AIR QUALITY MONITORING OF A PETROCHIMICAL PLANT (NO2, SO2, BTX, OZONE)

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ABSTRACT

Air pollution is specially taken in account because air quality monitoring is part of the initial strategy in the Algerian pollution prevention program. This work describes an environmental situation of a petrochemical plant and is related to:

- Diagnostic and development of sampling design,
- Sampling and analysis of atmospheric pollutants,
- Creation of air pollution data bank,
- Cartography of the studied pollutants.

The methodology adopted for this work is based on a systematic grid sampling of all the studied area including all pollution sources trough an area of 1200 ha. Samplers used are based on diffusive principle and environmental references used for results discussion are those defined by World Health Organization (**WHO**). Diffusive samplers are exposed during one month for SO2, NO2, and BTX and for two weeks for ozone.

INTRODUCTION

Air pollution comes from several stationary and mobile sources which, in many ways, can affect air quality **[1].** Wide varieties of hazardous chemicals can escape from industrial facilities and other activities to the environment and they are harmful for human health and the environment **[3-5]**. Air pollution has both acute and chronic effects on human health. It affects a number of different systems and organs as it linked with much mortality and reduced life expectancy. Prolonged exposure to low-level pollutants concentrations is as harmful to human health as exposure to higher levels for shorter durations.

In order to evaluate the current air quality on a plant oil area situated in littoral land and by the same way the effect of air pollution control measures, a monitoring network using fixed devices was implemented in source pollution neighbourhoods of a petrochemical plant. It is well known that an ideal surveillance and control system can be deviced employing continuous monitoring, telemetering, and electronic data processing but for a first step it was important to begin with a passive sampling using cheaper and efficient sampler than extend this work to a real time monitoring **[4]**. The scope was to identify the nature of pollutants and the source from what they are escaped. The activity of the studied area has as a secondary effect to generate an industrial pollution such as air, water and ground. The scope of this work is aimed on the atmospheric pollution generated by the various units production located on this plant. It consists on a passive sampling of NO_2, SO_2, ozone and BTX during three months through the entire flat. The diffusive sampling technique is largely used as an indicative method for monitoring concentrations of pollutants.

SELECTION OF INSTRUMENTATION AND METHODS

The environmental sampling approach used in this work is based on a systematic sampling witch involves selecting samples unites according to a specific pattern in term of space. The systematic grid sampling subdivides the studied area by using a square or triangular grid and collects samples from the nodes **[1-3]**. The samples are taken at a fixed time interval. All the area is represented in the sample and provides confidence that the site has been fully characterized. Samples are taken for a period of time at a specific location. Results are considered Vs. time. Our objective is to know the average temporal concentration of pollutants in order to compare it to standard concentration and by the same way evaluate for the first time the amount of pollution concentration generated by plant oil.

Devices used for air sampling are schematically described by Figure 1. The passive samplers are based on diffusive methods (fig.2). The object would be to measure the amount of SO_2, NO_2, ozone and BTX at locations where pollution sources are beforehand identified by environmental impact assessment. Samplers were deployed at 12 locations fixed-point; the sampling network is shown by figure 3. An advantage of fixed sampling is that measurements are made concurrently at all sites, providing directly comparable information, which is particularly important in determining relationship of polluting sources to local air quality and in tracing dispersion of pollutants throughout the studied area.

Sampling is done with devices that collect a sample over some specified time interval after which the sample is sent to a laboratory for analysis. The result is a single pollutant averaged concentration over the entire sampling period. This sampling is carried out by pollutants diffusion in the sampler during exposure duration.

The choice of instrumentation for carrying out the air-monitoring network through the petrochemical plant depends on the following factors:

- Type of pollutants
- Averaging time specified by air quality criteria or standards
- Expected pollutant levels
- Available resources

Most pollutants may be monitored by a number of different methods and techniques. The selection of the methodology to be used is an important step in the design of the monitoring portion of the assessment study.

Sites chosen for this work are described in table 1

Table 1: Monitored sites

Code	**Location**
S_1	Gate n°1
S_2	Beside helium unit
S_3	CP1 / polymed
S_4	FIR
S_5	Refinery
S_6	The palmers
S_7	Old airport
S_8	Cemetery
S_9	DRGS
S_{10}	Main gate
S_{11}	Towards gate 1
S_{12}	Primary school
S_{13}	ENIP building

RESULTS

Benzene:

Results obtained are described in figure 4. They show that the strongest values of benzene (7,1 µg/m^3 to 18,6 µg/m^3) were obtained on S_5 and S_8 sites. These sites are respectively located on the edge of the plant in the refinery neighbourhood. This explains that benzene emission was escaped from refinery during samples exposition. It is important to note that benzene is very harmful to human health it causes cancer so the WHO value guide is 5µg/m^3. S_{13} site has also given highest level of benzene but not as stronger as the former one.

S_5, S_6 and S_8 sites are also located in the refinery neighbourhood; they reveal an amount of benzene superior to the limit value recommended by the **W**orld **H**ealth **O**rganization and the European standards. The strongest concentrations of benzene have been recorded on these sites during all the campaign. The results given by S_2 site has recorded an amount of benzene equal to 9,7 ug/m^3 during March witch is superior to that recommended by World Health Organization. This site is located near the helium unit.

SO2:

All the SO_2 sampling results are lower than the World Health Organization (WHO) values guide (fig.5). The World Health Organization fixed for the sulfur dioxide a limit value of 50 µg / m^3 as an annual average. The monitoring of the SO_2 through the surface of the flat shape allowed to show that all the obtained results are widely lower than the WHO limit values as well as the European standards, except for isolated cases where the content in SO_2 reached the WHO value but exceeding the European limits value.

NO_2:

There are a number of oxides of nitrogen, which are referred as NOx. NO and NO_2 are the two oxides of nitrogen that are of primary concern to air pollution. NO is a colourless gas that is a precursor to NO_2 and is an active compound in photochemical reactions that produce smog. It is also a precursor to nitric acid, HNO_3, in the atmosphere and is a major contributor to acid rain. NOx and volatile organic compounds (VOC) react photochemically in a complex series of reactions to produce smog, which includes ozone, NO_2, peroxyacetyl nitrate (PAN), peroxybenzoyl nitrate (PBN) and other trace oxidizing agents.

Figure 6 shows the NO_2 monitoring results of three months duration samples exposure. The values are generally acceptable except for the S_{10} site which always gives contents raised in NO_2 but slightly lower than the WHO value guide. The values on sites S_1, S_2 and S_3 are nevertheless brought up; they also remain lower than the WHO value guide. This is justified by the dense circulation of heavy vehicles crossing by this post of main access towards the site of flat shape and those taking the National road which establishes the main entrance of the **Skikda city.**

The WHO as well as the European standards limited the NO_2 value to 40 µg / m^3. The NO_2 monitoring through any sites chosen on the flat, during all the phases showed that only the S_{10} site gives values in NO_2 bordering the limit value. The S_{10} site is situated near the main gate of the plant also near a main road.

Ozone:

The analysis of sampling results shows practically that the level of ozone trough all the studied flat is superior to that recommended by the World Health Organization. During the beginning of this monitoring ozone sensors have not given results. This was explained by the fact that these sensors were saturated. The geographical situation of the site also facilitates the ozone formation.

Results show that during the first half of March 2005 there was a strong concentration of ozone on all the studied area, which lasted until the second about fifteen April (fig.7). Furthermore we noted that the contents of ozone are raised during the wintry periods (spring including): The contents raised are not only relative to the sites of measure where they were obtained because the ozone is a secondary pollutant stemming from a reaction of pollutants precursors such as volatil organic compounds and NOx. These values are alarming until 109.4 $\mu g / m^3$ at the level of the site S_9 the contents raised on flat shape are not relative to the sites of measure.

CONCLUSION

Passive monitoring of NO_2, SO_2, BTX and ozone during three months was conducted throughout a petrochemical plant. The monitoring sites were selected based on a number of objective criteria to identify any spatial, as well as seasonal, variability of these air pollutants. The key objectives in the location selection were to obtain measurements that were representative of areas with greater population density, a variety of land-use types, including high traffic areas, and locations of schools.

Results obtained shows that BTX pollution is caused by the refinery; highest values were recorded in its neighbourhood, they are superior to WHO values guide. NO_2 has only given highest values in the main gate of the plant. This result was justified by the dense traffic of heavy **and hard cars.** The contents in SO2 obtained for the monitored sites are lower than the WHO guide value. Results of ozone monitoring are superior to that recommended by the World Health Organization.

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ANNEXES

Figure 1: Devices used for gas monitoring

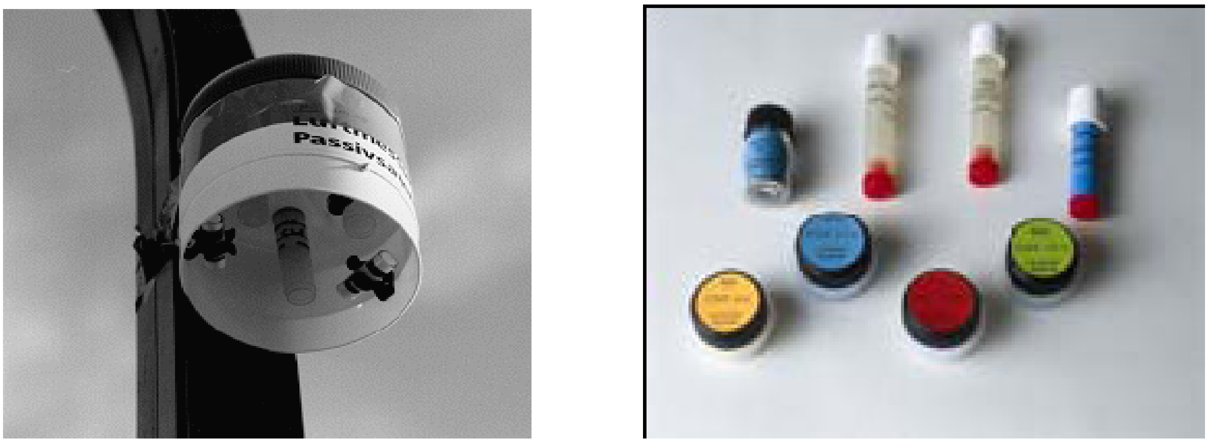
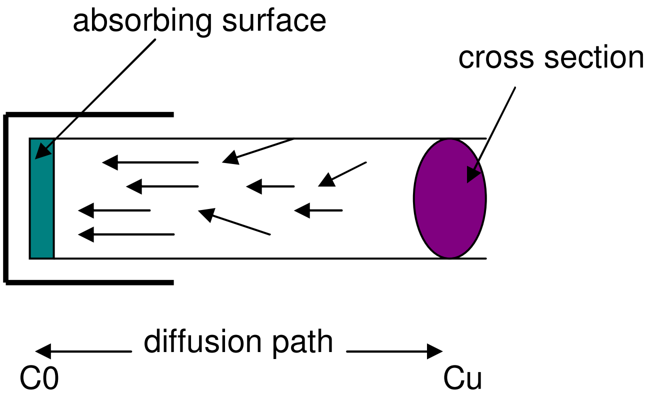


Figure 2: Principles of diffusion



$$\text{Concentration } c = \frac{l * Q1}{D * A * t} = \frac{Q1 *}{SR * t}$$

C: concentration [ug/m3]

D: diffusion coefficient [cm/sec2]

Q1: amount of analyte [ug]

t: exposure time [sec]

l: diffusion path [cm]

SR: sampling rate [ml/min]

A: cross section [cm2]

Figure 3: Cartography of the studied area

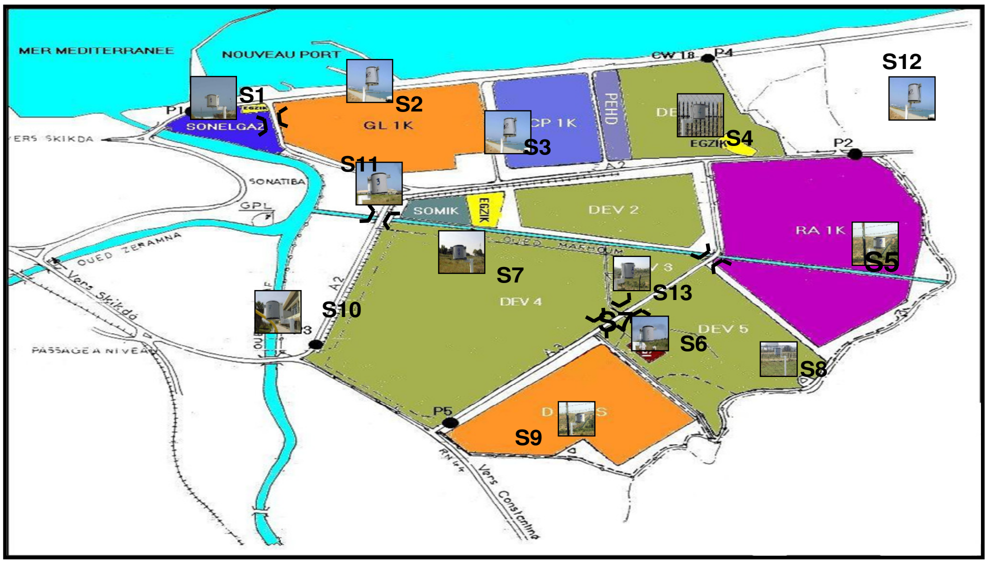


Figure 4: BTX monitoring

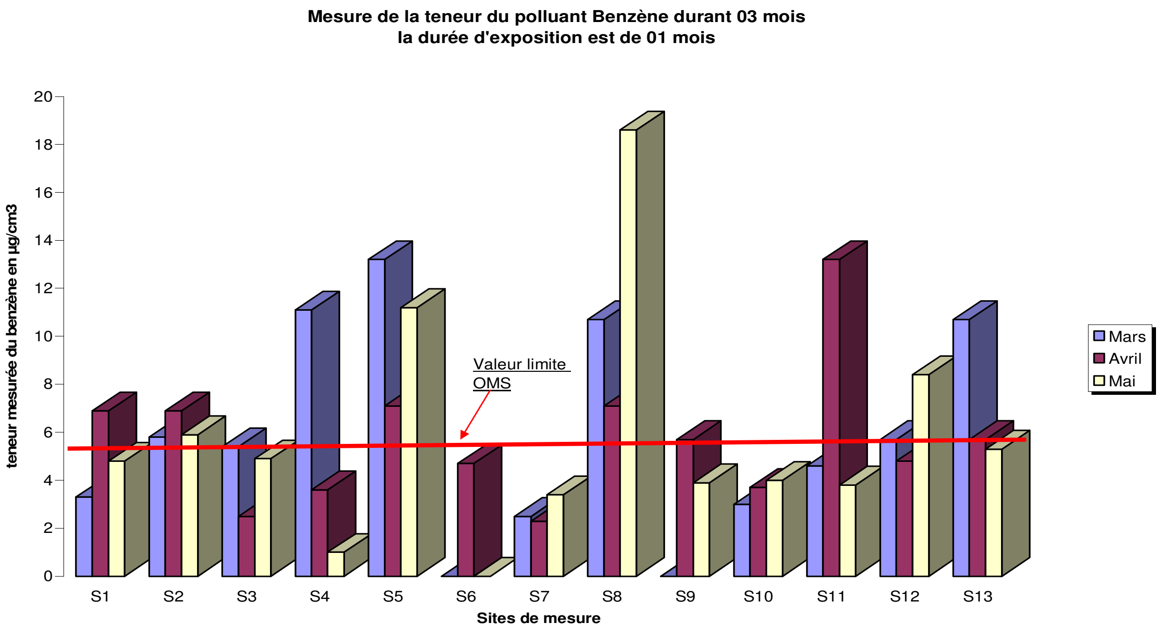


Figure 5: SO_2 monitoring

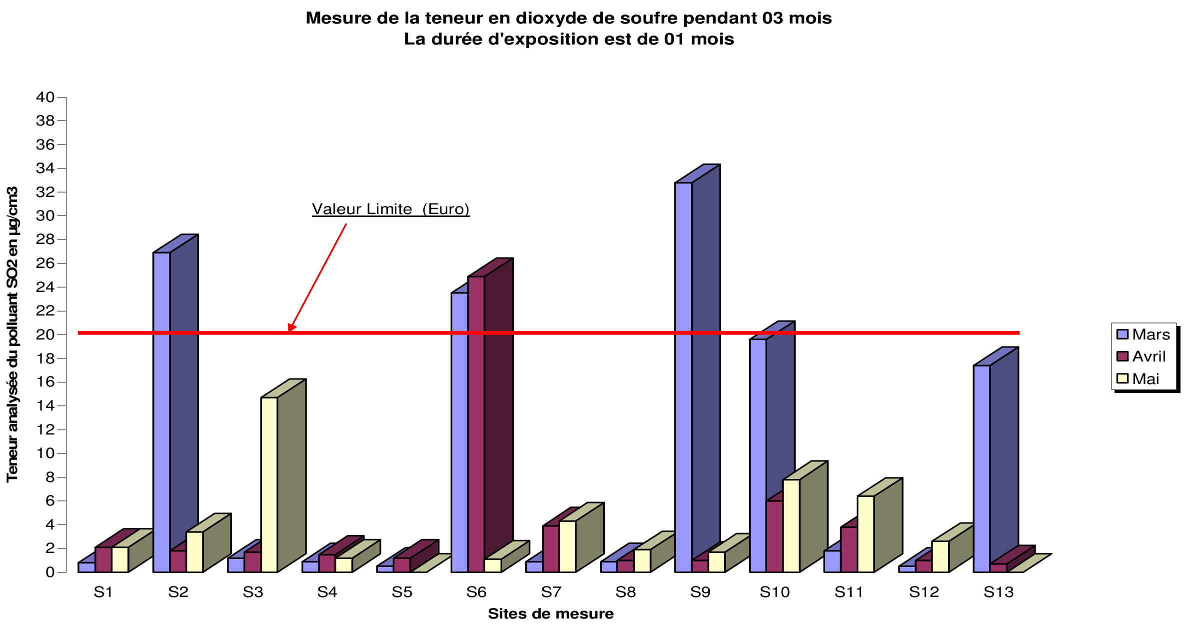


Figure 6: NO_2 monitoring

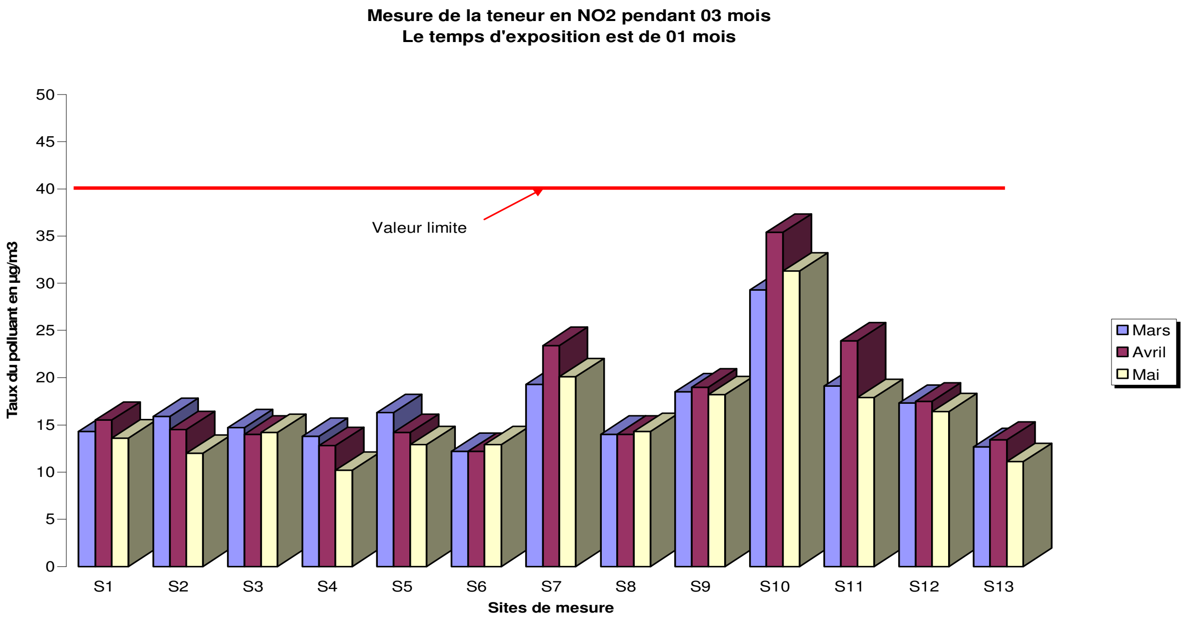


Figure 7: ozone monitoring