

Electronic supplementary material

A Experimental pressure relaxation kinetics

The pressure in the high-pressure tank was rescaled as $(P_1 - P_m)/((P_1(0) - P_2(0))/2)$ and the rescaled pressure was replotted in semi-log format as a function of time. Examples of typical relaxation kinetics are reported in Fig. A1 and A2 for the 80 nm track-etched membrane and for a Norway spruce sample taken in the longitudinal direction, respectively. For the Norway spruce sample, the relaxation is systematically exponential and the characteristic time can be accurately determined from an exponential fit. For the track-etched membranes, the data fit an exponential law at low mean pressure. However, at high mean pressure, the relaxation deviates from the exponential law. In this case, only the first data points were fitted to an exponential law (see Fig. A1 for $P_m = 1933$ mbar) to estimate the short-term characteristic pressure relaxation time.

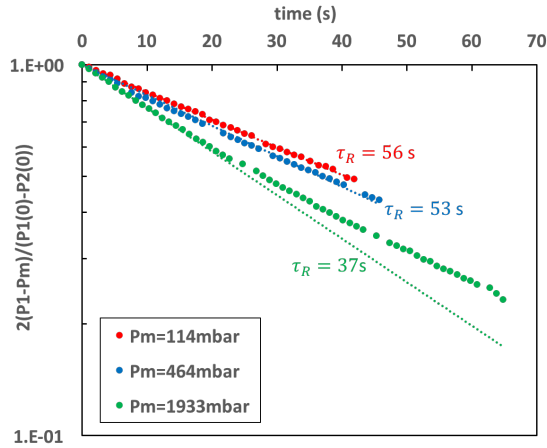


Fig. A1 Pressure relaxation in the high-pressure tank for the 80 nm track-etched membrane at mean pressure $P_m = 114$, 464 and 1933 mbar. The dotted line corresponds to the exponential law fitted either over the complete time range or over the short-term range. The characteristic pressure relaxation times are reported on the graph for the different mean pressures.

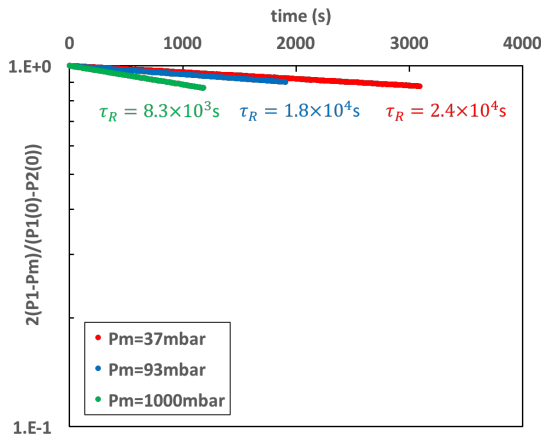


Fig. A2 Pressure relaxation in the high-pressure tank for a Norway spruce sample taken in the longitudinal direction at mean pressure $P_m = 37$, 93 and 1000 mbar. The characteristic pressure relaxation times (determined from an exponential fit) are reported on the graph for the different mean pressures.

B Norway spruce: sensitivity of the apparent permeability to the parameters ϕ , r_2 and n_2

The Norway spruce sample is considered to be adequately described by Comstock's model (1970) and variations in S_u (Eq. 17) were calculated as a function of the Knudsen number Kn_2 for $u = r_2, n_2$ and ϕ . Note that two Knudsen numbers were defined, namely, the Knudsen number Kn_1 characteristic of the gas flow in the tracheids (upper horizontal axis of Fig. B1 and Fig. B2) and the Knudsen number Kn_2 characteristic of the gas flow in the

openings in the margo of the bordered pits (lower horizontal axis of Fig. B1 and Fig. B2). Fig. B1 reports the variations in S_u for the apparent permeability in the longitudinal direction with K_{app} given by Eq. 20. Fig. B2 reports the variations in S_u for the apparent permeability in the tangential direction with K_{app} given by Eq. 21.

For both longitudinal and tangential directions, it was found that S_{r_2} reaches a plateau value close to 3 at low values of the Knudsen number. This value corresponds to the r_2^3 -scaling characteristic of the viscous regime in orifices (the margo openings control the apparent permeability in that Kn-range). The plateau value in the longitudinal direction is slightly less than 3 since the conductance of the tracheids also contributes (slightly) to the permeability (see Eq. 20). At high values of the Knudsen number, S_{r_2} reaches another plateau. The plateau value is different for the longitudinal and tangential directions. The plateau value (equal to 2) in the tangential direction corresponds to the r_2^2 -scaling characteristic of the free molecular regime in the margo openings. The plateau value for the longitudinal direction is significantly lower (<0.5). This reflects a weak dependence of the permeability on the opening parameters: in Kn-range concerned, the apparent permeability in the longitudinal direction is indeed mainly controlled by the conductance of the tracheids.

S_{n_2} is a constant function equal to 1 for the tangential direction since, in that case, the apparent permeability is proportional to n_2 (see Eq. 21). For the longitudinal direction, S_{n_2} varies from about 1 at low values of the Knudsen number (where the apparent permeability is mainly controlled by the margo openings) to about 0.25 at high values of the Knudsen number (since the apparent permeability is increasingly controlled by the tracheids).

S_ϕ is a constant function equal to 1 for both directions since the apparent permeability is proportional to ϕ .

In the Kn-range investigated experimentally (in purple in Fig. B1 and Fig. B2), the variations in S_ϕ , S_{r_2} and S_{n_2} for the longitudinal direction are distinct. It is thus possible to determine the values of ϕ , r_2 and n_2 . However, for the tangential direction, the variations in S_{n_2} and S_ϕ are identical and it is therefore impossible to separate the effect of ϕ from the effect of n_2 from the tangential data alone.

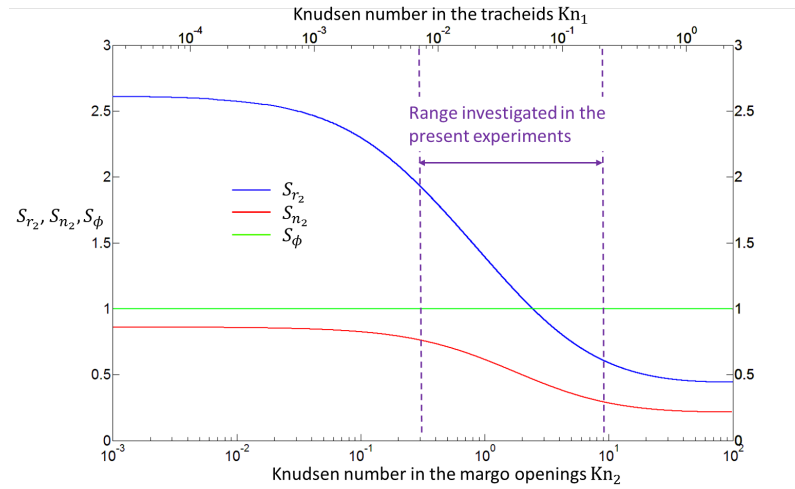


Fig. B1 Variations in S_{r_2} , S_{n_2} and S_ϕ as a function of the Knudsen number for the apparent permeability in the longitudinal direction

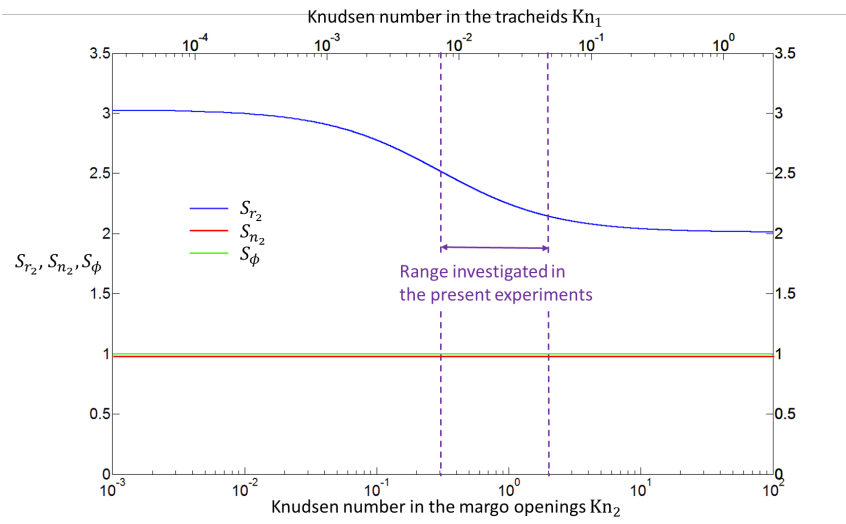


Fig. B2 Variations in S_{r_2} , S_{n_2} and S_{ϕ} as a function of the Knudsen number for the apparent permeability in the tangential direction