Forestry Commission Project Report 045 - Extended summary

Woodchips drying – literature review

Summary

This project stemmed from an increasing interest in the active drying of woodchips, driven by concerns regarding cash flow and logistics that were made more acute by the cold winters and resulting high fuel demands in 2009-2010 and 2010-2011.

A literature review covering commercial chips drying was carried out, and it identified a shortfall of operational information and guidance. Large scale drying occurs on an industrial scale of tens or hundred of cubic metres per hour and has a large demand for infrastructure. Small scale drying often uses converted trailers and buildings, using fans to force air through chip piles. Data showed that drying times are extremely dependent on initial and target moisture content, conditions and drying system type, and generally have a negative energy balance. It indicated that case studies were required to confirm drying rates for given systems in given conditions and to calculate energy balances.

Effects of Moisture Content

Moisture content directly affects woodchips calorific value as the water contained within woodfuel not only contributes to weight but not energy content, but also must be evaporated during combustion, and the energy required to do so, known as the latent heat of evaporation, will not be 'available' for the heat output from combustion. The net calorific value of a fuel will therefore decrease with increasing moisture content. For example the net calorific value of an oven dry tonne of spruce wood is 5.4 MWh, and for each additional percent of moisture content, the net calorific value will decrease by 0.0594 MWh.

The drying process

Drying woodchips aims to meet the specification of end users, to reduce transport costs, and also has the benefit of reducing fungal spore build-up, loss of dry matter and self heating problems associated with long term storage of green chips.

Air drying will occur whenever the ambient air passing through woodchips has a lower relative humidity than the equilibrium relative humidity of the chips themselves. Drying occurs in two stages, the first being evaporation of water from the chip's surface, known as the constant drying rate, and the second stage being the diffusion of water from the centre towards the surface of the chips, known as the falling drying rate.

Drying can be passive, where timber, residues or chips are piled or stacked, and ambient temperatures and air flow reduce moisture content, or active, where an assisted air flow or applied heat is used to remove moisture from material. This air flow can be of ambient air, or air heated by a variety of sources (e.g. solar, boiler heat exchanger, directly from flue gasses).

Drying takes place progressively from the heat source. Water evaporation will maintain a low temperature in the chips until dried, at which point the next layer will start to dry. This effect creates a drying front and will lead to a variation of moisture content through the chips pile. Air flow must carry wet air out of the pile or stack, otherwise condensation will happen when it meets cooler layers. The air flow must be sufficient to counteract the "back pressure" caused by the relative porosity of the material, in the region of 250–280 N/m^2 (McGovern, 2007).

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Operational experience and data

Some information could be found on large, industrial scale drying operations in Scandinavia, however information on small to medium scale drying proved extremely scarce, particularly with regards to energy balances and costs. Published information that could be found identified large variations between drying timelines and energy balances.
A large amount of operational research concerning woodchip drying was published in the 1990s, but this mostly focused on SRC and has limited application for heating woodchips producers, due to different feedstock characteristics and chips specifications.

This confirms the need for operational trials to take place in order to get a better handle on systems efficiency, costs, and associated energy balance for the active drying of woodchips at the small and medium scale.

Contact: martin.price@forestry.gsi.gov.uk
Telephone: 01606 324 957 - 07771 810 130

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