A small simulation study of moisture content variations in furniture in different tropical climates

Wadsö, Lars

1994

LUNDS TEKNISKA HÖGSKOLA
Byggnadsmaterial

UNIVERSITY OF LUND
LUND INSTITUTE OF TECHNOLOGY
Division of Building Materials

A small simulation study of moisture content variations in furniture in different tropical climates

Lars Wadsö

Rapport TVBM-7081

Lund, augusti 1994

to those for wooden parts with square or rectangular cross sections with the smallest dimensions equal to the dimensions given above.

Material data

The sorption isotherm used was taken from Avramidis (1989). It is based on the well known USDA isotherm, which is mean of an absorption and a desorption isotherm. The isotherm was taken at 25^{o}C from the equation given by Avramides for an isotherm according to an equation from Zuritz et al. Figure 2 shows the isotherm.

The diffusivity used was taken from Siau (1984). It is a theoretically caluclated softwood diffusivity which is in the same range as recently measured diffusivities. It was calulated at 25^{o}C. Figure 3 shows its variations with moisture content (the diffusivity has moisture concentration, kg/m^3, in wood as potential).

The poly-urethane coating has a mass transfer resistance of 100 000 s/m (Nevander and Elmarsson 1981, vapor content of air as potential). A similar value was given by a major coatings manufacturer for one layer of their poly-urethane coating.

Results

Figures 4-7 gives the results of the simulations for the four furniture components.

Discussion

It should be noted that the calculated amplitudes in moisture content are probably too large as there was no hysteresis in the used isotherm. The hysteresis (and possibly the anomalous sorption discussed by Wadsö 1994 and others) will decrease the moisture content variations.

Daily RH variations would certainly influence the moisture content of furniture part A (the thin veneer). Figure 4 does, however, give a values close to the daily mean moisture content.

A number of (more or less trivial) conclusions may be drawn from the results:

- Thin veneers follow the variations in relative humidity closely.
- Thicker wood pieces have dampened mean moisture content variations.
- Coated wood has dampened mean moisture content variations.

The dampening resulting from a coating is dependent on the vapor resistance of the coating. In the present case the value used was for a poly-urethane coating which has among the highest vapor resistances of wood coatings. Still the dampening was not more than to abount 60% of the uncoated wood. A coating does decrease the moisture content variations, but can never eliminate the raise in moisture content in a humid climate.

Shrinkage/swelling is approximately proportional to the moisture content shown in Figs. 4-7.

References

Arfvidsson, J. and Claesson, J. (1989), A PC-based method to calculate moisture transport, Proc. Heat and Mass Transfer in Building Material and Structure, 4-8 September 1989, Dubrovnik, Yugoslovia, Ed. Chadwick.

Avramidis, S. (1989), Evaluation of 'three-variable' models for the prediction of equilibrium moisture content in wood, Wood Sci. Technol. 23 251-258

Nevander, L. E. and Elmarsson, B. 1981, Fukthandboken, Svensk Byggtjänst, Stockholm, Sweden

Siau, J.F. (1984), Transport processes in wood, Springer-Verlag

Wadsö, L. (1994), Unsteady-state water vapor adsorption in wood: an experimental study, Wood Fiber Sci., 26(1) 36-50

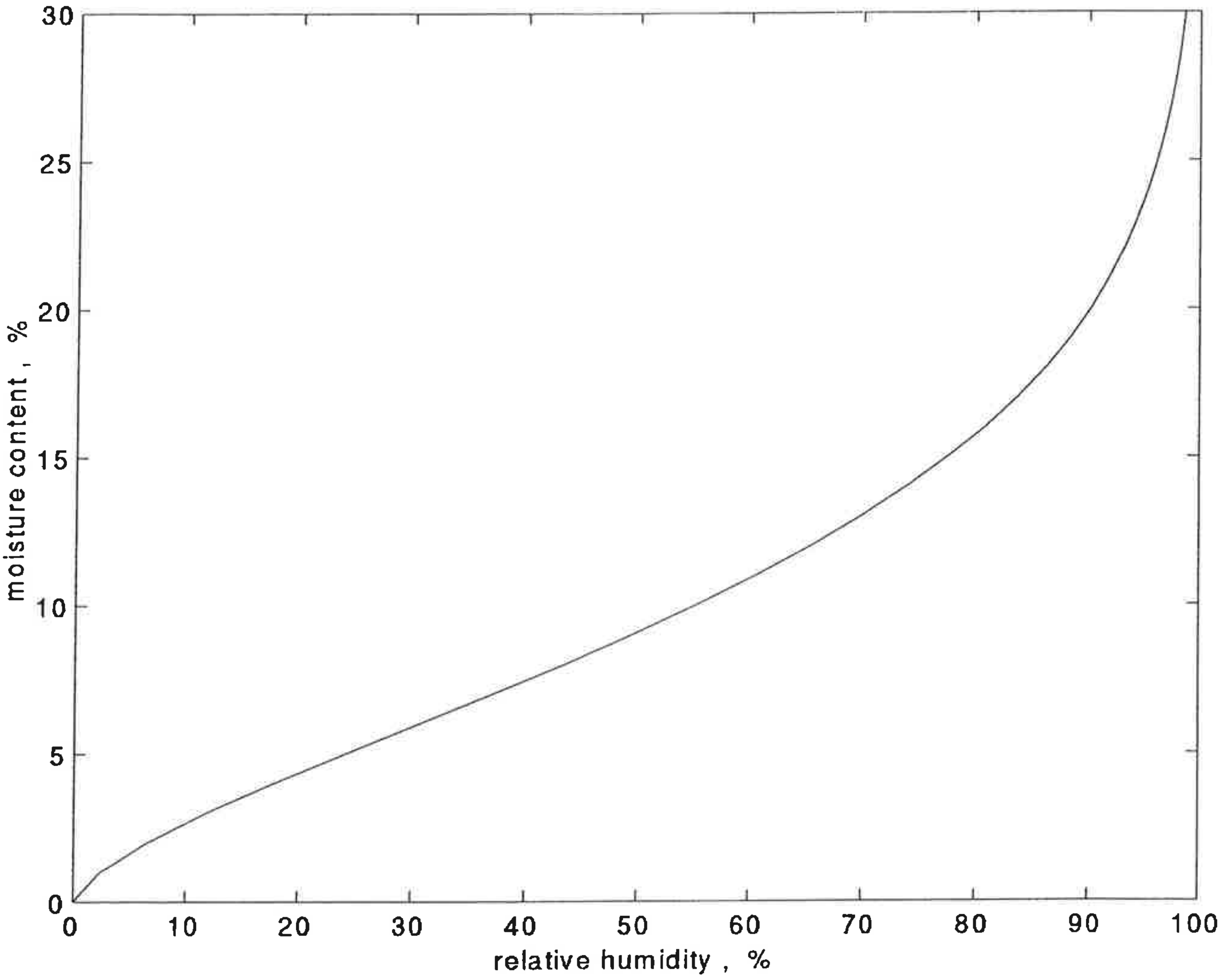

Figure 1. Sorption isotherm from Avramidis (1989).

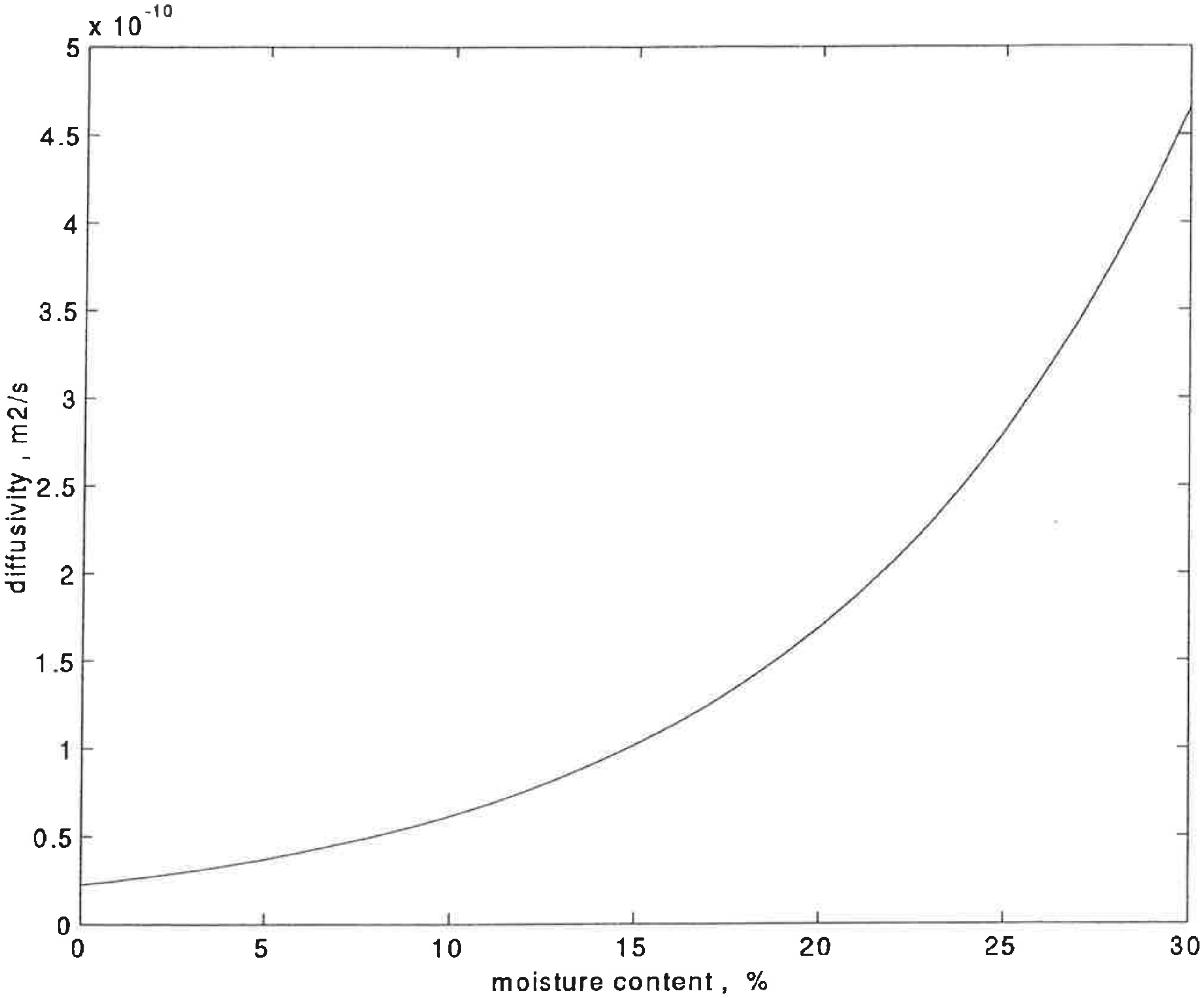

Figure 2. Diffusivity of softwood in the transversal direction (Siau 1984).

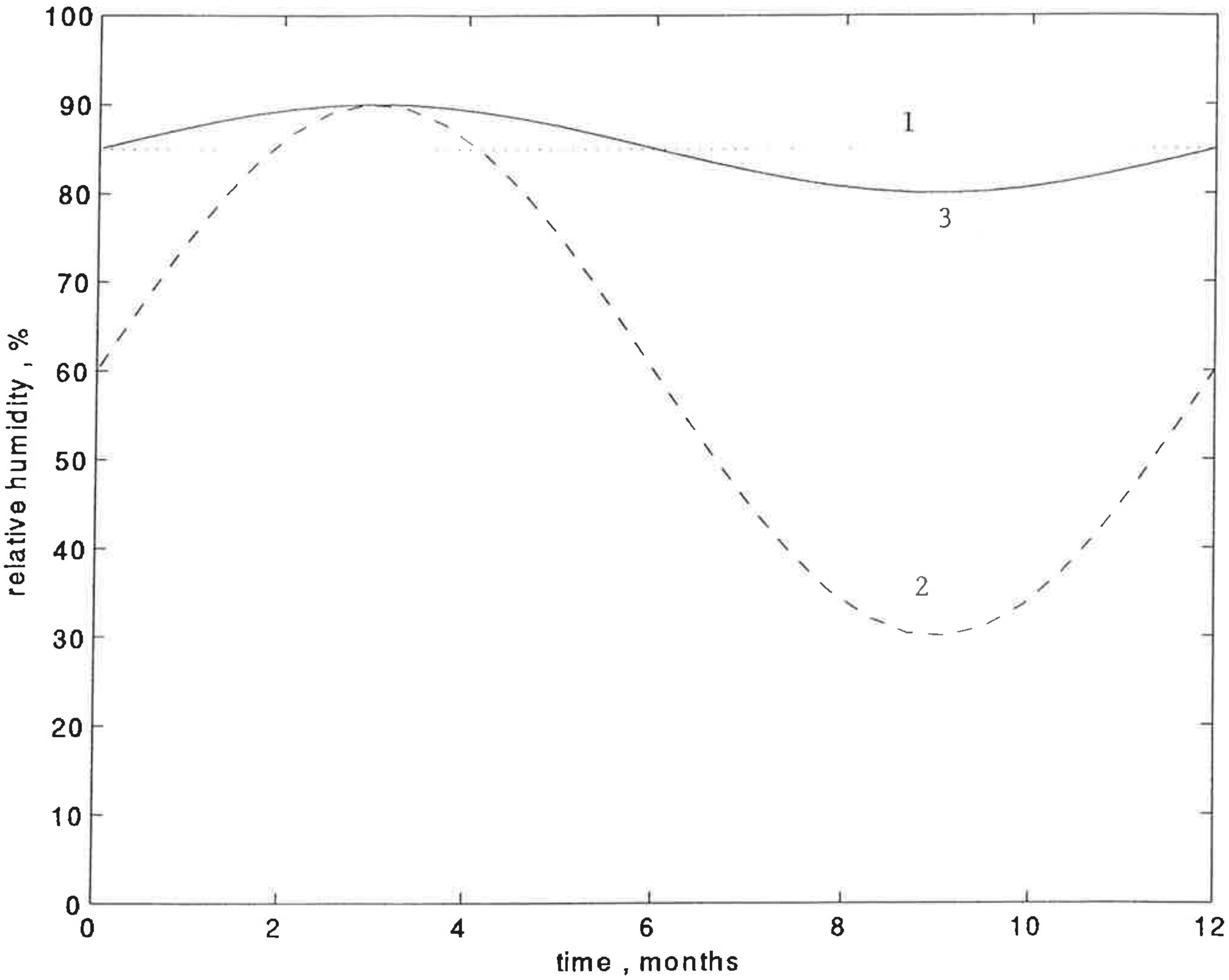

Figure 3. The simulated climates (note that they all start with their mean value at t=0).

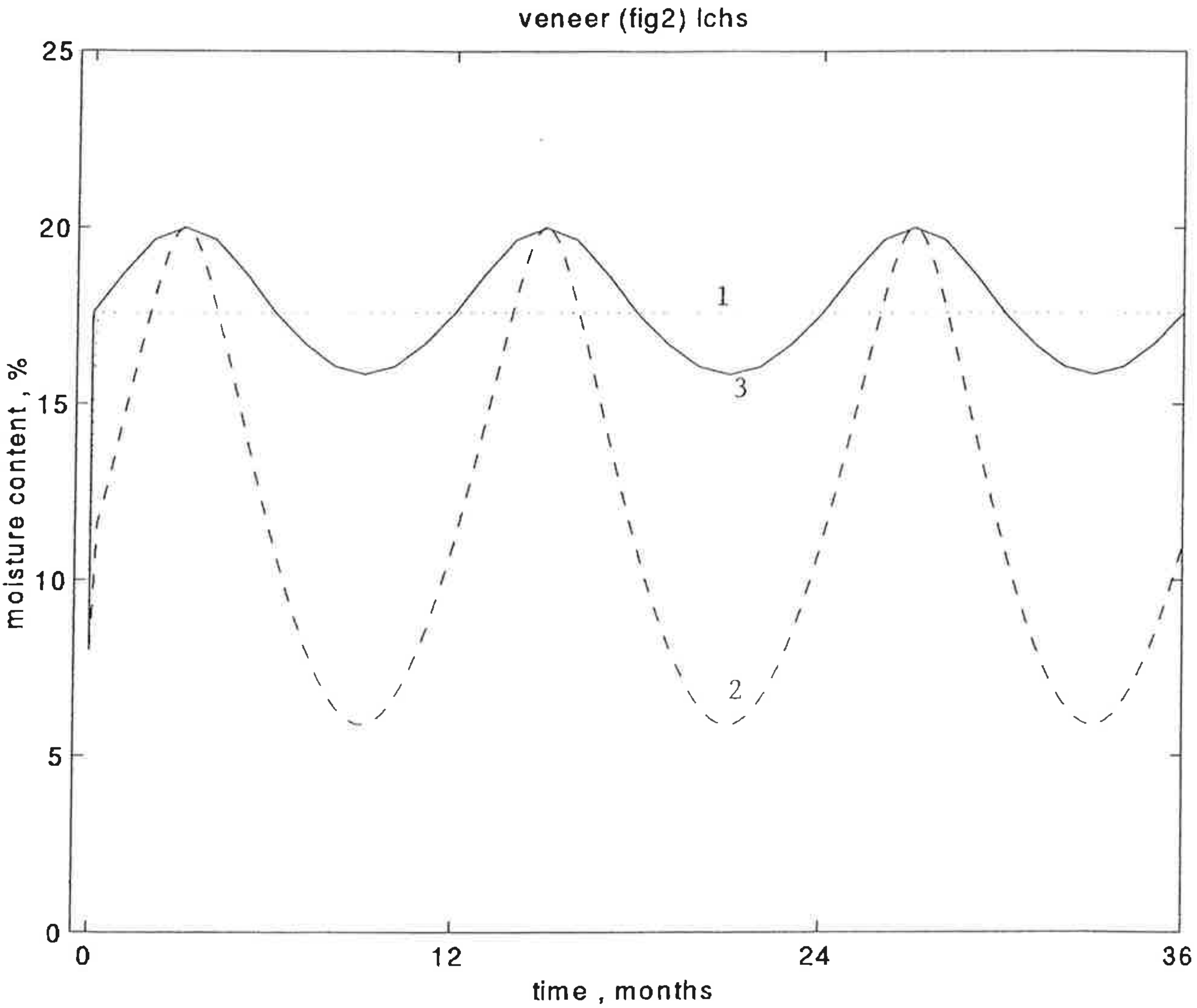

Figure 4. Simulation for the 1 mm veneer (A).

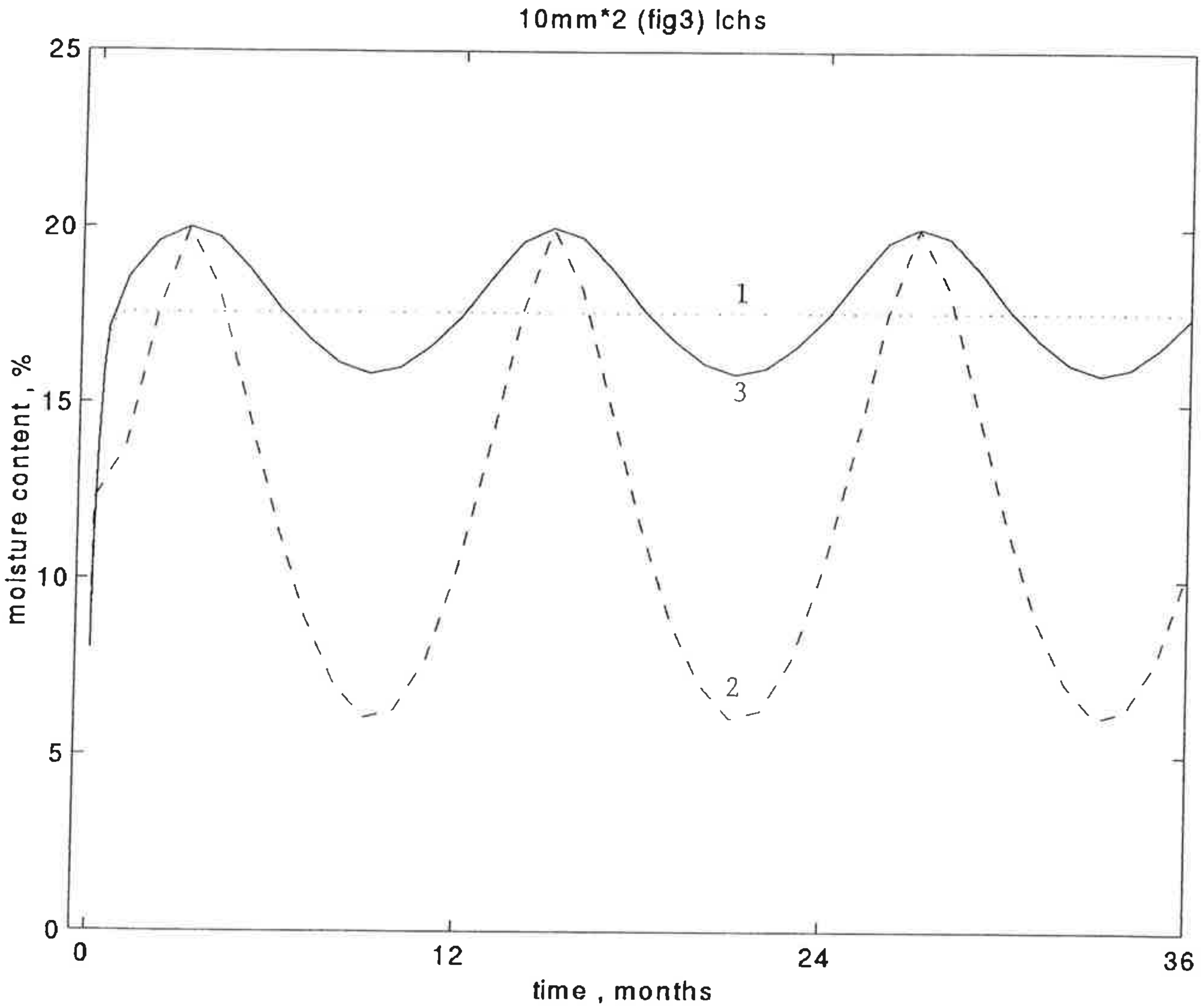

Figure 5. Simulations for the 20 mm sample (B).

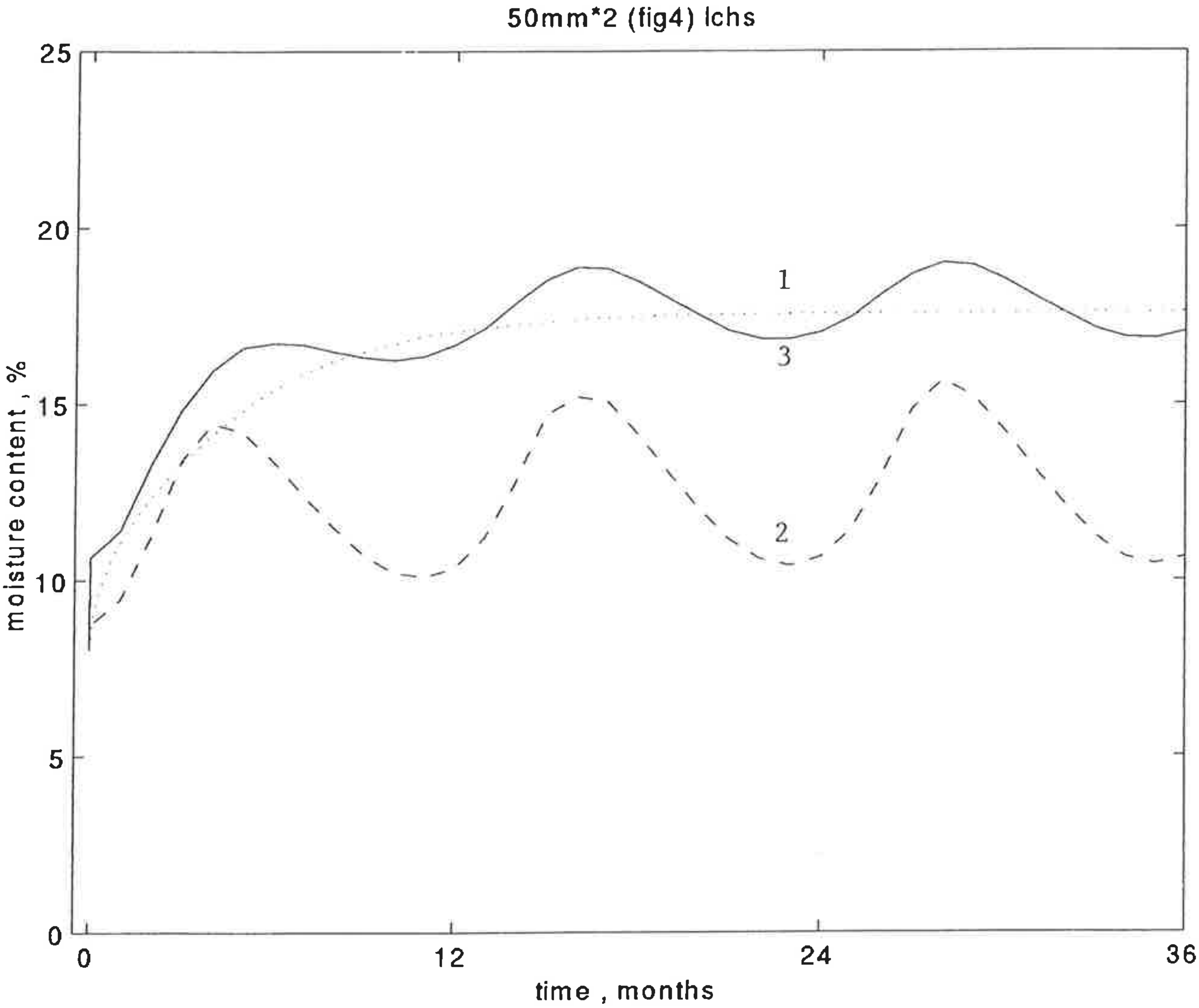

Figure 6. Simulations for the 100 mm sample (C).

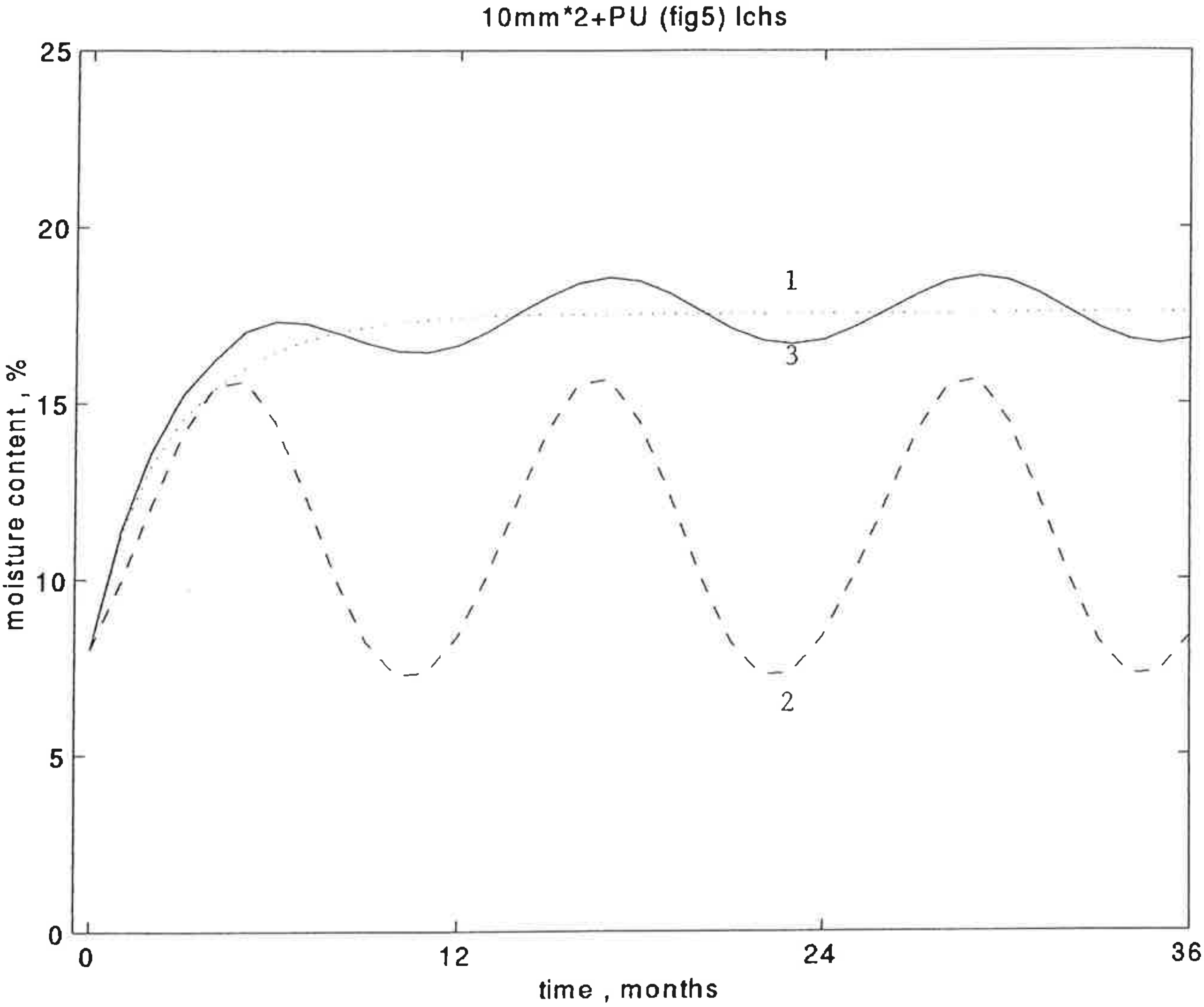

Figure 7. Simulations for the coated 20 mm sample (D).