EMRP Call 2013 – Energy and Environment

Selected Research Topic number: **SRT-g12**
Version: 1.0

Title: Multiphase flow metrology in oil and gas production

Abstract

When oil is extracted from a well it typically exists as a multiphase flow comprised of time-varying ratios of oil, water and gas. Measuring the flow rate of each component is necessary for resource-efficient exploitation and minimising environmental impact. However, typical multiphase flow measurement systems have an uncertainty of 2 % at best, which can rise to 20 % under field conditions. The uncertainty of such measurements can also be considerably worse in the field due to variability in field conditions unique to multiphase metering, such as flow patterns and component ratios, which vary randomly as well as predictably during the lifetime of a well. In order to support resource efficiency and hence the security of European energy supply, these measurement and uncertainty issues in multiphase flow measurement need to be addressed.

Conformity with the Work Programme

This Call for JRPs conforms to the EMRP Outline 2008, section on “Grand Challenges” related to Energy and Environment on pages 8 and 23.

Keywords

multiphase flow; metrology; measurement; metering; oil; gas; water; uncertainty; energy

Background to the Metrological Challenges

Europe is currently dependent on oil & gas as its primary energy source to a greater extent than all other energy sources combined and this is likely to remain so for many decades to come. When oil is extracted from a well it typically exists as a multiphase flow, comprising time-varying ratios of oil, water and gas. In early land-based and shallow water production systems the metering of such flows was achieved using separation systems with individual metering of each phase (i.e. single phase flow measurements). However, this method was extremely expensive and impractical for economically marginal reserves, or those in remote or deep-water locations. Therefore, compact multiphase metering systems capable of simultaneously metering oil, water and gas were developed in the mid-1980s.

Current multiphase flow measurement uncertainty for produced oil, gas and water mixtures is 2 to 3 % under limited flow conditions when replicated in a calibration lab, but this soon becomes 5 to 20 % in operational conditions and the uncertainty can be considerably worse due to variable field conditions. In contrast, single phase flow measurement uncertainties of less than 0.1 % are commercially achievable. However, this is only achieved when measuring relatively pure single-phase fluids and can increase to 10 to 15 % when impurities are introduced in significant quantity, e.g. if single phase metering is used to measure flow rates in ‘oil’ immediately following first stage separation.

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 the traceable measurement and characterisation of multiphase flow in complex and variable field conditions, such as in oil and gas production.

EURAMET, EMRP-MSU
National Physical Laboratory
Hampton Road, Teddington,
Middlesex, TW11 0LW, UK

Phone: +44 20 8943 6666
emrpA169@npl.co.uk
www.euramet.org

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The specific objectives are

1. To develop an accurate and validated metrological reference network using existing test and calibration facilities for multiphase flow. Agreement between the facilities should be consistent with respective uncertainty budgets.
2. To improve the current theoretical and experimental mapping of flow patterns as a function of field variables such as pressure, temperature and component fluid properties and velocities.
3. To improve methods for handling non-deterministic behaviour, e.g. alternative numerical approaches such as chaos theory. A reduction by a factor of two in the uncertainty attributable to chaotic fluid behaviour should also be achieved.
4. To evaluate and improve flow visualisation methods for both laboratory and field-based measurement. This should include real-time cross and through-sectional imaging for mixtures and flow velocities appropriate to multiphase production.

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 R&D work, the involvement of the user community such as industry, and standardisation and regulatory bodies, as appropriate, is strongly recommended.

Proposers should establish the current state of the art, and explain how their proposed project goes beyond this.

EURAMET expects the average size of JRPs in this call to be between 3.0 to 3.5 M€, and has defined an upper limit of 5 M€ for any project. The available budget for integral Research Excellence Grants is 30 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 energy and industrial 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.