AIR POLLUTION STUDIES AT THE UNIVERSITY OF NATAL

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The current programme of research work began in 1982, and concerns the mathematical modelling of atmospheric dispersion. The underlying objective is to take advantage of modern computer developments to devise fast models with good output resolution. The output should be immediately comprehensible; for example, in the form of coloured concentration or dosage contours overlayed on a map of the area. Where real-time display of such output is required, particular demands are placed on computational speed, and a rather different model structure is needed.

The first study aimed to develop a microprocessor-based "instrument" which would provide an "on-line" panel display of the pollution pattern around an industrial source. Like other industrial instruments, this should have a sensor end (wind bivane) connected through to a diaplay end (VDU screen), and installation should be straightforward. This has in fact been achieved using the R.M. Young Gill Anemometer Bivane, a 64 K RAM Apple II Microprocessor, and a Taxan colour screen for the graphics. The system is currently operating at a local industry, where it forms an important part of the complaints vertification procedure. Filtering of the bivane signals by the microprocessor allows interpretation of the higher-frequency, turbulent components as vertical and horizontal diffusivities, whilst the mean components are assumed to represent the entire, local wind-field, as a time-varying flow. A variable emission of pollutant is allowed from one point at a chosen height in the defined map area, and its distribution is simulated using a segmented Gaussian plume model. A continuous display shows concentration contours superimposed on a colour map of the area. The picture is updated once a minute. A control box allows "dumping" of the graphics picture to paper, "zooming" to a smaller area for better definition, or examination of wind and model data on a text screen. Short range tests using a SO_2 tracer proved that the device gave satisfactory predictions. The system consists largely of standard components, costing under R10 000.

A second study currently aims to develop a more flexible, enhanced model suitable for minicomputer execution. Multiple sources and spatially and temporally-variant wind and diffusivity fields are to be allowed. An important objective is to incorporate wind shear, including directional shear. These phenomena often outweigh the assumed contributions of eddy diffusion in atmospheric transport. As an example, vertical diffusion in a sheared flow may "pop" material up into a higher velocity stratum, whence it may drop back somewhat downstream, thus enhancing horizontal "diffusion". One intended application is the simulation of mine dump and power station emissions in the Eastern Transvaal Highveld, where important directional shear and upper "jet-streams" have been measured by acoustic sounding equipment. The model is to run off a flexible meteorological sub-programme which will make optimal use of whatever meteorological data are available, allowing defaulting where wind/stability data are lost. An initial test application will be attempted for a local industrial area, where a system of five instrumented meteorological masts, using a digital data-acquisition system, has already been set up.

Instruction of undergraduates in Air Pollution is presently limited to a 6-lecture course in 3rd Year Chemical Engineering. Although stack design and sampling, and plume rise, are treated, the gas-cleaning equipment design is covered in other courses (cyclones, precipitators, scrubbers, etc.). Concentration and dosage limits, and typical TLV's, are considered, but the bulk of the course concerns mathematical modelling of the transport mechanism, including Taylor's analysis. Students are taught to fashion the Gaussian distribution for instantaneous or continuous sources, to allow for "ground-reflection", settling and washout, and to find the point of maximum concentration. They are referred to the various sources for diffusion parameters (e.g. Sutton) and the effect of stability is discussed.