EMRP Call 2012 – Open Excellence, Industry and SI Broader Scope

Selected Research Topic number: SRT-**s08**
Version: 1.0

Title: Traceability of gas flow measurements for special applications

Abstract

Gas flow measurements for special applications are becoming more and more important for a wide range of industries such as the automotive, aerospace, energy generation, chemical and pharmaceutical industries. Until now the monitoring and measurement of gas flow in these special applications, i.e. the measurement of gas flow at high temperature, under high pressure or the measurement of a number of gas compositions, is carried out using established measurement principles for conventional applications in combination with theoretical correction factors. However, the development of specific reference devices and procedures for the calibration of gases in the conditions in these special applications will provide more accurate and precise measurement values. This, in turn, could increase the efficiency of power conversion processes and save production process costs.

Conformity with the Work Programme

This Call for JRPs conforms to the EMRP Outline 2008, section on “Grand Challenges” related to Industry & Fundamental Metrology on page 37.

Keywords

Traceability, high temperature gas, high pressure gas, industrial gases, high flow rate gas, gas composition, gas mixing, measurement uncertainty

Background to the Metrological Challenges

Gas flow measurements for special applications include the measurement of exhaust gas from motor engines, the thermal energy of gas in combined heat and power plants, the entrance gas flow of CO_2-free coal gas power plants, gas flow in high pressure systems (e.g. underground gas storage, aircraft engines), steam flow measurements and the mixing of industrial gases to produce specific gas compositions.

Current, conventional calibration and testing of gas meters is usually performed at fluid properties close to ambient temperature and pressure and for high pressure the upper limit is 50 bar. However, special applications operate at temperatures and pressures far above ambient conditions, e.g. 300 – 1000 °C and up to 700 bar. Furthermore, the measurement of industrial gases at low flow rates is achieved with devices calibrated with air. As the physical properties of air differ significantly from most industrial gases, measurement error usually occurs and this error is often greater than the measurement uncertainty of the air calibration procedures. In addition to this, specific industrial gas mixtures, needed for example for testing gas analysers, are currently generated by gravimetrical methods, which are inflexible, cost-intensive and time-consuming.

As a result of these issues the measurement of gases for special applications must accept a higher measurement uncertainty (2 % – 5 %) and the monitoring of such processes occurs with lower accuracy and precision. Considering the importance of determining the efficiency of engines or production processes, this uncertainty value is too high and therefore a decrease in the uncertainty is needed. By decreasing the uncertainty to 0.5 % - 1 % this would support technology development and lead to the reduction of the uncertainty of gas flow measurements by a factor of 5.

The state of the art for gas flow measurements is the calibration of the measurement devices for gas flow at available conventional test rigs close to ambient conditions and the extrapolation of these calibration results

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EMRP
European Metrology Research Programme
Programme of EURAMET

The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union

to the special application conditions. This is based on assumptions of similarity of fluid flow (e.g. the Reynolds number and/or other dimensionless flow numbers at calibration and application) and the calculation of meter body changes under the applied special application conditions. However, the uncertainties associated with the use of these assumptions haven't been determined and any traceability to the SI-units is currently lacking for gas flow measurements under special application conditions.

Scientific and Technological 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 JRP-Protocol.

The JRP shall focus on methods for the reliable and traceable measurement of quantity and flow rate of gaseous fluids for special applications.

The specific objectives are

1. To develop traceable measurements with uncertainties better than 1 % for special applications with large (industrial scale) gas flows at temperatures greater than 250 °C and/or pressures significantly greater than 50 bar, by (amongst others)
    a. Characterising and quantifying the influence and interdependencies of such high temperatures, high pressures, high flow rates and various gas compositions on the measurement uncertainty
    b. Increasing the reliability of uncertainty budgets for gas flows in special applications by developing and adapting mathematical models.
    c. Producing accurate and high precision reference standards for such gas flows in special applications
2. To develop traceable measurements with uncertainties better or equal to current gravitational methods for low gas flow rates (lower than 5 l/h) for special applications requiring accurate mixing of gases

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 work, the involvement of the larger community of metrology R&D resources outside Europe is recommended. A strong industry involvement is expected in order to align the project with their needs and guarantee an efficient knowledge transfer into industry.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this and how it will use or extend the knowledge developed in JRPs ENG01 'Characterisation of Energy Gases' and ENG03 'Metrology for Liquefied Natural Gas'.

The total eligible cost of any proposal received for this SRT is expected to be around the 2.7 M€ guideline for proposals in this call. The available budget for integral Research Excellence Grants is 42 months of effort.

Potential Impact

Proposals must demonstrate adequate and appropriate participation/links to the "end user" community. This may be through the inclusion of unfunded JRP partners or collaborators, or by including links to industrial/policy advisory committees, standards committees or other bodies. Evidence of support from the "end user" community (e.g. letters of support) is encouraged.

You should detail how your JRP results are going to:

- feed into the development of urgent documentary standards through appropriate standards bodies
- transfer knowledge to the industrial sector, in particular the automotive, aerospace, energy generation, chemical and pharmaceutical sectors.

You should detail other impacts of your proposed JRP as detailed in the document "Guide 4: Writing a Joint Research Project"

You should also detail how your approach to realising the objectives will further the aim of the EMRP to develop a coherent approach at the European level in the field of metrology and includes 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 Member States and countries associated with the Seventh Framework Programme whose metrology programmes are at an early stage of development to be increased
- outside researchers & research organisations other than NMIs and DIs to be involved in the work

Time-scale

The project should be of up to 3 years duration.