

Moisture, Volatiles and Ash in Biofuels with the TGA801

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Overview

Moisture, Volatiles and Ash are some of the most important parameters determined in the characterization of biofuels. Generally those parameters are determined by the thermogravimetric behavior of the samples at different temperatures and in different atmospheres. Moisture determination is done according to suitable standard procedures at temperatures of approximately 105°C. Ash determinations are made at 550°C, or higher temperatures. The measurement of the so-called Volatiles is a technical parameter determined by measuring the amount of sample released at higher temperatures without burning/oxidizing. So generally this is determined in an inert (Nitrogen) atmosphere and at a fixed temperature and time period. In most cases this time period is 7 minutes and the temperature above 900°C.

Analytical Parameters

The LECO TGA 801 is a special thermogravimetric analyzer that has been developed for the determination of Moisture, Volatiles and Ash content of solid fuels. Nineteen (or thirty-eight) samples, with sample weights of up to 5 g can be analyzed simultaneously. All 3 parameters are analyzed in one run, just by running one step after the other. The system is fully automated, so only sample input has to be done manually.

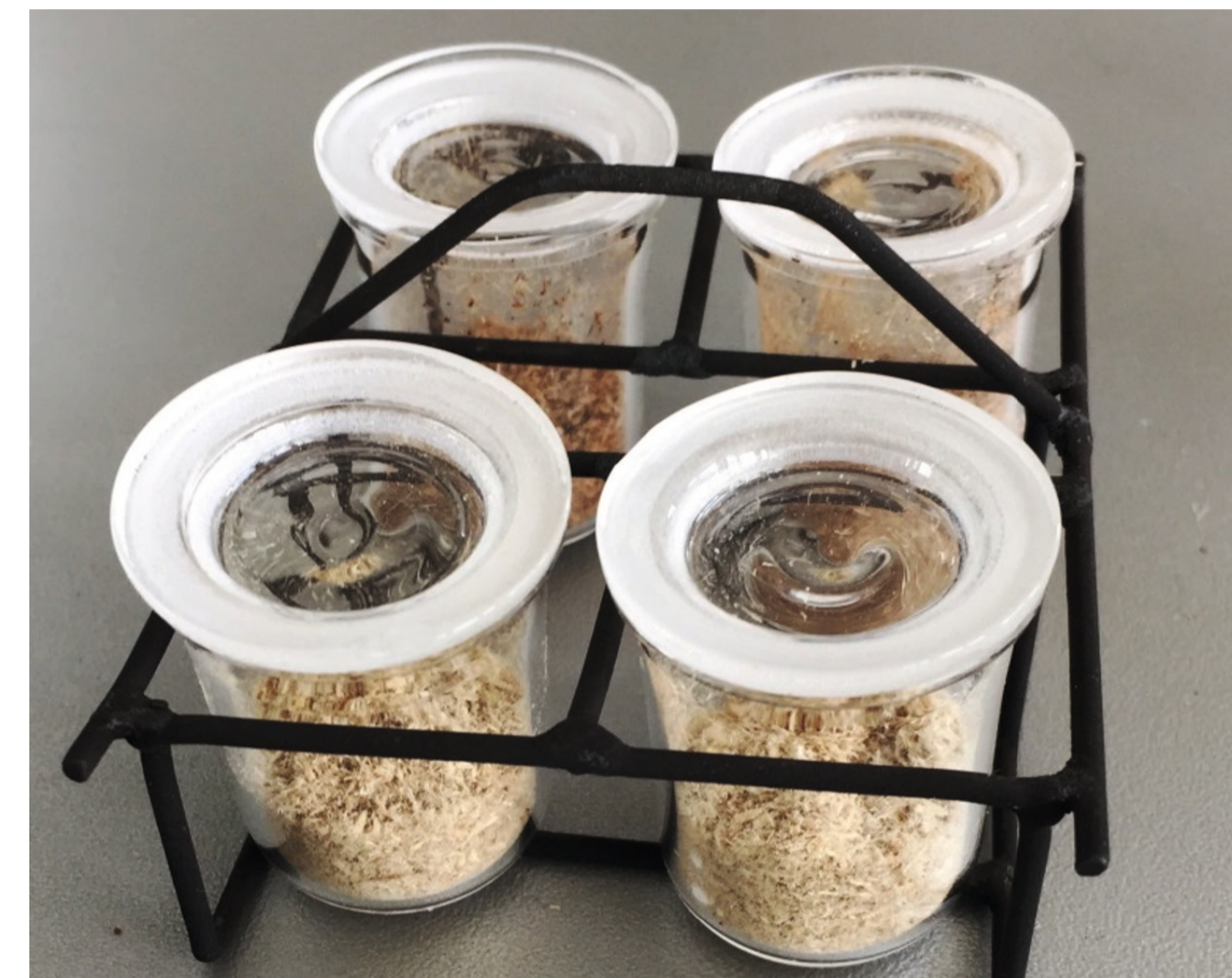


Figure 2: ISO 18123 crucibles for determination of the volatile content.

In this paper the moisture, ash and volatiles results from the ISO methods and those from the automated LECO TGA 801 method for different biofuels and waste materials are compared. In addition, different wood chips, peat samples, coal samples and plastic waste results are also compared for moisture, volatile and ash contents. The samples were analyzed using a LECO TGA 801 system, and the cited ISO procedures. The wood chips were ground with a mill, and the peat coal and plastic samples had been prepared for analysis using appropriate procedures.

	WP 1	WP 2	Peat 1	Peat 2	Coal 1	Coal 2	Plastic 1	Plastic 2
M TGA	5.71	5.12	2.72	2.78	1.25	2.31	<0.1	<0.1
M ISO	5.75	5.15	2.73	2.75	1.22	2.33	<0.1	<0.1
Ash TGA	1.60	5.69	4.29	6.39	7.37	11.99	11.87	8.74
Ash ISO	1.62	5.63	4.32	6.30	7.32	11.93	11.80	8.79

Table 1: Moisture (M) and Ash results from ISO and TGA procedures for various samples. Wood pellet (WP) and Ash values are reported on a dry basis.

As shown in Table 1 the average moisture and ash values for all of the samples agree very well. This behavior had been expected, because procedures and temperatures for the ISO and TGA programs are more or less the same.

	WP 1	WP 2	WP 3	WP 4	WP 5
Vol TGA	80.33	79.17	76.26	80.07	84.39
Vol ISO	79.72	78.59	77.32	80.61	84.26
Difference	0.61	0.58	-1.06	-0.54	0.13

Table 2: Volatile (Vol) results from ISO and TGA procedures for Wood pellet (WP) samples reported on a dry basis.

A comparison of the data for Volatiles from the wood pellet biofuel samples shows a linear relationship between the Volatiles results using the ISO method and Volatiles results using the TGA method with a "goodness of fit" or R² of 0.94. The maximum delta between both methods is 1.06 % and the average difference is 0.1 %.

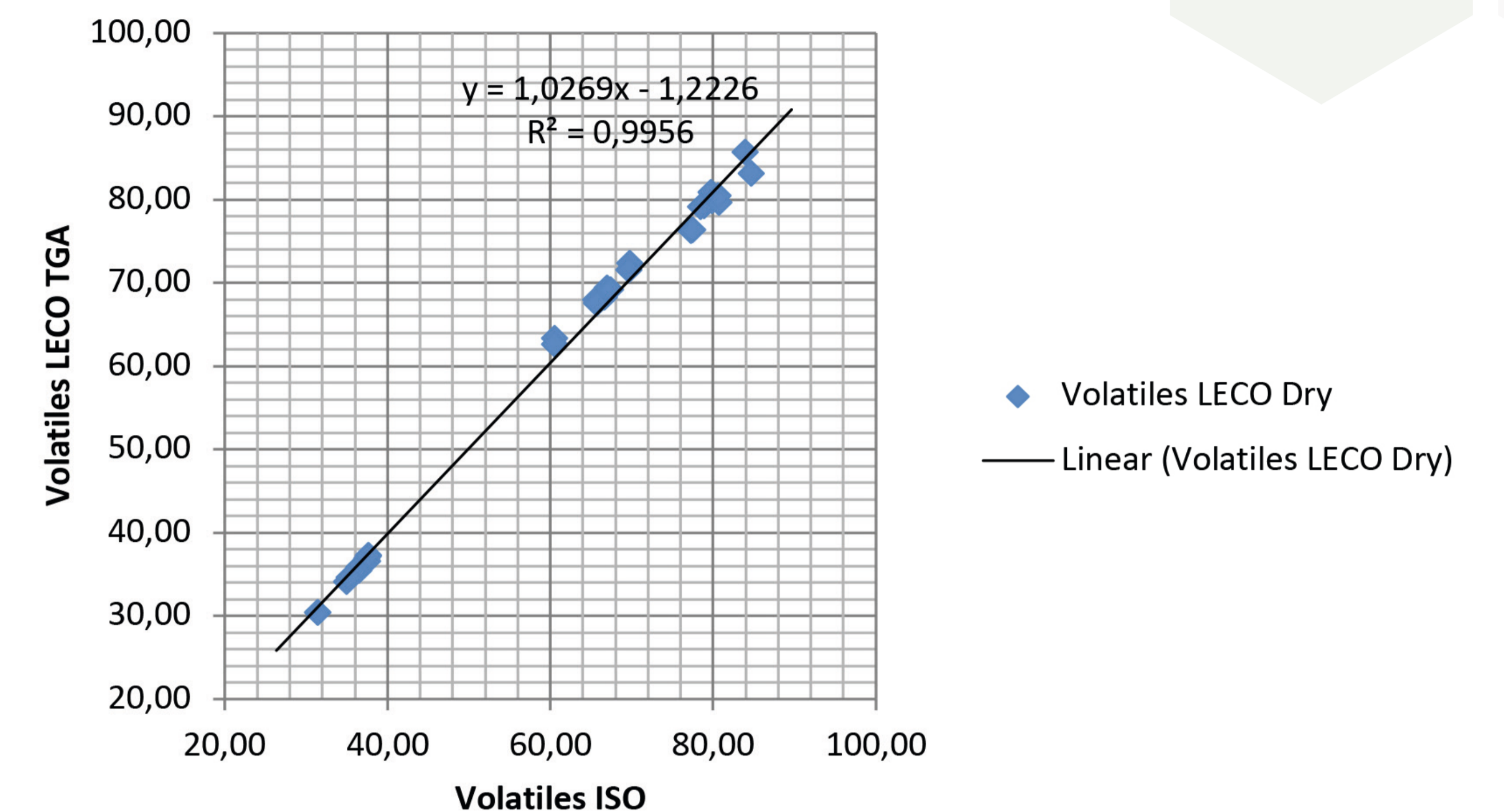


Figure 3: Comparison of Volatiles ISO Method / LECO TGA Method for coal, wood and peat samples.

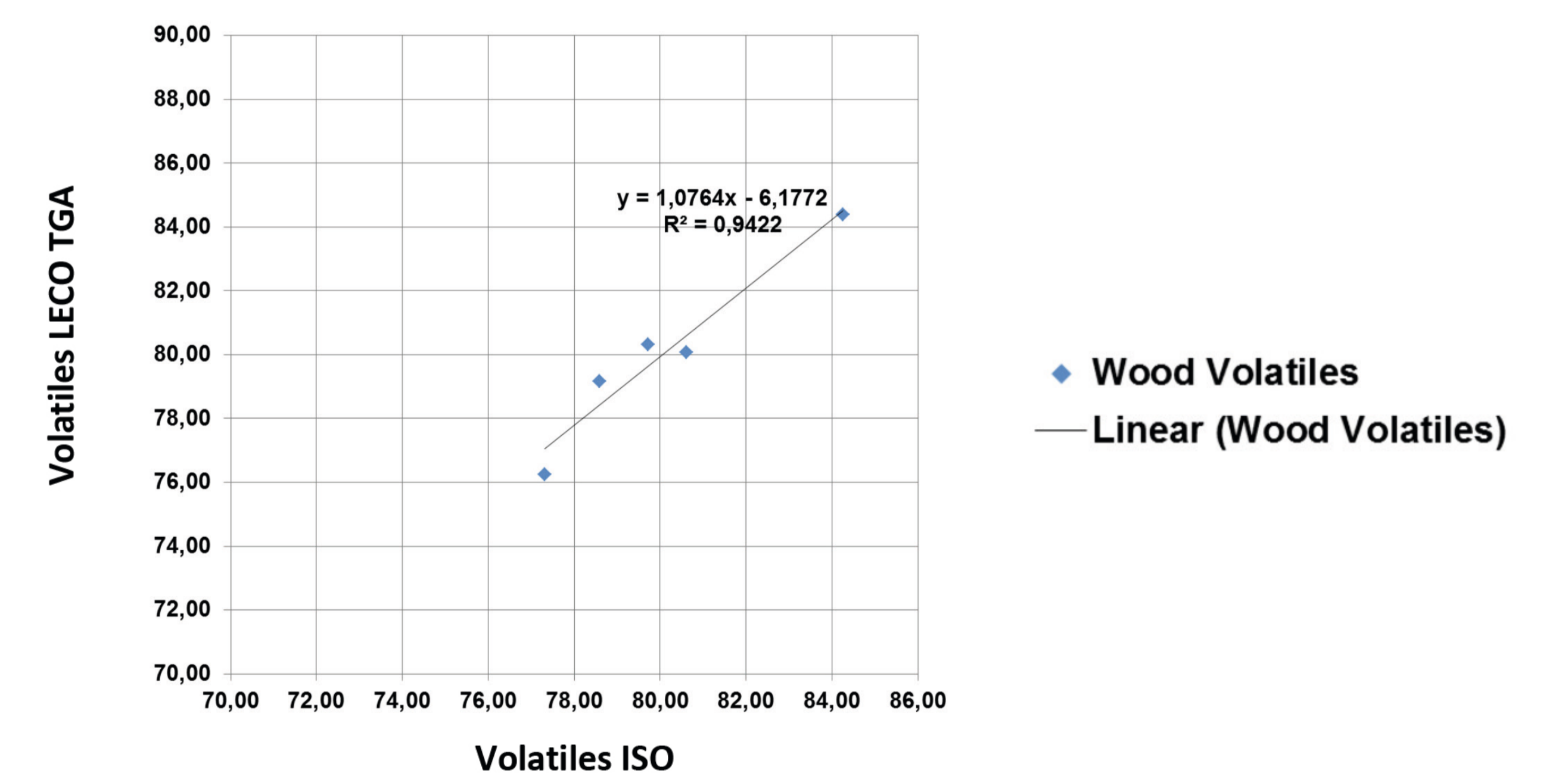


Figure 4: Comparison of Volatiles ISO Method / LECO TGA Method for wood samples only

Conclusion

The LECO TGA 801 is able to analyze beside moisture and ash also volatiles in solid biofuels with a very good coincidence to the ISO methods for solid biofuels. Any additional data handling parameters like calibrations or adjustments are not necessary. The advantage of having all 3 proximate analysis parameters determined automatically is obvious: automation, data security, convenience, and throughput.



Figure 1: LECO TGA 801 with ceramic turntable and crucibles.

Moisture, Ash and Volatile determination can be done according to the ISO standards 18123, 18122 und 18134. According to these standards moisture, volatiles and ash are determined at different temperatures.

Automated systems can be used for determination of these parameters if it can be shown that the results match the results of the ISO methods.

Biofuel Moisture and Ash values from the automated TGA method and the manual ISO methods are expected to be the same because of the close similarity in the procedures. However, there is a procedural difference between the TGA and ISO methods for Volatiles. Both methods record the mass loss for a certain number of minutes at 900°C, but the TGA needs additional time for heating up the system from the moisture step (~105°C) to the volatile temperature of 900°C.