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Original Research Paper

Application of Software Technology for Air Pollution Prediction Model

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ABSTRACT

Air pollution models are routinely used in environmental impact assessments, risk analysis and emergency planning, and source apportionment studies. The atmospheric regulations are responsible for changing the air pollution concentration. The prediction of air pollution concentration has been done by various mathematical models. The use of software technologies will be beneficial for environmental measurement and conservation. This research article aims to develop the software based air pollution prediction and measurement model which is helpful to draw the air pollutants concentration of any place away from the source of emissions. The Gaussian plume rise mathematical formula was used for developing the software by using visual basic language. Air pollutant measurement and prediction model will be helpful during environmental impact assessment study as well as to analyse the impact and concentration of air pollutants in and around industrial belts.

INTRODUCTION

The atmospheric regulations are responsible for changing the air pollution concentration. The prediction of air pollution concentration has been done by various mathematical models. The software technologies will be beneficial for environmental measurement and conservation (Barad 1958). This paper aims to develop the software based air pollution prediction and measurement model which is helpful to draw the air pollutants concentration of any place away from the source of emissions. The Gaussian plume rise mathematical formula was used for developing the software by using visual basic language.

Air pollution models are routinely used in environmental impact assessments, risk analysis and emergency planning, and source apportionment studies. In highly polluted cities like Delhi, Mumbai, Chennai and Kolkota, regional scale air quality models are used to forecast air pollution episodes; the results from these models may initiate compulsory shutdown of industries or vehicle restrictions. The various roles served by air pollution models, which cover a broad range of scales from local to global, lead to distinct modelling requirements. The focus of this review will be on the near-field impact (< 10-20 km) of industrial sources (Berkowicz et al. 1987).

The term “air pollution model” usually refers to a computer program, but in the past it has also included hand calculations or use of charts and tables from simple handbooks. A dispersion model is essentially a computational procedure for predicting concentrations downwind of a pollutant source, based on knowledge of the emission characteristics (stack exit velocity, plume temperature, stack diameter, etc.), terrain (surface roughness, local topography, nearby buildings) and state of the atmosphere (wind speed, stability, mixing height, etc.). Fig. 1 illustrates the flow of information in a generic air pollution model (Fedra 2000). The basic problem is to predict the rate of spread of the pollutant cloud, and the consequent decrease in mean concentration. The model has to be able to predict rates of diffusion based on measurable meteorological variables such as wind speed, atmospheric turbulence, and thermodynamic effects (Briggs 1974). The algorithms at the core of air pollution models are based upon mathematical equations describing these various phenomena which, when combined with empirical (field) data, can be used to predict concentration distributions downwind of a source. This work investigates the working of Gaussian plume model with software development based on the equation.

MATERIALS AND METHODS

Gaussian air pollutant dispersion equation: The technical literature on air pollution dispersion is quite extensive and dates back to the 1930s and earlier. One of the early air pollutant plume dispersion equations was derived by Bosanquet and Pearson. Their equation did not assume Gaussian distribution nor did it include the effect of ground reflection of the pollutant plume.

Sir Graham Sutton derived an air pollutant plume dispersion equation in 1947 which did include the assumption of Gaussian distribution for the vertical and crosswind

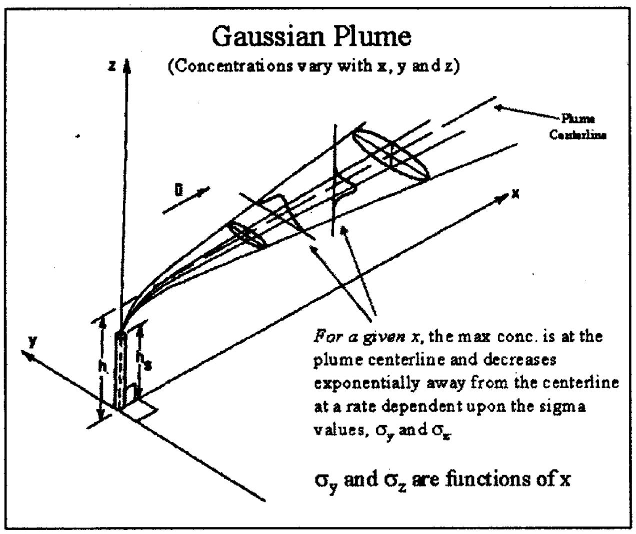

Fig. 1: Gaussian plume model.

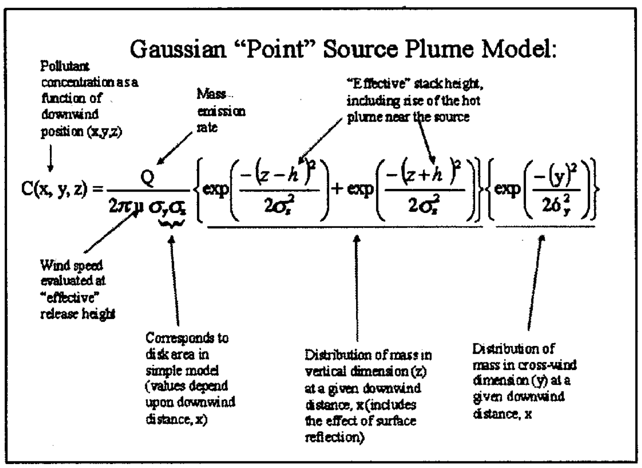

Fig. 2: Gaussian plume equation.

dispersion of the plume and also included the effect of ground reflection of the plume. Under the stimulus provided by the advent of stringent environmental control regulations, there was an immense growth in the use of air pollutant plume dispersion calculations between the late 1960s and today (Gifford 1960). A great many computer programs for calculating the dispersion of air pollutant emissions were developed during that period of time and they were called "air dispersion models". The Gaussian plume model and Gaussian plume equation are shown in Figs. 1 and 2. The above equation not only includes upward reflection from the ground, it also includes downward reflection from the bottom of any inversion lid present in the atmosphere. The sum of the four exponential terms in g_3 converges to a final value quite rapidly. For most cases, the summation of the series with $m = 1$, $m = 2$ and $m = 3$ will provide an adequate solution. σ_z and σ_y are functions of the atmospheric stability class (i.e., a measure of the turbulence in the ambient atmosphere) and of the downwind distance to the receptor. The two most important variables affecting the degree of pollutant emission dispersion obtained are the height of the emission source point and the degree of atmospheric turbulence. The more turbulence, the better the degree of dispersion (Fedra 2000).

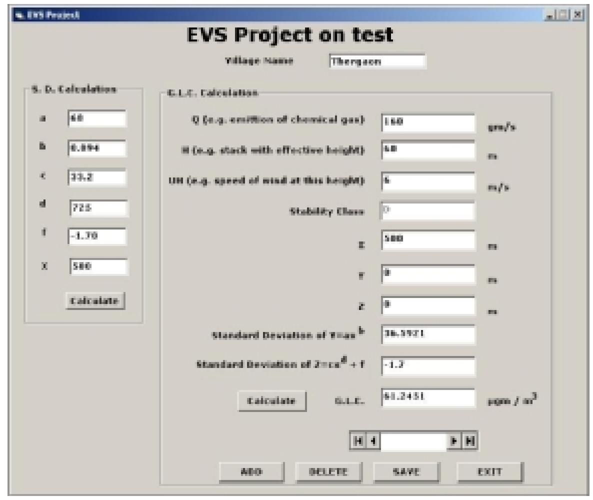

Fig. 3. Picture of Gaussian model software image.

The resulting calculations for air pollutant concentrations are often expressed as an air pollutant concentration contour map in order to show the spatial variation in contaminant levels over a wide area under study. In this way the contour lines can overlay sensitive receptor locations and reveal the spatial relationship of air pollutants to areas of interest.

RESULTS AND FINDINGS

The result of this software calculates the air pollutants ground level concentration far emitted from industrial stacks. The following window shows the application picture of this software.

Visual Basic Code

```
first = (Q / (3.1416 * UH * sigmaY * sigmaZ))
second = (-((H * H) / (2 * (sigmaZ * sigmaZ))))
c = first * (Exp(second))
```

A practical application of the model by use of the software is shown in Fig. 3. Air pollutant measurement and prediction model will be helpful during environmental impact assessment study as well as to analyse the impact and concentration of industrial air pollutants concentration in and around industrial belts. This software model is well executed and authentication is checked using general calculations.

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