Industrial Applications

Analysis of VOCs emissions from a car painting line

Context & Challenges

Volatile Organic Compounds (VOCs) are a major environmental concern because of their carcinogenicity, toxicity and their role in tropospheric ozone formation. The European legislation has imposed stricter objectives for VOCs emission levels in industrial effluents. If VOCs' removal is not possible for technical reasons, industrials have to implement treatments. Car manufacturing, involving the application of paints, varnishes and lacquers is particularly affected. Indeed, it is impossible to remove use of solvents as they are ensuring a good adhesion of paint on metal. The objective of the study is to monitor VOCs emissions from a car painting line to identify precisely the molecules to treat in the gaseous emissions.

Chromatotec® Solutions

Chromatotec® airmoVOC C6-C12 (MCERTS certified for VOC monitoring) was selected for this work based on its high performance for the continuous analysis of (C6-C12) VOCs in gaseous samples. It consists of a Gas Chromatography (GC) analyzer with Flame Ionisation Detection (FID). Concentrations measured can range from very low (ppt level, thanks to the use of a pre-concentration trap) to high (ppm), making it suitable for emission measurements.

VistaCHROM software allows easy data acquisition and treatment. Reference substance tables included allow the automatic identification of the target compounds by the retention time of the peaks obtained in the chromatograms. Moreover, validation of the results is assured by the internal calibration system and data can be transferred automatically using Modbus or remote control.

This compact and transportable instrument requires only a small amount of space and power supply. As the instrument is very stable and robust, it does not need maintenance on a daily basis. Zero air and hydrogen could be provided by Chromatotec® airmoPURE and Hydroxychrom generators respectively, for even more flexibility compared to conventional systems.

Technical information and results

Up to 28 VOCs have been identified and quantified with the airmoVOC C6-C12 during this field campaign. Identification of unknown compounds have been carried out automatically by retention time with the substance tables included in VistaCHROM software and parallel analysis by laboratory GC coupled to Mass Spectrometry (MS). Chromatotec® analyzer can also be upgraded by coupling to the MS in online transportable GC/MS for field deployment.

Analysis on different stacks along the painting line process revealed that VOCs detected in the flue gas are globally the same but with different concentrations (Figure 1). N-butyl acetate, ethylbenzene, m- and p-xylene, m- and p-ethyl toluene and 1,2,4 trimethyl benzene were the main molecules contributing to flue gas composition fingerprint. 1-butanol and o-ethyl toluene were also abundant, mainly in Stack 4.

Nevertheless, some VOCs like propylene glycol methyl ether acetate (PGMEA) have been detected only in some specific stacks. It was co-eluted with ethyl-benzene (Figure 2) but thanks to GC/MS it was possible to strictly identify it. Then it was quantified by the FID of the airmoVOC.

It was possible to follow simultaneously the instant concentrations of the main VOCs identified in the atmospheric emissions (Figure 2).

The majority of the VOCs detected are aromatics and their derivatives. Indeed, these compounds are only lightly soluble in water so they could not be trapped in the water bed system installed under the coating lines to treat gaseous emissions.

The results obtained by airmoVOC C6-C12 and the average concentration in Total Organic Carbon (TOC measured by FID) during each analysis were compared to check if the total VOCs could be detected. Results are given in Table 1.

Comparing the sum of the compounds detected thanks to Chromatotec® airmoVOC C6-C12 to the TOC concentrations, it appears that the majority of the VOCs could have been quantified. In fact, the maximum deviation between the two measurements is inferior to 20%.

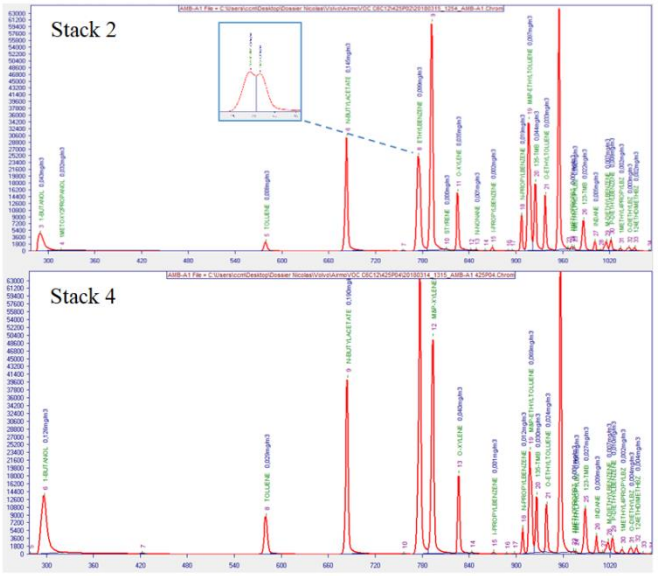

Fig. 1: GC-FID chromatogram (detector value vs retention time) view with PeakViewer software for VOCs emission profiles at stack 2 and stack 4.

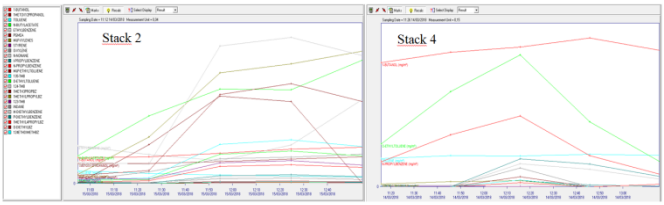

Fig. 2: Instant concentration of 25 VOCs on Stack 2 and Stack 4

	Stack 2*	Stack 4**
Sum of VOCs airmoVOC (ppm)	141,8	319,8
TOC (ppm)	117,6	284,4
Ratio Sum VOCs/TOC	*1,2*	*1,1*

* Average on 5 measurements / ** Average on 6 measurements

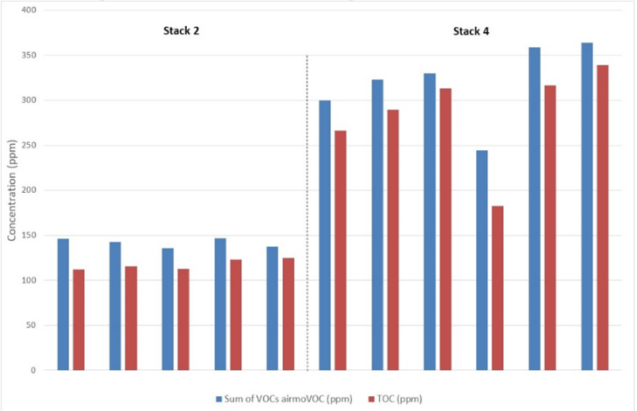

Table 1: Comparison between the sum of specific VOCs (airmoVOC) and TOC (FID)

Conclusion

The monitoring of specific VOCs showed that N-butyl acetate, ethylbenzene, m- and p-xylene, m- and p- ethyl toluene and 1,2,4 trimethyl benzene are the seven major compounds detected in the atmospheric emissions of the car painting lines. 1-butanol and o-ethyl toluene are also abundantly present in some specific stacks. Total specific VOCs concentrations are relatively close to TOC measurements with a light difference of maximum 20%. This could be due to the under-estimation of some chemical species by TOC.

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