EMRP Call 2010 - Industry & Environment

Topic number: SRT-14i

Title: Vacuum metrology for production environments

Abstract

Vacuum is an indispensable tool for many industrial processes, but is poorly characterised in practical applications. Traditional techniques have established total pressure standards for pure gases under stable conditions. In order to better control industrial processes traceable standards and methods are required for partial pressures and dynamic pressures. In addition vacuums are degraded by leaks and out-gassing, and there are currently insufficient metrological techniques to evaluate the scale of leaks in anything other than pure gases. Research is needed to establish traceable industrial standards, and to develop standardisation.

Conformity with the Work Programme

This Call for JRPs conforms to the EMRP 2008, section on "*Grand Challenges"* related to *Industry* on:

page 12 "Innovative set-ups for new industrial and societal needs … pressure standards for ultra high vacuum (UHV), and extreme UHV conditions" and

page 37 "... applications such as the semiconductor industry require better standards in the extreme ultra high vacuum regime"

Keywords

Vacuum, vacuum gauge, partial pressure measurement, traceability, dynamic measurement, vacuum standard, standardisation.

Background to the Metrological Challenge

Vacuum is an indispensable tool supporting many industries, including; the semiconductor industry, photovoltaic industry, lighting industry and food packaging industries

Primary and secondary standards for total vacuum pressure are well established and provide the absolute pressure scale for pure gases under equilibrium and stationary conditions, from 10^{-9} Pa to 10^{5} Pa. Unfortunately industrial processes use gas mixtures, rather than pure gases, an in general have dynamic rather than static pressure. Because of this the existing standards are not well matched to the industrial need. To further complicate matters, industrial processes use vacuum gauges are used, and unlike gas pressure these are not well characterised.

A more thorough characterisation of industrial vacuum is required including:

- Measurement of total pressure and pressure of the gas components in the vacuum (partial pressures)
- Dynamic changes of the partial and the total pressures
- In-situ methods for calibration of quadrapole mass spectrometers (QMS) and other vacuum gauges in industrial environments

Maintaining high vacuum is critical for many high science applications (e.g. fusion reactors), in addition leak testing and outflow measurement is crucial in industry (cold storage, air conditioning, vacuum sealed devices, containment vessels and systems for toxic, radioactive and environment polluting substances) and some of which have legislative requirements e.g. DIN 8964 (part 2) and EN 14091. Experimental metrology for leak testing is insufficiently developed, with no universally accepted standards for measuring leaks under conditions different from those at the time of measurement.

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

EMRP
European Metrology Research Programme
Programme of EURAMET

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

Currently these minuscule gas / particle flows are difficult to measure, since they are very different from the standard measurement of test gas (most often helium), and are regularly required for leaks discharging into atmospheric pressure rather than vacuum. Comparative measurement of leaks at various conditions are rarely available (ref 3)], therefore standardised measurement techniques, data conversion techniques and primary standards need to be developed for leak testing and outgassing of mixtures other than pure gases.

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 overall aim of the JRP is to provide validated and reliable measurements/methods with traceability wherever it is practicable to do so.

The specific objectives are

1. Dynamic vacuum measurement, including the development of vacuum systems with very fast pressure changes and of methods for the detection of very fast pressure changes, and associated modelling (such as by Monte Carlo methods)
2. Partial pressure measurement, such as based on mass spectrometry and optical detection methods
3. Measurement of outgassing rate and material characterisation
4. Leak measurement and testing.

Proposers shall give priority to work that meets documented industrial needs and that which supports transfer into industry e.g. by cooperation and/or by standardisation.

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

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.

Where a European Directive is referenced in the proposal, the relevant paragraphs of the Directive identifying the need for the project should be quoted and referenced. It is not sufficient to quote the entire Directive per se as the rationale for the metrology need. Proposals must also clearly link the identified need in the Directive with the expected outputs from the project.

You should also detail other Impacts of your proposed JRP as detailed in the document “Guidance for writing a JRP”

You should detail how your JRP results are going to:

- feed into the development of urgent standards through appropriate standards bodies
- transfer knowledge to the following industrial sectors; vacuum industry, coating and process tool industry, process engineering, automotive industry, aerospace industry and safety engineering

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. 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 3 years duration.

Additional information

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

1. http://www.vdma.org/wps/myportal/Home/de/Branchen/K/KDV/Wirtschaft_/KDV_20090929_Art_Mae_ISVT_Pressemitteilung?WCM_GLOBAL_CONTEXT=/wps/wcm/connect/vdma/Home/de/Branchen/K/KDV/Wirtschaft_/KDV_20090929_Art_Mae_ISVT_Pressemitteilung
2. http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_tc_browse.htm?commid=51654&development=on
3. Bloomer R N 1973 Leaks, *Vacuum* **23**; 231-238
4. SAMPE Journal, 44(2), 2008, www.sampe.org
5. European regulation 842/2006 relating to the refrigerant greenhouse gases