COST ANALYSIS OF AUTOMATED LONG-TERM SAMPLING IN COMPARISON TO EXISTING APPLICATION MODES OF MANUAL SHORT-TERM SAMPLING

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Introduction

Most discussions over last few years about monitoring of dioxin emissions of incineration facilities were focused on the possibility of on-line monitoring, long-term sampling or manual sampling. Because of the fact, that manual sampling can give only weak informations of the total dioxin emissions due to a spot measurement of several hours during one year, the general wish is to have an on-line monitoring, which is however not yet possible. Therefore it could be shown over the last few years that continuous monitoring by long-term sampling could be a good alternative and gives good statistical informations in an acceptable cost frame[1].
Because of the unsatisfactory informations which are given by manual sampling, some plants are controlled more frequently by manual sampling, by demand of the local authorities. Such more frequently manual samplings lead to an intensive cost increase of the dioxin emission control.
As reported in earlier publications, the ROCEPA (Republic if China EPA) was setting up a project for continuous monitoring of PCDD/F[2].
One topic of this project, which is surely also of general international interest, was a cost analysis for the comparison of long-term sampling and different application modes of manual sampling, which are applied practice in Taiwan in different plants.
For the project, the long-term sampling system AMESA® was chosen and therefore the published results are calculated on the basis of the AMESA® system price.
Additional other calculations show that also for dioxin inventories in European countries, the costs by using a long-term sampling system would be in an acceptable cost efficient range.

Methods and Materials

The functional principle of the AMESA® system was described in several publications[3,4,5]. In principle the used method complies with the cooled probe method of EN-1948 with the exception that the condensate flask is installed after the XAD-II cartridge and that therefore the condensate does not need to be collected and analysed. This is in accordance to US EPA method 23A. Additionally the plane filter for the dust collection is replaced by quartz wool included in the top of the XAD-II cartridge. The cartridge containing the adsorbed dioxins and furans is evaluated together with a data medium in an accredited laboratory. By means of this process, dioxins and furans are separated from dust, the gas phase and the condensate in one adsorption step. This process not only registers dioxins and furans, but also further organic substances with a similar volatility and polarity. With this method it is possible to collect the dioxin and furans up to 4 weeks on one XAD-II cartridge. Therefore the complete yearly dioxin emission of a plant could be determined.

Results and Discussion

In Taiwan exists for the different incineration facility different requirements for the frequency of the manual sampling. Table 1 shows an overview, what kind of sample requirements are possible. According the Taiwanese regulations there is a demand for a complete sampling campaign in different time periods. Each sampling campaign consists of totally 5 samples.
The plant type B, which is described in the table is the practice according to the Taiwanese law, the types C – F are common practices in different facilities.

Serial no.	Plant type	Frequency of dioxin sampling	Quantity of incinerators	Quantity of annual accumulated samples	Average qty of test and inspection / year each incinerator	Average qty of samples per year each incinerator
1	B	Each incinerator 1 time / year	4	4	1,00	5,00
2	B		3	3	1,00	5,00
3	B		2	2	1,00	5,00
4	C	Choose one incinerator 4 times / year	4	4	1,00	5,00
5	C		3	4	1,33	6,67
6	C		2	4	2,00	10,00
7	D	Each incinerator 2 times/year	2	4	2,00	10,00
8	D		3	6	2,00	10,00
9	E	Each incinerator 4 times/year	2	8	4,00	20,00
10	E		3	12	4,00	20,00
11	F	Each incinerator 6 times per year	2	12	6,00	30,00

Table 1. Annual Sampling Frequency

In figure 1. is showed the result of the cost comparison between automated and manual sampling. For the investment costs of the instrument was calculated a depreciation over 10 years. In this specific case of Taiwan, for a sampling frequency of 16 and more, the automated sampling is less expensive than the manual sampling. Surely the costs for analysis, services instruments etc are different from country to country. However, such calculations could be done for each country.

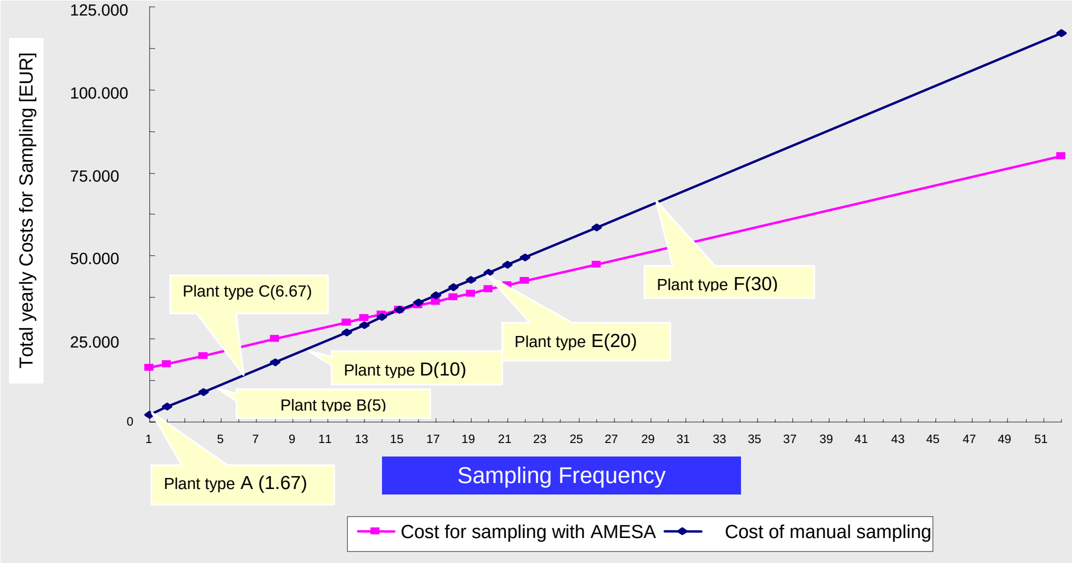

Fig. 1 Comparison of sampling costs in Taiwan between automated and manual sampling

As it was shown and published by de Fré[6], the total dioxin emission of a plant and therefore the total dioxin emission inventory of a region or country could be underestimated strongly. To get better estimations and results it is therefore very important to sample the dioxin emissions all the year. However, still by using a long-term sampling system like AMESA®, this leads also to relatively high analysis costs, if up to 13 or like it is practice in Belgium up to 26 samples and analyses are done each year. One possible alternative is the practice which is applied in German waste wood combustion plants. As it was shown by Mayer[7], one good compromise for reducing the analysis costs could be to analyse only a mixture of e.g. 4 extractions, which were gained by 4 samples. In this specific application, the XAD-II cartridges were changed and extracted weekly and then the mixture of 4 weekly probes is analysed. Only if the dioxin concentration value of the 4 mixed samples is too high, the extractions of the weekly probes have to be analysed separately to get more detailed informations in which specific week the dioxin emissions were higher.
As many results showed over the last 3 years in Europe, the dioxin emissions in modern plants are normally below the limit value. However from time to time there could be high emission peaks. By manual sampling on 1 – 3 days per year such peaks are normally not detected. So to get a good cost-effective survey over the total dioxin emissions it could be also helpful to install a long-term sampling system and to analyse only the mixture of the extractions of several samples e.g. by monthly sampling only one analysis every 3 months. In such a case there would be under normal conditions only 4 analysis per year, instead of 12. Only if in the 3 months mixture the values would be too high, then the 3 single samples would be analysed. Such an operating handling would assure to detect all dioxin emissions of the plant by relative low costs under normal conditions. Additional there exists the possibility to check with higher time resolution the possible reasons for high emissions if the single samples have to be analysed and the corresponding stored operating data´s will be checked.

		Mode 1		Mode 2		Mode 3	
	Unit price [€]	Qty	Price [€]	Qty	Price [€]	Qty	Price [€]
Depreciation	9.000	1	9.000	1	9.000	1	9.000
Operation	250	1	250	1	250	1	250
Maintenance and spares	3.000	1	3.000	1	3.000	1	3.000
Yearly calibration	3.000	1	3.000	1	3.000	1	3.000
Sample preparation	100	12	1.200	24	2.400	24	2.400
Sample extraction	50	12	600	24	1.200	24	1.200
Sample analysis	650	4	2.600	6	3.900	12	7.800
Total annual costs			!Syntaxfehler,)		!Syntaxfehler,)		!Syntaxfehler,)

Table. 2. Cost comparison for AMESA® application modes

In table 2. are shown the costs of different application modes with the AMESA® system. Once again depreciation over 10 years was estimated for the investment costs.

The costs for one manual sampling including sampling extraction an analysis vary in Europe between 3.000 € to 10.000 €. If once time a year on 3 following days the manual sampling will be done, the costs vary between 7.000 € to 12.000 €.

In fig. 2 are shown the results of the comparison between the costs of automated sampling and the minimum costs of manual sampling, depending on the different application modes of AMESA®. Still by this comparison of the minimum manual sampling costs with AMESA®, the usage of AMESA® is less expensive by a sample frequency of more than 6 samples per year.

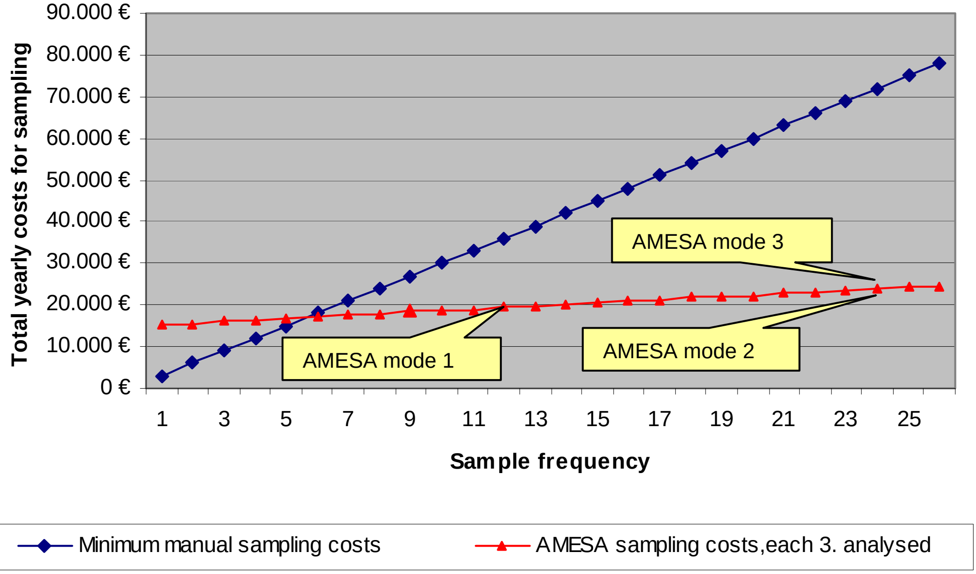

Fig. 2 Comparison of sampling costs in Europe between automated sampling by AMESA® and manual sampling

Both examples from Taiwan and from Europe show that by higher sampling frequencies an automated sampling system is the more cost-efficient solution. Additional such an instrument is a really good tool to detect really the total yearly dioxin and furan emissions of a plant. Therefore quite more accurate dioxin emission inventories can be given by relatively low costs.
Additionally such an instrument is suitable to optimize the operation of a plant with the effect, that the dioxin emissions could be reduced effectively, like it was shown several times over the last few years[8].

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References

1. Results of one year continuous monitoring of the PCDD/PCDF emissions of waste incinerators in the Walloon region of Belgium with AMESA®, Jürgen Reinmann (2002), Organohalogen Compounds, Vol. 59, 77-80
2. K.W. Mehl, A. Huang, J. Reinmann (2003), Short-term and long-term dioxin sampling and analysis at a MSW incinerator in Taiwan, Organhalogen compounds, Vol. 60, 497 – 500
3. W. Funcke, H. Linnemann, Ch. Phillipp (1993) Long-term-Sampling Method for Polychlorinated Dibenzofurans (PCDF´s) and Dibenzo (p) dioxins (PCDD´s) in Flue Gas of Combustion Facilities, Chemosphere, 26, 2097-2101
4. E. Becker, J. Reinmann, W. Rentschler, J. Mayer (2000) Continuous Monitoring of the Dioxin-/Furan-Emissions of all Waste Incinerators in Belgium, Organhalogen compounds, Vol. 49S, 21 -23
5. Jürgen Reinmann, Werner Rentschler, Ernst Becker (2001) New Results and Features of the Continuous Dioxin-/Furan Monitoring System AMESA®, Organohalogen Compounds, Vol. 50, 99-102
6. R. De Fré, M. Wevers (1998), Underestimation in dioxin emission inventories, Organohalogen Compounds, Vol. 36, 17-20
7. J. Mayer, R. Grümping (2002), Continuous monitoring of dioxin emissions from a waste wood combustion plant, Organohalogen Compounds, Vol. 59, 81-83
8. http://environnement.wallonie.be/data/air/dioxines/menu/menu.htm