TÜBİTAK
ULUSAL METROLOJİ ENSTİTÜSÜ

Certificate of the Reference Material

Name of the Material : Biodiesel

Material Code : UME BIOFMET CRM 01

Issue Date : 27.12.2024

Revision Date : 27.12.2024 (Revision history can be found on the last page)

Validity Period of the Certificate : 12 months from the sales date

Certified Values :

Parameter	Certified Value [1]	Uncertainty [2]	Unit
Gross Calorific Value [$q_{V,gr}$] [3]	39901	97	J/g
Density at 15 °C [4]	0.88353	0.00035	g/cm^3
Kinematic Viscosity at 40 °C [5]	4.419	0.039	mm^2/s

[1] The certified values and uncertainties are traceable to the International System of Units (SI).

[2] The expanded uncertainty of the certified value includes characterization, homogeneity, stability components and is stated as the standard uncertainty of measurement multiplied by the coverage factor $k = 2$, which for a normal distribution corresponds to a coverage probability of approximately 95 %. The standard uncertainty of measurement has been determined in accordance with GUM “Guide to the Expression of Uncertainty in Measurement”.

[3] Calculated from the arithmetic mean of the accepted results of gross calorific value at constant volume submitted by four laboratories applying DIN 51900-2 method.

[4] Calculated from the arithmetic mean of the accepted results submitted by two laboratories applying ASTM D4052 and EN ISO 12185 methods.

[5] Calculated from the arithmetic mean of the accepted results submitted by two laboratories applying ASTM D7042 and EN ISO 3104 methods.

Sales Date

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Certified Values (*continued*) **:**

Parameter	Certified Value [1]	Uncertainty [2]	Unit
Ca [6]	1.03	0.31	mg/kg
K [6]	1.01	0.34	mg/kg
Mg [7]	0.48	0.11	mg/kg
Na [8]	1.70	0.57	mg/kg
P [9]	2.13	0.51	mg/kg
S [10]	8.7	1.4	mg/kg

[1] The certified values and uncertainties are traceable to the International System of Units (SI).
[2] The expanded uncertainty of the certified value includes characterization, homogeneity, stability components and is stated as the standard uncertainty of measurement multiplied by the coverage factor *k = 2*, which for a normal distribution corresponds to a coverage probability of approximately 95 %. The standard uncertainty of measurement has been determined in accordance with GUM "Guide to the Expression of Uncertainty in Measurement".
[6] Calculated from the arithmetic mean of the accepted results submitted by two laboratories applying ICP-MS and ICP-OES methods.
[7] Calculated from the arithmetic mean of the accepted results submitted by two laboratories applying ICP-MS, HR ICP-MS and ICP-OES methods.
[8] Calculated from the arithmetic mean of the accepted results submitted by three laboratories applying ICP-MS, HR ICP-MS and ICP-OES methods.
[9] Calculated from the arithmetic mean of the accepted results submitted by one laboratory applying HR ICP-MS and ICP-OES methods.
[10] Calculated from the arithmetic mean of the accepted results submitted by three laboratories applying ICP-MS, HR ICP-MS, ID ICP-MS and ICP-OES methods.

Informative Values

Parameter	Assigned Value	Uncertainty [1]	Unit
Net Calorific Value [$q_{V,net}$] [2]	37360	91	J/g
Mono-Glycerides [3]	0.566	0.019	g/100 g
Di-Glycerides [3]	0.1752	0.0080	g/100 g
Tri-Glycerides [3]	0.1432	0.0089	g/100 g
Free Glycerol [3]	0.0193	0.0027	g/100 g
Total Glycerol [3]	0.204	0.019	g/100 g

[1] The expanded uncertainty of the assigned value includes characterization, homogeneity, stability components and is stated as the standard uncertainty of measurement multiplied by the coverage factor *k = 2*, which for a normal distribution corresponds to a coverage probability of approximately 95 %. The standard uncertainty of measurement has been determined in accordance with GUM "Guide to the Expression of Uncertainty in Measurement".
[2] Calculated from the certified gross calorific value at constant volume [qV,gr] by using the following equation:
qV,net,= [qV,gr – (206 x hydrogen content of biofuel, in percentage by mass + 23.05 x water, in percentage by mass)] as defined in DIN 51900-1.
[3] Calculated from the arithmetic mean of the accepted results submitted by one laboratory applying EN 14105 method.

Informative Values (*Continued*)

Parameter	Assigned Value	Uncertainty [1]	Unit
Methyl Linoleate [4]	28.7	2.2	g/100 g
Methyl Palmitoleate [4]	0.248	0.069	g/100 g
Methyl Palmitate [4]	8.67	0.93	g/100 g
Methyl 11-Octadecenoate [4]	58.4	3.1	g/100 g
Methyl Stearate [4]	2.40	0.31	g/100 g
Methyl cis-11-Eicosenoate [4]	1.09	0.21	g/100 g
Methanol [5]	0.176	0.035	g/100 g
Water [6]	339	89	mg/kg

[1] The expanded uncertainty of the assigned value includes characterization, homogeneity, stability components and is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which for a normal distribution corresponds to a coverage probability of approximately 95 %. The standard uncertainty of measurement has been determined in accordance with GUM “Guide to the Expression of Uncertainty in Measurement”.

[4] Calculated from the arithmetic mean of the accepted results submitted by one laboratory applying GC-MS method aiming quantification of relative amount based on total area of the methyl esters.

[5] Calculated from the arithmetic mean of the accepted results submitted by one laboratory applying GC-FID method.

[6] Calculated from the arithmetic mean of the accepted results submitted by two laboratories applying EN ISO 12937 coulometric Karl-Fischer method with direct and oven sample introduction systems.

Parameter	Measured Value [1]	SD [2]	Unit
C	77.29	0.23	g/100 g
H	12.33	0.16	g/100 g

[1] Arithmetic mean of the accepted analysis results (n = 12) by one laboratory applying ISO 16948 method.

[2] Standard deviation of the 12 measurement results.

Description

The material is approximately 500 mL of filtered biodiesel filled into amber glass bottle after spiking with Ca, K, Mg, Na and P standards in mineral oil and homogenization. Detailed information about the preparation of the material can be found in the certification report.

Intended Use

This material is intended to be used for method validation of the determination of calorific value, density, kinematic viscosity, and Ca, K, Mg, Na, P and S mass fractions in biodiesel and for quality control purposes.

Instructions for Use

Bottle should be shaken before opening the cap. All precautions should be taken to prevent contamination and evaporation during the use of the material. In order to prevent contamination, it is recommended that the bottle should be opened in a clean environment and pipette should not be inserted into the bottle. After use, the bottle should be tightly recapped immediately.

The minimum sample intake is defined by the required sample volume stipulated in the respective standard methods.

This material can be safely dispatched under conditions where the temperature does not exceed 45 °C for up to two weeks, i.e. at ambient temperature without applying any cooling elements.

Storage Conditions

The material should be stored at (22 ± 4) °C in a dark and clean environment. TÜBİTAK UME cannot be held responsible for changes that might happen to the material at the customer's premises due to non-compliance with the instructions for use, and the storage conditions given.

Safety Information

The material is manufactured for laboratory use only. General laboratory precautions should be followed during storage and use of the material. It is recommended to use and dispose of the material according to the existing safety rules.

Participants

Information about the laboratories participated in the characterization study is presented in the following table.

Laboratory	Address
BAM	Bundesanstalt für Materialforschung und -prüfung, Berlin, GERMANY
BRML-INM	BRML-INM, National Metrology Institute, Bucharest, ROMANIA
DTI	Danish Technological Institute, Aarhus, DENMARK
GUM	Central Office of Measures, Warszawa, POLAND
IMBiH	Institute of Metrology of Bosnia & Herzegovina, Sarajevo, BOSNIA and HERZEGOVINA
LGC	LGC Paragon Scientific Ltd. Prenton, Wirral, UNITED KINGDOM
PTB	PTB, Physikalisch Technische Bundesanstalt, Braunschweig, GERMANY
TÜBİTAK UME	National Metrology Institute, Gebze - Kocaeli, TÜRKİYE

Methods and/or Techniques Used for the Determination of the Certified Values

Techniques used in the characterization studies:

Method/Technique	Parameter
ISO EN 18125 / Isoperibol Calorimetry	Calorific Value
ASTM D4052 and EN ISO 12185 / Density Meter	Density at 15 °C
ASTM D7042 and EN ISO 3104 / Stabinger Viscometer	Kinematic Viscosity at 40 °C
Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Ca, Mg, K, Na, S
High Resolution Inductively Coupled Plasma Mass Spectrometry (HR ICP-MS)	Mg, P, Na, S
Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES)	Ca, Mg, P, K, Na, S
Isotope Dilution Inductively Coupled Plasma Mass Spectrometry (ID-ICP-MS)	S

Revision History

Date	Remarks
27.12.2024	First issue.