Environmentally friendly process for making high density fibreboards

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Background

- Urea-formaldehyde (UF) and phenol-formaldehyde (PF) resins are used as binder in many fibre- and particleboards
- Formaldehyde has recently been classified as a cancerogenic substance by WHO (IARC 2004)
- Although formaldehyde emission can be decreased to a minimum with conventional techniques it can still be released from the composite under certain conditions

Goal

- A process to make fibreboards without use of conventional resin such as UF or PF

Approach

- Activate wood with hydrogen peroxide in order to achieve self-bonding properties between wood particles/fibrers when hotpressed into boards

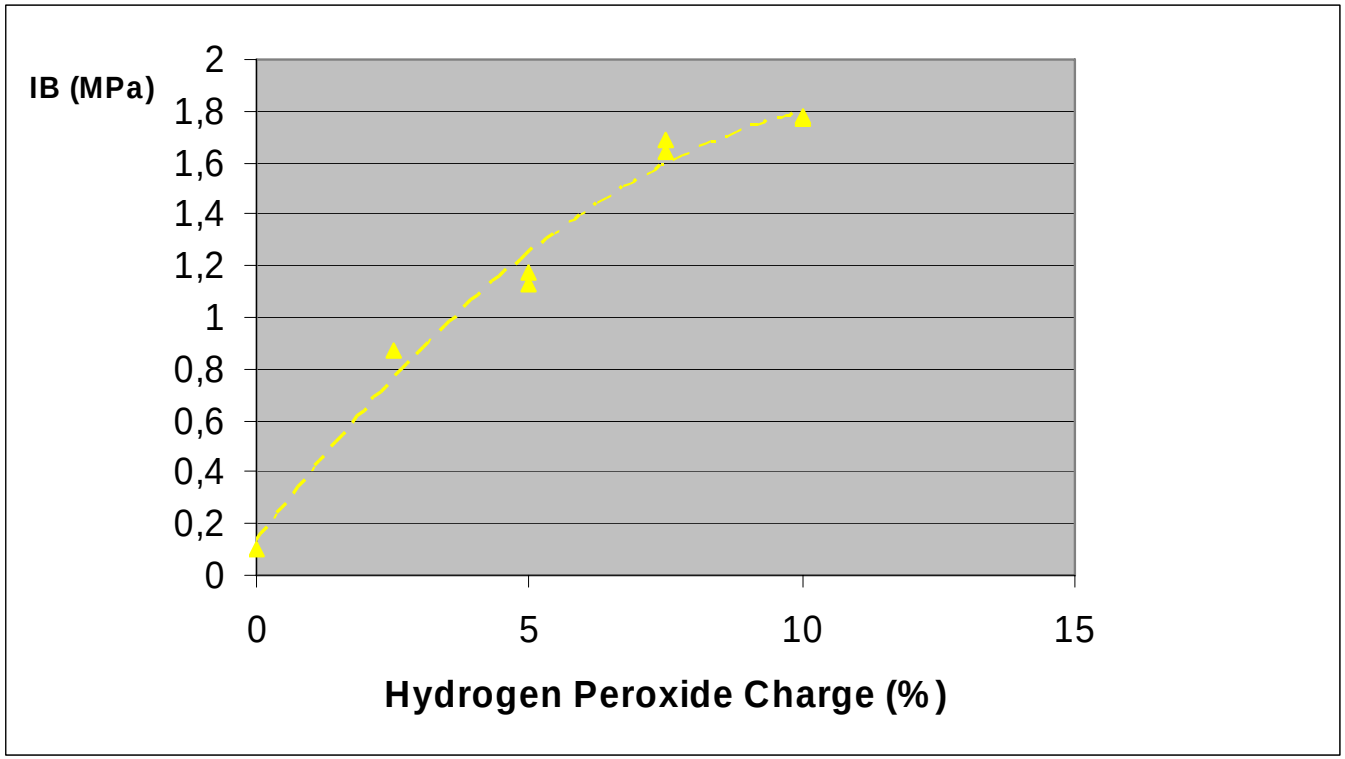
Activation mechanism

- Hydrogen peroxide decomposes in presence of iron-ions forming radicals that reacts with the wood preferably on the outer surface of wood particles
- Reactive groups (radicals, keto and carboxylic –groups, hydroxylation of aromatics) are formed which can bond when the material is hot-pressed together
- Studies on ester-formation on a cellulose matrix (Licentiate thesis, Anna Pantze)

Procedure for board from activated wood particles

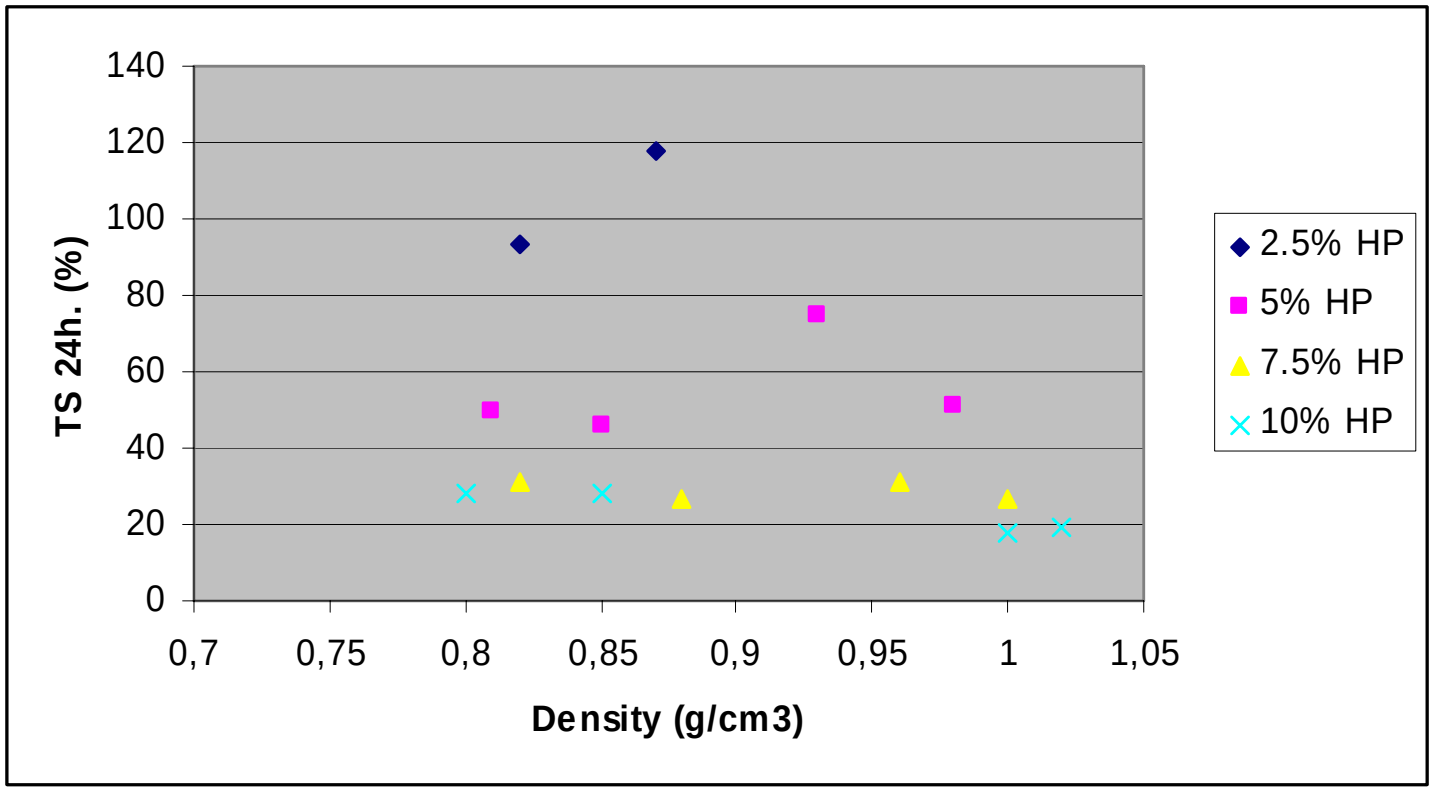
- Wood particles were activated with iron(II)salt and hydrogen peroxide
- Moisture content of activated particles was adjusted to ca. 12%
- Particles (80 g) were packed 14x14 cm^2 in a form which allows humidity to escape and hot-pressed at 170 ^oC at 4.2 mm

Hydrogen peroxide charge on internal bonding strength



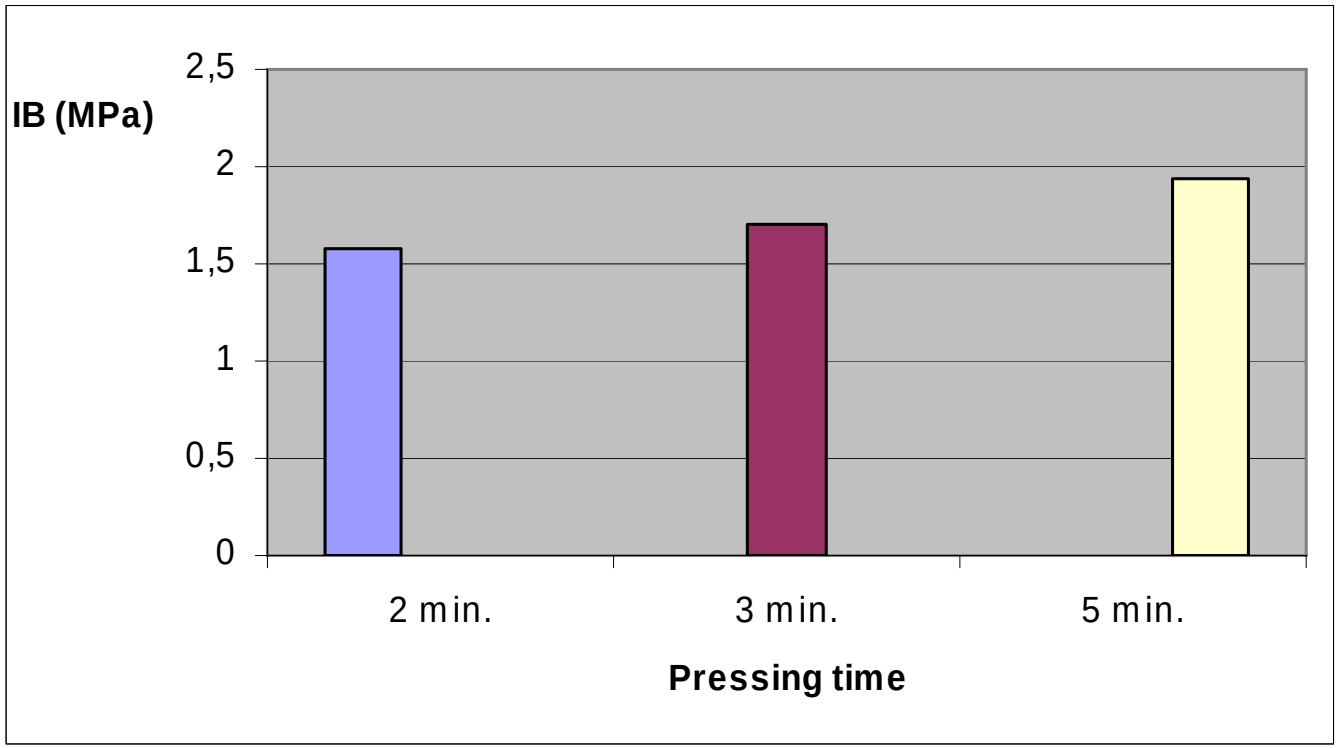
- **Density of board increased also with higher hydrogen peroxide charge**

Thickness swelling in water

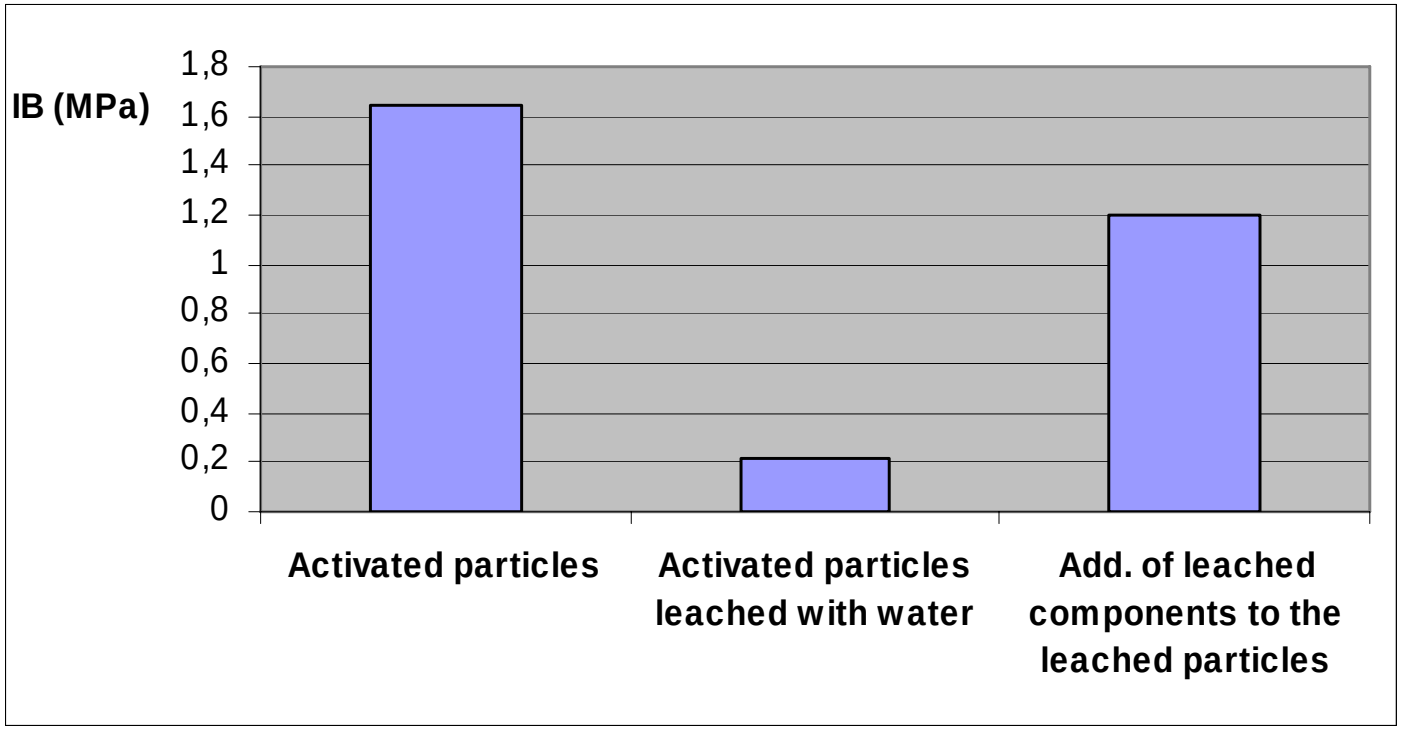


- At same material charge, spring back is lower and IB is higher when charge of hydrogen peroxide is higher
- At similar board (0.85 g/cm^3) density IB is similar
- Thickness swelling in water decreased with HP charge but was relatively unaffected by variation in densities in the study (800-1050 kg/m^3)

Effect of pressing time



Importance of water extractable components in activated particles for strength of board



Wood particles which had been water extracted before activation also gave a strong board when hot-pressed

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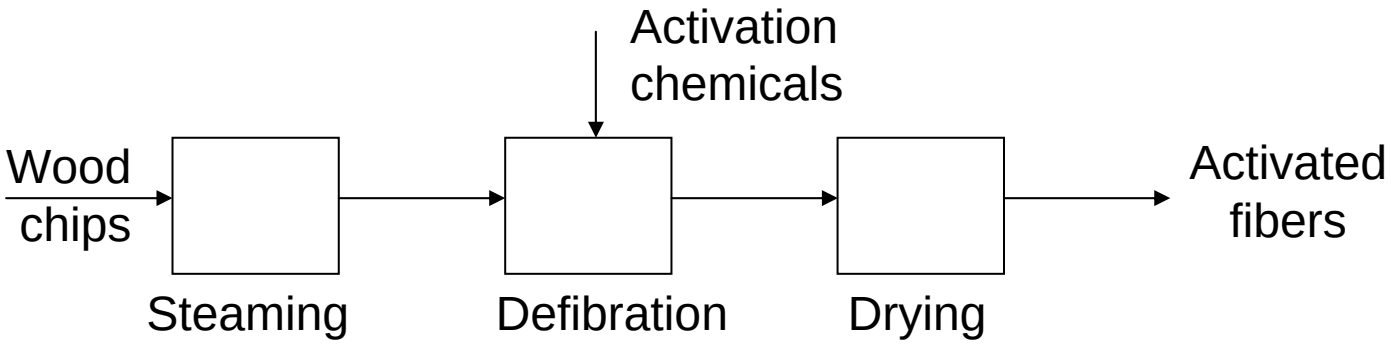
- Water soluble components formed during activation is of large importance for bondning properties of the activated particles
- These components are relatively stable which suggests that radicals have only minor importance on the bondability of activated particles
- Processes which uses an open press type where large part of water is removed as liquid like paper-machine or masonite board are not working with our activation method

Benefits of fibers made in a defibrator

- Slender wood fiber or bundles of fibres with high specific area are formed by careful defibration in a defibrator
- Application of chemicals can be efficiently done within the system
- Moisture content of the fibers are adjusted by driers in the end of the process

Procedure

- Fibers from wood chips were formed and activated with hydrogen peroxide at Metso panelboards pilot-defibrator in Sundsvall
- Fiber mats were formed using a pendistor and prepressed before hotpressing into boards of 50x60 cm^2
- Board thicknesses of 3 and 6 mm have been pressed



Properties of high density fibreboard from birch

Birch fibers activated with 4% hydrogen peroxide

- Average Internal bonding strength, 0.75 MPa
- MOR, 29 MPa
- Average density was 950-1000 kg/m^3
- Thickness swelling in water 24 hours was <30%

- Fibers activated with 2.5% HP swelled more in water, TS was 40-50%

Influence on moisture content of activated fibers

- At moisture content of less than 8% boards could be pressed although with a low resistance to swelling in water, TS >30%
- At high moisture (>14% MC) steam pressure built up in the board caused mostly delamination of board even though cooling of the press was applied in the end of pressing
  - Some boards did not delaminate and had low TS
- Further studies on the influence of humidity on the board properties are of importance before performing industrial tests

Effect of other raw materials

- Board of activated mixed hardwood had somewhat better properties than birch
  - IB was 1.4-2.5 MPa
  - $TS_{24h.}$ ≤20%
- Thickness of boards may have importance for properties of board
- Softwood species such as pine need further development

Profiled board

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Conclusions

- According to our experience the activation technique is safe and an efficient way to activate fibers for high density fibreboards
- Use of formaldehyde containing binder is omitted which give a more environmentally friendly board
- Moisture content in the fibers which is of great importance can be controlled in the process
- We see a high potential in the process as the glue-free technique is estimated to reduce production cost of boards

Thanks to

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