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Rapid moisture determination for wood logs

For a rapid determination of the moisture content of wood logs numerous test devices in a price range between 10 and 800 Euros are available on the market. Comparative measurements with 12 wood samples in the usual moisture range show, that only few devices can fulfil the requirements concerning accuracy and repeatability when compared to moisture results from a drying cabinet determination. Moisture content readings higher than 30 % (i.e. 43 % wood humidity as based to the dry matter) should in most cases be interpreted carefully. The true moisture content is also almost consistently underestimated by the rapid test devices. The correct use of the terms „moisture content“ (wet basis) and the term „wood humidity“ (dry basis) as common in wood industry is sometimes questionable in the technical documents of the devices.

Keywords
Firewood, moisture content, rapid determination

Abstract
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3 figures, 1 table

Many tests with wood-fired household heating plants have shown that the moisture content of untreated wood logs is the most important quality-determining parameter. Too high a wood moisture content on burning results in increased output of health-threatening organic compounds and dust in the exhaust emissions. For this reason moisture content for such furnace fuel should be limited in future to 20% (i.e. 25% wood humidity). This proviso is planned in the amended 1st Federal German Emission Control Regulation (1. BlmSchV) and is to be tested for as part of regular biennial official furnace/chimney inspections. However, it is still unclear which measurement equipment could be applied for this task. The investigation presented here therefore offers an overview and evaluation of available rapid test equipment.

Choice and mode of action

On the basis of market research 19 different measurement instruments (involving 21 different modes of action) from 13 manufacturers were selected for the tests. Two instruments measured capacitance change (dielectricity) (**figure 1**). Most worked according to the principle of electrical conductivity measurement, being mainly equipped with insertion needles (**figure 2**). Four instruments featured a separate ram electrode enabling deeper penetration of the wood (**figure 3**). Rapid testing was carried out with a total of 12 logs (four beech, three birch and five spruce) 33 cm in length, whereby in each case moisture was measured with two repeats on the original log and on the same log after it had been freshly split. Additionally, measurement locations were continually changed (twice on the sawn surface, three times on the inside length). Moisture content measurement in the drying cabinet at 105 °C was used as reference. The measurement values given by each instrument

were uniformly calculated on a fresh mass basis, i.e. the measurement referring to the moisture proportion of the dry mass was converted to moisture proportion of the total mass including water which is the accepted moisture content parameter with wood fuel.

Practical measurement range

The results indicate substantial unreliability when reading moisture contents over 30%. Here, with all measurement instruments (exception: Schaller humimeter) substantial deviations from the reference method results were discovered. For this reason some manufacturers limit the permitted measuring range, e.g. to a maximum 40% moisture content **(table 1)**. The results also show that measurement precision in this range was mostly unacceptably low. For this reason further evaluations were limited to moisture contents between 19 and 30%, although often the recommendations for use covered contents over this range.

Comparison of instrument categories

It was shown that instruments equipped with ram electrodes delivered substantially better results in the case of mean deviation (over all investigated parameters) of around –6.9% (or 8.1% scatter) compared with the instruments with insertion needles by which the mean relative deviation of –20.2% (or 21.1% scatter) was around three times higher. Measurement instruments using the dielectric principle were, on average, even more imprecise with –29.3% deviation (or 29.8% scatter) because the required smooth application surface was hard to find on a wood log. These instruments are apparently unsuitable for application on logs with their typical rough surfaces.

Measurement variations

When comparing the wood types spruce and beech, relatively limited differences in the measurement precision were discovered. With beech logs the measurement unreliability was around 3% less than for spruce. Regarding the choice of the respective measurement locations on the logs the manufacturers mostly offered no detail information. The tests showed, however, that measurements on the (inner) length of the logs mostly gave better results than those on the sawn surface. This applied, however, only to the greater majority of instruments using the electrical conductivity principle. A measurement on freshly split wood - such as recommended by some manufacturers – also gave somewhat better results, although this did not apply to the instruments with ram electrodes.

Conclusions

The results indicate that rapid tests for log moisture offered by commercially available measurement equipment almost consistently underestimate the values. Caution is recommended, especially with higher moisture contents regarding the practical suitability and precision of calibration and this applies especially to instruments applying the dielectric measurement principle.

Tab. 1

Characteristics of tested instruments and measured accuracies given as mean relative deviation of moisture content (w) of all rapid measurements (related to the reference moisture reading in percent)

Measurement instrument	Measuring range according to manufacturer	Measurement range tested	Mean relative deviation	Price including purchase tax
Electrical conductivity measurement instruments with ram electrodes				
Schaller humimeter with ram electrodes*	10 - 60 %	10 - 30 %	-2,9 %	790 €
Greisinger GMH 3830 with GHE 91 electrode	5 - 46 %	10 - 30 %	-5,9 %	352 €
Gann Hydromette HT 65 with M 18 electrode	4 - 38 %	10 - 30 %	-8,7 %	518 €
Lignomat maxiLigno with E 12 electrode	6 - 43 %	10 - 30 %	-10,1 %	356 €
Electrical conductivity measurement instruments with insertion needles				
PCE FME with NF 4-17 sensor	5 - 50 %	10 - 30 %	-7,5 %	653 €
Greisinger GMR 100	0 - 50 %	10 - 30 %	-23,7 %	118 €
HEDÜ 2, in 1 needle mode	0 - 44 %	10 - 30 %	-9,0 %	237 €
BES Bollmann Easy Comfort, needle mode	5 - 32 %	10 - 30 %	-21,0 %	189 €
BES Bollmann Easy Comfort, contact mode	5 - 32 %	10 - 30 %	-32,9 %	189 €
Doser LWM 2	5 - 23 %	10 - 30 %	-31,0 %	307 €
Wöhler HBF 410, needle mode	0 - 44 %	10 - 30 %	-9,8 %	117 €
Gann Hydromette Compact S	9 - 33 %	10 - 30 %	-19,6 %	137 €
Trotec T 500	5 - 33 %	10 - 30 %	-19,2 %	155 €
Fuva S 06	6 - 50 %	10 - 30 %	-22,6 %	96 €
testo 606-1*	8 - 48 %	10 - 30 %	4,3 %	99 €
PCE – 333	6 - 31 %	10 - 30 %	-10,1 %	46 €
Trotec T 60	6 - 31 %	10 - 30 %	-11,3 %	46 €
Wetekom MD-018	0 - 38 %	10 - 30 %	-59,5 %	10 €
Lignomat miniLigno X	6 - 43 %	10 - 30 %	-30,5 %	180 €
Dielectric measurement instruments				
Doser DM4 A	0 - 50 %	10 - 30 %	-17,9 %	486 €
HEDÜ 2 in 1 search mode	0 - 44 %	10 - 30 %	-40,8 %	237 €

* Following contact with the manufacturers it was found that the readings, contrary to the information in the operator manual, are not to be interpreted as „wood humidity“ but instead as „moisture content“.

But there's also another worrying fact: in practice, and also regarding some manufacturers, there's still imprecision or even ignorance in the application of the terms „moisture content“ and „wood humidity“. This situation is of considerable importance for measurement results because the definitions are ba-

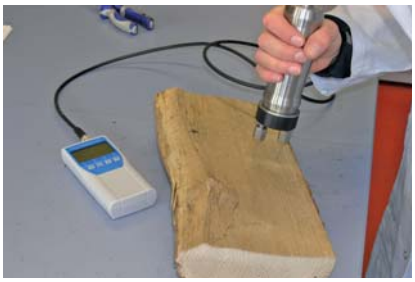
Fig. 1

Test device using the dielectrical principle

Fig. 2

Test device using the electrical conductivity via steel needles

Fig. 3



Test device using the electrical conductivity via ram electrodes

sed on completely different parameters that first of all have to be converted using the respective values. This statement is, for instance, emphasised through the fact that one of the manufacturers states in its product description that wood humidity is measured but on request informed that, in reality, it was the moisture content that was measured. Only 3 of the 19 instruments explain the definitions of the two terms in their user manuals so that in practice wrong interpretations can hardly to be avoided. In some cases both the wood humidity and moisture content were addressed in the instructions. With 15 from a total of 19 instruments the interpretation of the given measurement value as „moisture content“ instead of „wood humidity“ would have lead to a significantly higher precision.

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Documentation

The complete research report is available as part of the series “Berichte aus dem TFZ“ (Vol. 16). Free download: www.tfz.bayern.de