International Research Journal of Environmental Sciences ISSN 2319–1414
Vol. **6(5),** 46-48, May **(2017)** *Int. Res. J. Environmental Sci.*

Short Review Paper

Role of meteorology in control of industrial air pollution

Taulat Qayoom
Department of Chemistry, Islamia College of Science and Commerce, Srinagar, Kashmir -190002, India
taulat.qayoom@gmail.com

Available online at: www.isca.in, www.isca.me
Received 11th January 2017, revised 19th May 2017, accepted 22nd May 2017

Abstract

For developing countries like India, it can never be a question of choosing between environment and development - the nation stands to lose if one were to be chosen at the cost of the other. The interests of the nation lie only in planning development in a manner that it shall not harm or adversely affect our natural resources or environmental quality in either the short or in the long run and shall in other words be sustainable. Of late, with rapid pace of industrial development in our country, the concern for environment has become more pronounced. Air pollution is one of the main factors affecting environment. In view of injurious effects of various air pollutants on health of human beings and other living creatures, and their detrimental effects on plants, property and human environment, considerable attention is now being focussed in our country on air quality management to achieve sustainable economic development with the minimum environmental degradation.

Keywords: Meteorology, Industrial Plant, Air Pollution.

Introduction

The density of the air pollutants from the time they are released into the atmosphere till they reach the receptor is largely governed by prevailing meteorological factors[1]. The undesirable effects of air pollution emphasizes the need for understanding the role played by the atmosphere in affecting the levels of pollutant concentrations. With a constant rate of emission, pollutant concentrations on the ground may be many times greater under unfavourable meteorological conditions than under the most favourable one.

Air pollution and meteorology behaviour

Since the capacity of the atmosphere to dilute pollutant emissions varies considerably in space and time depending upon meteorological parameters for their transport and diffusion in the lower layers of the atmosphere, the role of the meteorology in air pollution control and abatement measures has been receiving increasing attention[2].

The various stages that need to be considered in the movement of air pollutants from sources (emissions) to receptors include: i. Emissions, ii. Initial atmospheric behaviour of pollutants (plume rise, downwash etc). iii. Atmospheric processes (Atmospheric transport and diffusion). iv. Wet and dry deposition, v. Impacts on receptors.

Meteorological factors in the dispersion of pollutants

The important meteorological parameters which govern the transport and diffusion of pollutants in the atmosphere are: i. Wind speed, wind direction and their fluctuations. ii. Atmospheric Stability, iii. Temperature inversion, iv. Mixing height, v. Vertical variation of wind with height.

Meteorological principles applicable in selection of locations of industrial plants

Meteorological principals find their application in controlling the pollution in an industrial plant especially while deciding its location, design and equipment and in its day-to-day operation[3]. Choice of the site depends on a comparative assessment of the potential of air over the sites to dilute air pollutant releases from the industrial plant. The winds may be light with slow diffusion at one place and opposite may be true with predominantly viable and strong winds having rapid diffusion at another place. As such geographical site which has a climate regime favourable for atmospheric diffusion could be considered for new industrial plant with minimum pollution hazards. It has been recognised by industrial planning agencies that incorporation of air pollution climatology considerations into long-range air resources management programs is an indispensable tool in industrial development schemes[4].

The main characteristics of a region can be had by the interpretation of previous climatological records of the representative meteorological station in the area. Air pollution potential climatology of an area is normally studied by simple approach of mixing height, mean layer wind, and ventilation coefficient which are derived from rawinsonde observations[5] of the representative station. In absence of rawinsonde observations, the wind rose analysis of the representative station is used in most climatological assessment.

After choosing a suitable location it is advisable to estimate concentration of pollutants and allied micro-meteorological factors prior to the start of construction. These will provide base-line data for evaluating the contribution of new plant due to local pollution after the plant goes into operation. Such measurements must continue during the construction phase of the plant and for at least one full year after production starts to determine actual pollution due to plant operation and its probable future limits.

Meteorological principles in plant and stack design

The stack is a very important component of an industrial plant through which the pollutants are emitted into the atmosphere. The principle factors which must be accounted for while designing a stack for air pollution control strategies are: i. Air quality standards. ii. Meteorological conditions, iii. Topographical features.

Generally the higher the stack, the lower are the ground level concentrations at any given point down-wind, under similar meteorological conditions. Effective heights (H) is the sum of physical stack height (hs) and plume rise (h) [H=hs + h]. h can be calculated from a knowledge of stack characteristics and the meteorological parameters.

h can be positive or negative. When h is negative, the effective stack height becomes less than the physical stack height and we shall here consider the conditions under which h is negative.

A decrease in effective stack height can occur due to aerodynamic effect of an obstacle on fluid flow. The shape and orientation of plant building is important in this respect. The aerodynamic effects of the building[6] on the flow can cause down-wash when the wind speed exceeds certain critical value. These critical speeds vary with the aerodynamic properties of plant structures and with direction of the wind in relation to the plant structure. A climatological study of parameters like duration, frequency and directional distribution of critical wind speeds will help in plant design and its orientation to minimise the problem.

h can be negative, also when the stack gas velocity is less than1.5 times the wind speed usually observed in the area. In such cases entrainment of effluent may occur into the turbulent wake of the stack.

Terrain effects

Effluents from a stack in the wake of a hill are also subject to downwash. Each terrain situation should therefore, be studied before deciding on stack height which will generally be dependent upon direction.

Some rules of thumb for good stack design are: i. Minimum stack height should be at least 2½ times the height of the nearest tallest building to avoid down-wash. ii. Efflux velocity from the stack should be greater than 1½ times the wind speed at stack level with a non-exceedance probability of 95%. iii. Ground concentrations may be excessive for cold ventilation emissions if the stack diameter is less than 1m and physical stack height is less than 30m. iv. The maximum ground level concentrations occur at the distance of about 5-10 stack heights downwind during unstable atmospheric conditions. v. Ground level concentration (GLC) from industrial plants can be minimised using higher stacks. The maximum GLC varies inversely as the square of effective stack height.

Meteorological approach in abatement of air pollution problems due to industrial plant

One of the major impact of an industry is on air quality in its neighbourhood. Emissions of air pollutants from single or multiple stacks of an industrial plant downgrade the quality of ambient air in the surrounding area. It is, therefore, necessary to assess the impact of pollutant emissions from the industry on air quality so that appropriate measures are taken to keep the air quality within the prescribed ambient air quality standards which are numerical values of pollutions concentrations that should be exceeded.

Atmospheric diffusion modelling provides a link between emissions from a polluting source or a complex of sources and a resultant impacts (in the form of pollutant ground level concentrations) at receptors. As transport and diffusion of pollutants are dependent on meteorological conditions such as wind speed and stability which vary over typical ranges, the ground level concentration is known to vary over several orders of magnitude at a given location for constant emissions. A variety of models based on physical concepts regarding atmospheric processes have been developed which can be used to identify and evaluate the levels of control required to solve industrial air pollution problems.

A typical air pollution impact analysis involves the following: i. Knowledge of pollutants, type of sources and their emission rates. ii. Assessment of existing status of air quality (Background levels of air pollution). iii. Choice of an appropriate atmospheric diffusion model, iv. Meteorological data suitable for input to the model. v. Superimposition of ground level concentrations obtained using the model, on background to the predicted ambient air quality after commissioning of industrial plant. vi. Identifications of mitigation measures if required.

The following control measures are often suggested based on meteorological approach for abatement of air pollution from a single point source of an industrial plant: i. Optimum stack height of proposed industry to limit pollutant concentrations in the surrounding area within the prescribed ambient air quality standards (AAQS). ii. Emission reduction or alternation of the temperature and exit velocity of stack effluents for fixed stack heights for operating industry.

Multiple-source modelling can be undertaken in similar fashion for control strategies although considerable book-keeping is required with respect to source inventories.

Conclusion

Air pollution meteorology plays an important role in an air management programme. Air quality management is an inter-disciplinary field requiring the collaboration of meteorologists, environmental engineers, health officials, ecologists, land use planners, sociologists and economists. Collaboration of experienced air pollution meteorologist is essential for proper management of air resources to avoid misuse/mismanagement of the atmosphere which serves as a repository for several tons of pollutants deposited daily in each community of the world.

References

1. Harold J.P., Hoecker W.H. and Herbert H.J. (1949). Meteorological Conditions and atmospheric Contaminants. *Air Pollution in Donora, A different air. Maxwell Reprint Company, New York*, 149-159.

2. Guttikunda Sarath K. and Gurjar Bhola R. (2012). Role of Meteorology in seasonability of air pollution in megacity of Delhi, India. *Environmental monitoring and assessment,* 184(5), 3199-3211.

3. Cogliani E. (2001). Air Pollution forecast in cities by an air pollution index highly correlated with meteorological variables. *Atmospheric Environment*, 35(16), 2871-2877.

4. Hidy G.M. and Pennel W.T. Multipollutant air quality management. *Jour. of Air & Waste management Assoc*., 60(6), 645-674.

5. Fires in Northwest India (2017). Natural Hazards. USA, NASA., Earth Observatory.

6. Lu R. and Turco R.P.(1995). Air Pollutant Transport in coastal environment-II. Three dimensional Simulation over Los Angeles Basin. *Atmospheric Environment,* 29(13), 1499-1518.