Oxidation stability of diesel, biodiesel, and blends

Reliable oxidation stability measurements in diesel, biodiesel, and blends according to EN 14112, EN 15751, and EN 16568

Compared to petroleum diesel fuel, biodiesel produces fewer emissions and is considered sustainable and environmentally friendly. Biodiesel can be blended with petroleum-based diesel in any ratio. Many countries therefore add biodiesel to conventional diesel fuel between 5% to 15% (v/v). Depending on the type of internal combustion diesel engine, the biodiesel fraction can be much higher or even used as 100% pure biodiesel fuel.

However, the quality of both the biodiesel and its blends needs to be monitored. One of the most important parameters is oxidation stability of fuel. During biodiesel production, the addition and effect of antioxidants (e.g., ascorbyl palmitate) inhibits autoxidation and increases the oxidation stability [1]. The 893 Professional Biodiesel Rancimat is an analytical system for easy and safe determination of the oxidation stability of biodiesel and its blends according to EN 14112, EN 15751, and EN 16568.

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SAMPLE AND SAMPLE PREPARATION

This application is demonstrated on various fuel samples which are listed in **Table 1**.

No sample preparation is required.

EXPERIMENTAL

The determinations are carried out using an 893 Professional Biodiesel Rancimat (**Figure 1**).

An appropriate amount of sample is weighed into the reaction vessel, and then the analysis is started.

With the biodiesel Rancimat method, the sample is exposed to an airflow at a constant temperature between 80–150 °C. Highly volatile secondary oxidation products are transferred into the measuring vessel along with the airflow where they are absorbed in the measuring solution.

Figure 1. 893 Professional Biodiesel Rancimat equipped with measuring and reaction vessels for the determination of oxidation stability of biodiesel and its blends.
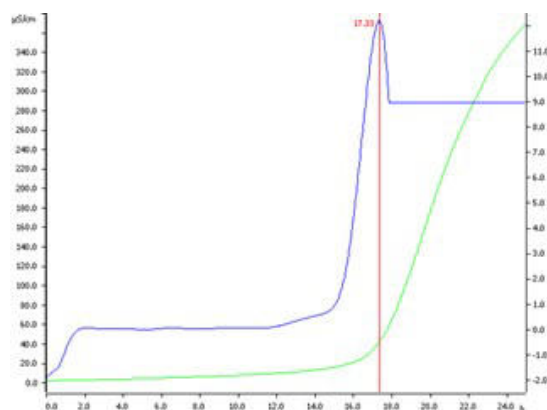
The conductivity of the measuring solution is continuously registered. The formation of secondary oxidation products leads to an increase in the conductivity. The time until occurrence of this marked conductivity increase is referred to as the «induction time», which is a good indicator for the oxidation stability (**Figure 2**).

Figure 2. Determination of the oxidation stability of a diesel blend with 20% biodiesel (v/v) at 110 °C.

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Furthermore, a power regression shows that the blends with the corresponding induction time achieved a coefficient of determination of 0.9996 (Figure 3). This demonstrates the accuracy of the 893 Professional Biodiesel Rancimat.
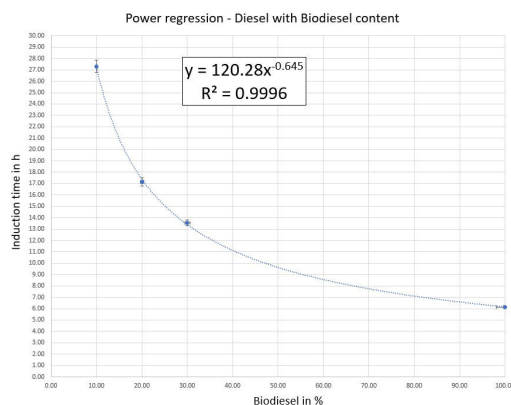

Power regression - Diesel with Biodiesel content

$y = 120.28x^{-0.645}$
$R^2 = 0.9996$

Figure 3. Power regression of diesel with biodiesel blend at 110 °C.

Table 1. Results for the oxidation stability of diesel, biodiesel, and blends with the 893 Professional Biodiesel Rancimat at 110 °C.

Sample (n = 4)	Mean value in h	SD(rel) in %
100% Diesel without biodiesel content	N/A*	N/A*
100% Biodiesel (made from organic waste)	6.15	1.2
Diesel blend with 30% biodiesel (v/v)	13.55	0.9
Diesel blend with 20% biodiesel (v/v)	17.15	1.0
Diesel blend with 10% biodiesel (v/v)	27.31	1.6

CONCLUSION

The oxidation stability of biodiesel and its blends with diesel fuels is an important parameter listed in a series of standard methods defining the minimum quality requirements for biodiesel marketed as vehicle fuel or heating oil.

By using the Rancimat, diesel oxidation stability can be easily determined for several samples at a time with eight measuring positions in two heating blocks, increasing laboratory throughput. The built-in display shows the status of the instrument and each individual measuring position. A button located at each measuring position on the instrument allows measurements to be started.

The use of practical disposable reaction vessels and dishwasher-safe accessories reduces cleaning to a minimum. This saves time and money and significantly improves accuracy and repeatability.

In this application, diesel, biodiesel, and various blends of both were tested. As diesel fuel itself is very stable against oxidation, no induction period could be found within a reasonable time at 110 °C. However, the determination worked very well for biodiesel and all blends tested.

It was also shown in a power regression that the blends with the corresponding induction time achieved a coefficient of determination of 0.9996, demonstrating the superior accuracy of the 893 Professional Biodiesel Rancimat for this analysis.

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REFERENCES

1. Metrohm AG. Oxidation Stability of Fatty Acid Methyl Esters (FAME, Biodiesel) – Reliable and Accurate Determination of the Oxidation Stability of Biodiesel According to EN 15751; AN-R-009; Metrohm AG: Herisau, Switzerland, 2024.

CONTACT

Metrohm Viet Nam
Phan Dinh Giot
70000 Ho Chi Minh

info@metrohm.vn

CONFIGURATION

893 Professional Biodiesel Rancimat

The 893 Professional Biodiesel Rancimat is an analysis system for easy and safe determination of the oxidation stability of biodiesel (fatty acid methyl ester, FAME) and biodiesel blends in accordance with EN 14112, EN 15751 and EN 16568 standards. With eight measuring positions in two heating blocks. The built-in display shows the status of the instrument and each individual measuring position. Start buttons for every measuring position enable the measurement start on the instrument. Cleaning effort can be reduced to a minimum through the use of practical disposable reaction vessels and dishwasher-safe accessories. This saves time and costs and significantly improves accuracy and reproducibility.

All accessories necessary for carrying out determinations are included in the scope of delivery. The StabNet software is required for instrument control, data recording and evaluation and for data storage.

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Equipment for determination of temperature correction with Biodiesel Rancimats.

Set for exact temperature adjustment

Consumable Kit Biodiesel Rancimat

Assembly of important expendable items for the Biodiesel Rancimat.

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