THE INFLUENCE OF PROCESS PARAMETERS ON THE IMPREGNATION STAGE OF BEECH WOOD CHIPS

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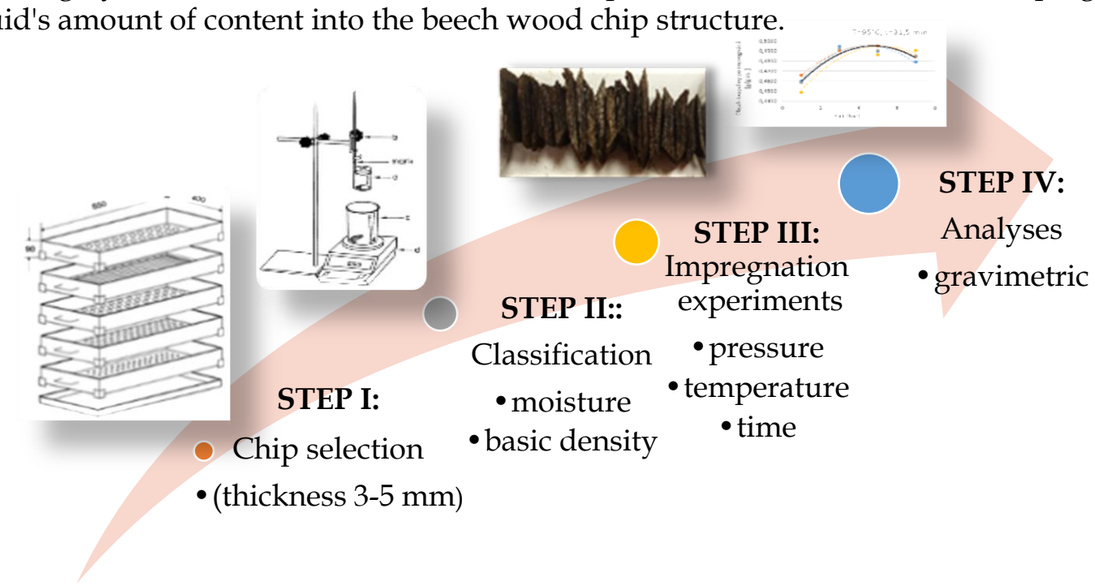
ABSTRACT

The paper deals with the influence of process parameters on the CBC process impregnation step, which occurs during kraft cooking/delignification. The impregnated raw material was beech chips with 37 - 49% moisture content, which were sorted into the required fraction on a laboratory sorter in the first step. The impregnation tests focused on the water penetration content of the impregnation fluid into the beech chips due to its operational availability and physical properties, which are well known.
The gravimetric analysis determined the fluid content after the impregnation cycle as the ratio of the weight of the impregnated wood chip structure to that of dry wood. Impregnation tests over 24 hours were chosen to compare the maximum amount of fluid impregnated into the chip structure. The individual analyses show that the amount of fluid impregnated is greatly affected by the pressure used, while the temperature has a minor effect. This is illustrated by the results on the individual graphs. The highest content of impregnated liquid is recorded at a pressure of 5 bar, at a constant temperature, and the established time of the impregnation step. While maintaining constant conditions and increasing the pressure to 7 bar, a decreasing trend of the fluid impregnation content was observed.
Therefore, process parameters such as temperature and pressure significantly affect the impregnation step, which is a crucial part of the whole CBC process and significantly influences homogeneous delignification, overall yield, and the amount of rejects.

EXPERIMENTS

The main objective of the experimental part was to study the effect of process parameters such as pressure, temperature and time on the impregnation stage of beech wood chips. The 3A fraction, which was sorted on laboratory sorter for 10 minutes, was used for the experiments. The preparation of experimental materials was followed by the moisture and basic density classification of wood chips. The experiments on the impregnation stage thoroughly monitored the influence of the operation conditions on the impregnation fluid's amount of content into the beech wood chip structure.



MATERIALS

For experiments was used beech wood chips with moisture ($37-46\ \%$) and basic density ($477-583\ \mathrm{kg.m^{-3}}$), which was established according to SCAN-CM 43:95. The beech wood chips were screened to obtain a chip thickness of $3-5$ mm, no bark or knots were included in the samples.

X	Basic density	($\mathrm{kg.m^{-3}}$)
m_{wood1}	Amount of dried beech wood chips	(g)
ρ	Water density = 1000	($\mathrm{kg.m^{-3}}$)
m_{bf}	Is the balance reading in grams, obtained with the basket full	(g)
m_{be}	Is the balance reading in grams, obtained with the basket empty	(g)

Fig. 1
Beech wood chips

$$X = \frac{m_{wood1} \cdot \rho}{(m_{bf} - m_{be})} \quad (1)$$

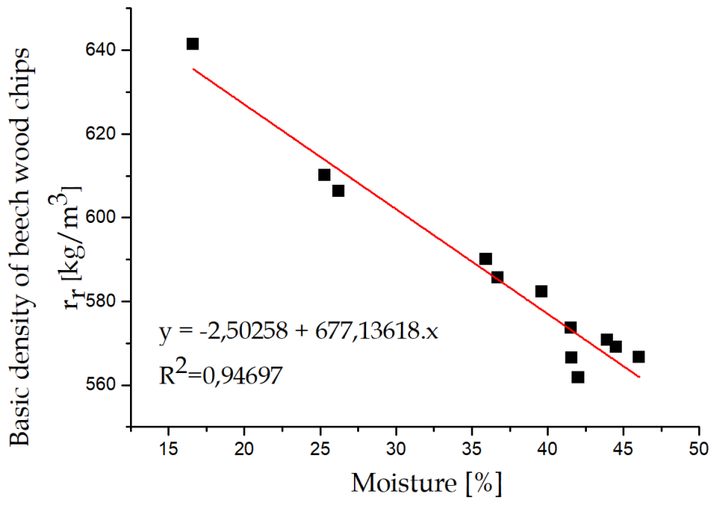


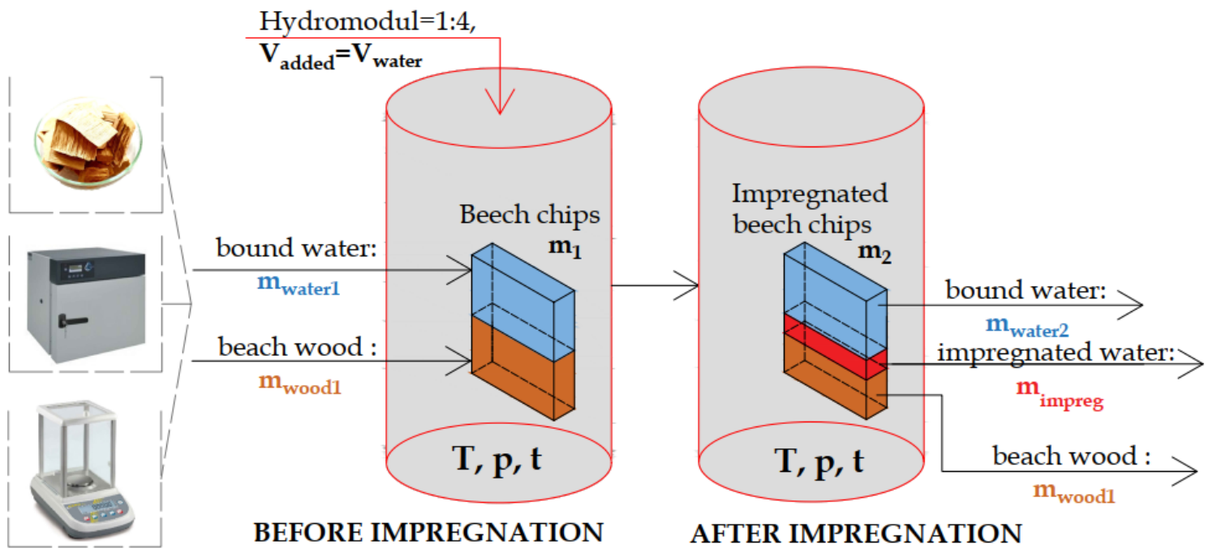
Fig. 2
Basic density of beech wood chips as a function of the moisture

Fig. 3
Full basket of beech wood chips

IMPREGNATION TESTS

In the first step, the beech wood chips of the desired fraction were weighed m_1 on a laboratory balance, and the part of the sample is placed in a drier to obtain moisture w_1. The weighed amount of chips was placed in a digestor (pressure vessel with temperature and pressure sensor) and closed with a sieve and a flange.

Subsequently are selected the exact values of the process parameters at which the impregnation takes place. After the impregnation test was closed, the chips are removed from the digester and reweighed m_2.



RESULTS AND DISCUSSION

This study involved the impregnation step of Continuous batch cooking of beech wood chips with different moisture. The thermal, temporal, and pressure effect on the impregnation was analysed to clarify beech wood chips' impregnation. The gravimetric analysis show that pressure had the most significant effect on the amount of fluid impregnated into the wood structure. The graphs show no significant increase in the amount of fluid impregnated when the pressure increase above 7 bar.

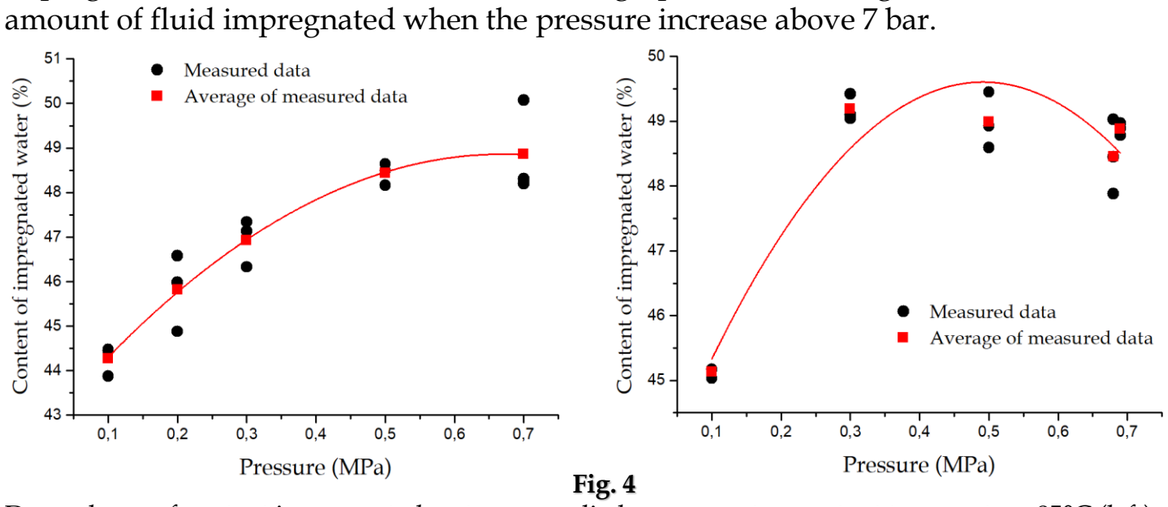


Fig. 4
Dependence of content impregnated water on applied pressure at a constant temperature 95°C (left) and 85°C (right)

$$m_{water1}(\mathrm{BOUND}) = w_1 . m_1 \quad (2)$$

$$V_{water1} = \frac{m_{water1}}{\rho_{water1}} \quad (3)$$

$$m_{wood1} = m_1 - m_{water1} \quad (4)$$

$$m_{impreg} = m_2 - m_1 \quad (5)$$

$$\Phi = \frac{m_{water1} + m_{impreg}}{m_2} . 100\% \quad (6)$$

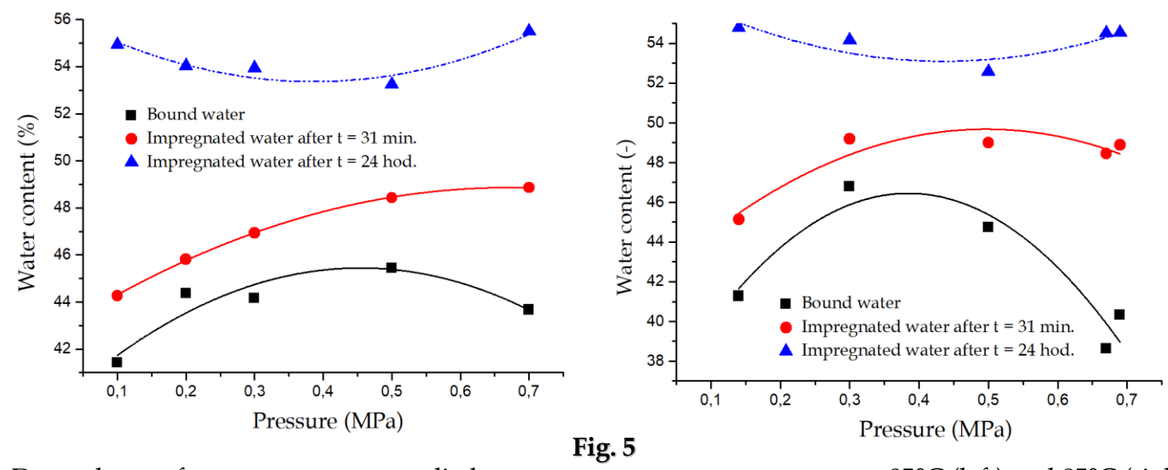


Fig. 5
Dependence of water content on applied pressure at a constant temperature 95°C (left) and 85°C (right)

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REFERENCES

[1] KOHÚTOVÁ, M., Impregnation of chips during the kraft process, bachelor thesis, 2018