CHAPTER 1

INTRODUCTION

Dust pollution due to mining activities is drawing greater attention as the awareness in the society is increasing about the environmental issues. Dust pollution is generally characterised by suspended particulate matter. Suspended particulate matter (SPM) generated from the different mining operations in a mine is a serious threat to the health of manpower as well as to the local community. Air pollution is one of the common environmental problems as faced by the management of surface mines. Due to demand to increase the production of the mineral and coal, there is a requirement to increase the capacity of the working machineries or use the high capacity heavy earth moving machineries. This leads to generation of more SPM which is likely to affect the environment severely.

It has been assessed (Gautam et al., 2012) that surface mine has been responsible for creating more impact on surrounding environment as compared to underground mining methods in the same area. In every surface mining method, starting from the surface of the earth till reaching to the ore deposit or coal seam, all activities are performed in open atmosphere which leads to higher degradation of the environment. In underground mining, all major activities are carried out beneath the earth surface and nothing is exposed to the surface environment and consecutively deterioration of the environment is very less in comparison to that of by surface mining methods. Dust is generated during all phases of exploitation and processing of mineral from fugitive sources in surface mines such as shovelling, ripping, drilling, blasting, transport, crushing, grinding, screening, and stockpiling etc. Health impacts from dust emissions are related to the main components of dust (silica, silicates, carbonates), as well as to rock impurities and trace components (asbestos etc.), those can cause serious diseases like pneumoconiosis, silicosis, asbestosis etc. (IFC, 2006).

Surface minerals extraction and processing operations can generate large quantities of fugitive dust that, when released in an uncontrolled manner, can cause widespread nuisance and potential health concerns for on-site personnel and surrounding communities. Typical fugitive dust emission sources may include minerals transfer points, conveyance, loading into crusher feed bins, haulage and blasting (Appleton et al., 2006). Vehicular traffic on unpaved haul roads of the opencast mines has been identified as the most prolific source of fugitive dust (Sinha et al., 1997). Excessive dust generation from such haul roads is a problem common to most surface mining operations especially in semi-arid and arid areas. Selection of optimal wearing coarse material for the haul roads reduces dust emission, but do not totally eliminate the potential to produce dust (Thompson et al., 2003). Overburden dumps are also one of the major sources of fugitive dust as identified by Konstantinos et al. (2011).

There is a continuous increase in mechanisation level of the surface mines due to increase in the production. Hence, there is every chance that all the surface mines would become deeper in nature as comparison to the earlier scenario. As surface mines and quarries become deeper, there will be an increase in the mining area exposed to the open environment. Hence, a significant increase in dust generation potential (including fugitive dust) is expected. It is desired to minimise the impact of fugitive dust on society in general and health of persons living in neighbourhood of mine in particular.

Coal mining is one of the core industry in India. Surface mining is one of the main mining method for the production of coal. Almost 80% of the coal is being extracted from surface mines in India. Its environmental impact cannot be ignored but is unavoidable to some extent. Most of the mining activities contribute directly or indirectly to air pollution. These air pollutants degrade air quality and ultimately affect people, flora and fauna in and around mining areas (Chaulya, 2004 & Nanda et al., 2001).

The health hazards associated with inhalation of suspended particulate matter (SPM) have been studied by Panda et al. (2013) which can cause disease like asthma, lung cancer and cardiovascular issues in humans. After inhalation, the size of the particle decides the location where the particle would rest in respiratory system. The size of the particulate matter also decides the part of the body getting effected by it. Larger particles are generally filtered in the nose and throat and do not cause problems, but particulate matter smaller than about 10 micrometers, referred as Respirable Suspended Particulate Matter (PM_{10}), can settle in the bronchi and lungs and cause health problems. Particulate matter which is less than or equal to 2.5 micrometers ($PM_{2.5}$) tends to penetrate into the gas-exchange regions of the lung.

There is always a need to predict and measure the concentration of suspended particulate matter in mining industry. There is a mandatory requirement for preparation of an environmental management plan (EMP) for a proposed mine. Even for a running mine, it is necessary to predict the future concentration of the dust in the upcoming phase of the mining activity. Therefore, prediction of dust concentration becomes compulsory. This prediction can be done using a suitable modelling tool.

There are several modelling tools like American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD), Industrial Source Complex model (ISC3), Fugitive Dust Model (FDM), Atmospheric Dispersion Modelling System (ADMS), etc. available, which can predict particulate matter concentrations at the given location in the space. These tools are validated by several researchers in the past (Chualya et al., 2003, Mishra et al., 2010, Huertas et al., 2012).

1.1 Research Problem and the Objectives

An opencast mine usually goes deeper and expands laterally to extract the coal from a dipping seam. It further requires more overburden to be removed and put inside the mine in the form of internal overburden dump. In such scenario, there is always a requirement to increase the length of the haul road to reach the bottom most part of the mine. It has also been seen that haul road and internal overburden dump are main sources of dust pollution in an opencast coal mine (CMRI, 1998). The behaviour of dust emission from haul roads and internal overburden dump at varying depth is the main area of concern of this study.

This study has been aimed to predict concentrations of particulate matter outside the mine using AERMOD for varying depth of the mine. Validation of AERMOD for Indian Geo-Mining conditions has been done. In the first step, a surface mine ‘A’ was taken for validation study. Surface and upper air meteorological parameters were collected for the mine location. Sources and receptors were identified and then predicted concentrations were statistically validated with the measured concentration of particulate matter. After this, a Mine ‘B’ was considered with five different depths ranging from 50 to 250 m at an interval of 50 m. Dust sources with same strength were considered at different depth of the mine. Particulate matter concentrations were predicted outside the mine region due to emission coming out from these dust sources. In the next step, internal overburden dumps of different height and haul roads of different length were considered for different depths of Mine ‘B’. Direction of wind was considered along, against and perpendicular to the location of the internal overburden dumps and haul roads to assess its effect on emission of particulate matter. In the concluding stage, particulate matter concentration due to dust emission from these sources was predicted outside the mine for different depths of the Mine ‘B’ as well as different orientation of the sources with the wind.

1.1.1 Objectives of the Research Work

The objectives of the research work are as follows:

1. The first objective of the research work was to validate the AERMOD for an opencast coal mine in Indian Geo- Mining conditions. It was required to use the model for further study.
2. The main objective of the research work was to find out the impact of depth of an opencast coal mine on dust concentration levels.
3. Assessment of impact of internal overburden dump and its location vis-à-vis wind direction at varying depth on the surface was another objective of

the study. Dust concentration levels generated from these internal overburden dumps were studied to find out the impact on the surrounding environment.

4. The objective of the research work was also to find out the impact of haul road and its location vis-à-vis wind direction at varying depth on the surface. This was done by studying the dust concentration levels generated from these haul roads.

Chapter 1 introduces the subject as well as the research problem. It also covers objectives of the study.

Chapter 2 presents a review of literature on the dust dispersion phenomenon in the mining industry. It also discusses the field studies and dust dispersion modelling which was done earlier by researchers. Further it covers different dust dispersion models and tools available.

Simulation and validation study for an opencast coal mine has been discussed in Chapter 3. The study site, field data collection has also been discussed.

Chapter 4 discusses problem formulation and simulation of mining system of varying depth. It also discusses the simulation of varying depth, haul road, internal overburden dump vis-à-vis direction of wind.

Chapter 5 discusses the prediction of the dust concentration level by AERMOD for different depths of the mine. It also covers the impact of orientation of haul road and internal overburden dump for different direction of wind.

Chapter 6 discusses conclusions from the study.