Forestry Commission Job Report 076 - Extended summary
Active woodchips drying trials - 1

Summary

The active drying of woodchips using a grain drying barn and hot air Lasco LA 150 boiler was investigated. Four trials were run:

Name of trial	Control	Trial 1	Trial 2	Trial 3
Start date	21/06/11	22/06/11	22/09/11	27/09/11
Material	Mixed Pine, fresh			
Particle size distribution	P31.5	P45	P45	P45
Volume of woodchips (m^3)	63	84	70	70
Drying air temperature	Ambient	Warm (c.30°C)	Hot (85-100°C)	Hot (85-100°C)
Duration (h)	24	12	21 (3 spells in 8 days)	23 (3 spells in 3 days)

In all trials a reduction in moisture content was observed, however the results indicate that drying periods of several days would be required to reach a target moisture content of c. 30% (wet basis) starting from fresh material, and that the associated costs would be significant. Modifications to the set-up studied could lessen those costs, but active drying is likely to remain a costly option for a relatively low-value product, and should be driven by well-identified business objectives.

Study description

Drying barn (drying woodchips can be seen on the right)

Midlands Wood Fuel are based in the West Midlands and produce and supply heating woodchips. The drying facility studied forms part of their storage and distribution network. It consists of a covered barn with a drying floor of c. 160 m^2; on either side of the corridor, flaps can be opened or closed to allow the air into selected areas of the drying floor. The grain drier fan (37kW capacity) and boiler were located in a different section of the barn, fully separated from the drying section by a wall. The boiler used to generate hot air was a Lasco LA150, a 150kW biomass boiler equipped with a flexible pipe and 8kW fan connected to the heat exchanger.

Lasco LA150 hot air boiler and flexible pipe

Drying fan connected to hot air pipe

Date of publication: February 2012

Variables measured		How	Frequency
Ambient air	Temperature, relative humidity (RH)	Datalogger	Hourly
Woodchips	Temperature	Dataloggers (6) in chips	Half-hourly
	Particle size	Composite sample[1] + test	Start of trial
	Moisture content (MC)	Composite sample[1] + test	Start and end of trial
Boiler fuel	Moisture content, calorific value	Composite sample[1] + test	Start of trial
	Volume of fuel used	Level measurement	Start and end of trial (+ refills)
Drying air	Temperature, RH, air speed	Datalogger	Half-hourly
Electricity	kWh consumption	Meter readings	Start and end of trial

Results

Energy balance data

	Unit	Control	Trial 1	Trial 2	Trial 3
Initial moisture content (net CV)	% (kWh/t)	52.2 (2,229)	55.1 (2,033)	41.6 (2,800)	40.6 (2,859)
Final moisture content (net CV)	% (kWh/t)	48.3 (2,427)	52.4 (2,156)	34.7 (3,211)	40.0 (2,895)
Total calorific gain[2]	kWh	293	104	1,417	27
Total energy input	kWh	665	1,380	2,075	2,240
Total energy balance	**kWh**	**-372**	**-1,264**	**-668**	**-2,110**
Energy balance (per m^3)	kWh/m^3	-6	-15	-10	-31
Energy balance (per t at final MC)	kWh/t	-20	-47	-43	-123

Summary of active drying costs

	Unit	Control	Trial 1	Trial 2	Trial 3
Total cost	**£**	**133**	**334.6**	**597.8**	**656.2**
Unit cost	£/m^3	2.1	4.0	8.5	9.3
Unit cost[2]	£/t	7.2	12.5	36.5	36.9

- Temperature of at least 30 ºC built up naturally within the pile of woodchips over a 48 hours period.
- In all trials, blowing air through the pile of woodchips resulted in the temperature initially dropping throughout the pile of woodchips (indicating effective ventilation). In trials 2 and 3 using hot air, the temperature rose again after the initial drop, to a level of c. 30 ºC.
- In trial 1, the temperature recorded on top of the woodchips was slightly higher than the ambient temperature, indicating that the woodchips were heated on the whole height of the pile but that little energy was 'wasted'. In trials 2 and 3, temperatures recorded on top of the pile of woodchips were substantially higher (by 3 to up to 19°C) than ambient temperature, indicating an imbalance in the system resulting in a waste of energy.
- The air flow recorded in trials 2 and 3, c. 33,600 m^3/h was consistent with the scale of those observed or recommended in published trials.
- No obvious difference could be found to explain the difference between moisture content loss in trial 2 (41.6% to 34.7% in 21 h drying) and trial 3 (40.6% to 40% in 23 h drying).
- Although the accuracy of calculations is affected by the use of assumptions and standard ratios, there was a clear indication that in the set-up studied:

- the energy balance per unit will be significantly negative to dry chips to target moisture content (c. 30%),
- only marginal calorific content increases are likely to be achieved for short periods of drying
- the cost of running such a boiler system will remain substantial, in part due to the likely low annual usage.

Note: it is common agricultural practice to use hygrometers to trigger grain drying only when relative humidity falls below a given threshold for better efficiency. During the trials ambient RH was recorded between 57 and 87% and will have affected the rate of moisture content loss, although it is not possible to quantify to which extent on the basis of the data collected.

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[1] As per (BS EN 14778-2011)
[2] based on hypotheses of softwood dry timber density of 410 kg/m^3 and solid wood to woodchips volume conversion factor of 2.7

Date of publication: February 2012