EVALUATION OF TWO FIREPROOF TREATMENT METHODS ON THE FLAMMABILITY AND THE SOUND ABSORPTION OF HEMP FIBERS

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Context and challenges

Vegetal wools

High-level multifunctional properties

- Acoustic absorption
- Thermal insulation
- Hygroscopic nature

Flammable

Challenges

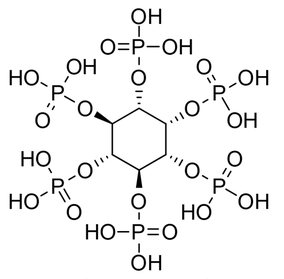
- The treatment needs to be viable at large scale and environmentally friendly

Objective

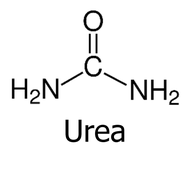
Evaluate the alternatives and the application methods of an environmentally friendly fireproof treatment in vegetal fibers, considering an industrial scale

The treatment

Immersion Method	Pulverization Method
Solution preparation with 10% phytic acid and 30% urea	
Immersion in solution	Spraying of the solution
Oven for 2h at 80°C and 120°C	
Wash and dry	Dry



Phytic Acid



Urea

Immersion

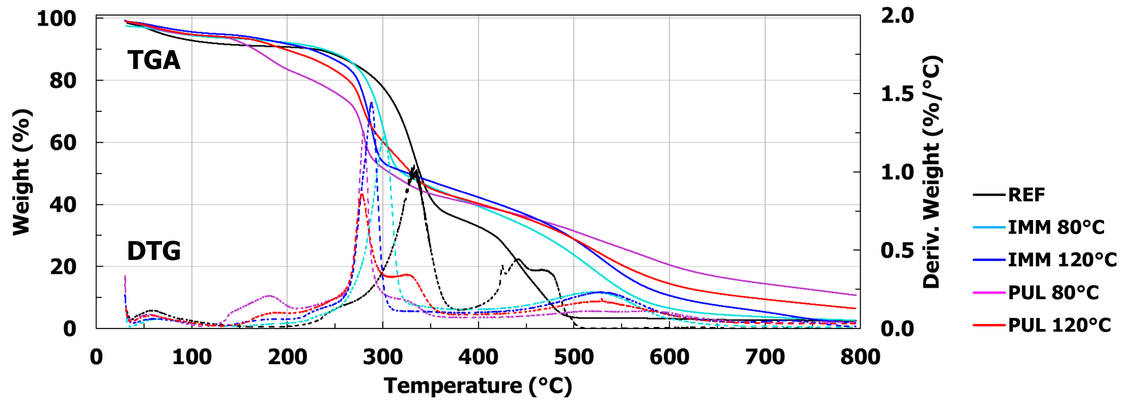
Pulverization

Consequences of the treatment

Sample	Phosphorus content	Real density (g/cm³)	Mass increase (%)
REF	0.08%	1.503±0.004	-
IMM 80°C	0.61%	1.504±0.002	3.0±0.8
IMM 120°C	0.66%	1.479±0.003	5.1±1.7
PUL 80°C	1.85%	1.496±0.003	14.3±4.6
PUL 120°C	1.56%	1.489±0.002	12.8±2.4

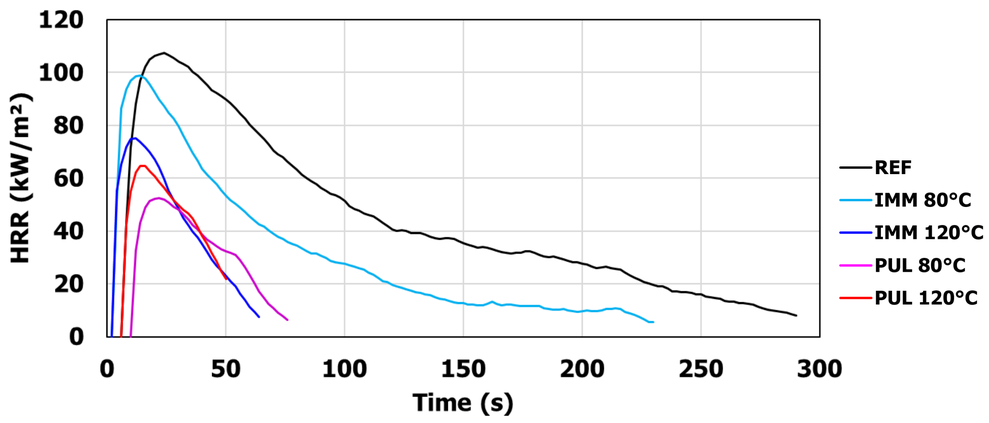
- Pulverized fibers achieved a higher phosphorus content than the immersed fibers
- A small decrease of the fibers' density (<0.03 g/cm³) is observed for the samples treated at 120°C
- A mass increase is observed on the treated fibers proportional to their phosphorus content

TGA/DTG: Thermal degradation

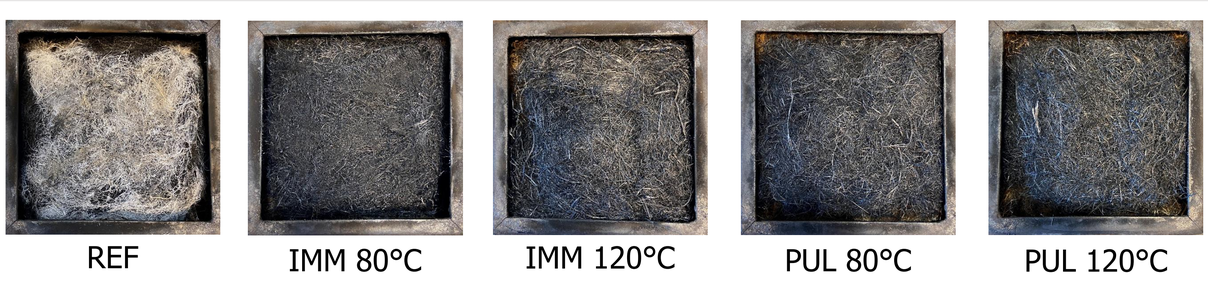


- Samples tested at 10°C/min under air atmosphere
- Earlier thermal degradation due to the acid catalysis
- Residue at 500°C increased from 3.6% (ref.) to 23-31% (treated samples)
- Pulverized samples presented higher residue
- Higher phosphorus content -> higher residue

Cone calorimeter: Heat release rate



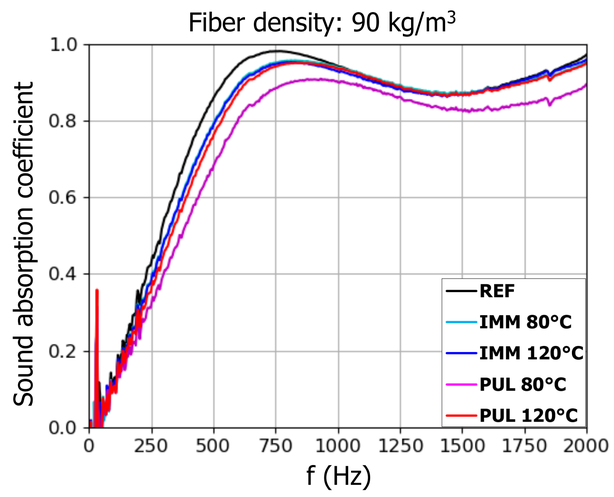
- Treated fibers: lower peak HRR, mean HRR and total heat released
- Pulverized fibers presented a lower flammability
- Higher phosphorus content -> better char formation



REF | IMM 80°C | IMM 120°C | PUL 80°C | PUL 120°C

Impedance tube: Sound absorption

- The treatment lowers the sound absorption capacity of the hemp fibers
- It also shifts the first peak of sound absorption to higher frequencies
- This effect is linked to modifications on the microstructure -> increase on the fiber's diameter



Conclusion

- The phosphorus grafted led to an increase in the fiber's mass but no significant modification on the fiber's density
- Both treatment methods reduced the flammability of the fibers
- A higher phosphorus content led to lower flammability
- The sound absorption performance of the hemp fibers slightly decreased with the treatment

Perspectives

- Production of fireproof treated hemp wools, adapting the treatment method to an industrial scale application
- Investigation of the flammability, acoustic and thermal performances of the hemp wools

Bibliography

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Acknowledgment

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie COFUND grant agreement No 101034248

This project has received funding from the project ANR BIOMETA - Projet-ANR-23-CE22-0012
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