EMPIR Call 2019 – Energy, Environment, Normative and Research Potential

Selected Research Topic number: **SRT-g15**
Version: 1.0

Title: New metrological methods for biofuel materials analysis

Abstract

Biomass is a key building block in biofuels which can be defined as a fuel produced through contemporary biological processes. Currently, the EU aims for biomass to increase to at least a 27 % share of the renewable energy consumption. This is supported by the United Nations, who's sustainable world goals emphasise the efficient use of renewable energy sources such as biomass. However, so far, the use of biomass as a substitute for fossil fuels has mainly been carried out by modification of coal fired combustion plants without taking the nature or quality of the biomass or biofuel into consideration. This missing information is important as traceable material analysis of biofuels would support the optimisation of their combustion with respect to higher efficiencies and lower emissions. Therefore, fast, accurate and reproduceable measurement methods to characterise key biofuel parameters (e.g. moisture, ash, impurities and calorific value) need to be developed.

Keywords

Biofuels, biomass, moisture, calorific value, impurities, ash content

Background to the Metrological Challenges

In 2016 19 million tons of wood pellets were consumed in EU and the number is expected to increase to 22.5 million tons by 2028. Determining the content of water in solid biofuels, such as wood pellets, is important as if the combustion cannot be regulated according to the water content, the worst-case scenario is that the boiler will not be able to combust the material, leading to shut down. This is especially significant for smaller power plants, but even for larger facilities, the content of water is critical for energy efficiency, boiler control, emissions related to incomplete combustion (e.g. particulates and carbon monoxide). Further to this, moisture can result in microbial growth and can lead to undesirable diesel bugs, moulds, yeasts and bacteria spreading throughout the biofuel.

Current biofuel measurements are dominated by traditional offline and relatively slow laboratory analysis, with the reference method for water determination in solid biofuels based on the Loss-on-Drying (LoD) technique in EN 14774. However, such documentary standards are adaptations of old standards for coal and their suitability for biofuels is unverified. In addition, the LoD method is cumbersome, prone to errors, cannot be used online and its traceability is questionable as it not only detects water but also other volatiles.

The ash content in biofuels (in combination with water content) is crucial for determining their calorific value and hence the energy content of the fuel. Furthermore, ash content quantification and qualification are needed for the handling of biofuel waste and deposits and to gain insight on slag formation. Currently, the ash content of solid biofuels can be determined off-line according to EN 14775. But in order to determine the calorific value of the biofuel not only are the ash and water content needed but also the content of Carbon, Hydrogen, Oxygen, Nitrogen, and Sulphur compounds. Offline measurements can currently be used to determine these values using EN 15289, but sampling constitutes a significant challenge for heterogenous biofuels.

The presence of inorganics (e.g. residual catalyst, salts) and organic biproducts (e.g. glycerol, partly converted fat, soap) in liquid biofuels can lead to undesirable solid precipitations in the fuel transportation systems and combustion chamber inlets, as well as corrosions. The content of impurities in liquid biofuels, especially inorganics, also impacts their caloric value and must be known in order to determine an accurate heat value. The physical characteristics of liquid biofuels such as Fatty acid methyl esters (FAME) compounds are more similar to those of conventional diesel fuels than pure vegetable oils. In addition, the properties depend on the type of vegetable oil. Currently, impurities in liquid biofuels can be measured with offline standard techniques, however faster online determination is needed as reducing the number of contaminants would lead to higher calorific values and boost the energy performance of biofuels.

EURAMET MSU, Hampton Road, Teddington, Middlesex, TW11 0LW, UK
Phone: +44 20 8943 6666 Email: msu@npl.co.uk
msu.euramet.org

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Objectives

Proposers should address the objectives stated below, which are based on the PRT submissions. Proposers may identify amendments to the objectives or choose to address a subset of them in order to maximise the overall impact, or address budgetary or scientific / technical constraints, but the reasons for this should be clearly stated in the protocol.

The JRP shall focus on the traceable measurement and characterisation of biofuels.

The specific objectives are

1. To develop traceable online measurements for water content in solid biofuels, for the measurement ranges 5 % - 12 % (wood pellets) and 20 % - 75 % (woodchips) with a target uncertainty of 5 %.
2. To develop improved methods for the sampling of biofuels (i.e. in cases where online methods cannot be used). This should include using data-science techniques such as machine learning to optimise calibration curves and uncertainties.
3. To traceably determine the calorific value of the solid biofuels by developing validated methods for the online measurement of ash content. In addition, to develop accurate methods < 0.2 % absolute repeatability (as per EN 14775) for determining the amount and composition of ash content in the measurement range 0 % - 1 %.
4. To develop validated methods to determine the amount and nature of impurities in liquid biofuels, including quantifying and qualifying inorganic and organic by-products. In addition, to develop a traceable method for the online determination of the calorific value of liquid biofuels.
5. To disseminate and facilitate the take up of the technology and measurement infrastructure developed in the project by the measurement supply chain, standards developing organisations (CEN TC 335, CEN TC 19) and end users (e.g. the European Technology and Innovation Platform (ETIP) and European Biodiesel Board (EBB).

These objectives will require large-scale approaches that are beyond the capabilities of single National Metrology Institutes and Designated Institutes. To enhance the impact of the research, the involvement of the appropriate user community such as industry, standardisation and regulatory bodies is strongly recommended, both prior to and during methodology development.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this. In particular, proposers should outline the achievements of the EMRP projects ENG09 Biofuels and SIB64 METefnet and how their proposal will build on this.

EURAMET expects the average EU Contribution for the selected JRPs in this TP to be 2.0 M€, and has defined an upper limit of 2.3 M€ for this project.

EURAMET also expects the EU Contribution to the external funded partners to not exceed 35 % of the total EU Contribution across all selected projects in this TP.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the “end user” community, describing how the project partners will engage with relevant communities during the project to facilitate knowledge transfer and accelerate the uptake of project outputs. Evidence of support from the “end user” community (e.g. letters of support) is also encouraged.

You should detail how your JRP results are going to:

- Address the SRT objectives and deliver solutions to the documented needs,
- Feed into the development of urgent documentary standards through appropriate standards bodies,
- Transfer knowledge to biofuel producers/suppliers and the energy sector.

You should detail other impacts of your proposed JRP as specified in the document “Guide 4: Writing Joint Research Projects (JRPs)”

You should also detail how your approach to realising the objectives will further the aim of EMPIR to develop a coherent approach at the European level in the field of metrology and include the best available contributions from across the metrology community. Specifically, the opportunities for:

- improvement of the efficiency of use of available resources to better meet metrological needs and to assure the traceability of national standards
- the metrology capacity of EURAMET Member States whose metrology programmes are at an early stage of development to be increased

- organisations other than NMIs and DIs to be involved in the work.

Time-scale

The project should be of up to 3 years duration.

Additional information

The references were provided by PRT submitters; proposers should therefore establish the relevance of any references.

[1]. M/298 Standardisation mandate to CEN in the field of solids biofuels