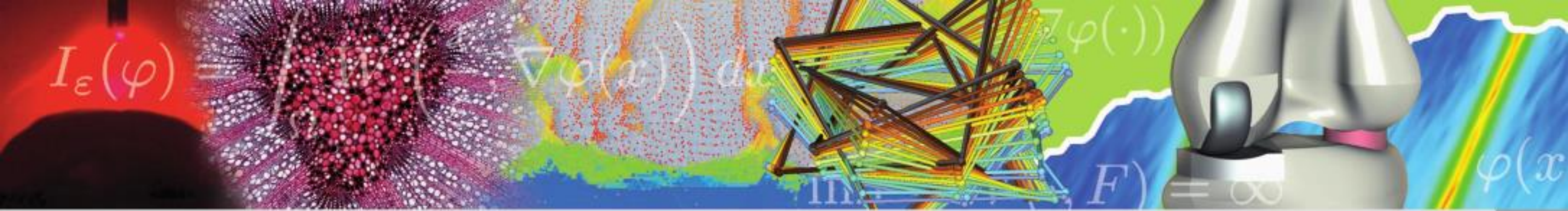

Caractérisation de la cinétique de diffusion hydrique du bois sans défauts de feuillus

B9

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ABSTRACT

Wood is a porous and hygroscopic material which is highly sensitive to the humidity of the environment and temperature (Hailwood and Horrobin, 1946). It express hygroscopic deformations and affects its mechanical properties (Wilfred & Kollmann, 1968) according to equilibrium moisture content (EMC) state or transient moisture changes. The sorption isotherm shows the relationship between EMC and the constant environment without describing that the equilibrium is a kinetics behavior (Schmulsky & Jones, 2011; Glass et al., 2018). The equilibrium process could be well fitted by the Parallel Exponential Kinetics model (PEK-model) which would need stronger physical evidence. This study carries out a comparison of different sorption processes and a start of discussion.

CONTEXTE & OBJECTIVES

- The relationship between the temperature T, relative humidity h and the equilibrium moisture content EMC can be present by: (Ross, 2010)

$$EMC(\%) = \frac{1800}{\omega}\left[\frac{Kh}{1-Kh} + \frac{K_1Kh + 2K_1K_2K^2h^2}{1 + K_1Kh + K_1K_2K^2h^2}\right]$$

$$\omega = 349 + 1.29T + 0.0135T^2$$
$$K = 0.805 + 0.000736T - 0.00000273T^2$$
$$K_1 = 6.27 - 0.00938T - 0.000303T^2$$
$$K_2 = 1.91 + 0.0407T - 0.000293T^2$$

- The equilibrium of the moisture content is a kinetics behavior, the process of mass W or moisture content MC by the time t can be fitted by the Parallel Exponential Kinetics model (PEK-model), which has a similar form as Kelvin-Voigt model (Kohler, 2006).

$$W_t = W_{eq1}\left(1 - e^{\frac{-t}{\tau_1}}\right) + W_{eq2}\left(1 - e^{\frac{-t}{\tau_2}}\right)$$
$$MC(t) = MC_0 + MC_1\left(1 - e^{\frac{-t}{\tau_1}}\right) + MC_2\left(1 - e^{\frac{-t}{\tau_2}}\right)$$

τ: *characteristic time*
1: Fast sorption
2: Slow sorption

- The equilibrium process associated with 2-independent process which depends on the regions of the sorption behavior takes place (Okubayashi et al., 2004):
  1. Fast sorption: at the external surface and amorphous regions
  2. Slow sorption: at the inner surface and crystallites

MATERIAL & METHODS

Materials:
European beech (*Fagus sylvatica*) and European oak (*Quercus petraea*)
Specimence size: 150 mm(L) * 12 mm(R) * 2 mm(T)
Instruments:
The auto-climate chamber Memmert HPP110 (5 to 70°C, 10 to 90%RH)
The balance METTLER TOLEDO ME204 (220g range, ∆m=0,1mg)

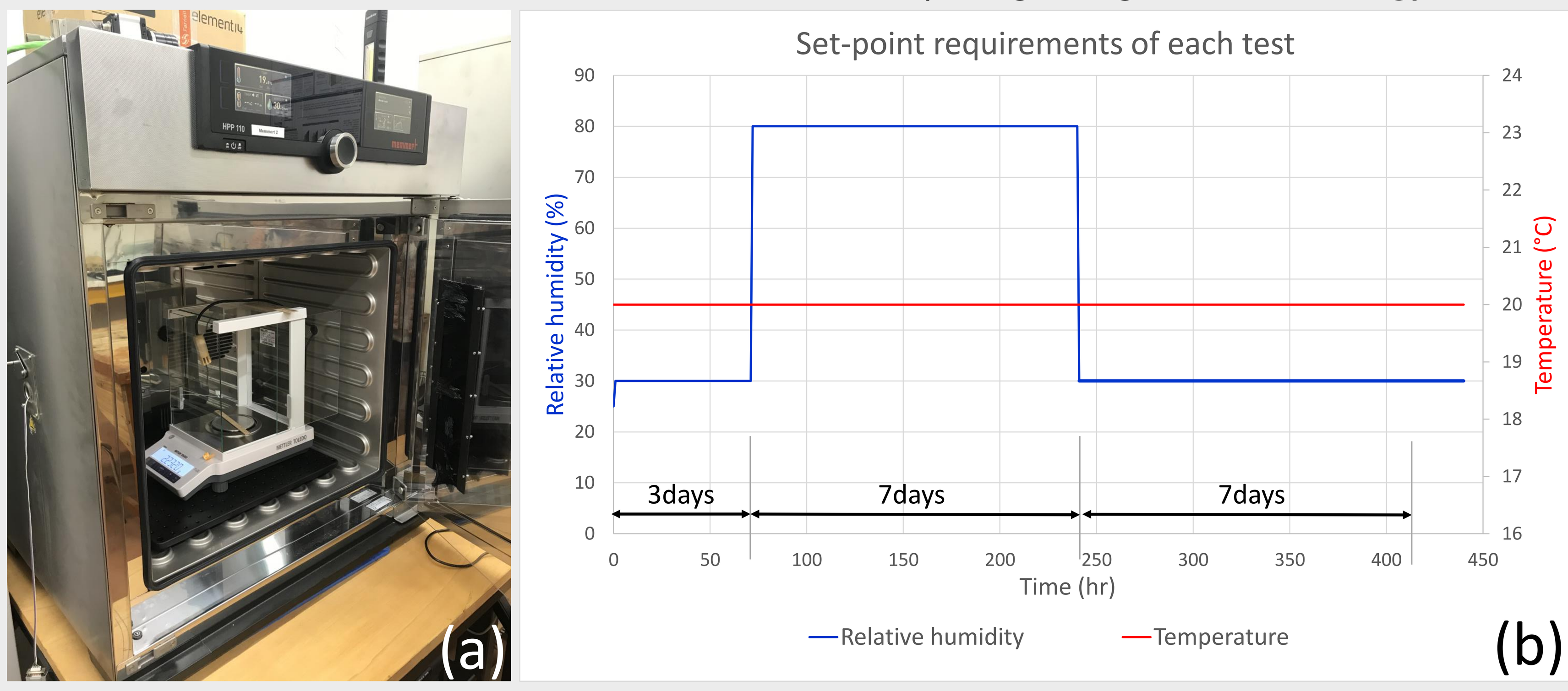

Fig. 1 (a) the setup of instrument (b) the environmental condition

RESULTS & DISCUSSION

1. **Stability of environment**:
The relative humidity h setting up can be seprated into 3 stage: (I) pre-stabelize (II) absorption (III) desorption.

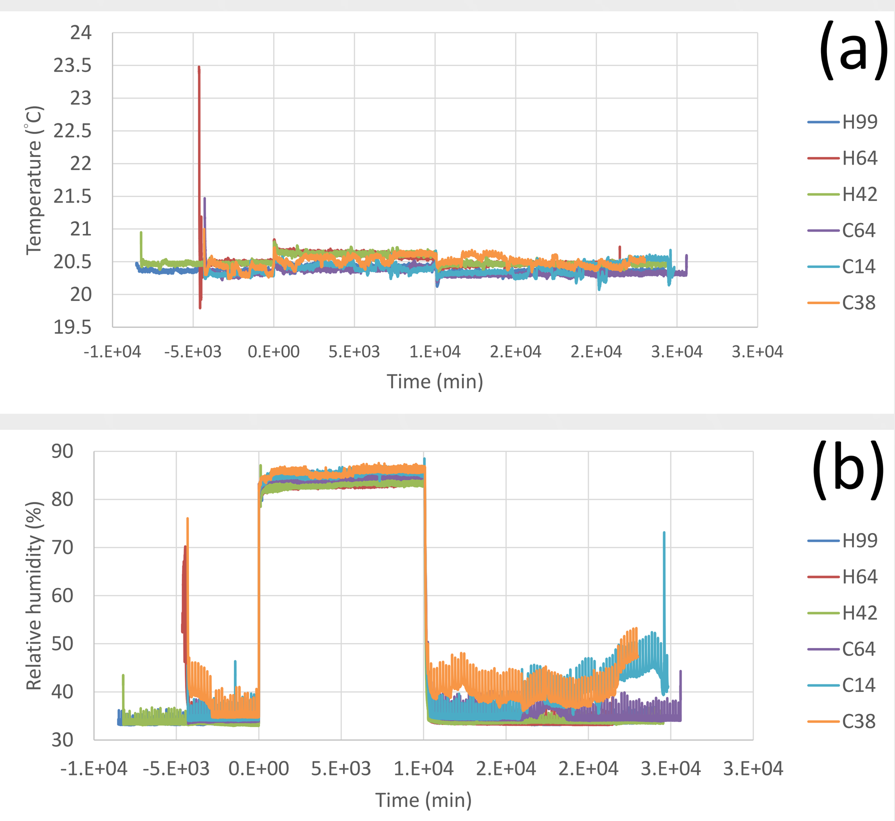

Fig. 2 the record of (a) temperature and (b) relative humidity

2. **Relative moisture content (rMC)**:
In order to compare the moisture situation among different specimens without the oven-dry weight, the rMC value was defined. According to the record of the environment condition, the h is relative stable at high level.

Calculation of rMC:
(1) The average value of h at high level.
(2) The EMC by the formula (Ross, 2010).
(3) The average mass W_{avg} of specimens which is stable at high humidity level.
(4) Get the dry weight W_d by calcutating.
(5) Change the mass value W_m into rMC value.

$$\frac{W_{avg} - W_d}{W_d} = h_{high\ level}$$

$$rMC(\%) = \frac{W_m - W_d}{W_d} \times 100\%$$

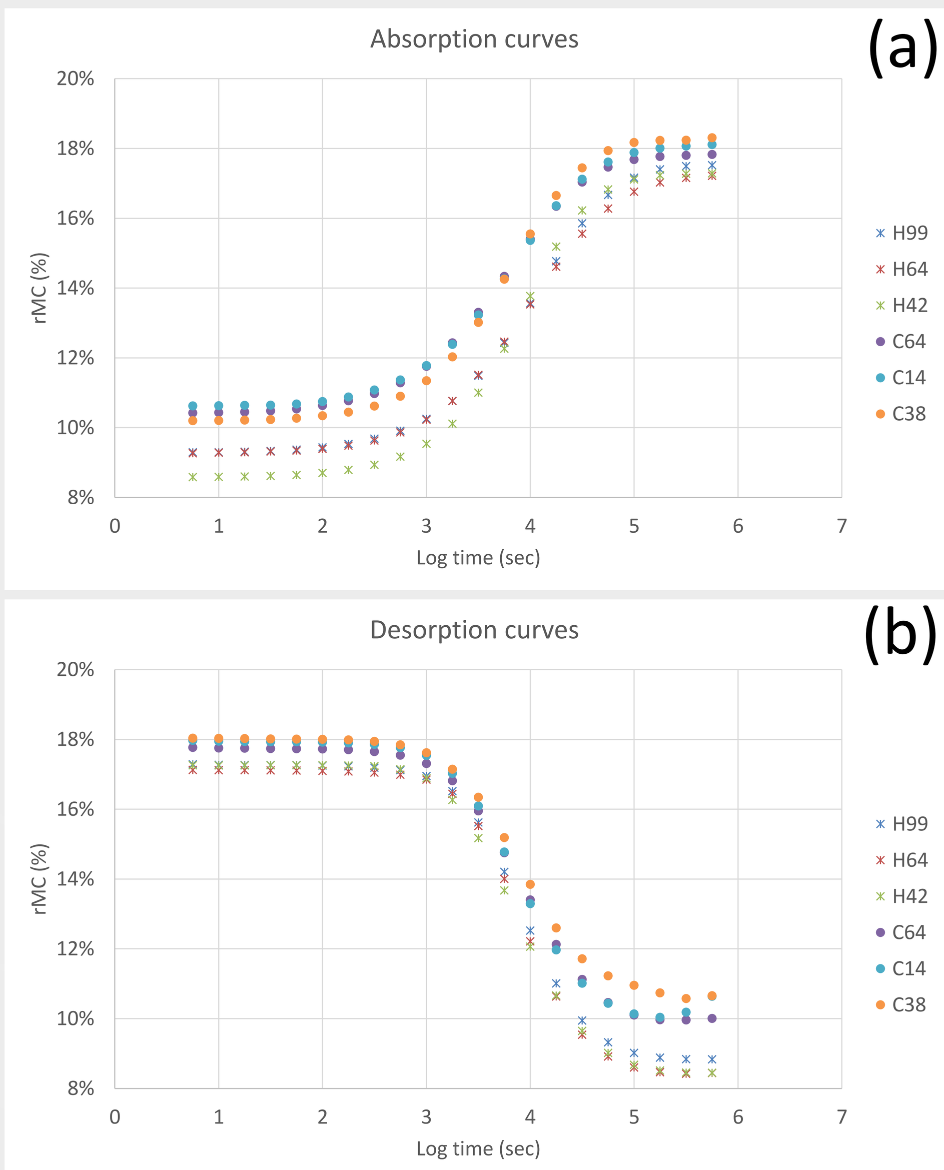

Fig. 3 the results of (a) absorption and (b) desorption

3. **Curves fitting**:
From the result of the mass, the behavior of fast and slow sorption could not be seprated obviously. To simplfy the function, the testing result was fitted by :

$$MC(t) = MC_0 \pm k\left(1 - e^{\frac{-t}{\tau}}\right)$$

$$Error = \sum (rMC - MC(t))^2$$

Table 1. the parameters of fitting result

	k		τ		Error	
	ab	de	ab	de	ab	de
H99	0.0700	0.0804	10000	10000	0.0006	0.0002
H64	0.0750	0.0857	11851	13089	0.0002	0.0001
H42	0.0848	0.0860	10564	11730	0.0001	0.0001
C64	0.0710	0.0763	7097	12566	0.0002	≈ 0
C14	0.0715	0.0766	8379	11275	0.0001	≈ 0
C38	0.0783	0.0718	8148	12210	0.0001	≈ 0

ab: absorption process; de: desorption process

CONCLUSIONS & FUTURE WORK

- From the result of the experiment, the difference between species or among specimens didn't carry out an obvious tendency. More kinds of wood with higher diversity could be taken in to account.
- The process of fast and slow sorption behavior could not be separated by estimation (Himmel & Mai, 2016). The testing result can be well fitted by the function simplify and show the difference between absorption and desorption which could be compared with the sorption isotherm.
- The other types of models could be considered for describe the sorption process to have a better explanation of physical meaning.

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