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# A STUDY OF ATMOSPHERIC BENZENE CONCENTRATIONS AND NOISE EMISSION DURING TRAFFIC FLOW

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## 1. INTRODUCTION

A qualitative study of the relationship between Benzene, a major hydrocarbon pollutant from vehicles and road traffic noise is presented. In the study area high street level concentrations of vehicle exhaust fumes are very common, as a result of the combination of slow moving traffic and tall buildings. The buildings create a "canyon effect" reducing atmospheric dispersion of any low level gaseous emissions. (A situation common in many urban areas).

The reason for isolating Benzene initially in this study is that although a range of toxic organic and non-organic emissions are associated with vehicle exhaust, Benzene can be considered as one of the most carcinogenic components emitted. The relationship between Benzene exposure and cancer has been well documented 1 .

In this study an initial conflict became apparent. On the one hand noise levels increase with vehicle speed, whilst hydrocarbon exhaust emissions, are reduced. Figure 1 clearly demonstrates this relationship 3 & 4 . In our study area the mean speed over the Bus Gate marked in Figure 2 was measured to be 12 mph 2 . An awareness of this relationship is important when an analysis of the results is made.

Measurements of the atmospheric Benzene concentrations were made using a differential optical absorption spectrometer (DOAS) described in Sec 2. This instrument, an OPSIS AR500 can measure the average concentrations and range of gaseous atmospheric compounds over distances of up to 10 Km.

For this exercise, however, the transmitter was situated on the roof of a four storey building in Sheffield with the receiver and analyser located just 400m away in the Health and Consumer Services Department. The range and position of the equipment enable two slow moving roads to be monitored, separated by a highsided pedestrian precinct. Simultaneously, a precision grade integrating sound level meter monitored the noise level with 15 minute samples over a single 24 hour period. The position of the sound level meter and the OPSIS AR500 are illustrated in Figure 2 .

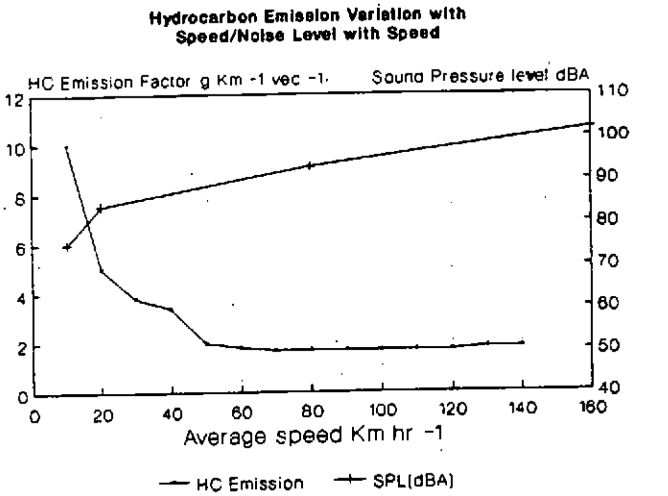


Figure 1

## 2. THE DOAS MEASURING PRINCIPLE

The DOAS works with a broad band light source of wavelengths ranging from about 200 nm to 700 nm. The system was developed by Perner 5 using a high pressure xenon light source, giving a broad band emission spectra. The spectrometer consists of a grating, mounted on a stepped motor which provides full control over the wavelength region. Light detection is performed by a photomultiplier tube. In front of this tube a rotating disc with six radially arranged slits is placed as shown in Figure 3. The instrument has the facility to eliminate the broad band characteristics of the spectrum, and other sources of interference.

The result is pure spectral information pertaining to the atmospheric gases. The output of a least square curve fitting procedure provides the concentrations of the appropriate gases being measured. The crucial point of this technique, however, is that the spectral scan rate is much faster than any possible atmospheric concentration.

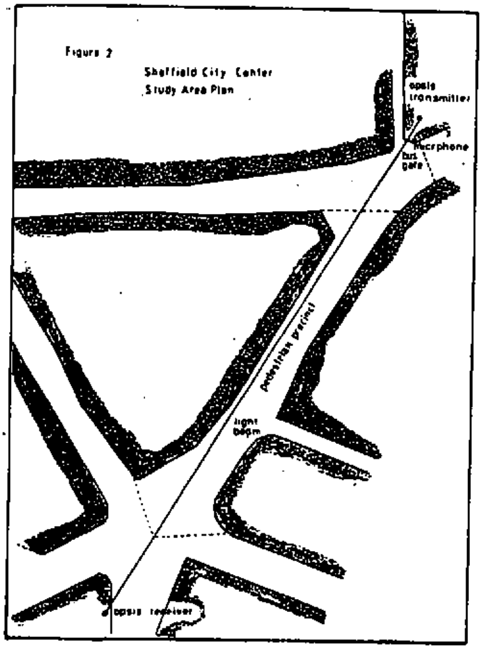


Figure 2 Sheffield City Center Study Area Plan

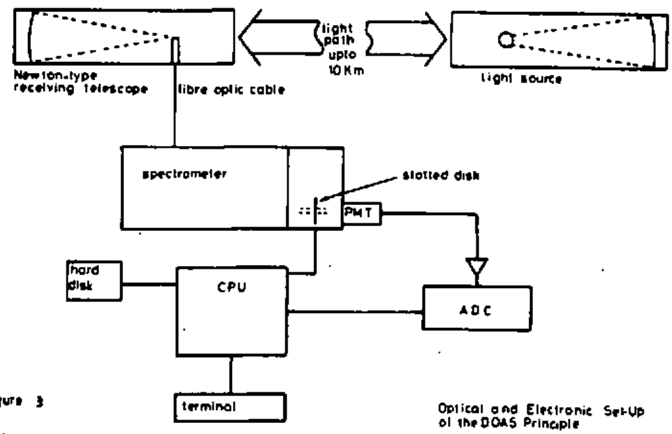


Figure 3 Optical and Electronic Set-Up of the DOAS Principle

BENZENE VS NOISE

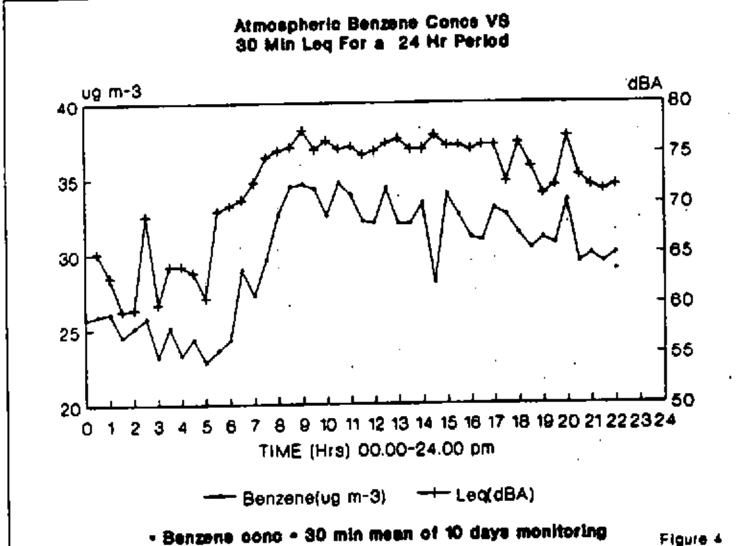


Figure 4

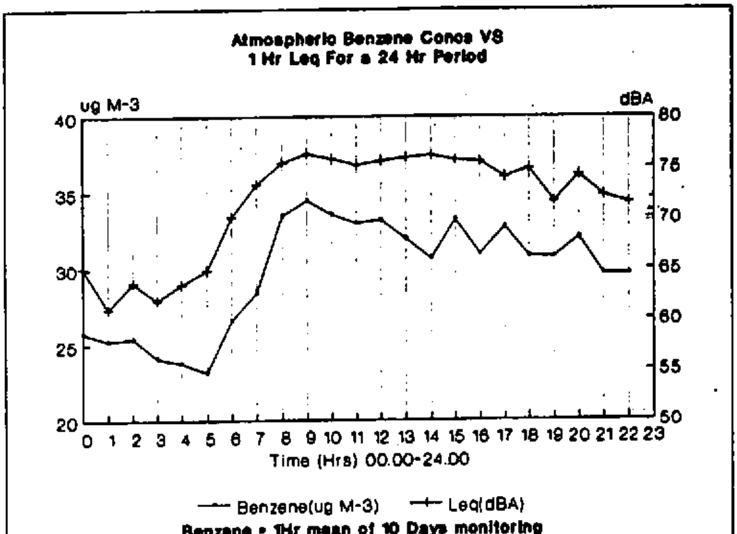


Figure 5

## 3. RESULTS

Atmospheric Benzene concentrations together with noise levels Leq dBA were measured over a 24 hour period, and are presented in Figure 4. The Figure shows the relationship between the two parameters against time. Between 12 a.m. and 5.00 a.m. the relationship between Benzene and Leq is uncertain at this stage in the work. A general increase in both noise and concentration begins at about 5 a.m. however, and is continous until 9.00 a.m. when a plateau is reached. The plateau slowly tails off towards the end of the day. Both parameters follow this general pattern, with the Benzene tail-off being more pronounced after 6.00 p.m. During the evening period, traffic is more free flowing in the City Centre, resulting in lower Benzene emissions (see Figure 1) but with no corresponding drop in road traffic noise.

Figure 5 is a refinement of Figure 4. Here the Benzene output has been averaged over a ten day period in an attempt to reduce localised atmospheric generated fluctuations in Benzene concentrations. Although a similar trend to the graph of Figure 3 is produced the midnight to 5.00 a.m. period is still partially unresolved. It is possible that atmospheric cooling is responsible for the divergent trend that appears between 3.00 a.m. and 5.00 a.m. with a small localised inversion effect, temporarily preventing the upward dispersal of the street level Benzene emissions.

In this preliminary study it is not possible to produce quantitative answers. Although broad patterns do exists, each day a City's movement of people and traffic is unique. Thus before quantitative assessments are possible a long term study is required.

## 4. CONCLUSION

A preliminary study of roadside Benzene concentrations and road traffic noise show that a potential relationship exists. For slow moving traffic, as atmospheric Benzene concentrations increase there is an associated increase in noise energy. In more free flowing traffic the noise is constant but Benzene concentrations are reduced.

No quantitative results are possible at this stage due mainly to the small sample (24 hours) of results. In this limited study both the atmospheric conditions and the inner city movement of pedestrians are variables, which only can be controlled with larger sample times.

## 5. REFERENCES

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N.B. - dB refers to $2 \times 10^{-5}$ $N/m^2$ throughout the text.

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