Preparing The Life Cycle Assessment of Wax Modified Wood Products

Olli Paajanen
Wood Laboratory
Mikkeli University of Applied Sciences

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Overview

- Background - Mikkeli University of Applied Sciences
- New modification equipment
- Considerations for preparing the LCA
- Conclusions

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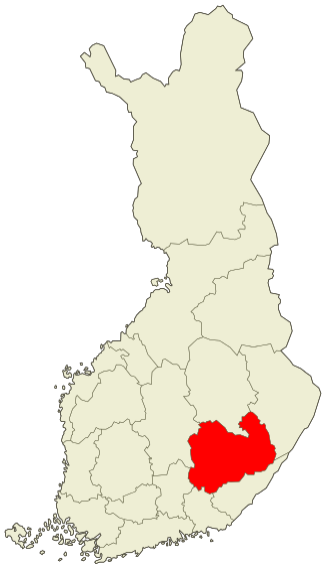

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- Main activities: teaching, research services to companies and larger projects (public+industrial funding)
- Traditional areas of interest at wood lab:
  - Impregnation, heat treatment, timber drying
- Good test facilities
  - Mechanical, biological, accelerated weathering etc.
  - Other labs of the Mamk are also at our disposal
    - → SEM, DMA, DSC, TGA, ETC.
- Welcome!

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Why – the Motivation for developing Wood Modification in Mikkeli?

- Previous projects, knowledge/expertise
- Area of interest, esp. durability of wood
- Needs of the industry
- Modification active field of wood research
- Potential to use wood to substitute other materials?
- Some commercial *high value* applications e.g. with high melting point waxes

- *LCA – not much experience esp. with wood products, but must be considered in the future/must be included in some form*

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The Project Pumok *-PUun MOdifioinnin Kehittäminen*

- The aim: **develop pilot manufacturing, research and testing environment of modern wood modification technologies**
  - Supports the needs of companies to develop their products and processes
  - Especially to develop high value added wood products that are treated with hot natural oil and/or wax mixtures**, with reasonable costs**
  - For instance, could modified wood replace use of aluminum in windows or could nordic wood species subsitute tropical hardwoods in certain end uses?
- Companies involved in the project: Stora Enso Wood Products Oy Ltd, Hexion Oy, Tehomet Oy, Karelia-Ikkuna Oy, Kurikka Timber Oy, Lieksan Saha Oy
- Funded by the companies and the European Regional Development fund
  - Regional strategy aims to increase the use of wood as well as the value of wood products manufactured in the region

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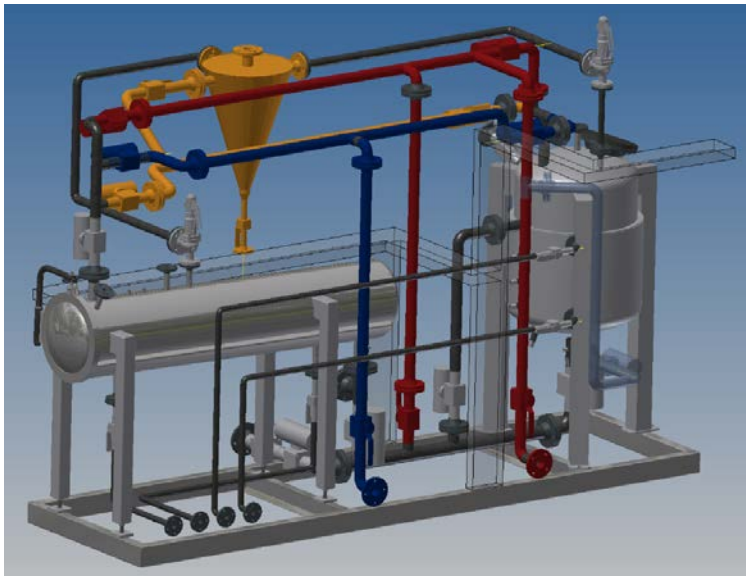
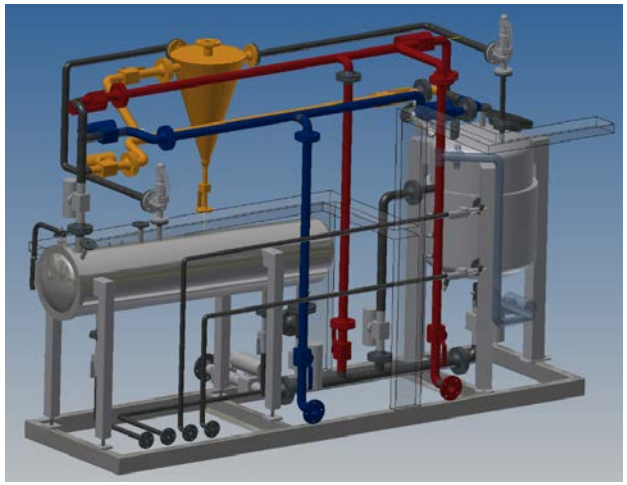
New modification equipment for testing high melting point waxes/oils/?



The New Modification Equipment

- Versatile, several process options
  - Hot wax and oil treatments
  - Thermal modification
  - *Traditional* impregnation
  - Drying processes
- Specs:
  - Up to 200 °C, 15.5 bar
  - Nitrogen/steam atmosphere
  - Storage vessel 250 l
  - Oil heating/cooling
  - Chamber diameter 380 mm, length 2000 mm → industrial scale/pilot production possible
  - Lab device or pilot plant?



Timeline

- Project started November 2014
- Device installation delayed for various reasons
- Equipment in limited operation 3/2016

  →Wax experiments started asap
- I started in Mikkeli 3/2016

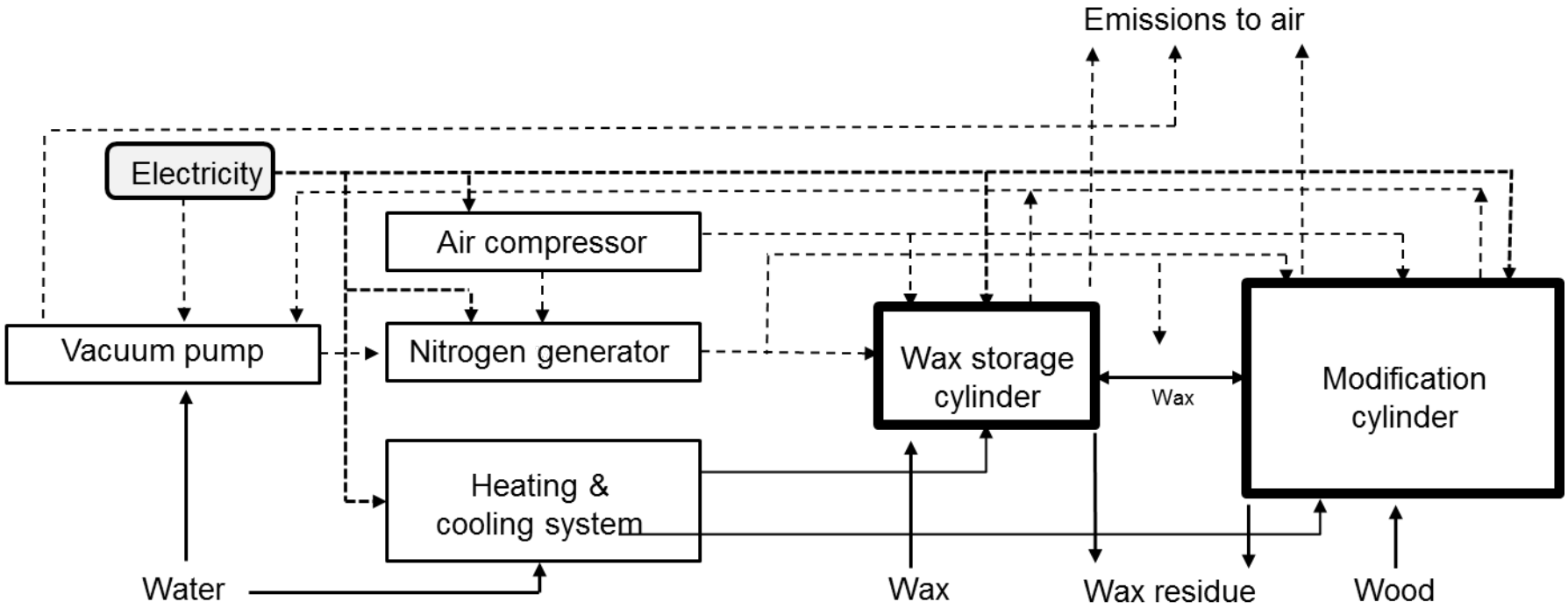
Some observations from the recent experiments

- In the end, most important: gathering experience about the functionality of the system, wax-wood interaction in the process etc.
- Minor bugs in the system, also some technical issues, that have been solved
- **Device works**, mostly as intended
- Wax properties have a major role
  - Not only melting point, also molecular size etc. – In principle only small differences between wax specs, but large difference in the way they act in the process
- Industrial waxes designed for other end uses – suitability?
- Process parameters are compromise
  - Process affects the wood
  - *What is important for the specific end use?*
- Process and device development is very time consuming, perhaps not enough emphasis on this aspect
- ***Modification or impregnation?***

LCA and the new system?

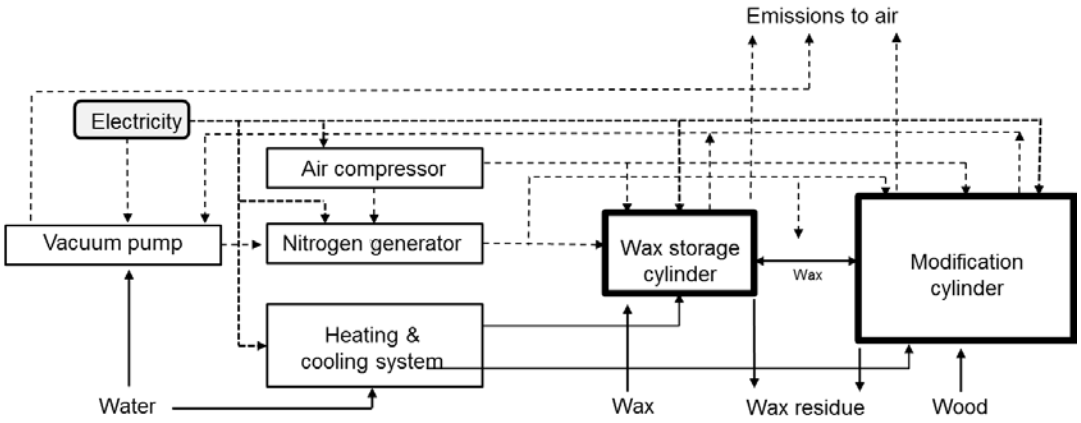
- The project plan includes a LCA section…
  - One driver for the development of the system
  - Provides evidence about the performance and environmental claims
- LCA-program is available; basic data on the materials, processes and function of the device are available
- But in practice?
  - What type of LCA?
  - Experimental or industrial process?
  - Process specifics? What to include?

The Process, Materials and Energy



Description of the basic process

- The process starts when a wood component is placed in a chamber - the chamber is sealed
- There is an oil circulation system that both heats and cools the chamber, if necessary.
- The wax is melted to liquid form in a heating cylinder, then pumped into the impregnation chamber
- Compressed air is used to operate the valves in the system
- As the pressure is lowered in the chamber, there are some emissions to air and there is also bound to be some wax residue or waste in the process
- Water is used in the cooling system and vacuum pump and electricity is needed for all functions in the process
- The simplified system a pilot scale process - while the basic process the details of a similar, a full scale industrial system will be different and this will have an impact on the LCA.
  - For instance, the choice of energy sources, especially heat; recycling of process waste etc.
- **It is also essential to consider, how the modification process is integrated to a larger manufacturing process – the modification is just one part in the manufacturing of a final product**



About the LCA

- What are the goals and purpose for doing it?
- Simple type – what does the process add ”on top off” e.g. sawing process?
  - Does it work that way? How to integrate into real life process?
- Comparative LCA - what was really asked or needed?
  - Comparative study on different impregnation processes?
    - Different impregnants
    - Different process parameters, wood moisture
    - Different service life, maintenance, end of life?
  - Comparative study on window frame materials?
    - Pine, heartwood, hardwood, PVC, wood-aluminum, wax impregnated, other?
    - Different service life, maintenance, end of life?
    - Manufacturing processes very different – system boundaries?
    - Cradle to gate? Grave?

The comparative LCA?

- Goal and Scope
- Functional unit
- System boundaries
- Allocation methods
- Impact categories
  - Many relevant, not only GHG!

Conclusion – aim for the future

- Work in progress – teaches a lot
- Many aspects to consider when doing LCA, also experience is essential
- The aim in wood modification is to improve the performance of a wood product - many promises have been made about the advantages of various modification procedures
  - The performance may be better, the process itself consumes energy and in most cases some substances are also used in the treatment process
  - Does the improvement in the properties justify the more complicated manufacturing process - increased costs, material and energy inputs?
- LCA is a valuable tool: even though it is focused on the environmental performance of the product, the approach and framework help to understand the manufacturing process better also from other viewpoints

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Thank you!

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