SO_2 EMISSIONS MONITORING: EUROPEAN SURVEY OF OPINIONS ON MONITORING USING THE SRM (EN 14791) OR PORTABLE INSTRUMENTAL TECHNIQUES

With increasingly strict emissions limits being brought in across many industries, there is some debate over whether the existing Standard Reference Method for SO_2 (EN 14791) is capable of reliably detecting these lower levels. Some would advocate moving to longer EN 14791 sampling times to increase sensitivity whilst others would propose moving to portable instrumental techniques capable of providing the increased sensitivity without needing to increase sampling times, with the added benefit of real-time data. However, many of these portable instrumental techniques require the sample to be dried before measurement (conditioned sampling), and here more data is needed to better characterise conditioned sampling at low SO_2 levels so the community can fully understand this capability. A new European metrology project called 'Sulf-Norm' aims to address such sampling questions so that the emissions community have the data they need to make fully informed decisions on the future of SO_2 monitoring.

Here we report one of the first activities under Sulf-Norm which has been to conduct a survey to determine industry preferences and perception of the pros and cons of SO_2 monitoring using EN 14791 or portable instruments. Fifty seven questionnaires were completed online via the Source Testing Association (STA) server, with participation from across Europe. Overall, portable instrumentation was the preferred method in most countries, although concerns were raised regarding species cross-interference and losses within the conditioning system. Issues were raised across the survey regarding the logistics of glassware on site, the sample-train, and user-error in leak testing.

Introduction

With a growing global focus on the effects of air pollution and its environmental impact, there is an ongoing effort not only to reduce current emission limits, but also to ensure that decreased emissions are measured with continued confidence and accuracy.

The serious health risks associated with air pollution continue to impact heavily on the populations of all European countries, alongside the financial burden that this then transfers to their healthcare systems and governments. A recent United Nations report suggested that over 40,000 premature deaths in the UK per year were the direct result of poor air quality, with many of these in the country's largest and most densely populated cities[1].

The EU is tackling these issues in terms of emission limits that must be adopted and enforced by all member states. This is being supported at CEN by the publication of standards that provide emission measurement methods that are passed into, or referred to in member state legislation; by convention such methods are referred to as Standard Reference Methods (SRMs). The role of the SRM has become two-fold: to periodically demonstrate compliance with emission limits and to calibrate, via parallel measurements, in-situ permanently installed instrumentation (referred to as Automated Measurement Systems - AMSs). Alongside the regular compliance testing, these AMSs are then used for year-round, continuous monitoring of emissions, as is required on all plants with >100MW capacity. Fundamentally, whether by compliance or calibration, the monitoring framework is underpinned by the capability of the current suite of SRMs.

In 2013, the Industrial Emissions Directive (IED)[2] brought in stricter emission limits for key pollutants, and the European Commission estimated that successful implementation of the IED would reduce premature deaths in Europe by approximately 13 000 p.a. With Best Available Techniques Conclusions documents bringing in even stricter emission limits across a number of industrial processes the emission monitoring community has started to discuss whether the capability of the existing suite of SRMs is sufficient to enforce such limits.

With respect to SO_2 the existing SRM - described in EN 14791[3] - is based on extracting a sample from the stack and passing it through impingers filled with $H_2O_{2(aq)}$, where the SO_2 is dissolved as sulphate for subsequent analysis off-line in an analytical laboratory, most commonly by ion chromatography. In principle, the sensitivity can be increased by sampling for longer periods of time (increasing the concentration of collected sulphate) and hence, this could be the solution to enforcing increasingly stringent emission limits. Alternatively, the community could move to using portable instrumental techniques (often optical in nature) that could provide increased sensitivity without increasing run times with the added advantage of real-time data. However, many of these techniques, in contrast to the SRM, require the extracted stack gas to be dried (conditioned) before being passed through the analyser.

For the emissions community to take informed decisions regarding the future approach to emissions monitoring, data are needed that show how far the SO_2 SRM can go in enforcing increasingly stringent emissions limits and if portable instrumental techniques offer a viable alternative. With respect to the latter, the European

Metrology Programme for Innovation and Research (EMPIR) project 'Sulf-Norm' is aimed at addressing some of the issues. Work is being undertaken in this project to better understand the performance of different conditioning technologies at low SO_2 levels applicable to a range of different industrial processes. As a starting point for the project a survey was carried out to exploit the experience the community has to date with conditioned (portable instruments) and unconditioned (SRM) sampling in order to gauge current perception of capability. Here we summarise the results of this survey and discuss the reported experiences, providing trends where possible.

Survey Respondents

This survey was made available online and hosted through the Source Testing Association (STA) servers, with the aim of being available to a range of organisations and relevant parties across Europe. A link was circulated to the STA membership and also by Sulf-Norm project partners to members of the emissions monitoring community within their respective nations, and in some cases beyond. A total of 57 questionnaires were completed online with the highest numbers of participation from Germany, Italy and the UK (Figure 1).

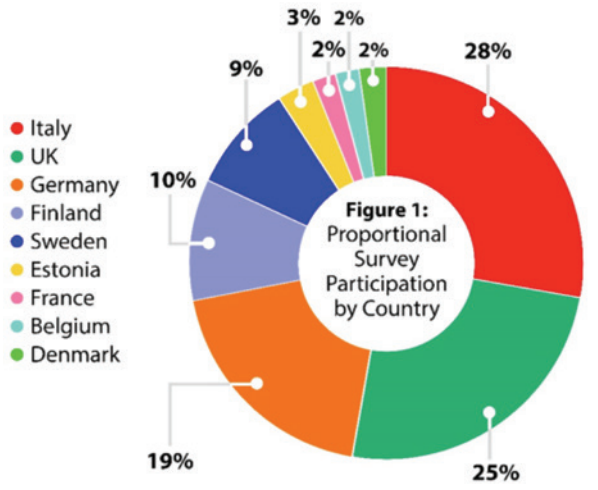

Figure 1: Proportional Survey Participation by Country

A broad range of institutions took part, with full-time staff numbers ranging from 10s to 1000s. The breakdown in Figure 2 shows that the majority of organisations who responded were independent test houses (65%). National regulators and in-company test houses also responded in high numbers, with other participants ranging from instrument manufacturers to energy producers.

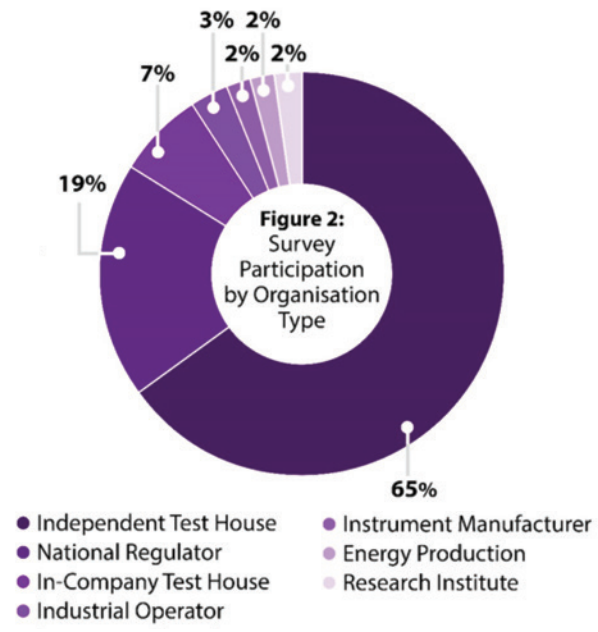

Figure 2: Survey Participation by Organisation Type

Trends Observed

Of the organisations surveyed it is seen that 24% offered only testing to EN 14791, 21% offered only portable instrumentation techniques and the remaining 55% offered both. In Figure 3 the results are broken down by country: Belgium, Denmark, Estonia and France are excluded as there were too few respondents from these countries to draw any meaningful national comparisons. Of those remaining Finland had a high proportion of organisations offering only portable methods, Germany and Italy showed a high proportion of organisations offering only EN 14791, and Sweden and the UK showed a high proportion of organisations who offer both. None of the respondents from Germany or Sweden offered only portable. Of course, not every organisation in each nation is included in the survey, however, these trends are likely to be representative.

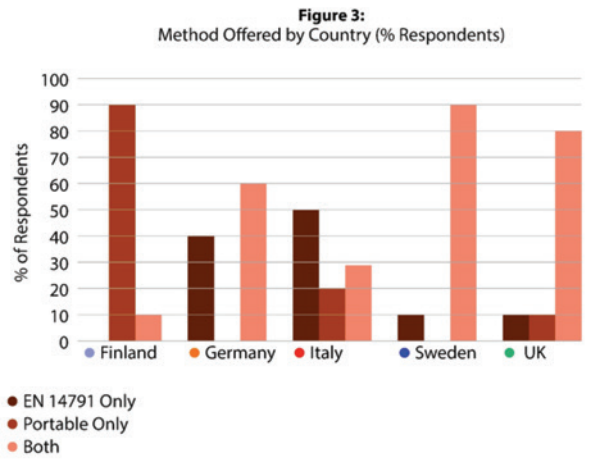

Figure 3: Method Offered by Country (% Respondents)

Much of this divide might be explained by the approaches of the national regulators in each country. For example, in the UK, Finland and other Scandinavian countries, alternative methods (AMs), such as those based on portable instrumental techniques, tend to be accepted by the national regulators whereas this generally is not the case in Germany and Italy where only the use of the SRM is permitted for regulatory purposes.

To gain an insight into the methods being used in the field, survey participants were asked to list the types of process plants on which they sample SO_2, and the types of testing they commonly undertake in these circumstances (i.e. compliance and QAL2 calibrations). These EN 14181 QAL2 calibrations are carried out after the installation of an AMS, taking parallel measurements and testing the range of validity of the calibration functions in order to ensure continued suitable operation. Under the Medium Combustion Plant Directive periodic measurement is required on small to medium combustion plants at least every three years (1MW-20MW thermal input), or every year (>20MW), but certain member states may require continuous measurement by means of AMSs[4]. The feedback below would suggest that AMSs are indeed in use on many medium combustion plants, with QAL2s being undertaken on these sites.

For medium combustion plants, as listed in Figure 4, portable instrumentation is most used when compliance testing, but less so for QAL2 testing. EN 14791 is used least at medium combustion plants, but it can also be seen that there are a high number of participants using both methods for compliance. EN 14791 is the most popular method for all types of medium combustion plant testing under QAL2, being used most commonly at single fuel waste incineration plants.

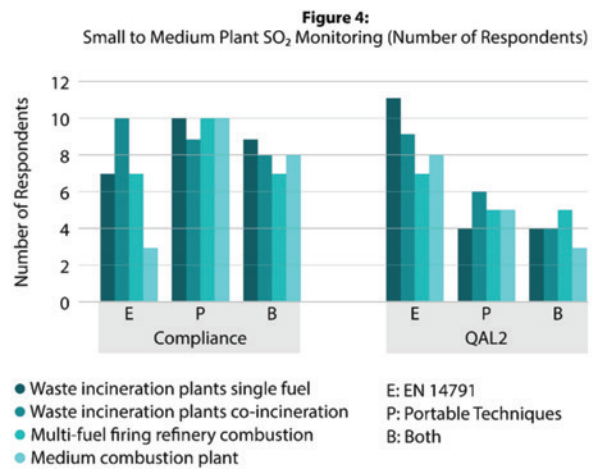

Figure 4: Medium Plant SO_2 Monitoring (Number of respondents)

When considering large combustion plants in Figure 5 it is seen that portable instrumentation is used more often than EN 14791 in most cases. These numbers are significantly higher for coal and lignite, peat, and co-fired biomass combustion plants. Biomass and liquefied gas combustion plants have results which are much closer in number, but it must also be noted that many participants recorded using both methods for compliance testing.

The number using both methods is significantly lower for QAL2 testing, and in contrast to medium plants, portable instrumentation appears to be used more commonly than EN 14791. Two notably higher examples of portable instrumentation testing are on liquefied gas plants and co-fired biomass combustion plants. Alternatively, for biomass combustion the use of EN 14791 is significantly more popular.

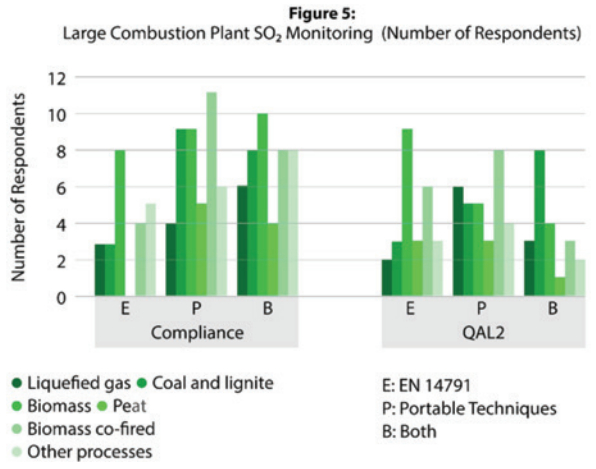

Figure 5: Large Combustion Plant SO_2 Monitoring (Number of respondents) E: EN 14791, P: Portable Techniques, B: Both

Respondents were asked which monitoring methods they would rather use if they had a free choice in the absence of any regulatory requirements. 59% of respondents selected portable techniques, with 24% preferring the SRM and 17% with no opinion. It was postulated that perhaps those without an in-house capability for analysing collected sulphate samples would inevitably have a preference for portable (in many member states the same organisation is not required to carry out both sampling and analysis under EN 14791). However, the data showed that, of those who had a preference for portable, sixteen (46%) had an in-house analytical capability whilst out of those who had a preference for EN 14791 only one (7%) used external analysis.

Trends in portable instrumentation varied across participants, the two most popular type of analyser were the Horiba NDIR (67% of respondents) and the Gasmet FTIR (44% of respondents). There were few notable trends by country, but every company from Italy who responded included the Horiba PG250/PG350 in their equipment list, with these models also proving popular in Finland. Germany, and the UK.

General Comments Returned

Respondents were asked for general comments on the application of both the SRM and portable techniques.

Asked what their preference would be in the absence of any regulator or national constraints it was found that 79% of Italian respondents and 66% of UK respondents preferred portable whilst 73% of German respondents preferred EN 14791. Interestingly, although all Swedish companies responded in favour of portable methods, the tests they reported offering are mainly in the use of both methods or EN 14791 alone (Figure 3).

It terms of commenting on the issues associated with each approach the most common responses were as follows. For EN 14791 44% reported issues in terms of handling glassware on-site listing contamination, quality of solutions, and space and logistics of setting up the sample train. 22% complained that data were not available in real-time and of sample train uncertainties in terms of frequency of user error in leak testing. Also, issues over freezing sample lines and solutions were listed, as might be expected from respondents residing in the cooler climates in the north of Europe.

With respect to portable methods, concerns due to bias caused by cross-interference from other species was mentioned by 44% of respondents, whilst 33% mentioned issues regarding losses in conditioning systems. Logistical issues of using gas cylinders on-site and permits to transport on the road were listed by 22% of respondents, whilst a small number complained about the time it takes to condition sampling systems on-site.

Conclusions

Respondents from 9 nations have highlighted a variety of issues from their experiences in using EN 14791 and portable instrumental techniques. With respect to the former, concerns expressed revolved mainly around contamination, quality of solutions and space / logistical requirements for setting up sampling trains on-site. With respect to the latter concerns were raised over cross-interference, losses in sampling systems and logistic issues with use / transport of gas cylinders. In terms of application we have seen that portable techniques are more commonly used for compliance measurements than QAL2, this perhaps being rationalised by differing regulatory approaches that in some member states would preclude the use of portable techniques, particularly for the latter.

There were some strong national preferences, no doubt driven in part by different regulatory environments. For example, it was seen that given a free choice 73% of German respondents would favour the use of EN 14791, whilst 79% of Italian respondents would favour portable instrumental techniques. Across all 57 respondents the preference fell on the side of portable techniques with 59% saying they would prefer to use this approach if free to choose. However, it should be noted that even if the industry preference is for portable techniques as this survey suggests – perhaps due to increased sensitivities being possible without extending run times and data being provided in real-time – as a community there must be confidence that the data such techniques provide are of sufficient quality. The highest response relating to portable techniques was on the issue of poor data quality due to cross-interferences, so this is clearly an area that needs further work if user-confidence is to be improved. Another key issue identified by the respondents relates to sampling (drying) of extracted stack gas. This highlights why the Sulf-Norm project was first proposed, which aims to provide important data into the debate over the future of SO_2 emissions monitoring.

References

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[3]BS EN 14791:2017 Stationary source emissions. Determination of mass concentration of sulphur oxides. Standard reference method

[4]DIRECTIVE (EU) 2015/2193 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 November 2015 on the limitation of emissions of certain pollutants into the air from medium combustion plants, p18.

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