CHAPTER - SIX

AIR QUALITY PREDICTIONS THROUGH MATHEMATICAL MODELING

6.1 Introduction

At SDCW one bagasse fired boiler of 12 TPH steam capacity is already in operation. The boiler emit primarily Suspended Particulate Matter (SPM) and NOx as bagasse does not contribute to SO2 through its 35 m stack location of which is shown in Fig. 2.1. The emission characteristics and emission loads are given in Table 6.1 which are worked out based upon SPM emissions limited to 50 mg/ Nm3 in flue gas after passing through bag filters. The emission loads are worked out based upon bagasse as primary fuel which is available from adjoining sugar mill. Peak incremental concentrations due to boiler stack are predicted to assess their incremental concentrations on ambient air quality. For prediction of ground level concentrations of SPM and NOx, computer simulation is carried out using CPCB recommended **ISCST3** dispersion model developed by USEPA.

6.2 Atmospheric Emission

Emission Source

Emission loads have been worked out on the basis of bagasse as fuel and the boiler stack provided with bag filters. The emission rate of SPM and NOx are calculated as below:

Particulate Matter

SPM in the stack after control systems	=	50 mg/Nm^3
Stack flow	=	5.912 Nm^3/s
Emission Load	=	5.912 x 50 mg/s
	=	0.295 g/s

NOx Emission Rate

The temperatures encountered in the steam generator while burning biomass fuels, are low enough not to produce nitrogen-oxides. However, for predictions of ground level concentrations the NOx concentration is taken as 100 ppm.

NOx emission rate from the stack, ppm	=	100
Flue gas volume, Nm3/s	=	5.912
NOx Concentration, Nm3/s	=	100 x 10^{-6} x 5.912
	=	0.0005912

NOx concentration, kg/s	=	0.0005912x 1.22
	=	0.000721
	=	0.721 g/s

(NOx density = 1.22 kg/Nm3)

6.3 Mathematical Modeling

In an attempt to predict impact on ambient air quality the Industrial Source Complex (ISC3) simulation model is employed. The algorithms of which are developed based on steady state Gaussian plume dispersion equation for continuous point source.

Industrial source air quality models are used as a tool to enable predictions of likely pollutant concentrations for a variety of emission and meteorological scenarios. This model is generally based on the available knowledge of the processes of plume rise and dispersion.

The programme make use of Gaussian Plume model. It employs the recent Brigg's plume rise equations, more recent updates of wind exponents and dispersion coefficients.

The concentrations predicted in this study should provide a good order of magnitude for the purpose of screening. First of all, these concentrations have been arrived at after extensive simulations and the maximum estimates out of the numerous possibilities are predicted to provide a typical 'worst case' scenario.

The pollutant emitted is expected to undergo some removal processes in the atmosphere (such as deposition and reaction). Since these processes of 'reduction' have not been modeled, it is expected that the simulation made in this report represent concentrations on a higher or conservative side. In this sense, the predicted concentrations should provide a very useful basis for rational assessment of air quality impacts due to emissions from the sugar mil boiler. The objective of this, modeling is to predict incremental additions in the concentrations due to the implementation of proposed power plant in the air shed of 10 km radius.

6.4 Meteorological Data

Application of an air quality model requires analysis and interpretation of hourly meteorological data of site or nearest IMD station. Meteorological data governs the transport and dispersion of emissions released in the surrounding airshed.

For predicting short term average concentrations hourly meteorological data of wind speed, wind direction, Ambient Air temperature, weather conditions available for the site was used. Based on this and as suggested by Turner (1970) the stability class were identified based on guidelines issued by CPCB on mathematical modeling. Also the mixing heights were selected as a credible scenario of lift effect for calculating maximum short term concentrations. The mixing heights for northern India were taken from published literature.

6.5 Estimation of variables for the short term simulation

The ISCST3 programme estimates y and z based on Brigg's rural dispersion parameters. A rural case with simple terrain was chosen since the land use in the airshed is primarily dominated by open spaces and is largely flat with low buildings. Plume rise ' h' for a stack of physical height h is calculated by the programme using Brigg's plume rise equations (Brigg, 1975). Regulatory default options such as plume rise, stack-tip downwash, buoyancy - induced dispersion, Wind Profile exponents and vertical temperature gradient for the model with rural dispersion have been selected for simulation of pollutants. Emission rates were considered as constant during the entire period.

The mathematical equations and the combinatorial strategy of stability class-wind speed combinations was used to estimate all possible short term concentrations at each receptor location. A suitable spatial resolution was used in the area of influence of 10 km radius in sixteen directions.

6.6 Computed Incremental Pollutant Concentrations

6.6.1 In order to compare with the prescribed standards, which correspond to the averaging time of 24 hours, the programme worked out all possible contributions and then identified the maximum of these concentrations. At the end of the simulation run, the programme thus computed the maximum possible concentrations (i.e. with an averaging time of 24 hrs.).

The maximum ten 24 hourly predicted GLC's of SPM and NOx and its probable locations are shown in Tables 6.2 & 6.3. The AAQ monitoring carried out during study period showed the 98th percentile values for NOx in the 10 km radius study area as 16.4 ug/m3.

6.6.2 The worst predicted 24-hourly concentration for SPM is 1.114 ug/m^3 and for Nox is 2.891ug/ m^3 occurring at a distance of 400 m from the emissions of 12 tph boiler.

6.7 Post Project Ambient Air Quality

With the promulgation of new National Ambient Air Quality Standards SPM in no longer a parameter of concern but in the case of stack emissions SPM is prescribed as a standard. Hence it becomes impossible to superimpose predicted SPM on the AAQ monitored RSPM. The overall incremental NOx concentrations obtained through these computations when superimposed on the baseline ambient air quality of the area shall ensure that the worst post project predicted ambient air quality shall be as follows :

	98th Percentile Concentrations (ug/m3)	Maximum Increment due to 12 TPH Boiler (ug/m3)	Maximum Final Predicted Concentrations (ug/m3)
SPM	-	1.114	-
NOx	16.4	2.891	19.291

It can be concluded from the predicted values that concentrations of SPM are very small and are unlikely to impact the Ambient Air Quality due to boiler emissions.