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Energy content and density of forest biomass – part 2

Example calculations for thinning wood (whole tree chips)

In part 1, the formulas for calculating the energy content and density in forest biomass were shown. Here in part 2, the results of example calculations for whole tree chips from thinning wood are presented. **Table 1** shows the values for the basic density and calorific value of dry matter (DM) that have been used in the calculations:

Table 1. Basic density and the corresponding calorific value in dry matter in whole tree chips from thinning wood ((Hakkila, 1978; Virkola, 1983), modified).

Wood species	$r_{0,g}$ Basic density kg DM/m³	$q_{net,\,dry}$ Net calorific value in DM MJ/kg_{dry}
Björk	475	19.04
Tall	385	20.36
Gran	400	19.19

Using the basic density from **Table 1**, the bulk density of the chips at different moisture contents can be calculated. **Figure 1** shows how the bulk density per solid cubic meter varies with the moisture content in chips of birch, pine and spruce.

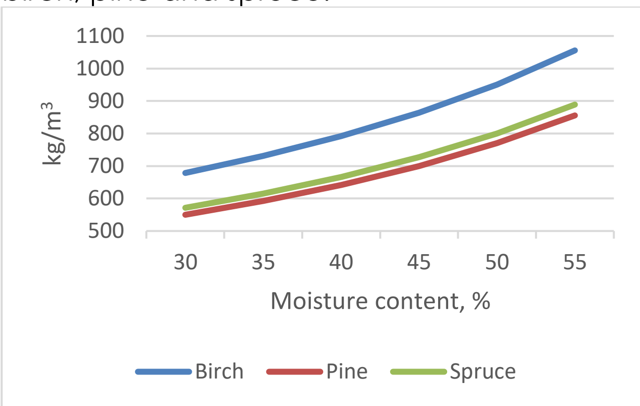

Figure 1. Indicative density of whole tree chips from thinning wood (kg/m³), solid cubic meters.

The density increases with increasing moisture content. The chips thus become heavier to transport while the energy content decreases, thereby reducing the profitability of transporting the chips. To calculate the actual volume, the conversion factor loose-m³/m³ = 2.5 between loose cubic meters and solid cubic meters for chips can be used to convert the density per solid cubic meter in **Figure 1** to loose cubic meters. **Figure 2** shows the density per loose cubic meter at different

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moisture contents.

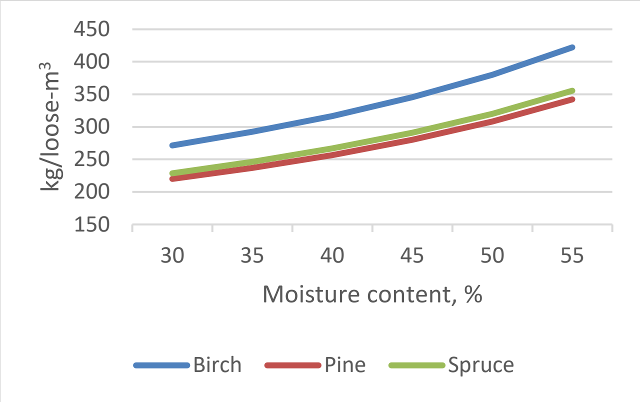
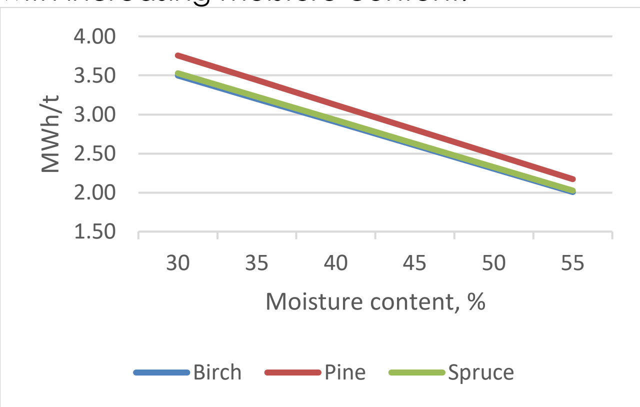


Figure 2. Indicative density (kg/loose-m^3) for chips from thinning wood assuming the conversion factor loose-m^3/m^3 = 2.5.

With the calorific value of dry matter from **Table 1** and the moisture content, the energy content, the net calorific value per unit mass, can be calculated. **Figur 3** shows the variation in energy content, the net calorific value at different moisture contents, expressed in the unit MWh/t. It is possible to observe how the calorific value decreases with increasing moisture content.



Figur 3. Indicative energy content (MWh/t) of chips from thinning wood.

With the density per loose cubic meter calculated in **Figure 2** and the energy content per ton of fuel from **Figur 3**, the energy content per loose cubic meter of chips can be calculated. **Figure 4** shows how the energy content per loose cubic meter of chips varies with the moisture content. Pine has the highest calorific value in dry matter per unit mass as seen in **Figur 3**, but birch has the highest energy content per volume because it has the highest basic density.

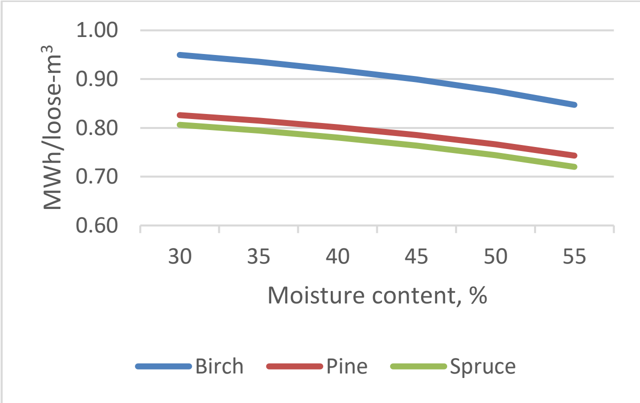


Figure 4. Indicative energy content (MWh/loose-m^3) of chips from thinning wood, assuming the conversion factor loose-m^3/m^3 = 2.5.

Read more:

Hakkila, P., 1978. Pienpuun korjuu polttoaineeksi. Folia Forestalia 342.

Virkola, N.-E., 1983. Puumassan valmistus, 2nd ed. Teknillisten tieteiden akatemia.

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SECURE-BIO-SUPPLY- Development of Long-Term Storage of Solid Biofuels to Enable a Sustainable Energy Transition

Contact us:
abo.fi/secure-bio-supply

Project information:

Time period: 1.3.2024–28.2.2026
Project Owner: Åbo Akademi University
Project partners: Novia University of Applied Sciences, Finnish Forest Centre
Financier: EU-FRO Just Transition Fund (Ostrobothnia's FRO (JTF) call 2/2023.) The Regional Council of Ostrobothnia.

The goal of the **SECURE-BIO-SUPPLY** project is to analyse the challenges and opportunities that changes in long-term fuel storage can create in Ostrobothnia.

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