



UPM

BMA Online biomass moisture analyzer's measuring accuracy and it's feasibility for different energy wood materials



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Sustainable Bioenergy
Solutions for Tomorrow

Timo Melkas
Metsäteho Oy

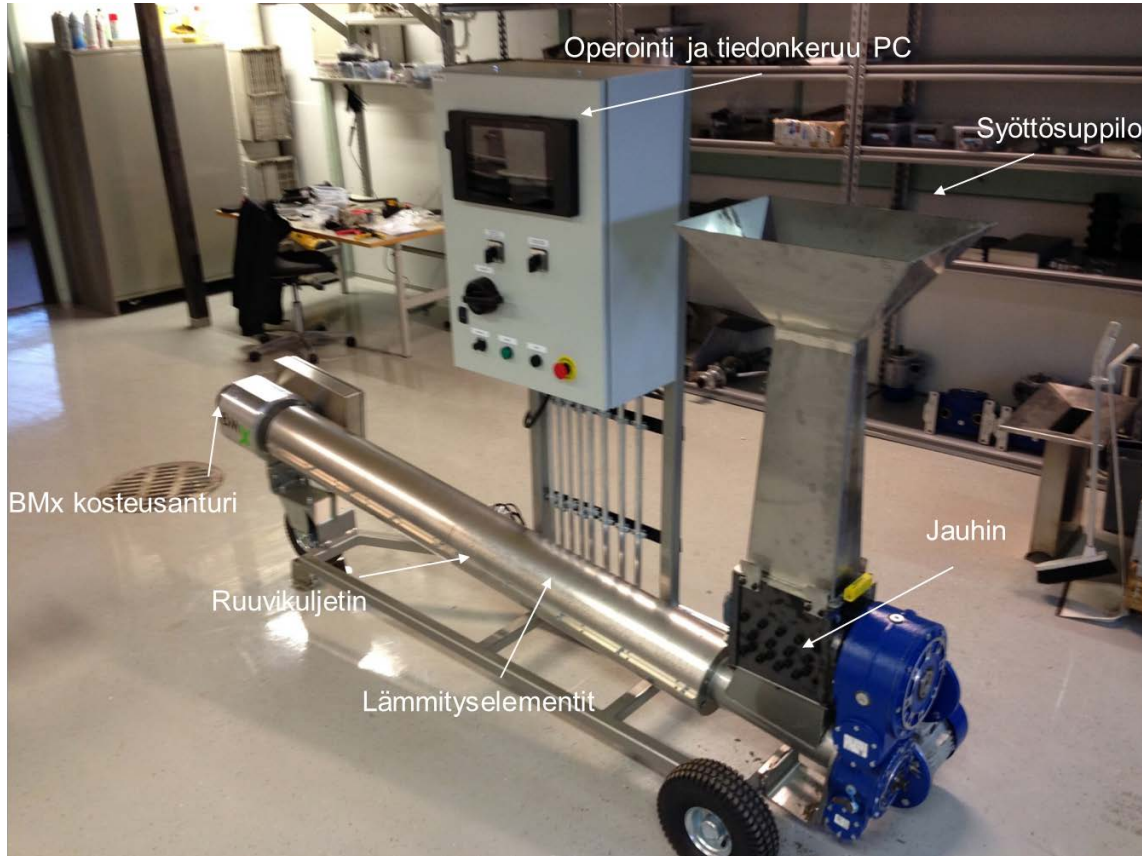
The aim and implementation of the study

- The aim of the study was
 - To develop a biofuel moisture online measurement system, which is suitable for use in terminals as well as at the reception of the power plants.
 - To verify the measurement functionality of the system under field conditions, and to study the accuracy of the measuring system with different fuel fractions (logging residues, stumps, bark).
- Data collection was carried out during 2015 in Pietarsaari (Alholmenskraft), Tervasaari (UPM) and in Kajaani (Kainuun voima).
- The development and construction of the online measurement system was done by Senfit Oy.
- Functionality of the measurement system under practical conditions and the accuracy of the measurement system with different fuel fractions was studied in co-operation Senfit Ltd, UPM, Alholmenskraft and Metsäteho Oy.

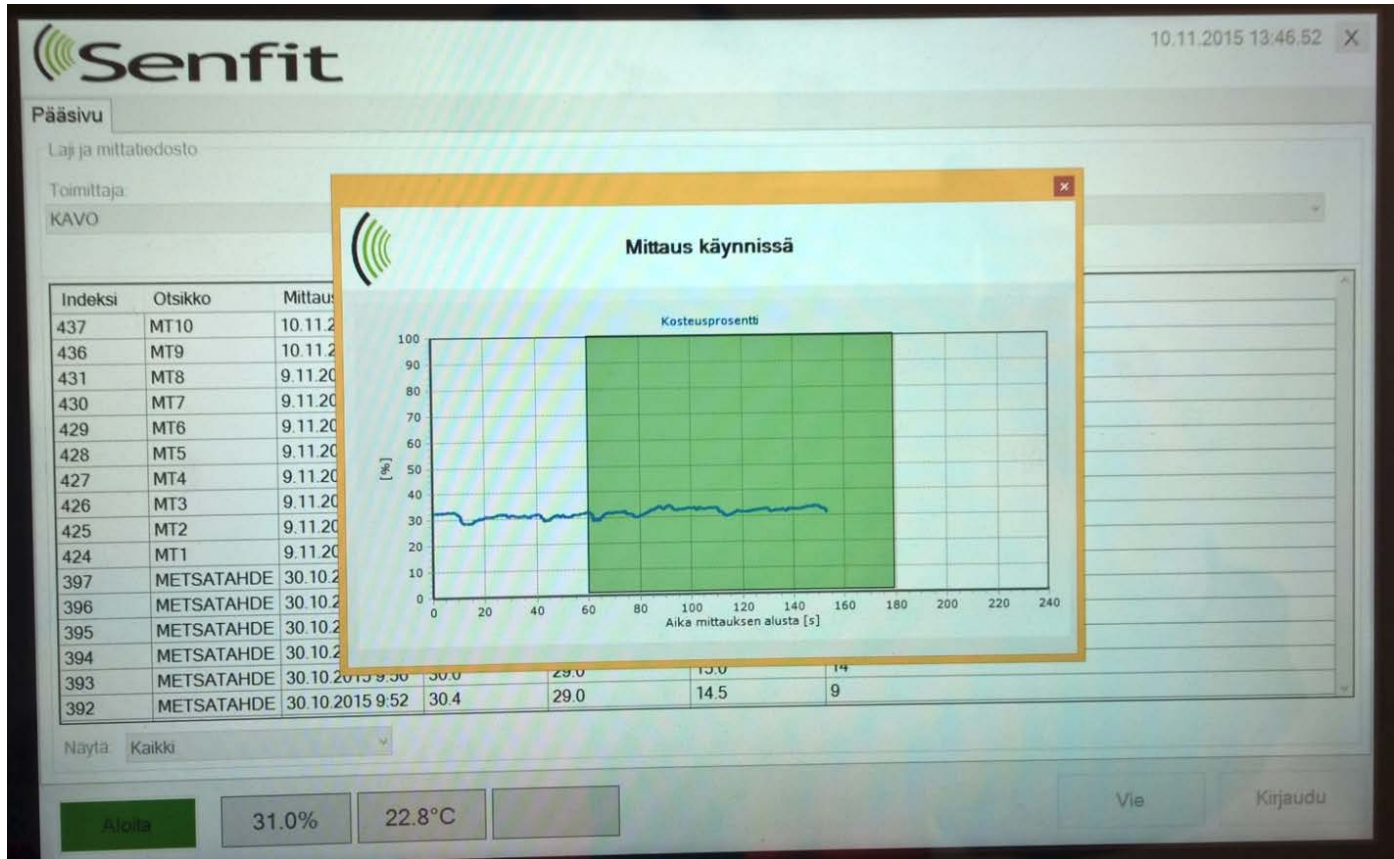
Online biomass moisture analyzer (BMx)

- Sample processing and moisture measuring is integrated with the same measuring device.
- As a measuring sensor is used the Senfit BMx flow-through sensor (*läpivirtausanturi*).
- The measuring system consists of
 - a feeding hopper and a refiner
 - a heating element and a screw conveyor
 - a BMx moisture sensor
 - an operation and data acquisition unit.
- The measuring device can be used either as a part of an automatic sampler or by the truck driver.
- The measuring device can also be integrated into the plant's fuel management system, which enables that the measurement data (batch based) can be transferred directly to the system in real time .
- In the study the samples (15 litres) were fed to the feeding hopper. Before analyzing the moisture, every sample was mixed and grinded into smaller fractions with the standard. The measurement device was calibrated for each fuel fractions (stumps, logging residues, bark) separately. Control samples (300 g) for the oven drying (reference measurements) were taken from the sensor output.
- The aim was to take an as representative sample as possible of each load.

Online biomass moisture analyzer (BMx)

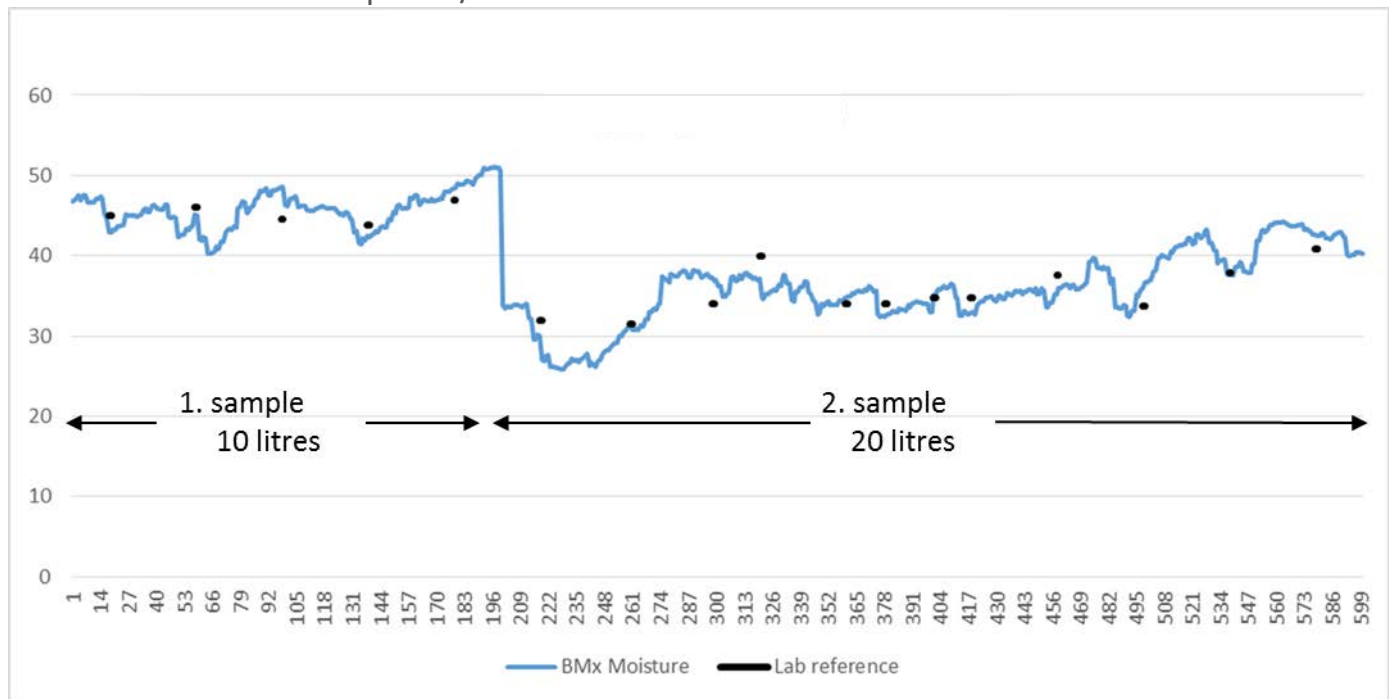


Measuring the moistures with Online biomass moisture analyzer (BMx)



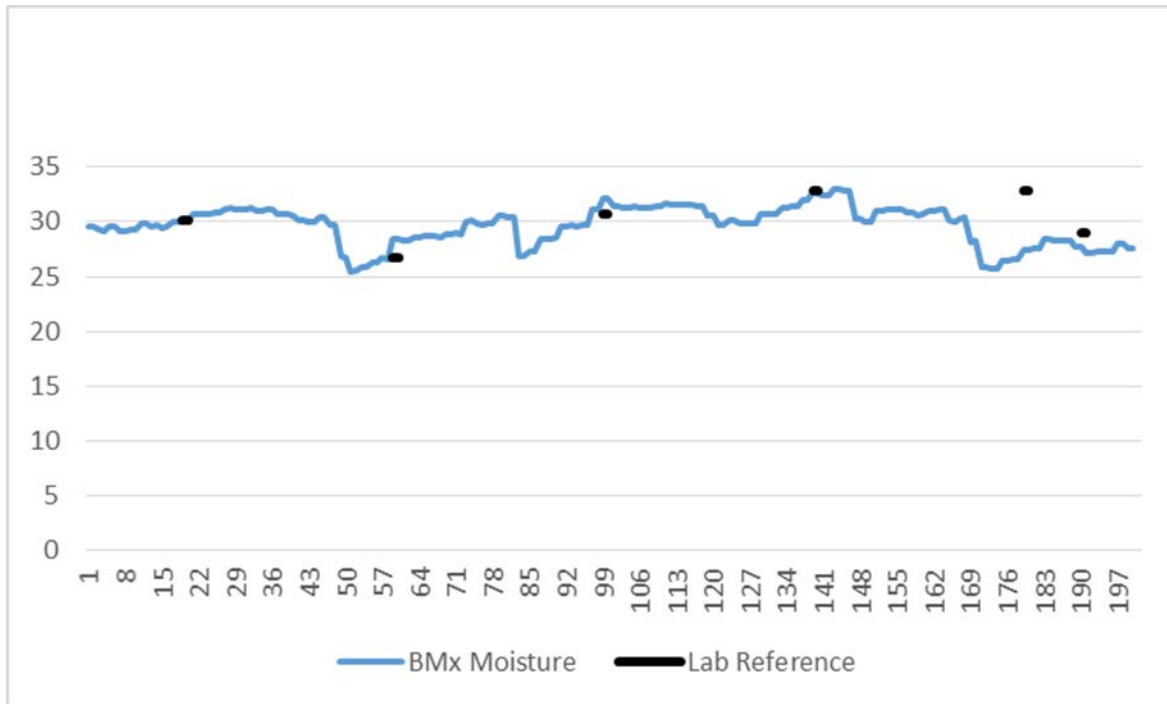
Moisture variation within the sample and the allocation of the reference samples (logging residues)

- Comparing two logging residue samples with reference measurements (oven drying).
- Samples were taken from the open field, thus the samples had wide variation in terms of moisture content (*pintakastuminen*).
- 600 measurement points/3 min.



Moisture variation within the sample and the allocation of the reference samples (stumps)

- Comparing one stump sample to the reference measurements (oven drying)
- Samples were taken from the open field, thus the samples had wide variation in terms of moisture content (pintakastuminen).
- 200 measurement points / 1 min



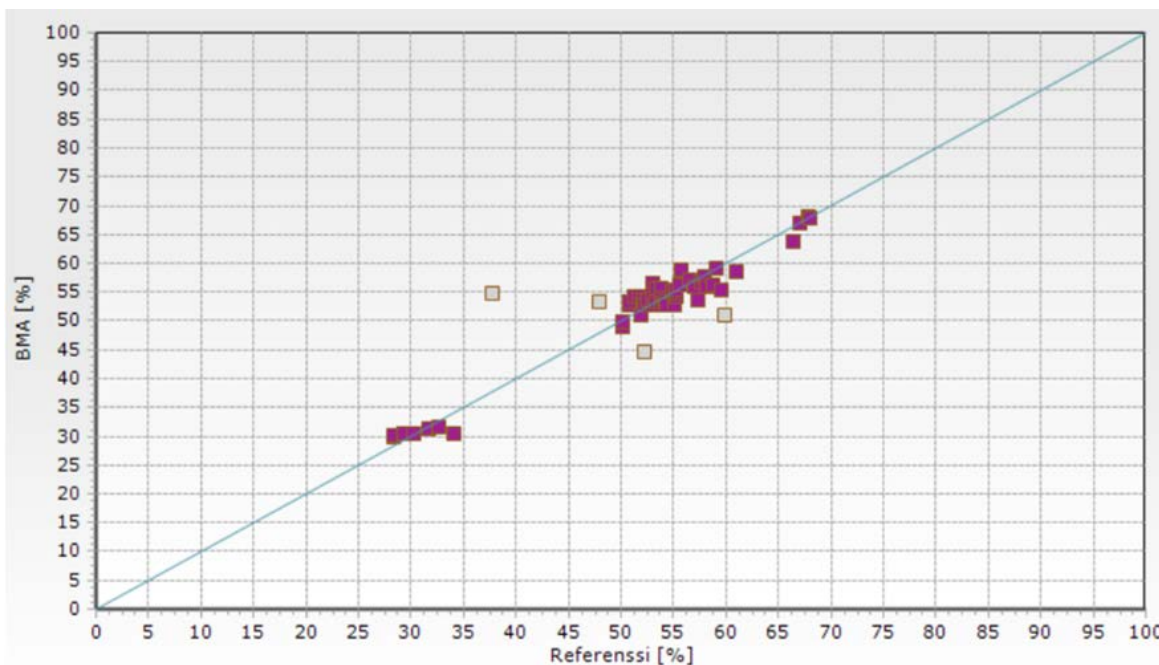
Results

- In the study each sample (15 l) was fed into the measuring device for the determination of moisture. After the analysis, the sample (15 l) was collected together and a sub-sample (300 g) was taken for oven drying.
- Senfit Online biomass moisture analyzer (BMx) measures continuously the moisture of the sample (200 000 measurements/min). The moisture of the sample (15 l) was calculated as an average of all moisture measurements measured from the sample.
- Reference samples were processed and oven dried based on *Quality guidelines for wood fuels in Finland - VTT-M-04712-15*.
- The results were compared with each other. The mean difference (average), standard deviation and standard error were calculated by fuel fractions (logging residues, stumps, bark).

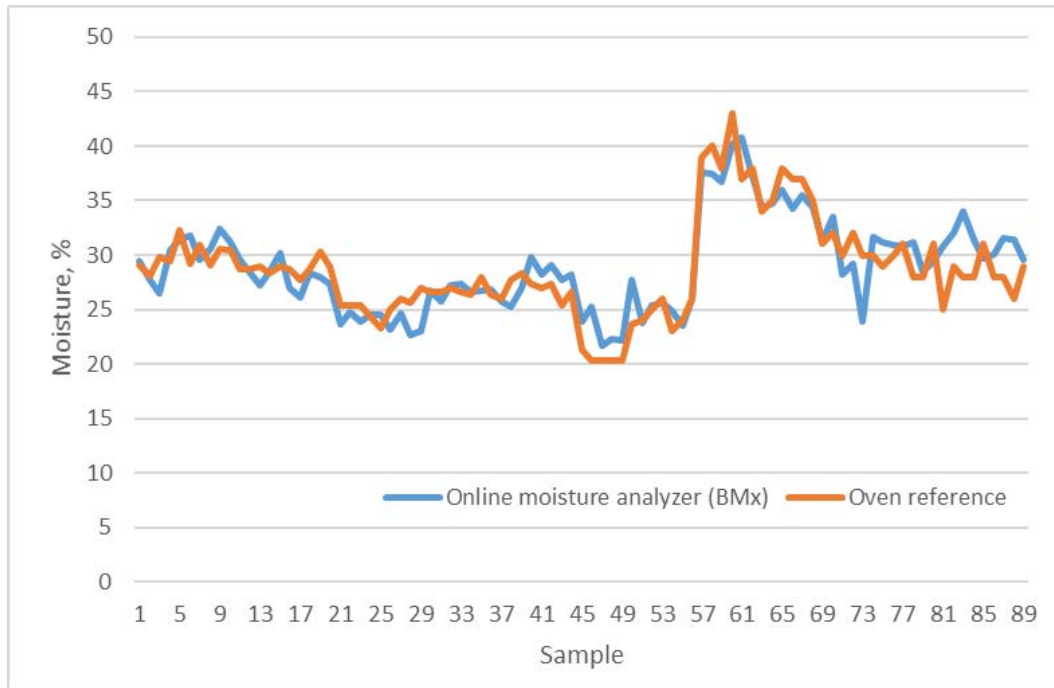
		N	Min	Max.	Average	Standard Deviation
Stumps	BMx - analyser	89	21.6	40.8	29.0	4.2
	Oven reference	89	20.3	43.0	28.7	4.5
	Difference	89	-6.1	6.0	0.2	2.2
Logging residues	BMx - analyser	104	24.0	54.7	38.7	7.5
	Oven reference	104	25.3	56.3	38.9	7.9
	Difference	104	-7.7	8.2	-0.2	3.1
Bark	BMx - analyser	52	27.0	64.2	52.4	8.7
	Oven reference	52	28.3	68.0	52.3	9.4
	Difference	52	-8.5	14.5	0.1	3.6

Standard error of Spruce and Pine bark (n=49)

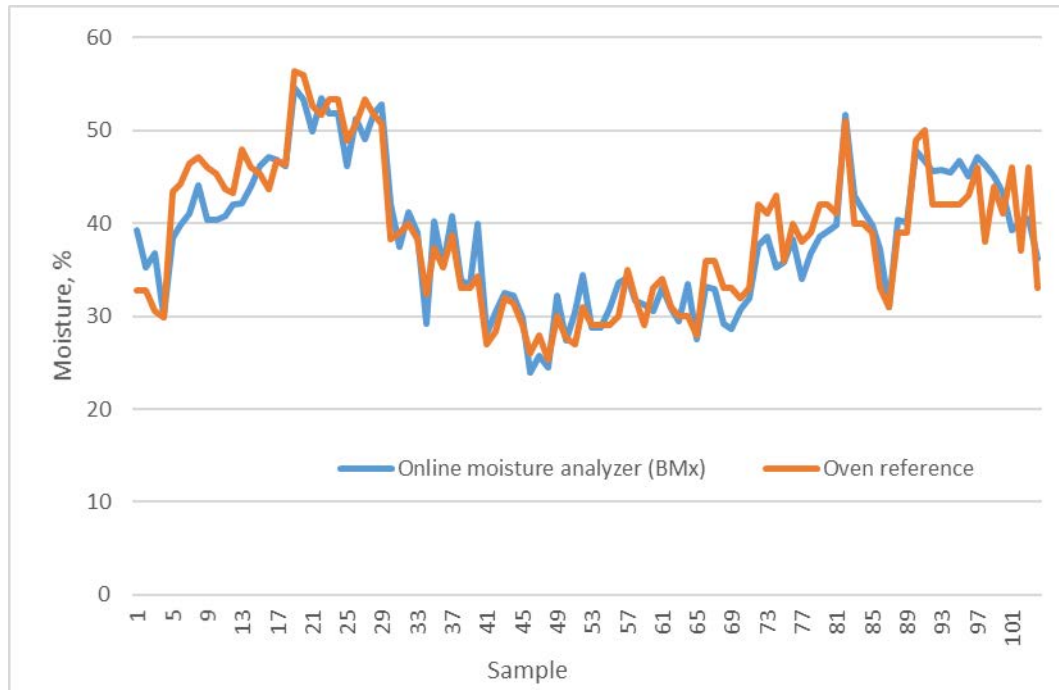
- The measurements were carried out in 1 minute periods . For each run, one control sample was taken. Because of the allocation of the reference samples, the 1 minute average moisture content from the BMx analyzer was used as comparison.
- There were a total of 53 observations (n), of which 4 outliers were removed (white).
- Standard error was 1.8 % compared to the oven drying.
- The data included samples taken during the winter and during the summer. Driest samples were measured in the summer from spruce bark samples.



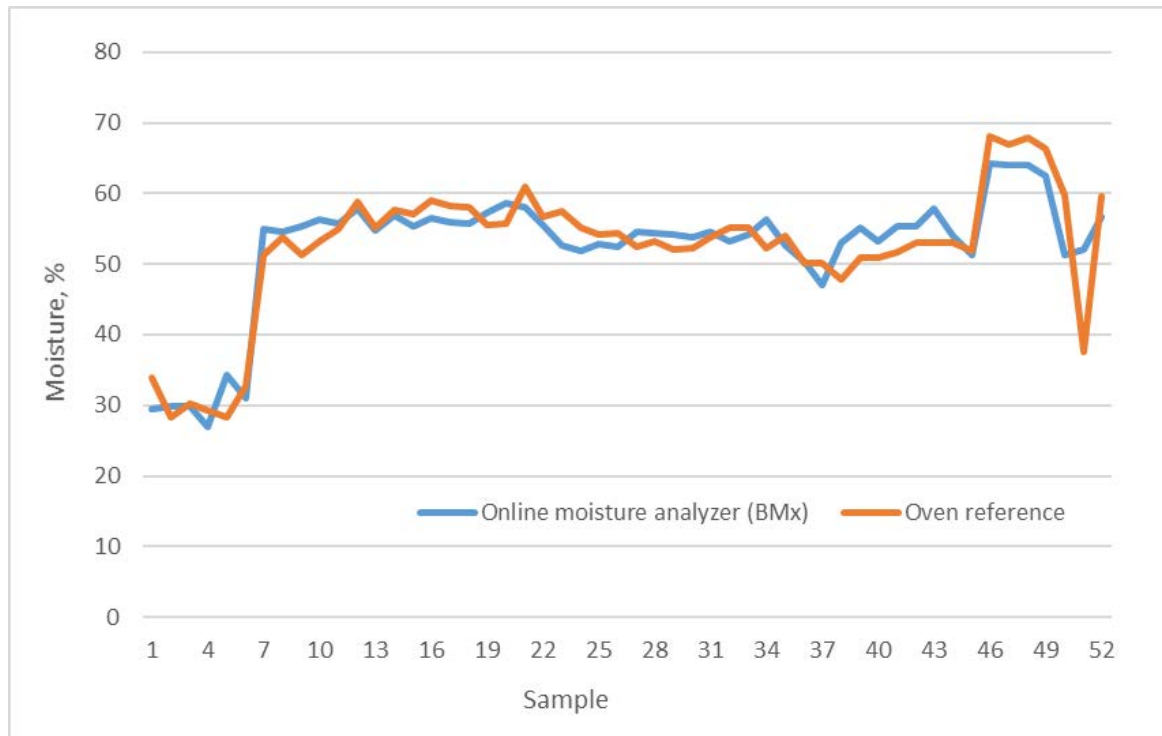
The moisture of the stumps (n=90) – Tervasaari and Kainuun voima



The moisture of the logging residues (n=104) – Tervasaari and Kainuun voima



The moisture of the bark (n=52) – Pietarsaari



Conclusions

- Online biomass moisture analyzer (BMx) produces fast and reliable moisture measurement. The measured values can be transferred in real-time to the plant fuel management system for the use in fuel logistics and process control.
- The device must be calibrated separately for each fuel fraction. For calibration purposes, it is necessary to collect enough samples – at least 30 samples with the broadest possible moisture variation from each fuel fraction.
- The device can be used to measure moisture in any fuel fraction. The aim was to gather at least one hundred measurement points for each fraction to make sure that measurement accuracy was reached. However, due to practical reasons, this was not achieved in all fuel fractions.
- Sample Size: The sample size should be appropriate to the device. The prototype was designed for the 10 liter samples. In the production model, the hopper will be increased to meet the users needs.
- Moisture variation inside the sample can be significant and quick.
- When comparing the results and in the calibration must pay attention to the allocation and timing of samples (oven drying vs. moisture measured by device)
- Sometimes, especially in early stages of the project, the device was clogged, if the material was fed too fast. Blockages of the device were eliminated by improving the mechanics and running reliability during the project.
- In the future, the objective is to develop a device that operates as an independent unit connected to the plants fuel management system and produces accurate information of moisture of energy wood fractions.



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