Publishable Summary for 15NRM01 Sulf-Norm
Metrology for Sampling and Conditioning SO_2 Emissions from Stacks

Overview

This project will deliver the pre-normative work without which full implementation of the EU's Industrial Emissions Directive will not be possible negating some of the health and the environmental benefits it is designed to deliver. Furthermore, this project will support CEN/TC 264 "Air Quality" in terms of laying the platform necessary to develop a new Reference Method for regulatory monitoring of Sulfur Dioxide (SO_2) emissions from industrial processes.

Need

There is a need to take continued steps to reduce pollution from industrial process plants to realise both health and associated economic benefits. The recent Industrial Emissions Directive (2010/75/EU) is bringing in increasingly stringent emission limits for a range of pollutants to meet these aims. The European Commission estimates that if this directive can be successfully enforced it will result in a reduction in premature deaths / years of life lost in Europe of 13,000 and 125,000, respectively, and realise associated cost savings of €7 – 28 billion per annum (COM(2007, 843 final)). There are also environmental drivers to reducing pollution as, for example, it was recently shown that the risk of SO_2 acidification of water and soil has been underestimated (www.eea.europa.eu/highlights/europe-still-playing-catch-up).

The seven prior directives that the IED has replaced were enforced through a series of Standard Reference Methods (SRMs) produced by CEN under mandate from the European Commission. These methods being either directly passed into, or referred to, in member state legislation, i.e. such CEN standards have special standing. With the decreased emission limits coming into force under the IED it is becoming clear that these SRMs may no longer be fit for purpose on all industrial processes. This issue has been formerly recognised by CEN/TC 264 who have highlighted the following future needs: "identify new monitoring requirements of the IED"; "assessment of current SRM to meet stricter limit values"; and "automated methods for measuring emissions" (N2204 Future Work Items of CEN/TC 264).

With respect to the current SRM for SO_2 (EN 14791) the original mandated validation work found an associated uncertainty ±1.7 $mg.m^{-3}$ (95 % confidence), whereas, for example, for LNG combustion gas processes the IED now requires ±1.0 $mg.m^{-3}$ (95 % confidence). Ultimately, such issues potentially compromise the enforcement of emission limits reducing the health and economic benefits described above whilst also impacting on the accuracy of the European Pollutant Release and Transfer Register, and commitments under the UNECE Convention on Long Range Transboundary Air Pollution (CLRTAP).

Objectives

The current SRM for SO_2 involves extracting industrial emissions and stack gas and passing it through a series of glass impingers filled with H_2O_2(aq) in which the SO_2 is dissolved as sulphate. Off-line analysis of each sample performed in a chemistry laboratory then gives a sulphate concentration, which can be related back to the in-stack concentration. Hence, the SRM is based on 'unconditioned sampling' as there is no need to remove water vapour from the extracted stack gas. Many in the community wish to move towards using direct analysis instrumental techniques (e.g. non-dispersive infrared: NDIR) in order to realise the uncertainty and sensitivity requirements needed for enforcing increasingly stringent emission limits. However, such techniques rely on "conditioned sampling" and there is as yet insufficient evidence that the various conditioned sampling approaches proposed are able to transfer extracted stack gas streams to the analytical instrument without physical and chemical changes occurring. If the community is to move towards such instrumental techniques for SO_2 it must first be demonstrated that conditioned sampling can be carried out compliant with current and future uncertainty requirements.

The specific objectives of this project are therefore:

- To determine a benchmark sampling performance for a range of industrial processes that use the existing Standard Reference Method for SO_2 (EN 14791). This will include a critique of the impact of the findings on the capability for enforcing decreased emission limits under the Industrial Emissions Directive;
- To investigate appropriate materials (e.g. stainless steel, borosilicate glass, ceramic) for conditioned sampling for use with different stack gas matrices i.e. in order to avoid sample alteration e.g. due to catalysing surface reactions. The stability of sampled gaseous components will be investigated in order to determine the consequences of short term affects;
- To evaluate the performance of chiller versus permeation based drying technologies for conditioned sampling to determine which processes are at risk of sample bias. The mechanism of sample bias shall also be determined;
- To contribute to a future revision of EN 14791 by providing the data, methods and recommendations, which are necessary for the standardisation of SO2 sampling, to CEN / TC 264. Outputs will be communicated through a variety of media to the standards community and to end users;
- To contribute to the production of CEN Technical Specification SO2 being drafted by CEN / TC 264 / WG16 and data to move standard closer towards EN status.

Progress beyond the state of the art

The current state of the art is defined by the SO_2 SRM as described in EN 14791, which relies on an approach of unconditioned sampling and wet chemistry off-line analysis. This project will enable the community to move beyond the current state of the art by validating and supporting standardisation of conditioned sampling critical to enabling uptake of real-time measuring systems with the potential to enforce not only emission limits under the IED but also future reductions under future legislation.

Stack gas is generally hot (e.g. 400 °C), wet (up to 40 % vol H_2O) and contains dust of a wide variety of compositions; hence the challenge is to filter, dry, and cool the gas without inducing any physical or chemical changes. To facilitate moving beyond the state of the art this project will carry out the necessary prenormative work to determine under which conditions various proposed conditioned sampling approaches are applicable and the characterisation necessary to lay to path for standardisation at CEN.

Results

Aligning to the three technical objectives listed above, the following top level results will be delivered under the project:

- A technical report summarising the performance of unconditioned sampling in a series of laboratory experiments under carefully controlled conditions and field trials at real industrial process plants;
- A technical report summarising the performance of conditioned sampling in a series of laboratory experiments under carefully controlled conditions and field trials at real industrial process plants;
- A national regulator position paper summarising a regulators perspective on the current state of SO_2 emissions monitoring capability and issues of enforcement.

Impact

Impact on standardisation community

This project is carrying out prenormative work and hence is very much geared towards achieving high impact in the standardisation community. The two impact objectives of the project are:

- To feed back to CEN/TC 264 the sampling performance of the SO_2 SRM (unconditioned sampling) in order to better understand the SRMs ability to enforce emission limits coming into force under the Industrial Emissions Directive;
- To contribute to the production of CEN Technical Specification SO_2 being drafted by CEN / TC 264 aimed at standardising instrumental based monitoring for this measurand.

However, in addition this project will also have broader impact at CEN and ISO with respect to working groups developing standards describing reference methods for HCl by instrumental techniques and NH_3, where conditioned sampling will also be considered. Also, very closely linked to this project is a new working group being created by CEN tasked with standardising proficiency testing based on stack simulator facilities. This

project will have representation on this group and outputs from this project will be used to influence the production of this standard.

Impact on industrial and other user communities

Instrumental based monitoring is real-time whereas with the existing SRM for SO_2 often it takes several weeks before the data is available. Consequently, if the community moves towards an instrumental approach it will potentially reduce periods of inaccurate emission reporting which is not only desirable from the perspective of a national regulator but also for the operator as by resolving issues more quickly they can demonstrate their commitment to environmental protection. Furthermore, as instrumental systems are automated there are potential savings for accredited stack testing organisations in terms of reduced staff time costs.

Instrument manufacturers also stand to benefit as once conditioned sampling has been validated and standardised it will make it possible for national regulators to accept such an approach significantly boosting the market for portable SO_2 analysers.

Impact on metrology and scientific communities

For an organisation to maintain their accreditation it is a requirement to take part in a proficiency testing scheme if an appropriate scheme exists. In recent years schemes have emerged based on stack simulation facilities (pilot plant scale facilities) with some based at National Metrology Institutes. This project will characterise conditioned sampling enabling proficiency testing scheme providers to set pass / fail criteria at appropriate levels (often a performance score of satisfactory, questionable, or unsatisfactory is awarded). This is significant as repeated poor performance can lead to an organisation's accreditation being suspended, hence, the work under this project is important as it will help ensure that performance expectations are set appropriately.

<table>
<tr><td colspan="2">Project start date and duration:</td><td>1st August 2016 (3 years)</td></tr>
<tr><td colspan="3">Coordinator:
Dr Marc Coleman, National Physical Laboratory Tel: +44 (0)208 943 6828 E-mail: marc.coleman@npl.co.uk
Project website address: TBC</td></tr>
<tr><td>Internal Funded Partners:
1 CMI, Czech Republic
2 VTT, Finland</td><td>External Funded Partners:
5 EA, UK
6 Uniper, UK
7 HLNUG, Germany
8 NAB, Finland
9 Ramboll, Finland
10 STA, UK</td><td>Unfunded Partners:</td></tr>
</table>