Fifth IMPRESS newsletter

Introduction

This is the fifth newsletter of the EMRP project "Metrology to underpin future regulation of industrial emissions" (IMPRESS), which aims to improve the technical possibilities to monitor emissions of pollutants to air to ensure compliance with EU directives and national legislation. This is key to enforcing emission limits and thereby enabling their reduction and control.

Industry needs to measure and report emissions for regulatory purposes including assessing stack emissions against concentration limit values, reporting annual mass emissions, and determining emissions of GHGs from area sources. In June 2014 a 3 Mio € project started within the European Metrology Research Programme for a three year period to investigate industrial emission measurements. It encompasses a multitude of national metrology institutes (NMI), universities and other stakeholders. Collaborators are welcome to link themselves to the project.

Project news

IMPRESS project partner NPL has created a highly adaptable facility capable of simulating a variety of different release characteristics over a wide range of emission rates of GHGs (1.1 – 55 $kg \cdot hr^{-1}$ for C_3H_8; 0.7 – 36 $kg \cdot hr^{-1}$ for CH_4; and 2 – 99 $kg \cdot hr^{-1}$ for CO_2). This facility has the ability to be operated remotely via a cable connection making the system both very safe and flexible in terms of spatial positioning of components.

Research highlights

"Impact of swirl on flow measurement in stacks – CFD modelling" (CMI, NPL, TU Delft)

We investigated a swirling flow in stacks which is generated by various shapes of supplying pipe by methods of computational fluid dynamic (CFD). We determined errors of flow rate measurement when S-type Pitot tube is used to measure gas velocity in a grid of points (the method according to ISO 10780 and ISO 16911-1). The considered shapes of the supplying pipe were – (a) straight pipe, (b) pipe with single 90° elbow and (c) pipe with double out-of-plane 90° elbow. A circular stack with diameter of 1.5 m and the measurement grid consisting of 12 points in two perpendicular lines were considered. The range of inlet velocities of the gas (3 – 30) m/s was investigated. The flow in a stack was modelled using the CFD software OpenFOAM.
Two types of the flow rate measurement errors were investigated – one related to the finite density of the measuring grid (assuming that the velocity measurement itself is unbiased) and second related to a shift of the S-type Pitot tube due to flow angle in the swirling flows. It was found out that in the cases of supplying pipes containing elbow(s) where a single swirl is generated (compared to double swirl appearing in the case of the straight supplying pipe), the error of flow rate metering due to the finite density of the grid is oscillating with the height of the sampling plane in the stack. This is caused by a velocity profile in the stack which is turning together with the swirl. The difference of the

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minimal and maximal error in the oscillation can reach 3 % in the studied cases. Example of results for the double elbow case is shown in Figure 1. It means that special attention should be paid to the height and orientation of the sampling ports in stacks in order to achieve the minimal error. It was observed that the amplitude of the error oscillation decreases with increasing flow rate and that the length of one period increases with increasing flow rate corresponding to the fact that the swirl velocity grows slower than the axial velocity. The additional error caused by neglecting the shift of the S-type Pitot tube due to the swirling flow is highest for the double elbow supplying pipe and it can reach values around 5 % in the studied cases. This error is largest for the smallest flow rate in all the studied cases.

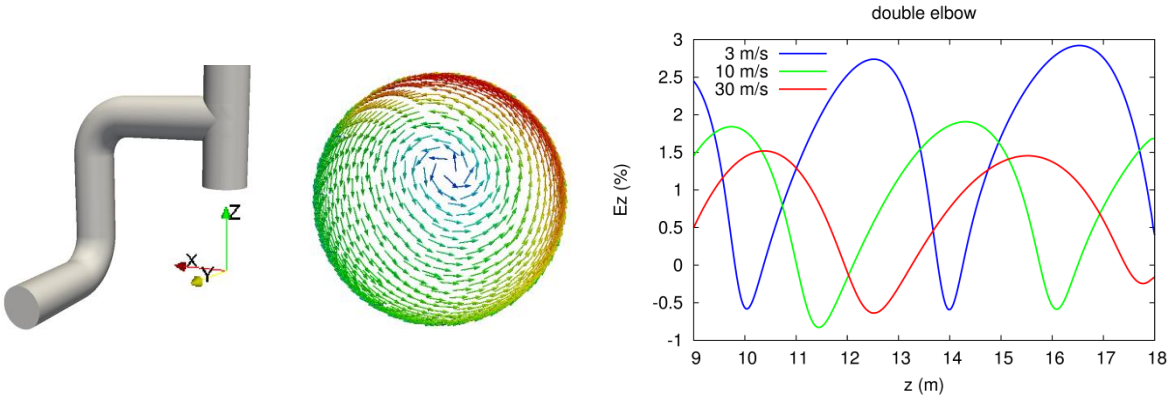

Figure 1: From the left: the supplying pipe of a stack with double elbow; the swirl pattern generated by the supplying pipe; the error of the flow rate measurement due to the finite density of the measurement grid and its dependence on the height of the sampling plane in the stack for three values of the gas velocity at inlet.

Standardisation activities

Recently the IMPRESS project has contributed to the following CEN working group activities by providing funding for convenorship and / or leadership of various sub-tasks:

- Support for CEN promulgating the following protocols into standards is now complete
  - FTIR protocol under WG36
    We attempted to launch the TC Consultation in summer 2016 but it was considered more work was needed. The group will meet again Jan 2017, but IMPRESS has provided all the support originally planned for this activity
  - SO_2 by optical methods protocol under WG16
    The TS produced by WG16 as a result of promulgating the protocol has been sent for Formal Vote
  - Protocol for determining if two methods can be considered statistically equivalent
    This standard is due to go to press in early 2017
- CEN / TC264 / WG38 Determination of fugitive VOC emission
  - Promulgation of protocols continues at WG38

IMPRESS project partner VSL attended the meeting of Dutch standardizaton committee 390030: “Emission measurements and general aspects” on 26 October 2016

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Dissemination activities

Recently work under IMPRESS has been disseminated at the following fora:

- American Geophysical Union (AGU) Fall Conference, San Francisco, USA, 12th – 16th December 2016.
  - *Differential Absorption Lidar Measurements of Benzene Emissions*
- Invited presentation at a workshop on Industrial Emissions at the Low Carbon Technologies & Products Trade Fair, Zhenjiang, China, 28th - 29th November 2016
  - *Differential Absorption Lidar Measurements of Industrial Emissions*
- Laser Applications to Chemical, Security and Environmental Analysis (LACSEA 2016), Heidelberg, Germany, 25th - 28th July 2016
- 12th International Conference and Exhibition on Emissions Monitoring. Lisbon, Portugal, 18th – 20th May 2016.
  - *Towards Quantitative Optical Gas Imaging of Fugitive Gas Emissions*
- 17th International Flow Measurement Conference (FLOMEKO 2016), Sydney, Australia, 26th – 29th September 2016.
  - *Impact of swirl on flow measurement in stacks - CFD modelling*
- A paper 'A Bayesian study of uncertainty in ultrasonic flow meters under non-ideal flow conditions' was submitted to the IOP journal "Metrologia" by TU Delft.

Contact and further information

Every 6 months a newsletter of the project will be distributed. Please forward this newsletter to your colleagues. They can send an email to any of the project's representatives with subject "register IMPRESS newsletter" to register for this 6-monthly newsletter.

Additional information on IMPRESS and the partners can be found on the project homepage http://projects.npl.co.uk/impress/.

The IMPRESS project is carried out by the following partners / institutions:

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