

# Automatic Dust Control for Modern Coalmines

Tejeswaran K M<sup>1</sup> and Syed Hafizulla Hussani<sup>2</sup>

<sup>1-2</sup>U G students, Department of Mining Engineering, Acharya institution of technology, Bangalore  
Email: tejeswarankm@gmail.com, Syedhafizulla23@gmail.com

**Abstract**—Modern coalmines produces huge amount of dust during the production and transportation of coal. Due to the lot of dust produced in this operation causes health problems such as lunges diseases and respiration problems to the miners. This paper discussed about auto dust controls which detected the dust and automatically water will be spared through the water pipes installed by this water can be saved and dust can be controlled more effectively. This also increases the safety of miners regarding dust and decreases the dust suppression cost.

**Index Terms**— coalmines, dust, lunges diseases, dust sensors, safety of miners.

## I. INTRODUCTION

Dust is a generic term used to describe fine particles that are suspended in the mine atmosphere. Dust is formed when fine particles are taken up into the atmosphere (entrained) by the action of wind, by disturbance of fine materials, or through the release of particulate-rich gaseous emissions (primary particles). In addition, gases such as sulphur dioxide and oxides of nitrogen may react over time to form particles, such as ammonium sulphate and ammonium nitrate (secondary particles). Dust is classified based on its particle size<sup>(1)</sup>

### A. Sources and types of dust from mining

A wide range of mining activities may generate dust, including:

- Removal of vegetation and topsoil.
- Removal of overburden material.
- Blasting and drilling operations.
- Operation of crushing and screening equipment.
- Loading and unloading of material on-site and subsequent transport off-site.
- Transport by vehicles on access roads and haul roads.
- Cutting of coal
- Wind action affecting stockpiles and exposed areas of the site.

Dust generated from coal mines is typically termed 'fugitive dust', which refers to dust derived from a mixture of sources, or sources which are not easily identifiable.

### B. Dust particle size and composition

The size and composition of dust particles generated by mining will depend on the type of mining activity and the geology of the site. Mining typically generates dust particles between 1µm to 100µm in size. Typical size ranges are:

- Submicron size (less than 1µm): 0.2 percent (generally generated from diesel emissions) of total emissions.
- PM2.5: 2 to 5 percent of total emissions.
- PM2.5 to PM10: 15 to 45 percent of total emissions.
- Greater than 10µm: 50 to 70 percent of total emissions.

A survey of dust sizes from coal mines in the United States (sampled up to 100m from the source) found that dust had a median size of 24µm. Dust in the range PM10 or less comprised between 11 to 23 percent of total dust emissions (by total mass).

The Metropolitan Air Quality Study (MAQS) identified coal mining in the Hunter Valley as a significant source of TSP (50µm or less), contributing 26 percent of human sources in the greater MAQS region. In addition, the National Pollutant Inventory (NPI) estimates the mass of PM10 emissions due to coal mining in the Hunter Valley area for the period 2003 – 2004 is 42,000,000kg<sup>(2,8,7)</sup>.

## II. MINERS DISEASES DUE TO DUST HAZARDS

A workers working in coal mines are facing occupational health hazards mainly due to dust produced by coalmines. The main diseases are:

- Pneumoconiosis
- Silicosis
- Asbestosis
- Siderosis

Before appreciating typical diseases arising from inhalation of dust in mines. Air borne dust of coal and other rocks in mines have harmful physiological effects. It is now well established that the incidence of pneumoconiosis, silicosis etc. depends upon

- The period of exposure to dusty surroundings, and
- Nature and concentration of the dust.

## III. METHODS FOR MONITORING DUST

### A. Dust deposition gauges

This method measures dust deposition rate and involves the passive deposition and capture of dust within a funnel and bottle arrangement. Data is usually collected over monthly periods and results are expressed in g/m<sup>2</sup>/month (ie. the mass of dust deposited per m<sup>2</sup> per month). This method enables determination of the relative ‘dustiness’ of sampling locations. It does not provide data on dust concentrations or enable determination of dust levels from a particular event or source. It does not give an indication of the potential health effects of the dust because it does not measure the amount of fine and very fine particles in the atmosphere<sup>(3,9)</sup>.

### B. High volume samplers

This method determines average dust concentrations and comprises the collection of dust by drawing a constant flow rate of ambient air through a filter. Data is usually collected over a 24hour period and results are expressed in g/m<sup>3</sup>/24hr (ie. mass of dust per volume of air per 24 hrs). A selective inlet may be fitted to a high volume sampler to restrict the particle size being sampled (for example, to ensure only PM10 particles are sampled). When coupled with a wind direction vane or matched with records of wind data, this method enables determination of dust levels from a particular event or source. It also gives an indication of the potential health effects of the dust because it allows measurement of fine and very fine particles in the atmosphere<sup>(9,3)</sup>.

### C. Continuous particle monitors

This method determines real-time (continuous) dust concentrations. A number of monitors are available including TEOM and Beta gauges. A selective inlet may be fitted to a particle monitor to restrict the particle size being sampled (for example, to ensure only PM10 particles are sampled). This method enables determination of short term dust events. As for high volume samplers, when matched with records of wind data, this method enables determination of dust levels from a particular event or source. It also gives an indication of the potential health effects of the dust<sup>(9,3)</sup>.

#### IV. COST OF DUST SUPPRESSION

Developing an effective and cost-efficient dust control program means accurately identifying and accounting for the true costs and savings of any new alternative, compared to your current practices. Using unpaved roads as an example, the costs can be grouped into the categories listed below:

- Road Improvement Costs: Drainage improvements, geometric improvements, repairing of failed areas, excavation and removal of substandard material, and addition of surface material.
- Surface Preparation Costs: Addition of select material (fines or coarse material), breaking up and loosening the road surface, watering, shaping, and compacting.
- Miscellaneous Costs: Traffic control, detour, inspection, crew supervision, material storage and liability costs.

#### V. DUST SENSOR

This dust sensor “GP2Y1010AU0F” is the device to detect dust, smoke, etc. and designed as a sensor for automatic running of application like water sprinkle in coalmines.

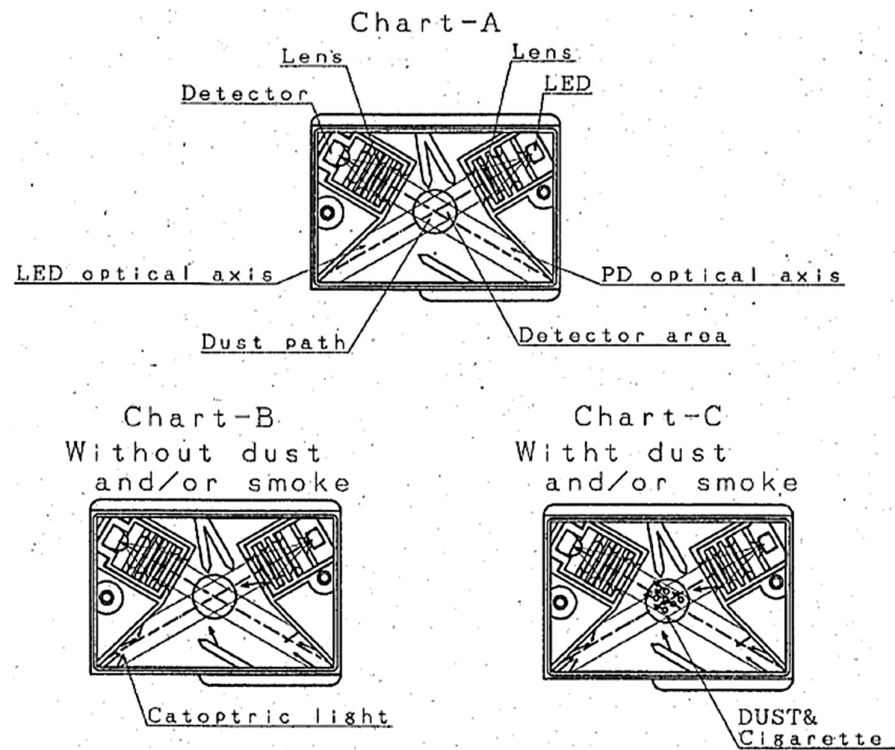


Fig:1 Dust sensor inner parts

Light from the light emitter (Light Emitting Diode) is spotted with a lens and a slit as shown on the chart-A. Also for the light detector (Photodiode), a lens and a slit is positioned in front of it to cut disturbance light and to detect light reflection (when detecting dust) efficiently. Area where those two optical axis cross is detection area of the device.

Chart-B shows what is ongoing inside of the device when no dust exists and Chart-C shows that when dust exists. The device makes voltage output even when dust is not being detected. This output voltage at no dust condition is specified as  $V_{oc}$  on the specification. This is because light emitted from the LED reflects at case of the device & some part of it gets to the detector.

Chart-C shows how the device works when dust and smoke exists inside of it. In this case, the detector detects the light reflected from the dust and/or a particle of smoke. Current in proportion to amount of the

detected light comes out from the detector and the device makes analog voltage output (Pulse output) after the amplifier circuit amplifies the current from the detector<sup>(5)</sup>.

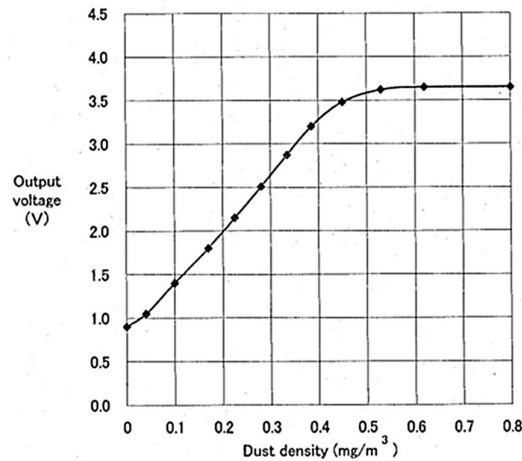


Fig:2 "Electro-optical characteristics" of the dust sensors

#### A. Mounting method

- There is a case that the sensor output may be affected when outer-light comes through dust through hole on the printed side. In order to avoid any influence from outer-light, locate the printed side of the sensor facing to inside of the application.
- In order to avoid any influence from the attachment of dust to the inside of the sensor, mount the sensor to the application so that the outlet of the connector on the sensor turns to a downward direction.
- Consider the structure and the mechanism of the equipment so that big dust (string dust, etc.) should not enter the inside of the sensor. The installation of a coarse mesh filter in front of dust through hole is effective for the capture of big dust.
- Consider the maintenance by vacuum cleaner in preparation for the false sensor output by the attachment of dust to the inside of the sensor.

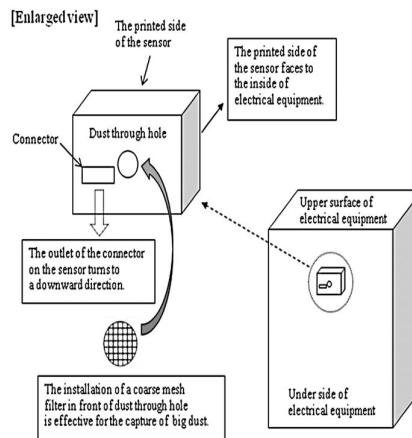


Fig:3 Mounting method of dust sensor

#### B. Basic output handling

- The output voltage  $V_o$  of this sensor is the sum of output voltage at no dust  $V_{oc}$  and output proportional to dust density  $\Delta V$ . Output proportional to dust density  $\Delta V$  is shown as follows.  $\Delta V = V_o - V_{oc}$  ( $V_o$ : monitor value)

- Output voltage at no dust  $V_{oc}$  is caused by the stray light occurring in this sensor. This sensor makes  $V_{oc}$  voltage even at dust density  $0\text{mg}/\text{m}^3$ . If dust attached within this sensor increases,  $V_{oc}$  becomes bigger. On the other hand, if dust attached within this sensor decreases,  $V_{oc}$  becomes smaller.
- To store  $V_{oc}$  in the memory of application is necessary to calculate  $\Delta V$  from monitor value  $V_o$ . If monitor value  $V_o$  lower than the memorized  $V_{oc}$  appears, this monitor value  $V_o$  should be stored in the memory of application as a new  $V_{oc}$ .
- If monitor value  $V_o$  maintains a bigger value than the memorized  $V_{oc}$  for a certain period of time, this monitor value  $V_o$  should be stored in the memory of application as a new  $V_{oc}$ .

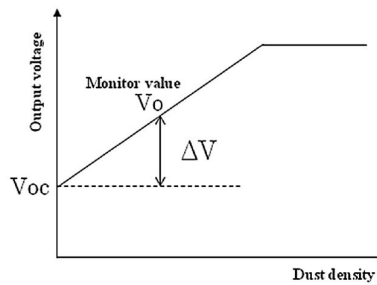


Fig:4 Basic output handling

## VI. CONCLUSION

The conclusions can be summarized as follows

- 1) By implementing the automatic dust control system in modern coalmines will increase in the safety for coal miners and productive.
- 2) The automatic dust control system saves large amount of water and man power and reduce in dust generation .dust can be monitored time to time by installing the dust sensors.
- 3) A foam dust suppression system for fully mechanized mines which integrates air-water linkage control, foaming agent automatic adding, foam preparation and foam injection.

## REFERENCES

- [1] Bridgman, H. Cohen, D. and Pickett, M. (2002) 'Modelling Fine Particulate Dispersion Over Short Time Spans From Open Cut Mining Activity', Australian Coal Association Research Program, Project C10035, ACARP, Brisbane
- [2] Carnovale, F., Tilley, K., Stuart, A., Carvalho, C., Summers, M. & Eriksen, P. (eds) 1997, Metropolitan Air Quality Study-Air Emissions Inventory, consultant's report to the NSW Environment Protection Authority, Sydney
- [3] Hunter Health: <http://www.hunter.health.nsw.gov.au/hph/pollution/coal2.htm> NSW Environment Protection Authority air quality monitoring program and data: <http://www.epa.nsw.gov.au/air/airdata.htm>,
- [4] Application note of Sharp dust sensor GP2Y1010AU0F, user manual.
- [5] Organiscak JA, Page SJ. Assessment of Airborne Dust Generated From Small Truck-Mounted Rock Drills. Report of Investigations 9616, Pittsburgh Research Center, U.S. Bureau of Mines (USBM). Pittsburgh PA; 1995. p. 1-6.
- [6] Colinet JF, James PR, Jeffrey ML, John AO, Anita LW. Best Practices for Dust Control in Coal Mining. Information Circular 9517. National Institute for Occupational Safety and Health (NIOSH). Pittsburgh PA; 2010. p. 1-10,43
- [7] USBM. Novel foam application lowers longwall dust. Technology news 326, USBM. Pittsburgh, PA; 1989. p. 1-2.
- [8] Mukherjee SK, Singh MM. New techniques for spraying dust. Coal Age 1984; 6:54-56.