Concentrations of selected volatile organic coumpounds in outdoor air in Bahrain**.**

Introduction:

Volatile Organic Compounds (VOCs) consists of a variety of organic compounds of aliphatic and aromatic hydrocarbons such as alcohols, ketones, esters, ethers, formaldehyde and many others. VOCs of hrdrocarbon origin are widely distributed in the air. Emissions of VOCs from stationary sources contribute to air quality problems that adversely affect public health and welfare. VOCs may be solvents, unreated feedback or decomposition products depending upon the type of process and process conditions.

Objective :

Air quality measurements done by EPC at four places in Bahrain, have indicated high concentrations of hydrocarbons (> 100 ppm) and there were many complaints of unpleasant dour emanating from the refinery.
As no measurement of VOCs were done earlier in Bahrain, EPC, decided to measure it with the following objectives.

1. To identify and quantify some of the volatile organic compounds (VOCs) in Bahrain

2. To assess the health effect of these compounds.

Materials and Methods

Volatile Organic Compounds

The survey was conducted in June 1994. Ten samples of air were taken from different places in Bahrain as shown in Figure-1. A stainless steel absorbant tube packed with 0.2 g tenax , a polymeric material (poly-2,6-diphenyl phenylene oxide 60-80 mesh) was used for sampling .

Using a vaccum pump (SKC-model 224-PCXR3) air was sucked through the tenax column at a constant rate of 0.6 litres per minute to collect approximately 200 litres of air (Alain Raymond and G. Guiochan, 1974).
The tenax tube was desorbed and the effluent gases analysed using Gas Chromatography Mass Spectrophotometry.
The detection limit was estimated to be in the region of 10 ng per tube, equivalent to 0.05 ng/l for a sample volume of 250 litres. These analysis were carried out by the Scientific Analysis Laboratories Ltd, Manchester, UK.

Mercaptans

Air at the rate of 0.6 litre per minute was sucked through a glass fibre filter (37 mm), impregnated with mercuric acetate, assembled in two piece filter cassettes, to collect about 200 liters.

20 ml of 25% (v/v) HCl and 5 ml of 1,2-dichloroethane were added to separatory funnel. The sample filter was folded and inserted into the neck of the separatory funnel. The funnel was shaken for 2 minutes without venting. The dichloroethane was transferred to sealed vial.

A 1 ul aliquot of the sample was taken and injected in the splitless mode onto a DB 624 fused silica column directly coupled to the ion source of a VG 7070 mass spectrometer. The mass spectrometer was operated in the repetitive scanning mode from 500 daltons at a resolving power of 1000 (10% valley definition).

Detection limits were estimated from the external standard response as being in the order of **5 ug/filter.**

Results and Discussion

The measurements of ambient air concentrations of thirteen volatile organic compounds are summarised in Table-1. These selected compounds are representative of organic outdoor pollutants with boiling points > 70 C (retained by the tenax adsorption columns). The histogram of the concentrations are shown in Figure-2 and 3.

All sampling were done either early morning or late evening at sunset. Early morning at 7 AM and evening at 7 PM high traffic was expected at most of the sampling locations. The last sample (No.10) was collected near the Sulmaniya Medical Centre incinerator, while incineration was going on. The results of the Sulmaniya incinerator sample is incomplete as desorption of the tenax tube caused a massive overload of the detector. The values seemed to be between at least 10 and 100 times greater than others.

The mean VOC concentration found was 8.87, 4.23, 12.38, 4.20, 3.76, 6.91, 5.44, 6.12, 3.10, 2.13 and 3.68 ug/m^3 for acetone-carbondisulphide, dichloromethane, hexane, cyclohexane, 4-methyl-2-pentanone, toluene, ethyl benzene, m,p xylene, nonane, decane and 0-xylene respectively.

From Tabe-1 and Figures 2 and 3 it is evident that most prevalent VOCs were n-hexane, acetone-carbondisulphide and toluene showing an average of 12.88 ug/$m^{3,}$ 8.87 ug/m^3 and 6.91 ug/m^3 respectively.

In northern Italy in 1986, values were for acetone (6.1 ug/m^3), dichloromethane (14 ug/m^3), hexane (14 ug/m^3) toluene (40 ug/m^3), ethyl benzene (7.4 ug/m^3), m,p, Xylene (24 ug/m^3), nonane (2.1 ug/m^3), decane (3.1 ug/$m^{3)}$ and O-xylene (8.7 ug/m^3) respectively (Table-1) (de Bortoli et al In case of carbondisulphide it is believed that a concentration of below 100 ug/m^3 will not cause any adverse health effects in humans (WHO, 1987).

There is sufficient evidence of carcinogenicity of dichloromethane (DCM) in experimental animals. On the basis of animal data showing the lowest observed adverse effect level of 347 mg/m^3 and a no observed adverse effect level of 87 mg/m^3, a value of 3 mg/m^3 (24 hr ave) is recommended as an air quality guideline value. In Los Angeles DCM concentration was 13 ug/m^3 (Table-6) and in Edison New Jersey concentration even showed 1270 ug/m^3, Compared to these values, Bahrain average value of 4.23 ug/m^3 is very low.

In Los Angeles which is typical of a highly polluted area, toluene concentration varied from 77 to 260 ug/m^3 (Table-4) and in London 60 ug/m^3. Comparing with these, Bahrain average value (6.91 ug/m^3) is very low. In Netherlands, outdoor air annual average concentrations for toluene was in the range of 3-4 ug/m3 (NIHEP, 1988). Toluene concentrations in smoking areas typically range from 40-1000 mg/l. In cars on motorways

averages of about 60 ug/m^3 were found during rush hours, the average even went upto 180 ug/$m^{3.}$ Benzene is recognized human carcinogen and ambient air quality standard of 5ppb (16 ug/m^3) and for toluene 7.5 mg/m^3 has been recommended by an advisory panel for the UK (DOE, 1994). WHO has recommended a value of 8 mg/m^3 for 24 hour average for toluene.

Toluene emissions result usually from point sources and from area sources eg. marketing and use of petrol. Toluene is the most prevalent hydrocarbon in the troposphere. Air monitoring data suggest that 0.75 ug/m^3 could be regarded as an upper bound background level to which all populations are exposed (WHO, 1987). Urban residents worldwide are exposed to considerable higher levels varying from 0.0005 to 1.31 mg/m^3.(WHO, 1987). Toluene levels in indoor environments are expected to be considerably higher than outdoors (as high as 610 ug/m^3) in those situations involving use of paints and solvents (WHO, 1987).

Conclusions

All the VOCs measured in air were lower than the values reported in other parts of the world.

Literature on the health effects of VOCs are very minimum. But comparing with values reported elsewhere (Table-,4,5 and 6) general conclusion can be made that concentrations of measured VOCs are not high enough to pose a health problem. High hydrocarbons found could be alkanes, health problems of which are presumed to be less than the unsaturated aromatic compounds. Silbergeld (1986) indicated that cancer is not one of the more widespread toxic-induced diseases, although it is serious when it occurs.
Organic sulphur compounds like methyl, ethyl and propyl mercaptans were not detected.

Recommendations

As high concentration of hydrocarbons are measured in the air, it is better to incorporate a continuous aromatic hydrocarbon monitoring in the present air quality monitoring system.

VOCs near high traffic urban areas needs monitoring.
More VOCs are to be measured taking large number of samples to get a correct estimate of these compounds in air and to judge its impact on health.

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