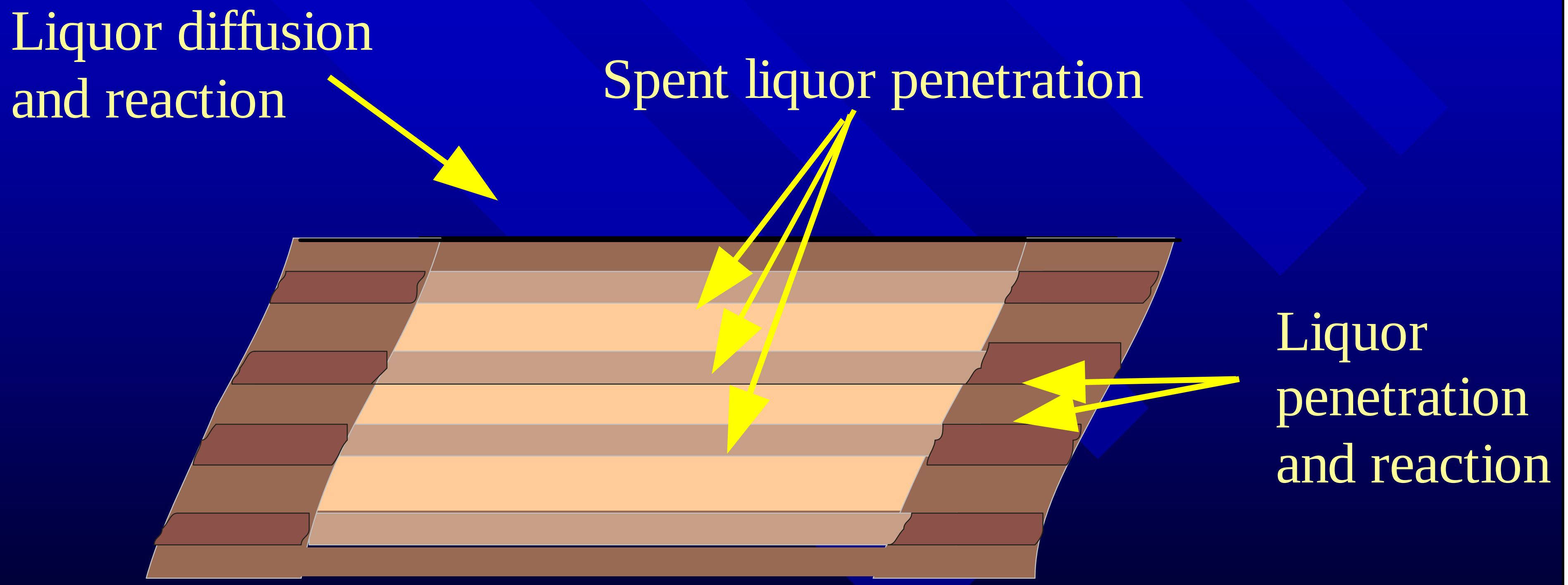
Eucalyptus – 30 minutes



Latewood of pine



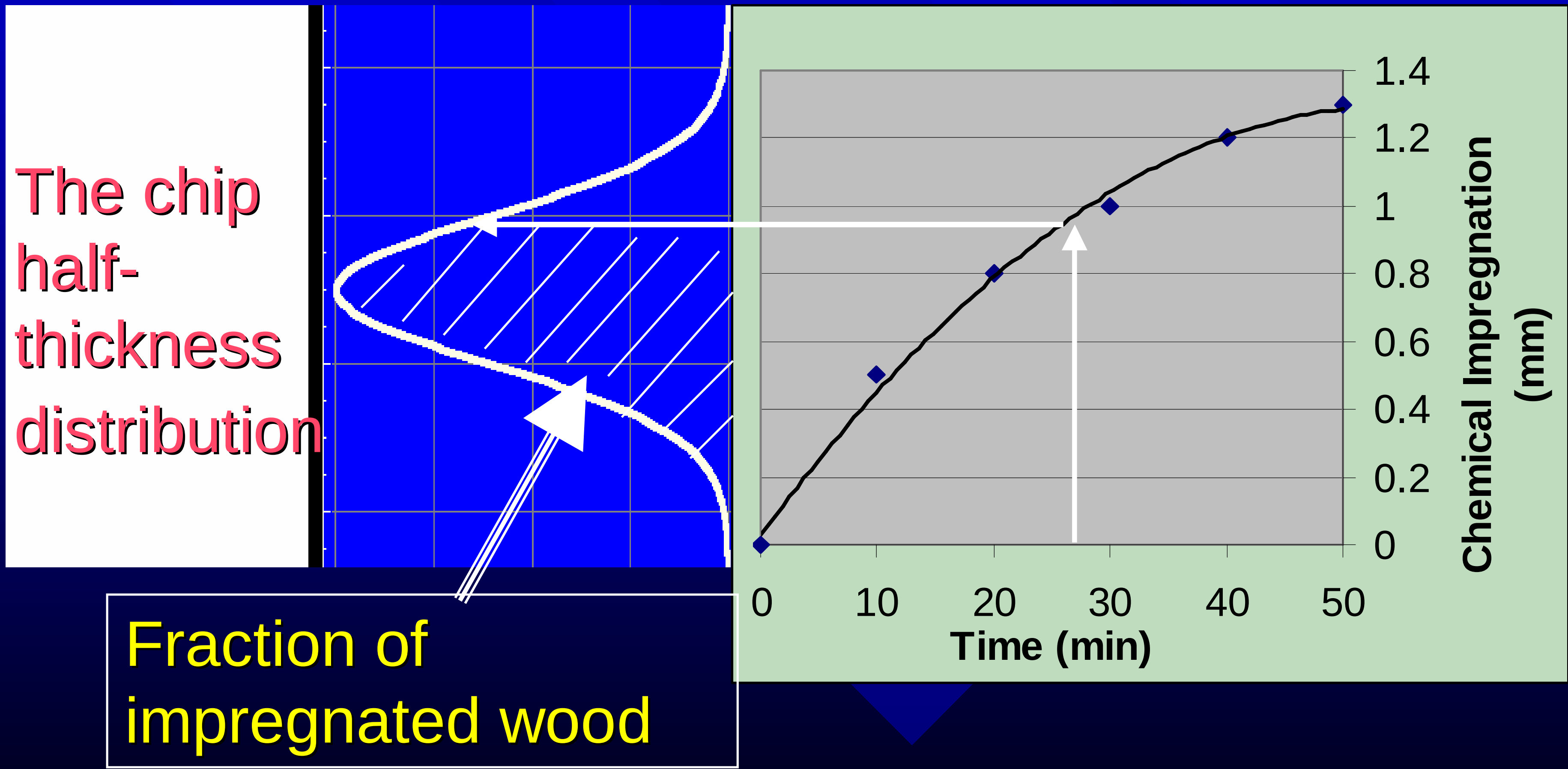
Mechanism of the chip impregnation



Liquid content inside wood

Liquid Content (g / g wood)	***Eucalyptus grandis***		***Pinus elliotti***	
	Exterior	Central	Early-Wood	Late-wood
	1.3	**0.75**	**2.5**	**0.7**

Prediction of the impregnation level



Prediction

If the speed of moving front is know, the level of impregnation can be predicted

Conclusions (1)

- Steaming (5 minutes) and pressurized immersion (6 Bar) can complete the liquid penetration
- Initially alkali does not reach the core a chip
- The chemical impregnation:

  reaction and diffusion

A front of the impregnation is always established.

Conclusion (2)

The time needed for chemical impregnation (time in which the front reaches the center of the chip) can be predicted for a given wood and treatment conditions

The end