Creating moisture prediction models for seasoned fuelwood

Jyrki Raitila, & Veli-Pekka Heiskanen, VTT Technical Research Centre of Finland Ltd
Marja Kolström, University of Eastern Finland
Johanna Routa, LUKE Natural Resources Institute Finland

Introduction

Outdoor seasoning of fuelwood is always very weather dependent and therefore only rough estimates for moisture changes can be provided without sampling. Modelling aims to increase this estimation. In this study specific multivariate formulas and linear mixed-effects multiple regression models for estimating moisture changes of stacked fuelwood pine during a specific storage time were created and compared.

Material and methods

The initial drying data for creating moisture models were gathered, on one hand by traditionally taking samples manually from stacked fuelwood from time to time (Finland B), and by recording automatically weight changes of fuelwood stacks placed on drying racks with load cells (Finland A). In the latter setting it was possible to constantly measure weight changes of fuelwood stacks without disturbing the pile structure. Meteorological data were also recorded.

Figure 1. Fuelwood drying racks in the Finland A field trials. Photo: Marja Kolström.

In the created models, the explaining variables were the net evaporation calculated daily by subtracting the precipitation from the reference evaporation, or daily sums of precipitation and evaporations themselves. In the latter, the equilibrium moisture content was taken into consideration as well.

Results

Linear regression models were chosen because they appeared the most functional and the structure was simple and understandable In the Finland A studies, the simplest regression model was chosen with one determining variable, net evaporation, for the model form.

Table 1. Drying models for covered and uncovered pine stem wood stored at the roadside (Finland A)

Roadside storage models				
DMC = coef * (evaporation – precipitation) + const				
Moisture content (i) = moisture content (i-1) – DMC				
Model	**coef**	**const**	**R^2**	**SE**
Pine stem wood, covered	0.062	0.051	0.705	0.2
Pine stem wood, uncovered	0.062	0.039	0.64	0.2

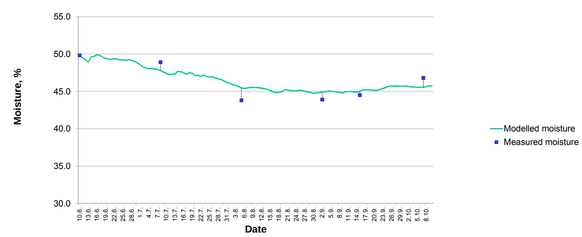

Figure 2. Modelled and measured moisture contents in Finland A studies.

In the Finland B model changes in moisture depend on the type of wood, initial moisture, ambient conditions of the storage and weather data. Moisture changes can be calculated with the following formulas:

$$w_{i+1} = w_i + a^*\Sigma P/(w_i - w_{eq}+b) + c^*\Sigma E(w_i - w_{eq})$$
$$M_{(i+1)} = 100^* w_{i+1}/(w_{i+1} + 1)$$

where
w_i = water content of wood at time t_i (kg_{H2O}/kg_{dm})
w_{eq} = water content at equilibrium at time t_i depending on the relative air humidity and temperature
ΣE = evaporation during period $t_i – t_{(i+1)}$, mm
ΣP = precipitation during period $t_i – t_{(i+1)}$, mm
a, b and c are experimental coefficients
M = moisture content, %

Conclusions

Continuous information on the drying behavior of the pile can be obtained more accurately compared with traditional sampling methods, without disturbing the structure of the wood pile during the study. These kinds of multivariate drying models can help optimize deliveries of fuelwood and therefore increase the efficiency of the whole fuelwood supply chain, particularly if they are integrated into Enterprise Resource Planning (ERP) applications.

Contacts

Jyrki Raitila
Tel. +358 40 7195117
jyrki.raitila@vtt.fi

Marja Kolström
Tel. +358 294453991
marja.kolstrom@uef.fi

Johanna Routa
Tel. +358 40 8015045
johanna.routa@luke.fi

UNIVERSITY OF EASTERN FINLAND

Luke NATURAL RESOURCES INSTITUTE FINLAND

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