

Dust Control Techniques in Opencast Limestone Mines: A Review for Occupational Health and Environmental Protection in India

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Abstract

Open-cast limestone mining is widely used to supply raw materials for the cement and construction industries. However, activities such as drilling, blasting, loading, crushing, and transportation produce significant amounts of airborne dust. Prolonged exposure to respirable dust particles poses serious occupational health risks to mine workers and harms the surrounding environment. Dust pollution can degrade air quality, damage vegetation, and cause respiratory diseases among workers and nearby communities. This study reviews the main sources of dust generation in open-cast limestone mines and assesses common dust control methods. Such as water spraying systems, wet drilling, dust extraction systems, haul road maintenance, and vegetative barriers. The study highlights the importance of integrated dust management strategies to minimize airborne particulate matter in mining areas and improve occupational health and environmental sustainability.

Keywords

Opencast Mining, Limestone Mining, Dust Suppression, Occupational Health, Environmental Protection

1. Introduction

Mining plays a vital role in economic growth by providing raw materials needed for industrial production and infrastructure development. Limestone is one of the key minerals used mainly in cement manufacturing, construction materials, and metallurgical processes. In India, most limestone deposits are mined using open-pit methods.

Although open-pit mining offers high productivity and easier mechanization, it also presents environmental challenges. A major issue associated with open-pit limestone mining is dust generation. Activities such as drilling, blasting, crushing, loading, and transportation release large amounts of dust into the atmosphere.

Dust particles from mining vary in size. Larger particles settle quickly, while smaller respirable particles stay suspended in the air and can be inhaled by workers. Prolonged inhalation of respirable dust can cause serious respiratory diseases and long-term health problems.

Dust emissions also impact the environment nearby. Airborne particulate matter can reduce visibility, harm vegetation, and degrade air quality in surrounding communities. Therefore, controlling dust emissions in open-pit limestone mines is crucial to protect worker health and minimize environmental impacts.

2. Sources of Dust in Opencast Limestone Mines

Dust generation occurs during several stages of the mining process.

Drilling Operations – Drilling creates blast holes and generates fine rock particles. Dry drilling produces large amounts of respirable dust.

Blasting Activities – Explosive detonation releases dust clouds that can spread over large areas depending on wind conditions.

Loading and Unloading – Mechanical handling of fragmented limestone generates airborne dust due to rock impacts.

Crushing and Screening – Mechanical size reduction produces fine particles which may disperse if dust collectors are not installed.

Haul Road Transportation – Vehicle movement on unpaved roads disturbs loose material and produces fugitive dust emissions.

3. Effects of Dust on Health and Environment

Dust exposure is a major occupational hazard for mine workers. Fine dust particles can penetrate deep into the lungs and cause respiratory diseases. Workers involved in drilling, blasting, crushing, and transportation activities are particularly vulnerable to dust exposure.

Environmental impacts include reduced air quality, deposition of dust on vegetation, reduced photosynthesis, and disturbance to nearby communities due to particulate pollution and reduced visibility.

4. Dust Control Techniques

Water Spraying System – Water tankers spray water on haul roads, loading areas, and crushers to suppress dust.

Wet Drilling – Water injection through drill bits reduces dust at the source during drilling operations.

Dust Extraction Systems – Bag filters and cyclone collectors capture dust in crushing and screening plants.

Haul Road Maintenance – Road grading, speed control, and regular watering reduce dust emissions from vehicle movement.

Vegetative Barriers – Plantation around mining areas acts as a natural dust barrier and improves environmental conditions.

5. Discussion

Each dust control technique has advantages and limitations. Water spraying is economical but requires frequent application. Wet drilling effectively controls dust at the source. Dust extraction systems are effective in fixed installations such as crushing plants. Haul road maintenance significantly reduces fugitive dust emissions. Vegetative barriers provide long-term environmental benefits.

An integrated dust management approach combining multiple techniques is considered the most effective solution for reducing dust pollution in opencast limestone mines.

6. Conclusion

Dust generation is a major environmental and occupational challenge in opencast limestone mining. Mining operations such as drilling, blasting, crushing, and transportation produce airborne particulate matter that affects worker health and environmental quality. Effective dust control measures such as wet drilling, water spraying, dust collectors, haul road maintenance, and green belt development should be implemented. Integrated dust management strategies and continuous monitoring can significantly reduce dust emissions and support sustainable mining practices.

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