Performance Study of AERMOD under Indian Condition

Vishwa H. Shukla[1], Prof.Dr.N.S.Varandani[2], Prof. Huma Syed[3]
[1]*Environment Engineering Department, L.D. Collage, Ahmedabad*
[2]*Principal Research Scientist, GERMI - Gandhinagar*
[3]*Asso. Prof of Environmental Engineering*

***Abstract*- AERMOD is regulatory model in USA, since 2005 and recently Australia has also recommended AERMOD as regulatory model for air quality modeling purpose. At present, ISCST – 3 (Industrial Source Complex Short Term – 3) models is being widely used for Environmental Impact Assessment (EIA) & source apportionment studies. AERMOD is not as popular and in application as ISCST – 3 till date in India. Out of the few studies carried out in India, it is seen that AERMOD tends to underpredict the results and also performed best when point, line and area wide sources have been used as source input in combination. Hence, present study focuses on to assess the AERMOD performance for point source as independent model source input. AERMOD is sensitive to main three land use parameters such as surface roughness, Bowen ratio and albedo. One of the probable causes of the underprediction could be traced to the selection of such default values for predictions. At present lack of availability of such values for Indian condition AERMOD model users uses such recommended values. So in this study efforts will be directed towards finding the values for Indian condition and checking their applicability. One of the parameter to be focused is Albedo. India is home of diverse climatic region and is differ from climate condition in western countries. So model may or may not perform equally best under Indian conditions. Systematic model evaluation is essential prior to model application for specific source under specific meteorological conditions in order to increase its credibility.**

***Index Terms*- AERMOD, Albedo, Environment Impact Study (EIA), Source Apportionment**

I. INTRODUCTION

Air pollution modeling is a method for providing information on air quality in a region based on what we know of the emissions, and of the atmospheric processes that lead to pollutant dispersion and transport in the atmosphere. In most air quality applications, the main concern is the dispersion in the Planetary Boundary Layer (PBL), the turbulent air layer next to the earth's surface that is controlled by the surface heating and friction and the overlying stratification. The key issues to consider in air pollution modeling are the complexity of the dispersion, which is controlled by terrain and meteorology effects. Growing awareness among the policy-making agencies regarding these adverse effects has led to the inclusion of air pollution control strategies as an integral part of urban planning. Prediction of pollutant concentrations with the aid of regulatory air quality models is an essential part for air quality management strategies. However, validation of the regulatory model is important before implementation in a different geographical and climatic zone for which the model is originally developed. Thus, prior to application, a model must be evaluated for local site conditions as performance of model varies for different source scenarios and climatic conditions. Air pollution models are classified according to the scales of application. Short-range models apply to spatial scales up to ten kilometers, while urban and long-range transport models to larger scales. The most widely used models for predicting the impact of relative inert gases, such as sulfur dioxide, which are released from industrial point sources, are based on the Gaussian diffusion (Venkatram, 2001). A Gaussian plume model assumes that if a pollutant is emitted from a point source, the resulting concentration in the atmosphere, when averaged over sufficient time, will approximate a Gaussian distribution in vertical and horizontal directions (Turner, 1964; Briggs, 1971; 1972). Gaussian models require meteorological data from a single meteorological station and assume this data to be applicable for the entire modeling domain. AERMOD was developed at the United States Environmental Protection Agency. The model is used for regulatory purposes in the United States and is a highly recommended model in many countries.

In India, AERMOD has recently been added to the list of recommended models for regulatory applications (CPCB, 2008). However, the most often used model is still ISCST3 which may be due to unavailability or inaccessibility of requisite extensive input data for AERMOD or other more sophisticated models for various regions of the country. In India, the application of air quality models is mainly limited to regulatory purposes with the Industrial Source Complex (ISC) of United States Environmental Protection Agency (USEPA) (ISCST3, 1998) being the model of choice. AERMOD has an improved approach for characterizing the fundamental boundary layer parameters and vertical profile of the atmosphere along with better representation of plume buoyancy, penetration and urban nighttime boundary layer (Cimorelli et al., 2004) as compared to the ISC model. It provides variable urban treatment of vertical dispersion as a function of city population, and can selectively model sources as rural or urban. AERMOD requires hourly surface and upper air meteorological observations for simulating the pollutant dispersion. However, meteorological observations with such frequency are not available for most other locations in India. The impact of the release of pollutants is also expected to have a large variation from area to area depending upon the type of pollutants and the environmental conditions in different areas. The adoption of model without prior performance evaluation leads to erroneous results in predictions. Fact is that, model a formulation has been carried under the conditions of western countries. So it should not be assumed that model perform equally well under Indian Scenario which has different meteorological cycles. Literature shows that AERMOD requires comprehensive surface and upper sounding meteorological data and sensitive to surface parameters like surface roughness, albedo and Bowen ratio. Lack of the availability of data related to such surface parameter for all the part of country like India, Users of the model use the values recommended by the USEPA (AERMOD model manual). Furthermore, comprehensive literature on performance evaluation under Indian regime shows that AERMOD have tendency to under predictions. Reasons for under prediction may be default values used in AERMOD.

For present study, an attempt has been made to evaluate the AERMOD performance for point source alone. Thermal Power Plant located in Gandhinagar – Gujarat, having flat region and fall under urban land use land cover category has been selected. Thermal power plant uses Indian coal as well as imported coal, which emits noxious gaseous pollutants mainly such as Sulfur dioxide (SO2), Nitrogen Oxide (NOX) and Particulate Matters. As Gandhinagar is located within city area limits, the pollution from the thermal power plant can be considered as major source of air pollution. However, Gandhinagar is considered as “Cleanest and Greenest city of the Gujarat”.

II. STUDY SITE

Gandhinagar is the capital of the state of Gujarat in Western India. Gandhinagar is located approximately 23 km North from Ahmedabad. City is located at geographical location of 23. 22 ˚ N and 72.68˚ E and 81 m above from mean sea level. Gandhinagar has a tropical wet and dry climate with three main seasons: summer, monsoon and winter. The climate is generally dry and hot outside of the monsoon season. The weather is hot to severely hot from March to June when the maximum temperature stays in the range of 36 to 42 °C (97 to 108 °F), and the minimum in the range of 19 to 27 °C (66 to 81 °F). It is pleasant in the winter days and quite chilling in the night during December to February. The average maximum temperature is around 29 °C (84 °F), the average minimum is 14 °C (57 °F), and the climate is extremely dry. The southwest monsoon brings a humid climate from mid-June to mid-September. The average annual rainfall is around 803.4 mm (31.63 in). Gandhinagar is fairly having flat terrain and thermal power plant is located in sector 30 as shown in **figure - 1** can be considered as major source of pollution after then the vehicular pollution. Gandhinagar Thermal Power Station (TPS) is working under organization of GSECL. This TPS is one of the big powers generating station in Gujarat State. The Gandhinagar TPS is situated at the right bank of river Sabarmati, is mainly constructed to meet with the power need of North Gujarat and to improve the voltage condition of the grid. It is first unit working since 1977. Thereafter, one by one power generating units have been installed.

Fig: 1 Location of Study Site

III. DATA USED

The emission rates of Particulate matter and Sulfur dioxide emitted from thermal power plant and their source characteristics, meteorological and ambient air quality has been collected for November and December 2014 of winter season.

Source Characteristics: