

Methods for Monitoring VOCs - Flame Ionization Detector

Florin LUPEIU post graduate student
Conf. univ. dr. Nicolae CHIRILĂ
Petru Maior University of Tg. Mures
Chirilan@upm.ro

Abstract

The project followed a study of VOCs concentration measurement made at a local furniture factory. The method used is FID - flame ionization detector and the parameter of interest is TOC - total organic carbon.

1. General description

The project followed a study of VOCs concentration measurement made at a local furniture factory. The method used is FID - flame ionization detector and the parameter of interest is TOC - total organic carbon.

Measurement period was stretched during 06.06.2008 - 15.05.2009. Exhaust gases from spray booths were analyzed with a portable analyzer (fig.1), which uses the principle of flame ionization. The analyzer is designed specifically for portable applications and it can operate in both continuous measurements and in short term measurements. Five analysis were made for each of the four spray booths.



Fig. 1 – Portable analyzer for VOC's

2. Purpose

The purpose is to monitor the concentrations of VOCs under environmental permits.

3. Methodology

The analyzer operates according to the principle of comparison. The unknown sample gas concentration is compared with the known concentration of the calibration gas. The physically measured quantity is converted into an electric signal by means of a flame ionization detector. Here an electric field is connected to a pure hydrogen flame which burns while being supplied with hydrocarbon-free air. If organic compounds are fed to this flame through the sample gas, a measurable ionization current is produced. The signal is proportional to the number of carbon atoms which are fed to the flame and are not pre-oxidized (fig. 2).

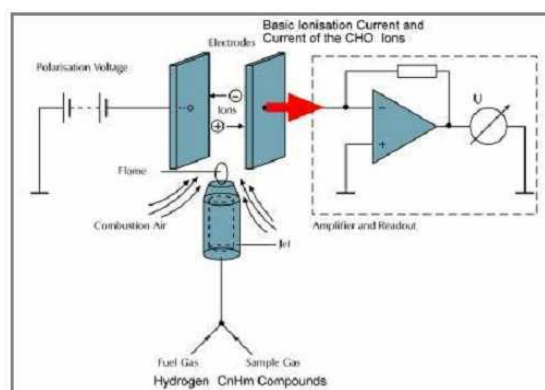


Fig. 2 – Flame ionization principle

The instrument has a linear characteristic, the slope can be defined by means of two points. In practice, this is done in a such way that first of all a test gas with a concentration value of zero is passed through the instrument, and the zero point is electrically set to zero subsequently. In a second stage, a certain concentration of organic compounds is fed tot the instrument, and the sensitivity of the instrument is then electrically set to this value. After this calibration process, the concentration of the gas to be measured can be determined.

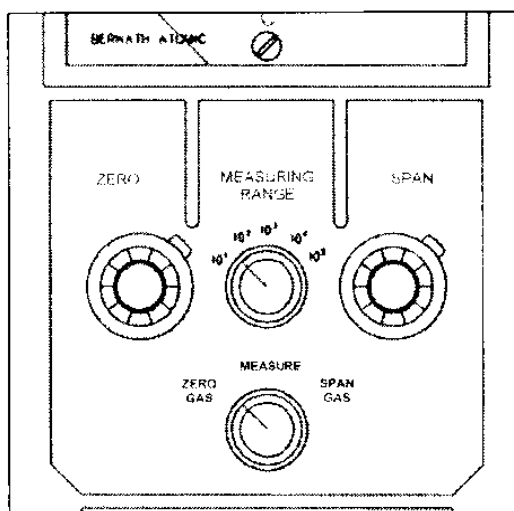


Fig. 3 – Analyzer interface

Calibration can be performed after the device was turned on 45 minutes before the flame is lit for approx. 5 minutes. For calibration of the analyzer used two bottles containing a test gas concentration of organic carbon and zero calibration gas containing propane, which total organic carbon mass concentration is 81,8 mg / Nmc.

The analyzer has a linear characteristic whose slope can be determined by two points. This is done essentially by first generating a zero concentration test gas (zero gas, synthetic air in this case) and thus the zero point is set electronically. In a second step, is generated by a gas analyzer whose concentration of organic compounds is well determined (calibration gas, for example. 1 vol% propane in air which means 81,8 mg / Nmc) and with which it will adjust the sensitivity of electronic device to indicate that value (fig. 3).

To set the zero point, the button for gas sample is rotated to the left in position ZERO GAS. The cylinder of synthetic air must be open. After a few seconds, the display will show a stable. Measurement value is set to zero using ZERO potentiometer, releasing drag. Ensure potentiometers then closes the cylinder of synthetic air.

To set the calibration, measuring range switch is rotated to the calibration basis, on the second scale. Turn gas sample button to SPAN GAS position. Propane cylinder is open and after a few seconds the display will show a stable. Use SPAN adjustment button to set a predefined value of 81,8 mg / Nmc. Ensure potentiometer and then close the propane cylinder. Finally, the button switches the gas sample in the middle position measure.

Through this calibration process, the exact gas concentration to be measured can be determined exactly.

The values were registered in a data logger and downloaded to a PC. The software generates a graphic of the registered values and data can be exported in to a table for further calculations or statistics.

4. Results

Sampling point	Data collection	Range of mediation	TOC (ppm)	TOC (mg/Nm ³)
spray booth 1	06.06.2008	12:15 – 12:28	34,83	56,00
		12:38 – 12:52	51,31	82,50
		13:01 – 13:27	44,47	71,50
		13:27 – 13:41	44,15	70,99
spray booth 1	01.08.2008	10:17 – 10:27	28,13	45,23
		10:34 – 10:44	18,86	30,32
		10:47 – 10:57	31,41	50,50
		11:00 – 11:10	16,62	26,72
spray booth 1	28.11.2008	13:27 – 13:36	34,52	55,52
		13:39 – 13:50	35,16	56,55
		13:50 – 14:00	47,13	75,80
		14:00 – 14:11	47,89	77,02
spray booth 1	13.02.2009	08:59 – 09:09	28,77	46,26
		09:09 – 09:18	35,65	57,33
		09:19 – 09:30	47,90	77,03
		09:30 – 09:31	23,86	38,37
spray booth 1	15.05.2009	10:30-10:40	24,93	40,09
		10:40-10:50	28,89	46,46
		10:50-11:00	26,81	43,11
		11:01-11:11	23,36	37,57

Table 1 - Results

5. Conclusion

For each analysis, sampling time is 10 minutes, recording values every 5 seconds. So we had about 120 to 130 of value. These values were recorded by the Logger's analyzer and downloaded to a computer. The software's Logger generated a graph with the values recorded and the data can be exported into an Excel table.

Irregularity graphs can be caused for various reasons:

- Exhaust flow
- The saturation of active coal
- Frequency of spraying worker
- Temperature
- Humidity

There have been excesses in the following:

Sampling point	Data collection	Range of mediation	TOC (ppm)	TOC (mg/Nm ³)	Limits
spray booth 2	06.06.2008	12:38 – 12:52	51,31	82,50	75 mg/Nm ³
spray booth 3	28.11.2008	13:50 – 14:00	47,13	75,80	
spray booth 4	28.11.2008	14:00 – 14:11	47,89	77,02	
spray booth 3	13.02.2009	09:19 – 09:30	47,90	77,03	

Table 2 - Conclusions

Deviations are insignificant. These values were caused by saturation of activated carbon filters. The solution is to recover solvents adsorbed on the surface of the coal or to change the load of activated carbon, depending on company's necessities.

10. References

- [1] Porcar, D. – Procedee și echipamente de epurare a aerului, Notițe de curs
- [2.] Popescu, M., Popescu, R., Strățulă, C. – Metode fizico-chimice de tratare a poluanților industriali atmosferici, Editura Academiei Române, București, 2006
- [3] Lăzăroiu, G. – Soluții moderne de depoluare a aerului, Seria Inginerie-Mediu, Editura Agir, București, 2006
- [4] Mișca, R., Ozunu, A. – Introducere în inginerie mediului. Operații unitare, Presa universitară clujeană, Cluj – Napoca, 2006
- [5] Banu, A., Radovici, O.M. – Elemente de ingineria și protecția mediului, Editura tehnică, București, 2007
- [6] Ecosens, Ministerul Apelor și Protecției Mediului, Institutul de Economie a Industriei - Model de registru al emisiilor și transferului de poluanți pentru România, 2002
- [7] Harte, J., Holdren, C. - Toxics A to Z. A Guide to everyday pollution hazards, Oxford, 1984
- [8] Strategia Națională pentru Protecția Atmosferei, 2004
- [9] US Environmental Protection Agency - An Introduction to Indoor Air Quality, <http://www.epa.gov>
- [10] International Programme on Chemical Safety INCHEM - Environmental Health Criteria Monographs (EHCs), <http://www.inchem.org>
- [11] Ghid pentru elaborarea planului de gestionare a solvenților organici cu conținut de compuși organici volatili în conformitate cu prevederile Anexei nr. 5 a Hotărârii Guvernului nr. 699/2003 cu modificările și Completările ulterioare
- [12] Sick Maihak – Analyzers and Process Instrumentation, www.sickmiahak.com
- [13] Asociația Experților de mediu – www.voc.ro
- [14] Agenția Națională de Protecția Mediului – www.apm.ro
- [15] Institutul Național al Lemnului, Îndrumar tehnic – www.inl.ro