FRESH CHIPS FOR HEATING PLANTS

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Seinäjoki University of Applied Sciences, University of Vaasa, and University of Helsinki have carried out the project called "Tuohi" in 2016-2018. European Funds for the Development of Rural Areas as well as the forest-owner associations, ELY-center of South Ostrobothnia and the energy companies financed this project.

Keywords: energy wood supply chain, Finland, fresh-felled energy wood, heating plant, wood chips.

Introduction

Wood chips as fuel in heating plants are considered to be the better, the drier they are (e.g. Kärkkäinen 2007, Lauhanen et al. 2014, Nurmi 1997, 2014). The prevailing way to take advantage of forest energy in drying and storage, however, is associated with inefficiency (Lahti et al. 2016).

The period between the harvesting time and the time for the final use of energy wood may be almost two years. Long storage time binds up the capital and adds the interest expenses of entrepreneurs. On the other hand, a long time of storage causes the loss of heating value of energy wood by the natural energy wood decomposition process (Routa and Sikanen 2014). Therefore, it would be cost-effective to get energy wood as soon as possible from forest to the power plants (Lahti et al. 2016).

Materials and Methods

Kauhavan Kaukolämpö Ltd's district heating plant has tested in its heat production wood chips made of freshly-felled energy wood with moisture content of about 50%. The heating plant of 10 MW boiler size is equipped with a condensing flue gas cleaning and heat recovery system. (Lahti et al. 2016).

Fig. 1. Kauhavan Kaukolämpö Ltd's 10 MW heating plant for district heating
1 pav. *Dešimties megavatų Kauhavan Kaukolämpö Ltd rajoninė katilinė*

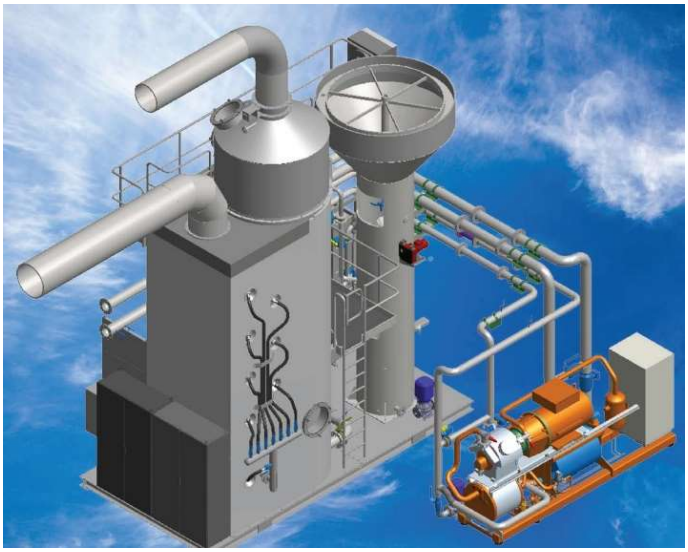

Fig. 2. Caligo flue gas scrubber and heat pump. The flue gas moisture of fresh wood acts as an effective heat exchanger when the flue gases are washed, and the energy is recovered in the heat transfer system (www.caligoindustria.com)

2 pav. *Caligo dujų plautuvas ir šilumos siurblys. Šviežios medienos dūmų drėgmė veikia kaip veiksmingas šilumokaitis, kai išmetamosios dujos yra plaunamos, o energija yra išgaunama šilumos perdavimo sistemoje (www.caligoindustria.com)*

Results

Practical tests at Kauhava district heating plant have shown that the total plant power output has increased, and the consumption of chips has reduced during the use of freshly-felled wood, compared to the conventional use of chips made of dried wood. According to preliminary tests carried out in the heating plant, the additional capacity has risen by even about 30% compared to the rated power of the boiler.

In addition to new boiler technology, three more explanations can be found for the growth of boiler at Kauhava heating plant:

- Freshly-felled and frozen energy wood components have not had time to evaporate and loose definitively the high energy potential bound in the volatile extractives during a short storage time period.
- Burning the extractives of fresh wood chips produces enough energy to replace the energy needed to evaporate the moisture, even if the wood material is frozen.
- The flue gas moisture of fresh wood acts as an effective heat exchanger when the flue gases are washed, and the energy is recovered in the heat transfer system. The heat pump recovers energy from water vapor, which is then transferred to the district heating network.

Small-sized and delimbed stems of the young pine and birch stands were used for chipping in the tests. The energy wood supply chains for fresh-wood chips were compared to the supply chains of dry wood chips.

The project carried out calculations on the profitability of the procurement of wood chips (Laitila 2005, Lauhanen et al. 2014). In these calculations, the costs in the supply chain consisted of: the stumpage price of energy wood stems, costs of logging operations in forest

as well as costs of storage and chipping operations and transportation of chips or stems to the heating plant. (Laitila 2005, Lauhanen et al. 2014).

The use of fresh wood chips at heating plant will cause significant changes in the wood energy price formation as well as in harvesting and storage logistics practices. Nevertheless, the current calculation formulas for calorific values do not give proper results when using fresh wood chips. New energy calculation formulas are needed to achieve a fair share of profits among all parties involved in the heat production chain.

It should also be noted that fresh wood chips can't be stored for a long time during the summer. Natural degradation processes reduce the calorific value and the extractives contained in the wood evaporate quickly. These facts give grounds for further experiments and tests.

Fig. 3. Freshly-felled birch energy wood. When the chipping happens soon after logging, the stores are not covered

3 pav. *Šviežiai nukirsto beržo biokuras. Kai skiedros gaminamos tuojau po kirtimo, rietuvės neuždengiamos*

Fig. 4. Chipping of freshly-felled energy wood near the Kauhava district heating plant

4 pav. *Skiedrų gamyba iš šviežiai nukirsto biokuro netoli Kauhava rajoninės katilinės*

The procurement of fresh-wood chips was more profitable than that of dry wood chips. The difference was 3–8 €/m^3 (euros per solid cubic meters of wood) depending on the logistic supply chain.

The energy wood stores at forest road sides were covered for dry wood chips supply chain. This increased the procurement costs compared with stores of fresh wood chips, which were uncovered.

Fig. 5. A covered energy wood store at Kauhava heating plant. Covering was done for determining the production costs of dry wood chips.
5 pav. *Biokuro atsargos netoli Kauhava katilinės. Biokuras buvo uždengtas siekiant nustatyti džiovintų medienos skiedrų gamybos sąnaudas.*

The chipping at Kauhava heating plant yard was less expensive than the chipping at forest road sides.

In addition, the procurement of dry wood chips and fresh wood chips was evaluated in the project workshops (Lahti et al. 2016). Fresh wood chips contain fewer microbes than dry chips do, so the health risks for workers are smaller. Storage time of fresh chips is short at forest road sides, so the emissions of carbon dioxide and nutrient leaching are lower.

Due to the clean combustion process happening in high temperature, the flue gases by fresh wood contain less carbon monoxide than conventionally for dry wood.

Conclusions

The results of the experiments at Kauhava heating plant can't be generalized, yet. Without the heat pump, the extra power can't be achieved. Thus, the heating plants need new investments. Full calorific value of the fresh wood is not taken into account in energy price formation, yet.

Further research will be needed on the seasonal impact of felling on the wood calorific value. In addition, experiments will be needed on the effect of the storage time on wood calorific value. More research data is also needed to make new formulas for the energy price formation.

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Nedžiovintų medžio skiedrų panaudojimas katilinėse

Santrauka

Seinäjoki taikomųjų mokslų universitetas, Vaasa ir Helsinkio universitetai 2016–2018 m. įgyvendino projektą "Tuohi". Europos kaimo plėtros fondai, taip pat miškų savininkų asociacijos, ELY centras Pietų Ostrobotnijoje ir energetikos bendrovės finansavo šį projektą.

Raktiniai žodžiai: energetinės medienos tiekimo grandinė, Suomija, šviežiai nukirsta energetinė mediena, katilinė, medienos skiedra.