

Testing moisture content (simple method)

This is a simplified version of the drying and analysis method found in the draft standard for woodfuel moisture content analysis published in the UK by the British Standards Institution¹ (BSI). The methodology contained here is designed to give an approximate figure for personal use using the minimum of specialist equipment and should not be used for marketing purposes or as a substitute for a complete analysis conducted by an approved test centre. Further details of the detailed methodology and testing laboratories are available from the Biomass Energy Centre website at www.biomassenergycentre.org.uk

Setting up Equipment

You will need the following equipment:

Sample containers	These must be airtight sealable containers appropriate to the type of fuel. Plastic food containers are appropriate for chip but for logs sealable airtight plastic bags may be used. You should weigh all containers before use.
Oven	An electric oven will work best. You need to check the oven's specifications for the maximum length of time that it can be run continuously. Fan ovens may not be appropriate for testing chip as the air circulation may blow fine particles out of the sample container.
Containers (for chip)	Should be corrosion resistant, non-combustible, and large enough to contain a complete sample (eg clean metal or ceramic roasting tin). You should weigh all containers before use.
Scales	Must be accurate to the nearest 1g, should have a "re-zero" or "tare" button to allow for the weight of containers, and be able to weigh several kg
Oven thermometer	In-oven thermometers are widely available from kitchen stores. Should be accurate to nearest 2°C, adjustable and must have a waterproof sensor for calibration.
Heat proof mat	To provide insulation between hot samples and the scales.
Heat proof gloves	eg oven gloves.

¹ Based on the suite of standards produced by CEN/TC335. A full, detailed methodology is contained in documents: BS EN 14774-2:2009, BS EN 14778-1:2005 BS EN 14778-2:2005 available from BSI or from BEC

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Calibration

The process of heating wood removes the water from your sample, but may also release other volatile compounds within the wood. This has been allowed for under the testing methodology, but it does mean that samples must be dried at a standardised temperature to avoid unreliable results. Domestic ovens are not precision instruments and frequently have a wide margin of error in terms of temperature control, so some form of calibration is necessary.

Thermometer calibration

First you need to check the calibration of the oven thermometer. The most straightforward way of doing this is to place it in a large bowl of ice water. When the temperature of the water stops changing adjust the thermometer according to the manufacturers instructions so that it reads 0°C. If the thermometer does not read low enough, then boiling water may be used to calibrate to 100°C, but bear in mind that this is more difficult to do safely.

Oven Calibration

To calibrate the oven, place the calibrated thermometer in the middle of the oven and set to 200°C (using the main oven control) when the oven has reached temperature check the reading on the thermometer against the oven setting. The oven manufacturer should provide instructions on any fine tuning of the temperature calibration possible.

When you have calibrated the oven, turn it down to 105° (the working temperature for moisture testing) and check it against the thermometer. Some oven models only allow calibration in 5° or even 10° increments and it may be that even with calibration you still need to set the oven control higher or lower to achieve an accurate temperature, using the calibrated thermometer as your guide.

Taking a sample

The critical factor in taking a sample is that it should be representative of the whole. You should have the same distribution of particle sizes in your sample as exist in the store, and the sample should have the same moisture content as the surrounding material.



Sampling and testing chip

In a large stack of fuel, there will be variations in the moisture content throughout the stack and you will need to take a sample from more than one place to allow for this. You should take a minimum of 5 samples, taking material from the upper, middle and lower parts of the fuel stack. Ignore any material from the lowest 30cm of the stack as this is likely to pick up additional moisture and other contamination from the ground.

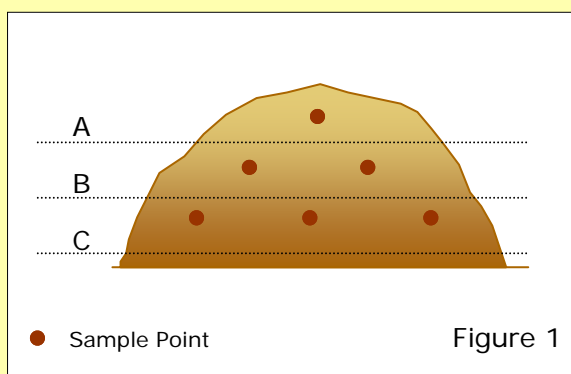
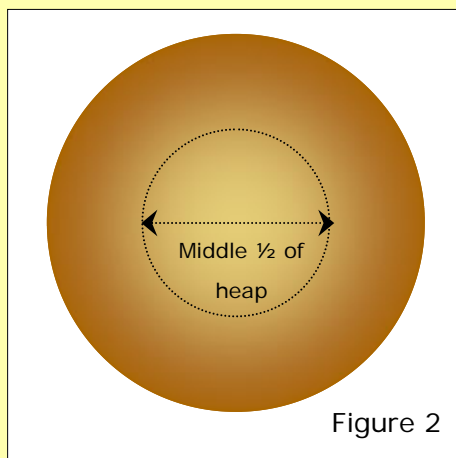


Figure 1

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You should dig through the heap and take samples of at least 1 litre each from different points (As shown in figure 1) from the middle $\frac{1}{2}$ of the heap as shown in figure 2. The number of samples required will increase with the amount of fuel to be tested. For batches of over 15 tonnes, increase the number of samples taken from layer C by 1 for every 5 additional tonnes². The samples should all be the same size, and include the same proportions of over and undersized pieces as the area they are taken from. If there is a large amount of observable variation through the stack, then you will need to collect more samples to take account of this. All samples should then be sealed in a pre-weighed airtight containers (eg plastic food containers) as soon as you have collected them. Do not mix the samples.

Testing the chip samples

- Preheat the oven to the point marked during calibration for an internal temperature of 105°C. You should use the thermometer used during calibration to double check.
- Weigh the samples in the airtight container before opening. This provides an accurate weight of the sample before any material or water is lost from the sample.
- Weigh the heatproof container that you will be using to heat the chip.
- If you are testing more than one sample, remember to label the containers so that you know which results apply to each sample.
- Transfer each sample from the airtight container to a labelled heatproof container
- Put all of the samples in the oven at the same time.
- Log each sample weight every two hours (you should make sure that you have a heat proof mat between your samples and the scales.) when the weight of a sample remains unchanged (to within 10g) for two consecutive measurements it can be considered to be oven dry.
- This process can take a long time, so make sure that you do not run the oven for longer than the manufacturers recommend. If the samples take longer than this (or you need to leave the samples) then switch off the oven leaving the samples inside and allow it to cool down and start heating again later.
- Meanwhile thoroughly dry the airtight containers on a radiator or similar and re-weigh (if any material has stuck to the inside)

Remember that it is very easy for heated, dry wood to catch fire. Make sure that you take care while testing and dispose of your sample in an appropriate manner afterwards.

² NB this methodology is not suitable for quantities in excess of 30 tonnes

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Sampling and testing logs

As with chip, you should choose logs to give a representative section of the load. Bear in mind that there is potentially a much greater variability between, and within logs than with other woodfuels. In the case of logs that have been seasoned before cross cutting, you should remember that logs cut from the end of the length will be significantly drier than those cut from the middle.

Moisture content is likely to vary between logs with different: size, species, number of split faces, and cracks, as well as where they occur in the stack.

You should pick a minimum of two logs to test per cubic metre. The logs should be chosen from the middle of the stack and not have been in contact with the ground.

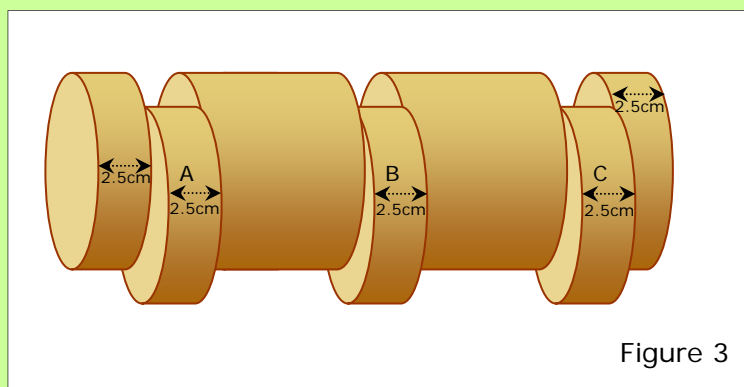


Figure 3

Remove all bark from the logs and cut one 2.5cm thick slice 2.5cm in from each end and one from the centre of the log (see figure 3). Make sure that your sample is representative as any areas that have been split or have been stored with the bark already stripped will be drier than logs which still have bark on.

When you have cut your sample sections from the logs, you should place them in an airtight container immediately (eg sealable plastic bags)

Testing the log samples

- Preheat the oven to the point marked during calibration for an internal temperature of 105°C. You should use the thermometer used during calibration to double check.
- Weigh the samples in the airtight container before opening. This provides an accurate weight of the sample before any material or water is lost from the sample.
- If you are testing more than one sample, remember to label them using a permanent marker so that you know which results apply to each sample.
- Put all of the samples in the oven at the same time (lay them directly on the oven shelves).
- Log each sample weight every two hours (you should make sure that you have a heat proof mat between your samples and the scales.) when the weight of a sample remains unchanged (to within 10g) for two consecutive measurements it can be considered to be oven dry.

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- Meanwhile thoroughly dry the airtight containers on a radiator or similar and re-weigh (if any material has stuck to the inside)

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Determining moisture content

You should now have accurate weights for:

- The airtight container
- The heatproof container (if used)
- The sample before drying
- The sample after drying
- The weight of any moisture left inside the airtight container after transfer to the oven
- The weight of any other material left inside the airtight container after transfer to the oven

You should be able to use these weights to determine the total weight of each sample before and after drying.

The moisture content (MC) of a piece of wood is defined as the weight of water expressed as a percentage of the weight of the wood either the total (wet) sample weight (wet basis) or the dry wood weight (dry basis) All fuel calculations are carried out on a "wet basis" (MC_{wb})³

The wet basis moisture content is a measurement of the proportion of the sample which is water expressed as a percentage of the total sample. For example if the wood in a sample weighs 50kg and the water in the sample also weighs 50kg, then the total MC of the sample would be 50% as half of the sample is water.

The $MC_{wb} = (\text{the weight of water in a sample} / \text{total initial weight of the sample}) \times 100$

³ "Dry basis" is expressed as the percentage of the oven dry weight of the wood. For example, if the wood in a piece of timber weighs 50kg and the water also weighs 50kg then the dry basis moisture content is 100%. The main advantage of this method is that the oven dry weight of the wood remains constant. This method is the standard used by many of the organisations doing research on wood, as well as building surveyors and architects. (It is rare to use dry basis measurements when talking about woodfuel)

The $MC_{db} = (\text{Weight of water in a sample} / \text{oven dry weight of sample}) \times 100$

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Analysis

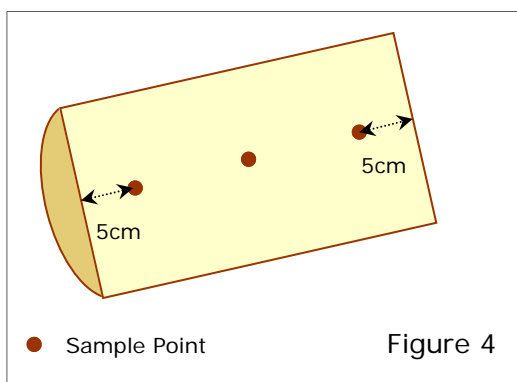
If you have taken samples as shown in the methodology above, you should have a figure for moisture content (in %) for each sample taken. Based on these sampling rates you can then work out a simple average (mean) of all the values to calculate a moisture content figure for the whole volume.

If your sampling regime is different from the one above, you will need to take into account the extent to which your distribution of samples is representative of the whole and if necessary adjust the mathematical weighting of different samples accordingly.

Moisture Meters and testing

If you are using a moisture meter for a quick indication of moisture content you should calibrate it first against wood that has been checked using the methodology above. You should also be sure that you know whether the meter is giving a reading in wet or dry basis.

Correct sampling practice is particularly important when testing logs, especially if it has been cross cut recently. If the wood has been seasoned in long (eg 2m) lengths there will be a significant difference between the middle of the length (high MC) and the ends (low MC) this can give rise to significant variation in measured values between logs.



To measure the moisture content of a firewood log using a resistance type hand held moisture meter, it must be freshly split and then three measurements taken on the freshly split surface: 5cm in from each end of the log and in the middle of the split surface with sufficient contact (see figure 4). It is recommended that you test at least 5 logs from each 2m³ batch. You should then calculate the average (mean) MC over all of the readings.

The resistance type of moisture meter can give a good indication of the moisture content of logs but they will only ever give an approximate indication. For a more accurate measurement of logs or when assessing wood chip, you should assess moisture content using the methodology contained here. If you wish to conduct an analysis for marketing fuel, or assessment of compliance to standards or specifications you should get a complete analysis conducted by an approved test centre.

A full methodology on how to determine moisture content and other physical properties of woodfuel has been published by the European Standards Committee CEN/TC 335, this is expected to be adopted by the BSI as a BS EN standard in 2011. For further details go to www.bsigroup.co.uk