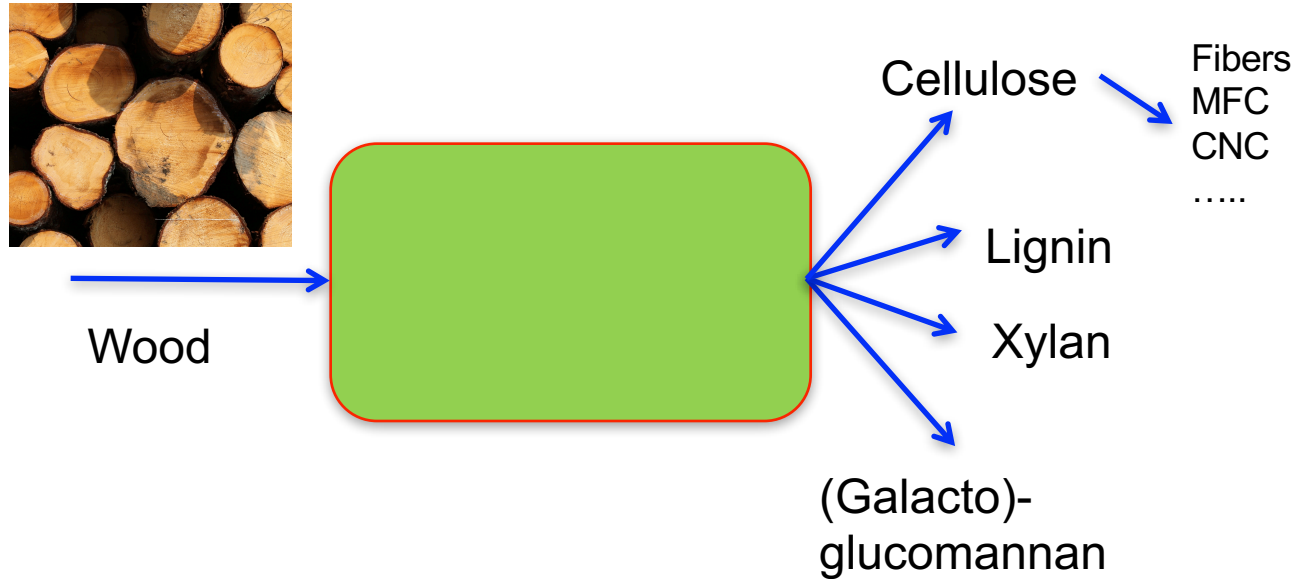


Forest Products and Chemical Engineering

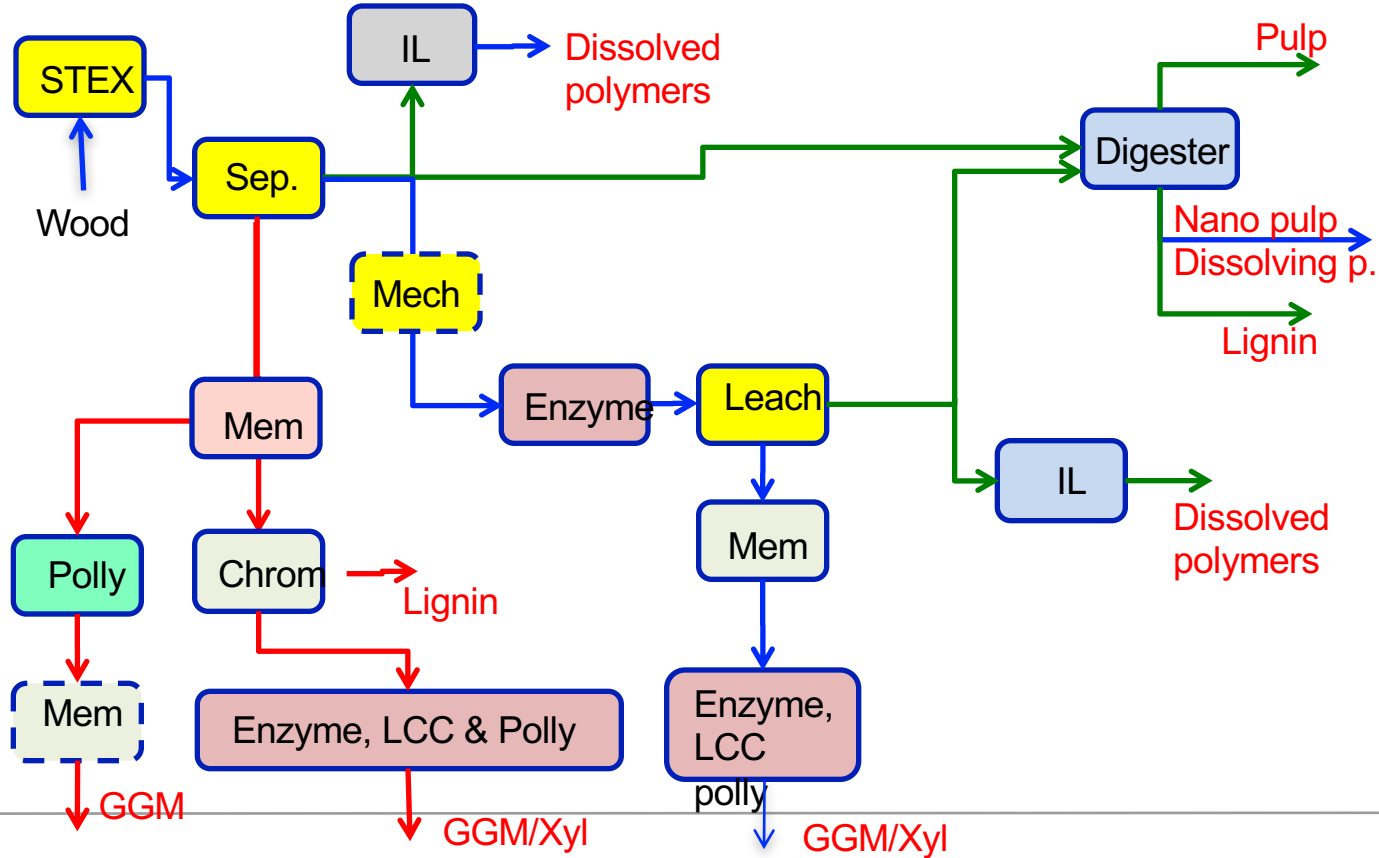
Hans Theliander (hanst@chalmers.se)

- **Two main research fields:**
 - **Heterogeneous reactions including mass and heat transfer.**
 - **Flow through porous beds.**
- **Applications:**
 - **The kraft paper pulp process.**
 - **Wood based materials biorefinery.**
 - **Properties/quality of products**

Wood based material biorefinery



Process prior the kraft pulp process

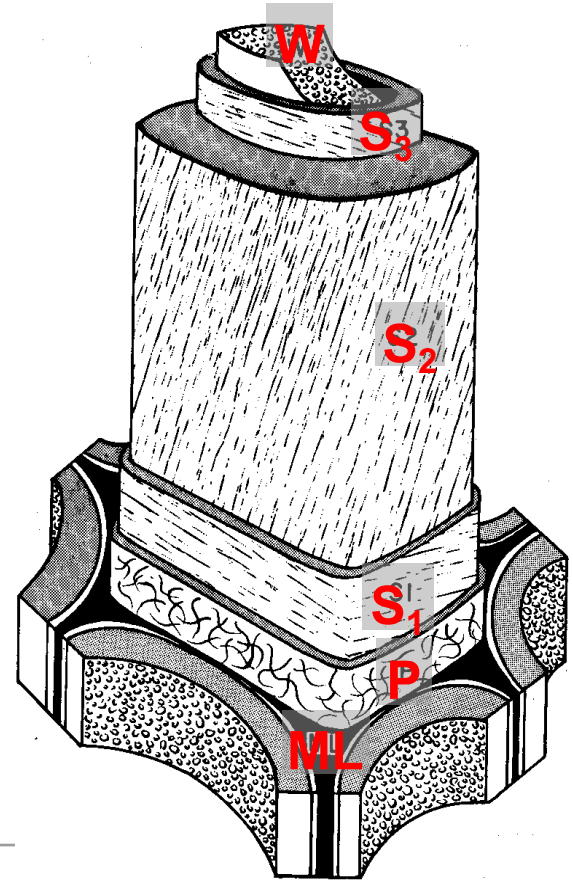
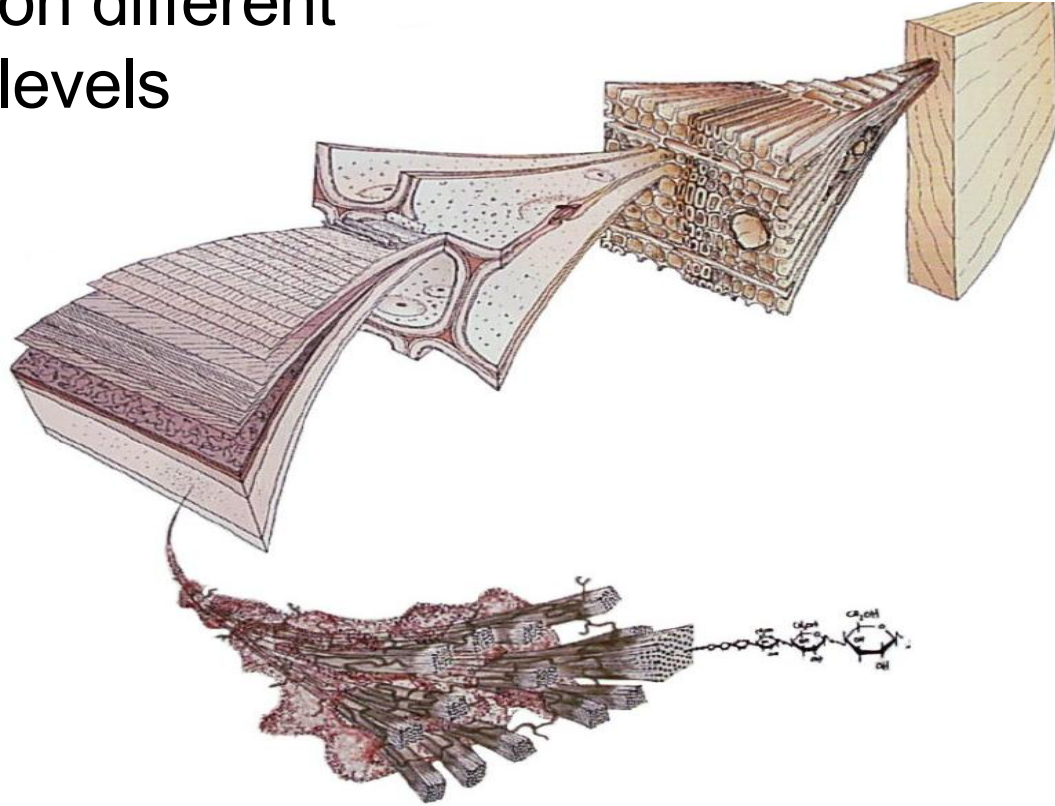


1. Extraction of wood component – Structural changes during steam explosion and/or digestion (Prof. Hans Theliander).
2. Membrane separation - Characterization of the pore system of a fouled membrane (Ass. Prof. Tuve Mattsson).

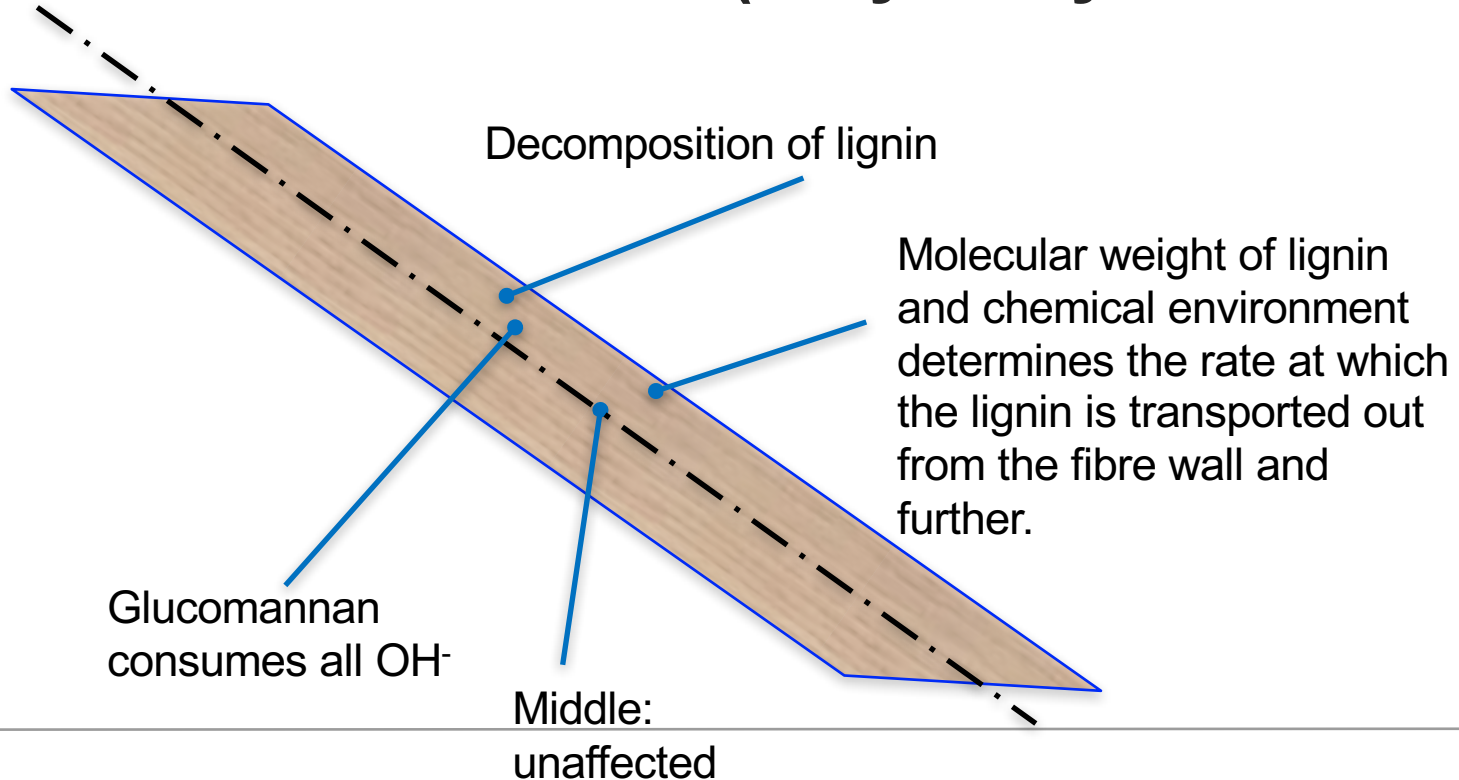
Extraction of wood component – Structural changes during steam explosion and/or digestion using the kraft paper pulp process

- **Steam Explosion:**
 - Mechanical forces are mainly influencing the microstructure.
 - The ultrastructure (fibre wall) is mainly influenced by extraction of polymeric material (mainly hemicelluloses): chemical reaction and mass transport.
- **Kraft cooking (delignification):**
 - The kinetics of the delignification is mainly determined by mass transport in the fibre wall and solubility of lignin macromolecules. Both the structure in the fiber wall and between the fibres are influenced.

Structure on different levels



Schematic of partly cooked wood chip (very early in the cook)



Questions we need some answer on

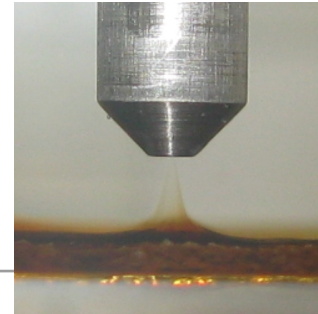
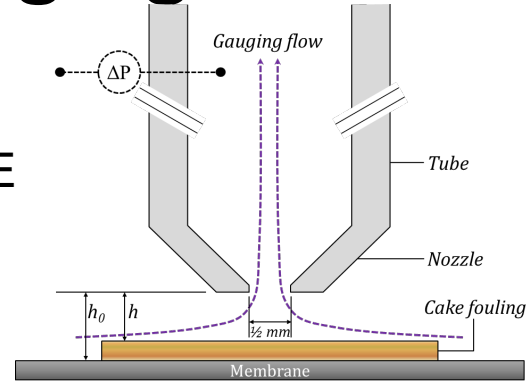
- ⊗ How is the pore structure in the fibre wall and the midlamella changed during the operations?
- ⊗ How does the concentration (density) gradients in wood chips and, if possible, fibre wall change during operations?

Membrane separation of wood constituents:

- Membrane separations can be expected to be one of the most important separation methods for wood constituents in the biorefinery.
 - Membrane operations are often very energy-efficient ways of achieving separation and fractionation.
 - Fouling is one of the main challenges that needs to be addressed to enable the use of membranes for separation in these systems.
-

Membrane fouling: Fluid Dynamic Gauging

- Simultaneous strength testing and thickness measurements of the CAKE fouling layer
 - *In-situ* real-time measurements without physical contact
 - Works with opaque feeds
 - Little prerequisite knowledge of feed req.
 - Capable of making local measurements



Membrane pore fouling:

