Title	Foam forming - potential production technology for building materials
Author(s)	Jetsu, Petri; Pöhler, Tiina
Citation	12th Global Insulation Conference and Exhibition 2017, 25 - 26 September 2016, Krakow, Poland
Date	2017
Rights	This presentation may be downloaded for personal use only.

Foam forming - potential production technology for building materials

Petri Jetsu, Tiina Pöhler

VTT Technical Research Centre of Finland Ltd

Outline

- Why foam technology?
- Introduction to foam forming technology
- Foam formed thermal insulation materials based on wood fibres - the effect of fibre type
- Benchmarking of wood based foam formed building materials against commercial materials
- Future actions

Why foam technology?

Foam forming is an enabling technology with six major benefits

1. Material uniformity is excellent – high quality and raw material savings
2. Possibility to produce highly porous as well as dense structures - wide product window with the one technology
3. Possibility to utilize different kinds of raw materials from nanofibers to several centimeter long fibres as well as high and low density particles
4. Possibility to produce layered products with excellent layer purity
5. Technology can be a resource efficient and cost competitive compared to many other manufacturing methods
6. Sustainable products can be produced by this technology

Background

History

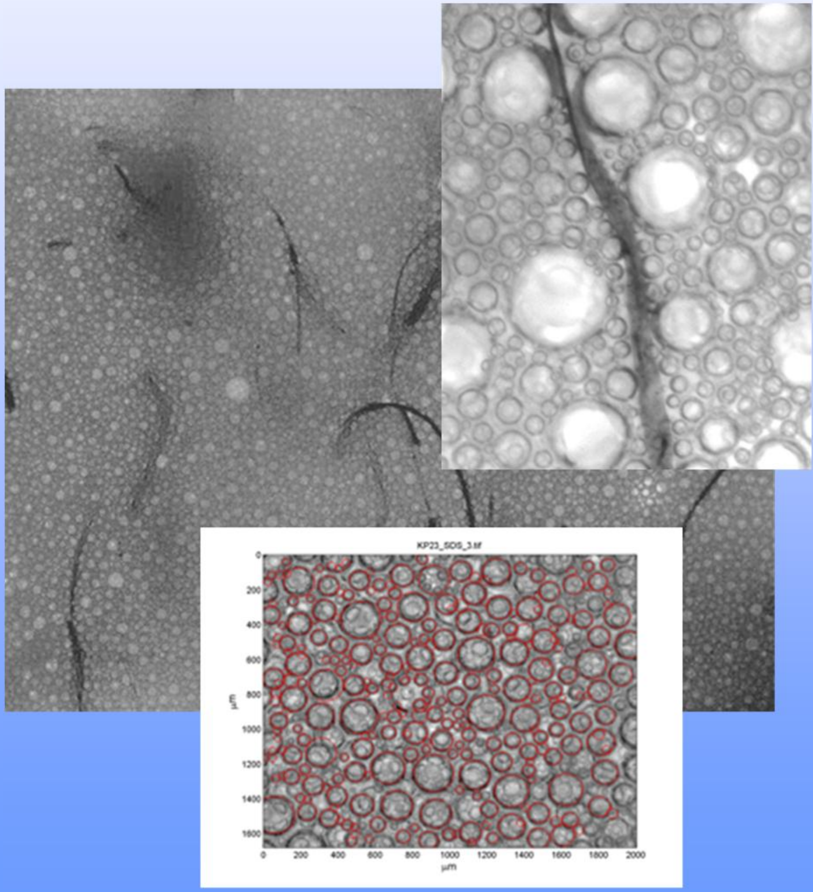
- Foam forming technology has been studied already in 1970’s, but implemented in some extent only in nonwoven and tissue industry at the moment.

Foam forming research at VTT

- First laboratory scale projects started in the mid of 2000
- Technology has up-scaled to the pilot scale in 2012
- Wide variety of raw materials have be used; wood and natural fibres, residues from wood industry (bark, saw dust etc.), man-made fibres, polymer powders…
- Wide variety of applications like printing papers, packaging boards, hygienic nonwovens, filters, thermal insulation materials, acoustic panels, building boards, cushioning materials, fibre/plastic composites etc. has been studied.
- New pilot line will be started during autumn 2017

Basics of foam forming

- Foam is generated by intensive mixing of water and foaming agent
- Typical air content is 40 – 70 %
- Typical bubble diameter is ~100 µm
- Foam stability can be controlled
- Fibres and other raw materials are mixed with aqueous foam
- Material is located in “bubble pockets” preventing flocculation, which leads to uniform material distribution



Main process phases and features of foam forming

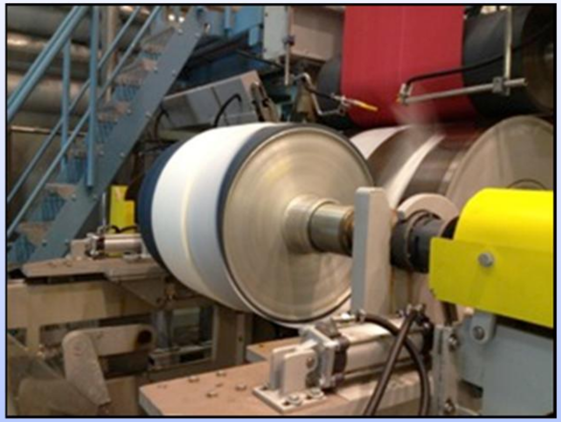
- **Generation of aqueous foam and mixing of raw materials** in the foam: In tank or on-line in tube
- **Web forming**: Spreading the foam on a wire through a nozzle and removing wet foam with vacuums, typical dry solid content of web is 10-25 % after this phase
- **Wet pressing**: Increase dry solid content of web to 40-50 % (Not used if aiming to highly porous structures)
- **Drying**: With contact or non-contact techniques
- Process can be batch or continuous process

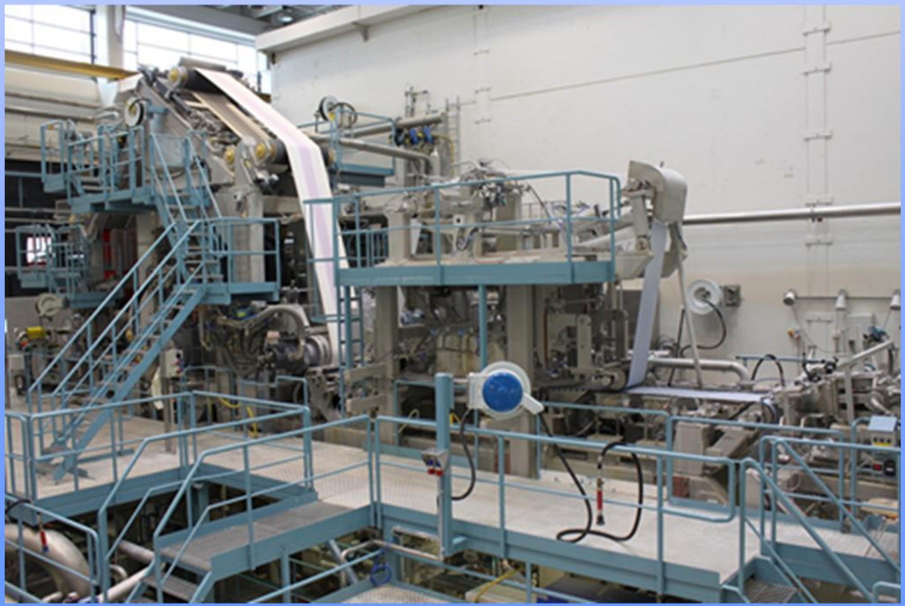
global insulation CONFERENCE & EXHIBITION

Pilot scale foam forming environment at VTT

Technical specifications:

- Design speed 2000 m/min
- Sampling speed <1000 m/min
- Roll width 250 mm
- Several forming geometry options
- Multilayer forming possibilities
- Two foam generation options (tank mixing & tube generation)
- Single nip press section
- Off-line dryer
- For paper-like products





global insulation CONFERENCE & EXHIBITION

Foam formed thermal insulation materials based on wood fibres – the effect of fibre type

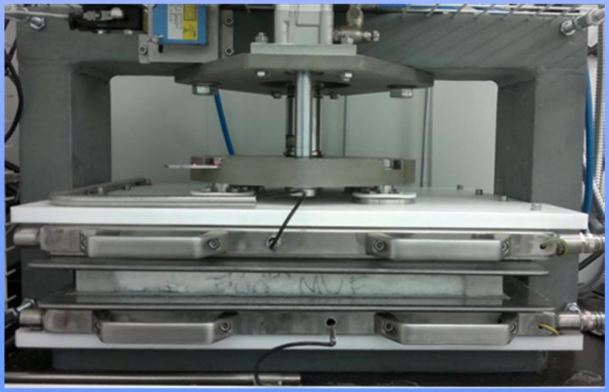
Preparation of foam formed materials in laboratory scale

Phases:

- **Fibre foam generation**: Mixing of pulp suspension and foaming agent
- **Sheet forming**: Fibre foam is poured into a mould and drained by gravity
- **Drying** in the oven
- **Rewetting** to dsc. 50 % and **pressing** to targeted thicknesses
- **Drying** in the oven

Foaming

Sheet forming



Pressing

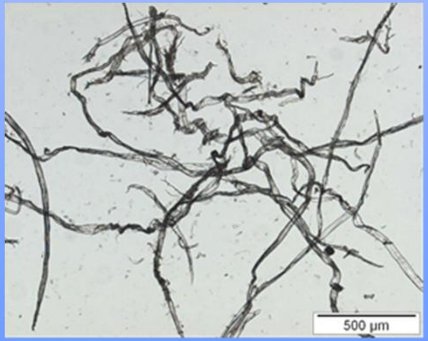
Fiber dimensions

	Fibre length, mm	Fibre width, µm
SW	2.00	29
HW	0.87	21
TMP	1.36	33
Glass	3-10	8-10
PLA	12	10-12

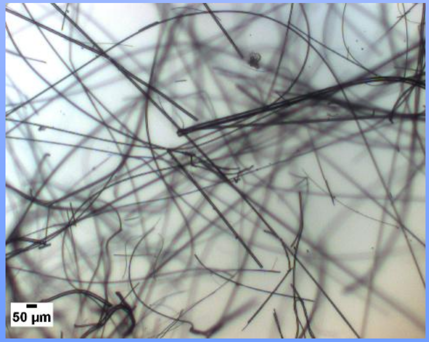
SW: Chemical softwood pulp
HW: Chemical hardwood pulp
TMP: Thermomechanical pulp
Glass: Glass fibres
PLA: Polylactid acid fibres

- SW, HW, TMP average fibre dimensions by Fibermaster analyzer
- Glass and PLA fibre dimensions estimated from optical microscope images

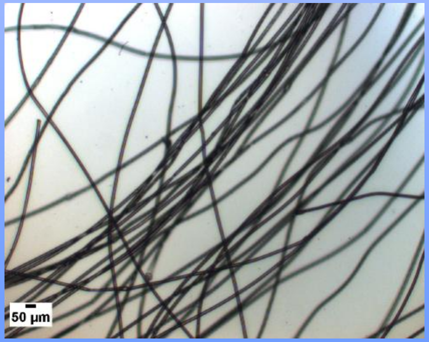
Optical microscope images



SW



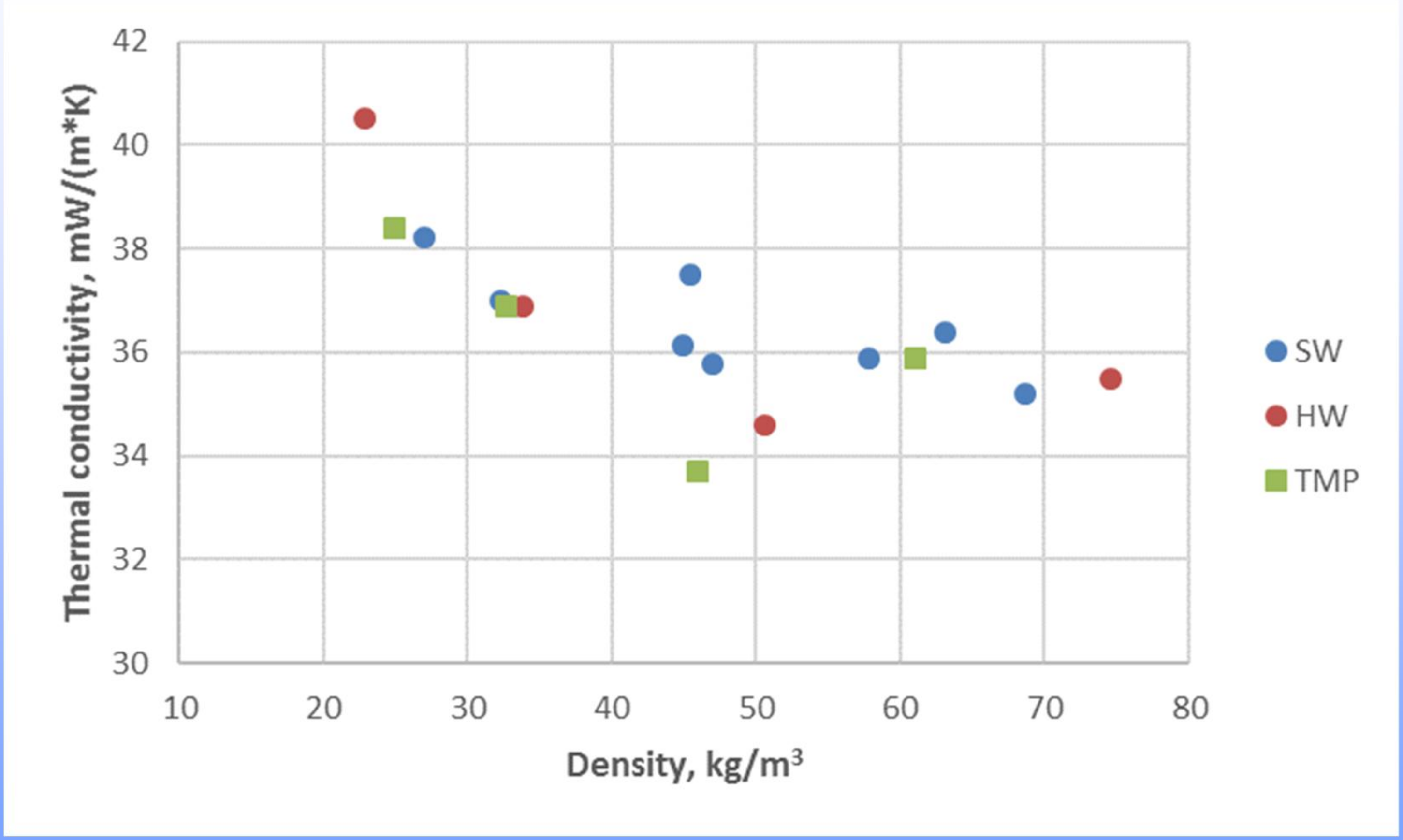
Glass



PLA

This result is part of WOTIM project funded by the WoodWisdom-Net Research Programme under the Seventh Framework Programme (FP7)

Thermal conductivity



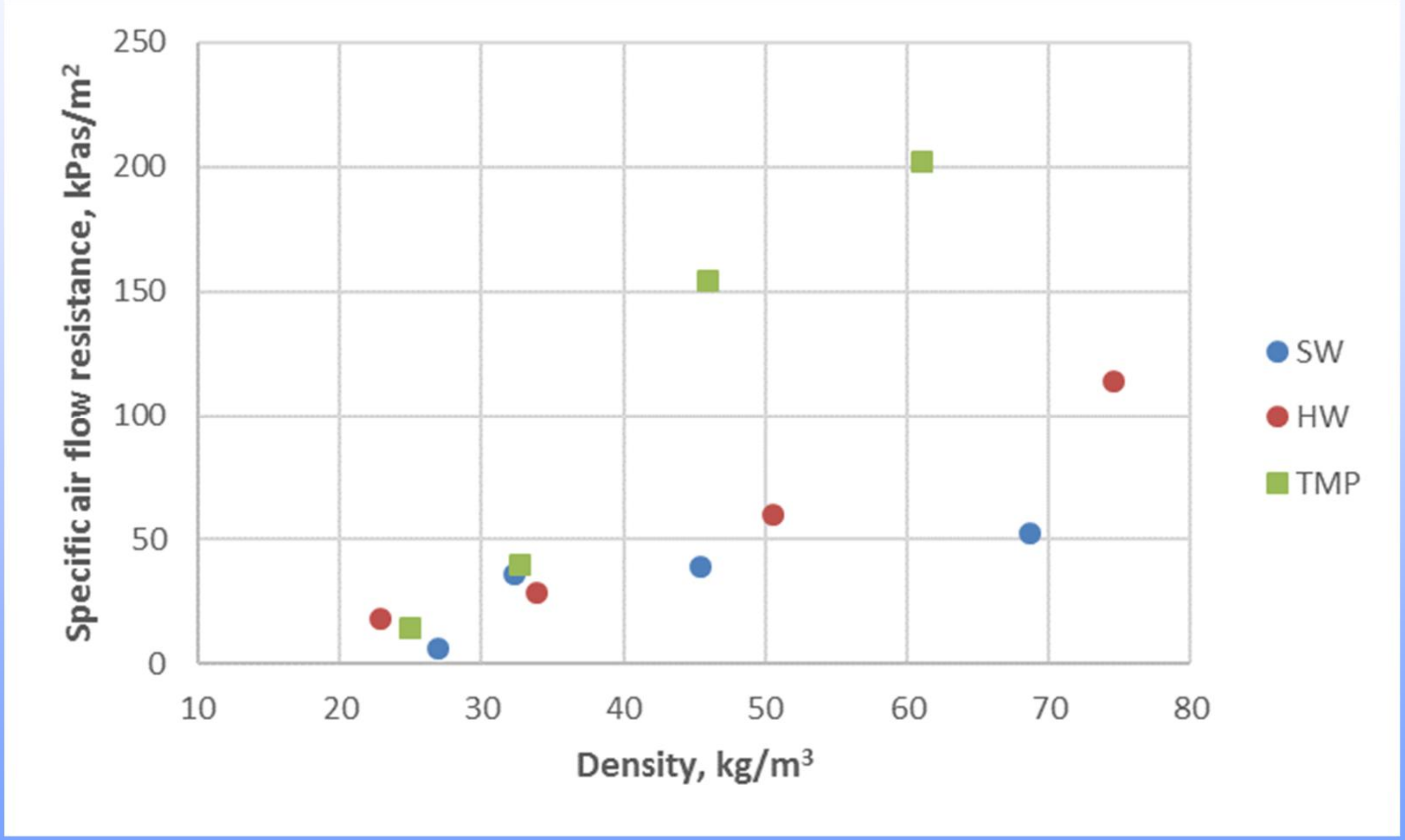
SW: Chemical softwood pulp
HW: Chemical hardwood pulp
TMP: Thermomechanical pulp

ΔT +20 °C

EN 12667

This result is part of WOTIM project funded by the WoodWisdom-Net Research Programme under the Seventh Framework Programme (FP7)

Air flow resistance

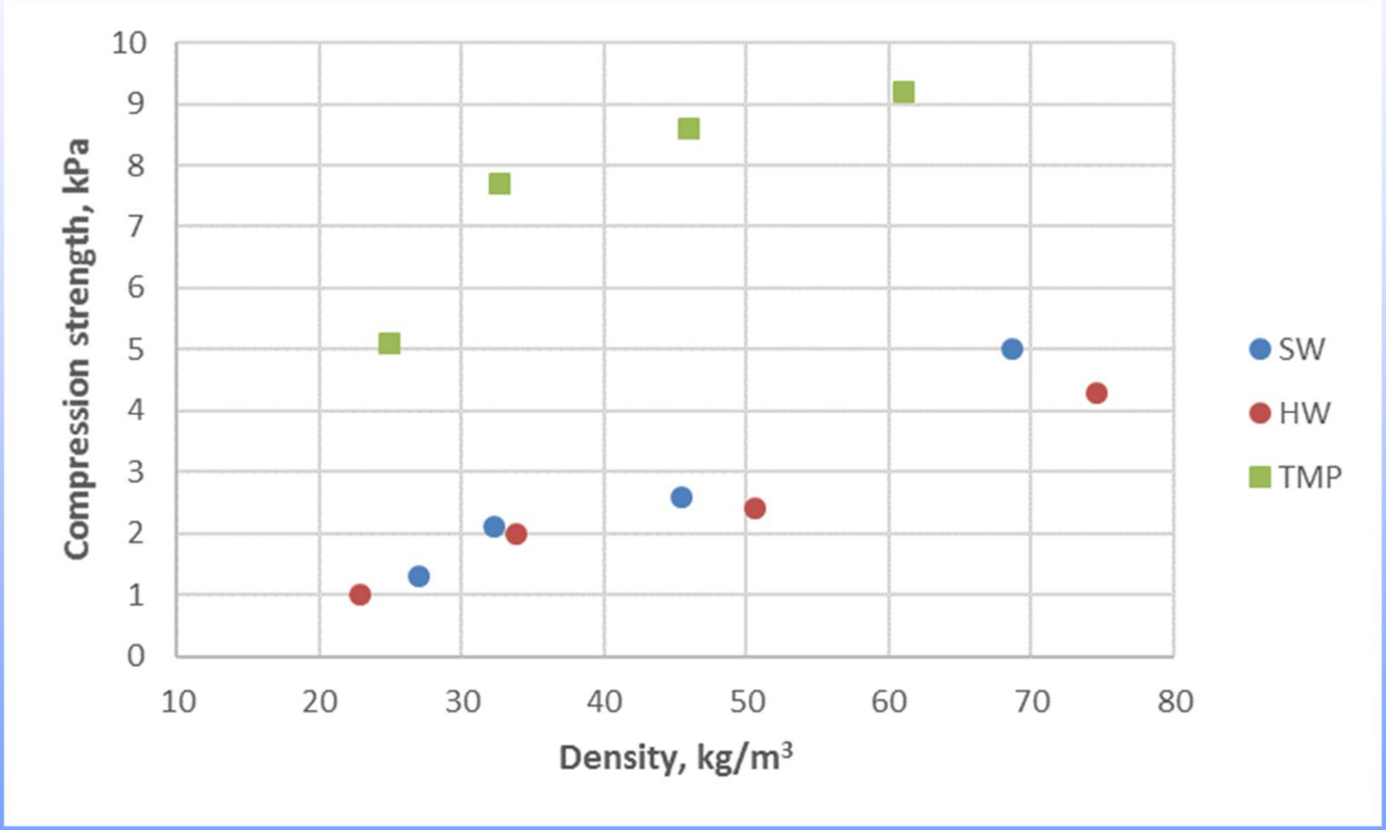


SW: Chemical softwood pulp
HW: Chemical hardwood pulp
TMP: Thermomechanical pulp

ISO 9053

This result is part of WOTIM project funded by the WoodWisdom-Net Research Programme under the Seventh Framework Programme (FP7)

Compression strength



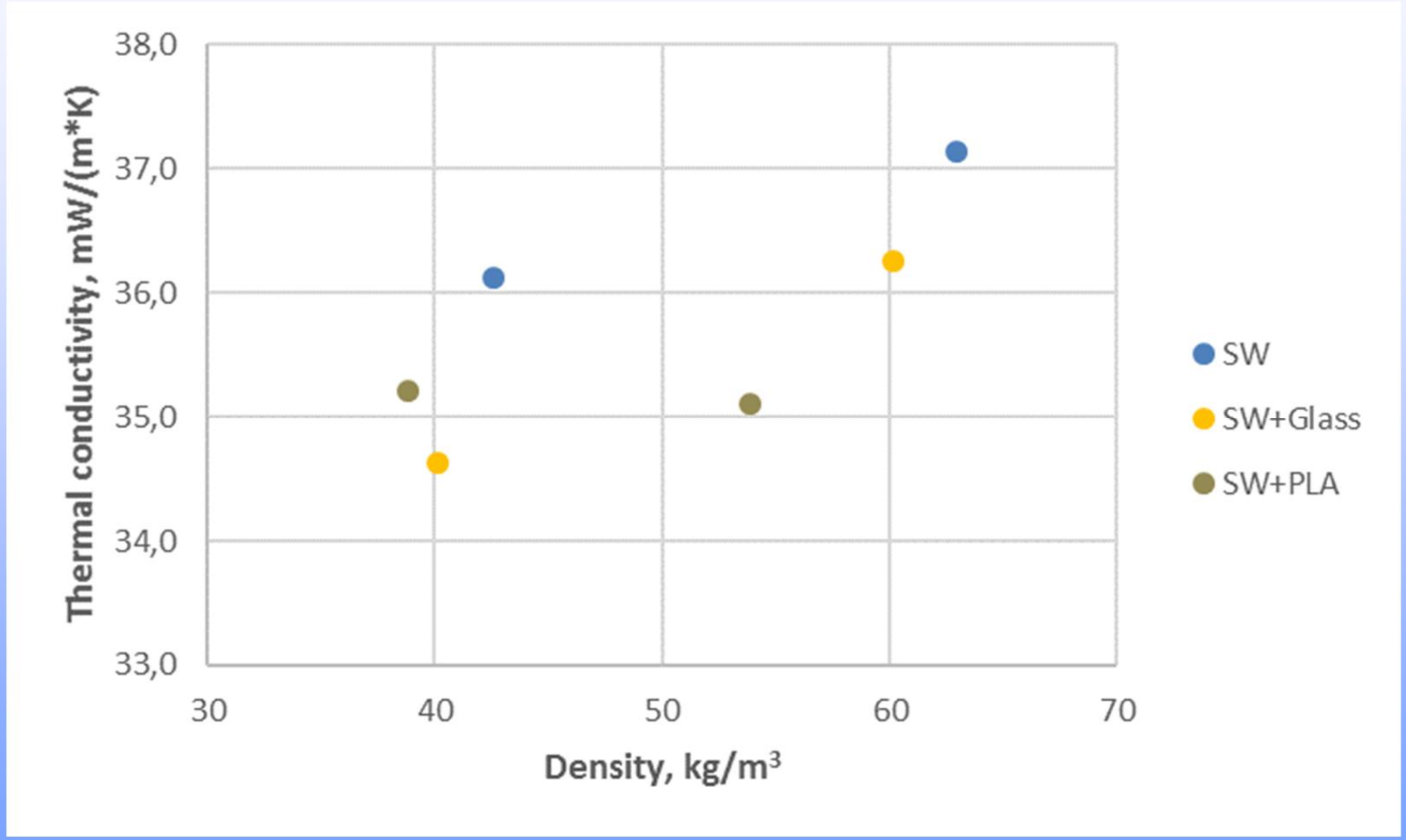
SW: Chemical softwood pulp
HW: Chemical hardwood pulp
TMP: Thermomechanical pulp

10 % compression

EN 826

This result is part of WOTIM project funded by the WoodWisdom-Net Research Programme under the Seventh Framework Programme (FP7)

Thermal conductivity of material mixtures



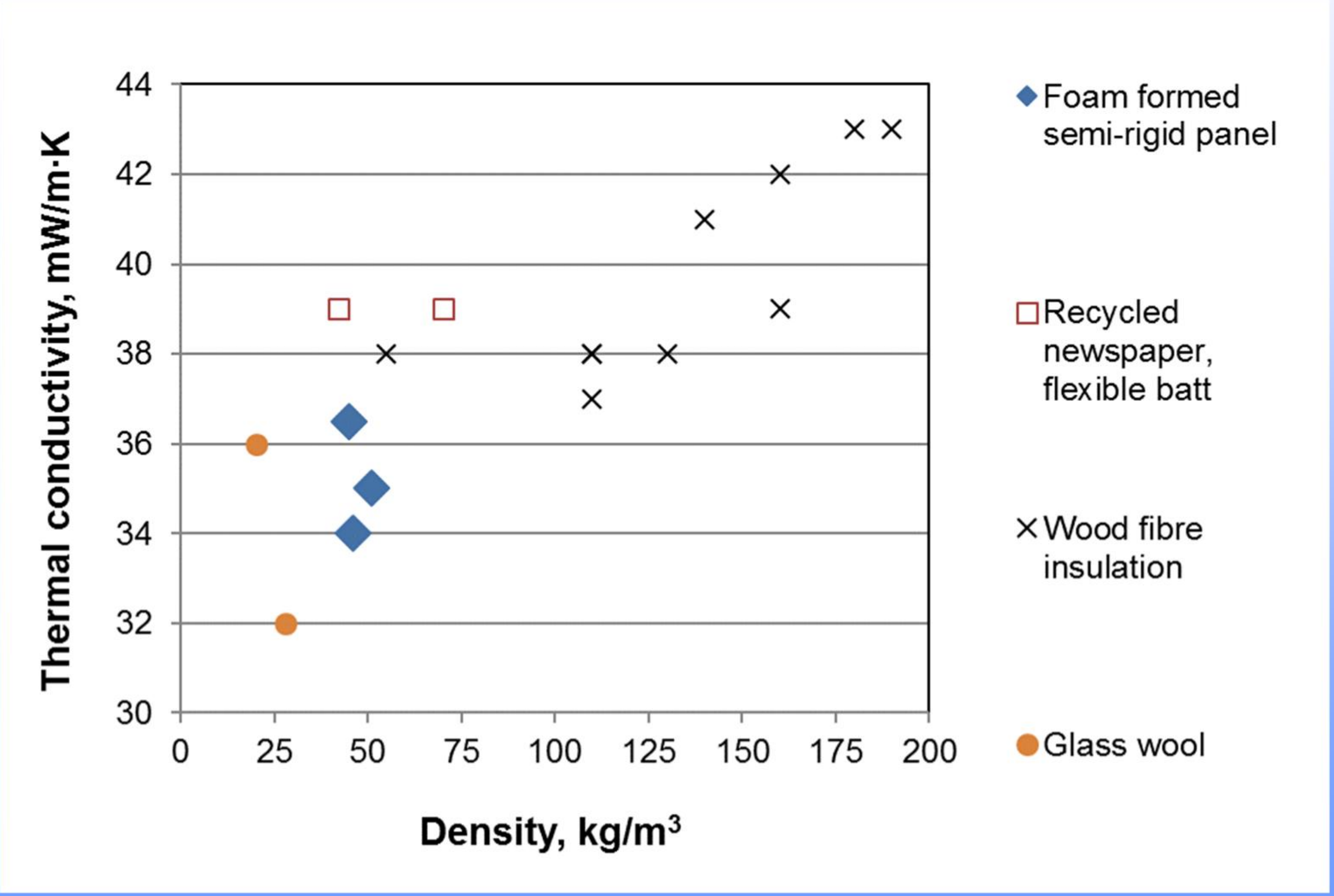
SW: Chemical softwood pulp
Glass: Glass fibres
PLA: Polylactid acid fibres

Man-made fibre proportion 20 %

This result is part of WOTIM project funded by the WoodWisdom-Net Research Programme under the Seventh Framework Programme (FP7)

Benchmarking of wood based foam formed building materials against commercial materials

Thermal insulation materials – thermal conductivity



EN 12667

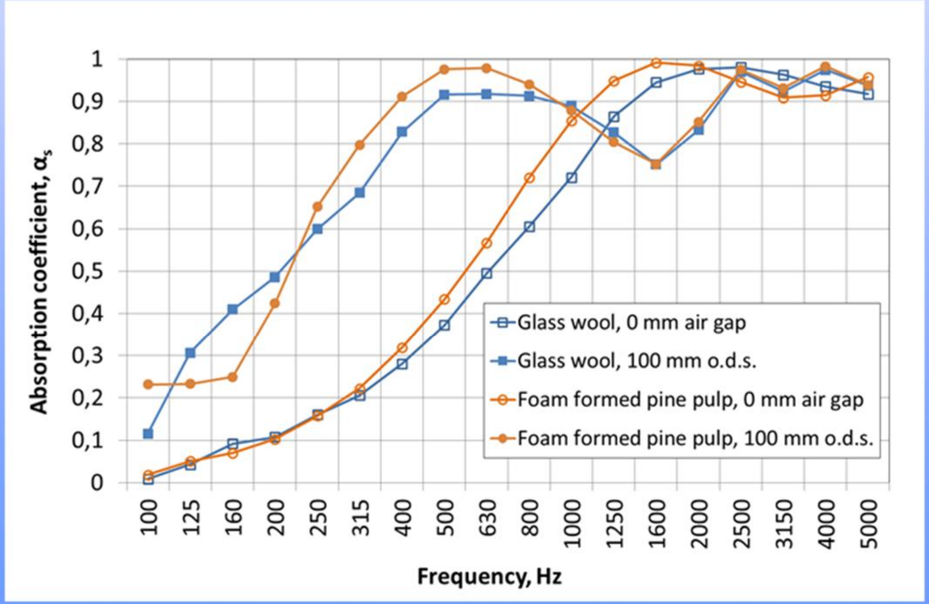
This result is part of WOTIM project funded by the WoodWisdom-Net Research Programme under the Seventh Framework Programme (FP7)

Acoustic panels - sound absorption

Material	Thickness	Density	Grammage	Flow resistivity
	mm	kg/m^3	g/m^2	Ns/m^4
Commercial glass wool	30	53	1585	27300
Foam formed pine pulp	30	42	1260	23600

Glass wool product

Foam formed pine pulp

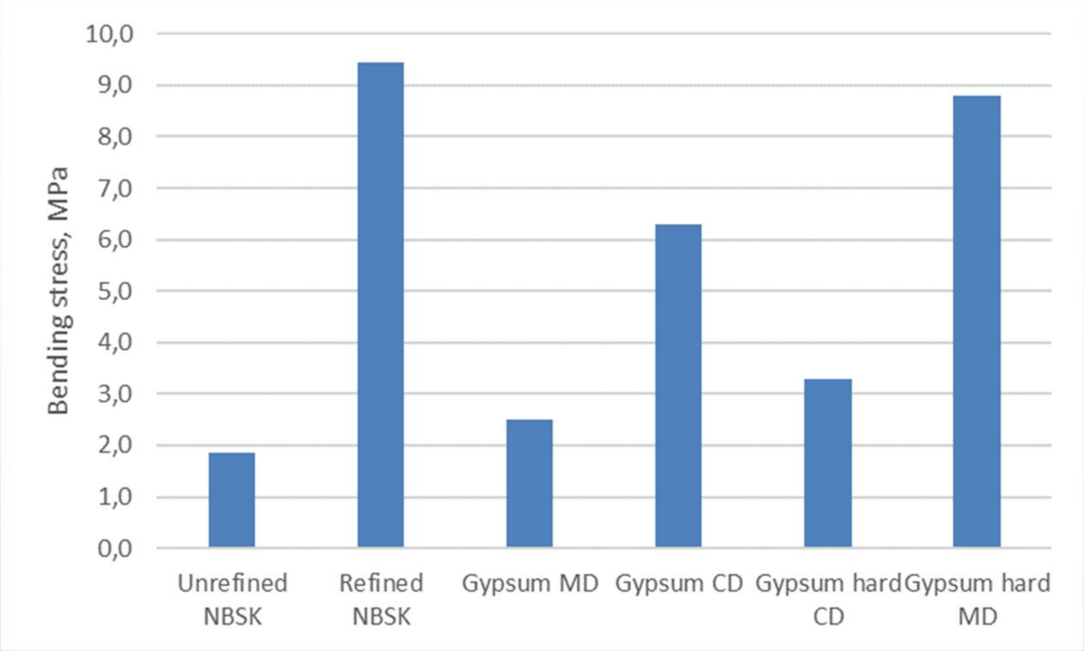


ISO 10534-2

Absorption coefficient 0=no absorption, 1= full absorption, o.d.s.= mounting level from surface

This result is part of FOAMSOUD project funded by the Finnish Funding Agency for Innovation (TEKES)

Building boards – bending strength



NBSK: Northern bleached softwood kraft

Internal wall element

- Surfaces: Foam formed boards
- Middle layer: Foam formed thermal insulation material

Foam formed fibre board

EN 12089

This result is part of OSIRYS project funded under the Seventh Framework Programme (FP7)

Status and future actions

Status and next steps

Status

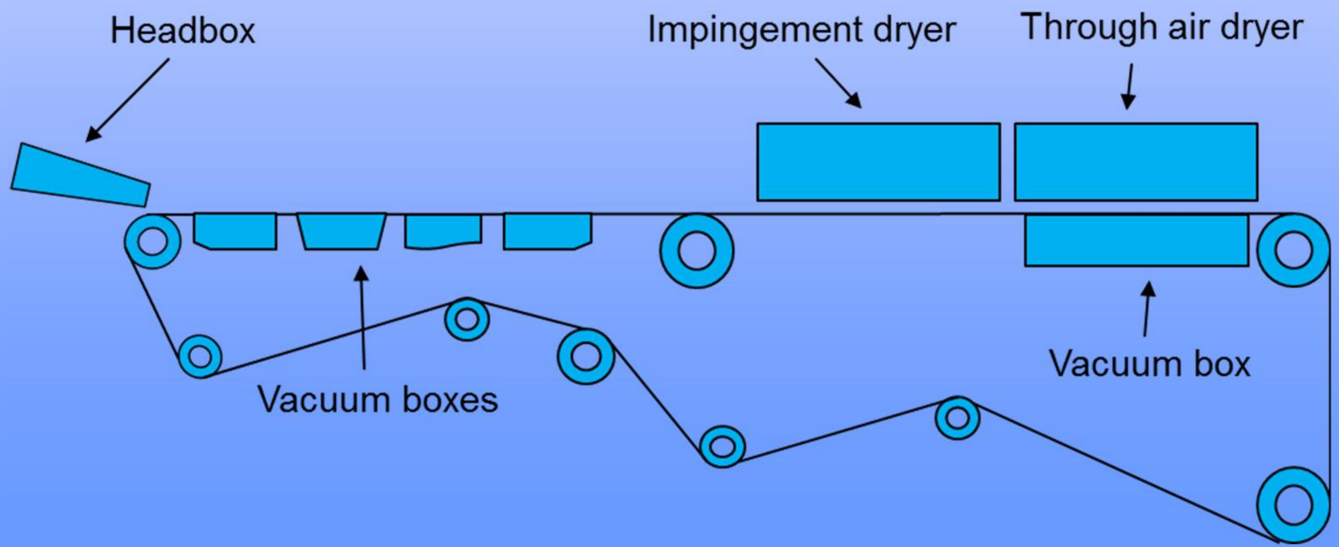
- Technical performance of foam formed building materials is proved in laboratory scale
- However there is still a need for the development/optimization work that all required properties can be achieved (varying with applications)
- Preliminary cost evaluations are promising in many cases

Next steps

- Up-scale the manufacturing of building materials in pilot scale – technical proof of concept
- Evaluate the cost and resource effectiveness of manufacturing based on pilot data
- Material production to demo buildings

New pilot line at VTT – Layout and technical specifications

- Design speed 1000 m/min
- Sampling speed < 200 m/min
- Sample width 600 mm (rolls or sheets)
- Two forming geometry options
- Multilayer forming possibilities
- Foam generation in tank
- For “thick” products (thickness 1 – 20 mm)



Foam forming - potential production technology for building materials

Petri Jetsu, Tiina Pöhler

VTT Technical Research Centre of Finland Ltd