GEO RESOURCES Journal

Journal for Resources, Mining, Tunnelling, Geotechnics and Equipment

Special Issue

Developments in Dust Control Technology in the international Mining and Tunnelling Industry

GeoResources Verlag ISSN | Online 2364-8430 • Print 2364-8422 www.georesources.net

Developments in Dust Control Technology in the international Mining and Tunnelling Industry

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The article reviews the key phases in the development of dedusting for the protection of underground workers. It describes the basic techniques and presents the various applications and limitations to use.

Mining • Tunnelling • Work safety • Dust control

Fig. 1: Dust exposure levels at underground workplaces

Ensuring the safety and protection of workers and equipment has assumed growing importance for the international mining and tunnelling industry. The ongoing mechanisation of shaft sinking, tunnel heading and mineral winning operations underground, as well as of mineral processing activities, has been accompanied by a continuous rise in the dust load at the various workplaces. While recent decades have seen a continuous decline in the silicosis rate in Europe thanks to modern dust control methods this occupational disease is still widespread around the world. In the light of this, dust extraction and air cleaning still pose significant challenges for all kinds of underground operations and these will be discussed in some detail below.

Significance of Dedusting

During the era of industrial development in the 19th and 20th centuries it was common practice in many engineering processes – initially purely for economic reasons – to separate the particles dispersed in the waste gases for product recovery purposes and to condition these gases in a series of downstream operations in preparation for subsequent processing. By the second half of the 20th century, however, industrial emissions became an issue of public concern with attention mainly focused on efforts to reduce air pollution levels in industrial conurbations. A series of regulatory requirements was to follow. In the mining and tunnelling sectors, and indeed at other industrial and manufacturing workplaces, health and safety tasks and responsibilities assume a degree of priority that goes far beyond that which applies to environmental protection in general (Fig. 1). Here special emphasis is placed on dust control and silicosis prevention. [1]

The ever stricter environmental protection legislation that has been introduced over the last 50 years is regulated, in the case of Germany, by the Federal Emmission Control Act [2] and set out in detail in the administrative regulation TA Luft (Technical Instructions on Air Quality Control) [3]. During this period great efforts were made, and are still continuing right up to the present day, to prevent or at least reduce the incidence of silicosis-related diseases not only through the development of new dust control methods but also by imposing continuous reductions in the airborne dust limits.

Even though the effectiveness of modern dust control techniques has brought about a marked reduction in silicosis morbidity in Europe, this occupational disease is still prevalent around the world – especially in mining countries. While silicosis is not exclusively a mineworkers' disease, nevertheless the vast majority of cases reported are associated with the mining industry.

As well as creating health issues and financial difficulties for those affected, this pulmonary disease represents a significant economic problem for mining nations. When silicosis was first recognised as an occupational disease in Germany in 1953 the production cost of coal immediately rose by more than 10 % as a result of the compensation payments now due to beneficiaries. In 1960 the German Federal Government responded by setting threshold values for the maximum permitted dust exposure levels at the workplace and established organisations charged with developing dust control methods.

Potential Dust Sources in Work Processes

The dust load of different underground and surface working processes varies considerably, ranging from 30 to 50 mg/m³ during shotcreting operations to as much as 50,000 mg/m³ when cutting hard rock with a full-face tunnelling machine (Figs. 2 and 3).

Dust Control Techniques

The following dust control measures are available to the mining industry, and in part to the tunnelling sector too:

- **Preventive dust control:**
  Dust control begins before the dust can be produced by the winning machine:
  - Strata infusion
  - Wetting of sedimented dust with water
  - Addition of wetting agents to the water sprays
- **Primary active dust control:**
  Suppression or extraction and separation of airborne dust using water sprays or dedusting systems
- **Secondary dust control:**
  Ventilation (air dilution) and breathing protection measures, e.g. dust masks

Preventive dust control measures will not be discussed further in this paper.

Water Spraying

The separation and suppression of the dust by means of water is the oldest and best known method of primary dust control. Water spraying can generally achieve a 50 to 60 % reduction in the fine-dust quota of the air, while encasing transfer points and crushers can result in a further capture of 80 to 90 % of the fine-dust emissions. For this to be effective the housing has to be quite dust-tight and the spray water has to be finely atomised using ultrasound or high-pressure jets operating at a minimum of 20 to 40 bar and then finely dispersed, preferably using a dust binding agent.

Water spraying (**Fig. 4**) is generally deployed in areas where dust extraction and filtration methods cannot be used due to technical, financial or spatial reasons.

Wet Dedusting

The processes that take place in a wet deduster can be broken down into four phases:

- The scrubbing liquid is added to the gas-dust mixture.
- The dust particles are merged with the fluid.
- The particles are coated with the water.
- The dust-water mix is separated from the gas flow.

The following types of scrubber are available:

- Baffle-type scrubber
  up to 90% separation efficiency
- Rotation scrubber
  up to 94% separation efficiency
- Venturi scrubber
  up to 99.85% separation efficiency
- Scrubber with angled demister
  up to 99.4% separation efficiency

Fig. 2: Shotcreting in a tunnel drivage

Fig. 3: Full-face mechanised heading

Fig. 4: Water sprays in the extraction

Rotation and venturi scrubbers were once widely used for dust extraction purposes underground. The Venturi scrubber, which is also known by its trade name Roto Vent, is able to achieve a separation efficiency of as much as 99.85 %, though this entails an increase in air resistance of up to 10,000 Pa.

The systems most commonly employed now are wet-type dedusters with angled demisters, which offer a low resistance of less than 1,500 Pa and at the same time are capable of achieving a relatively good separation performance. Because of their low energy efficiency wet-type dedusters are only used for inert dusts and for dust sources with low dust loads, e. g. for concrete spraying or when handling a pure-coal product.

Dry Dedusting

In the case of dry-type dedusters the dust-laden air flows through a fabric material which then separates the dust from the air. A pneumatic cleaning system is used to backflush and collect the dust, which can then be selectively released. A distinction is usually made between bag filters and pocket filters, which may be installed as individual elements or as multicassettes. Dry-type dedusters can achieve residual dust contents of up to 1 mg/m³ – irrespective of the dust load. Residual dust levels of less than 0.1 mg/m³ are only achieved by rigid body filters, such as cartridge and compact filter elements. Here the filter resistances will differ considerably depending on the structural shape and the construction material.

Summary

The choice of a suitable dust control system will often depend on the permissible emission limits and on the reduction potential offered by one method or another.

Spraying methods are normally permitted above ground in order to help reduce emission levels or act as a supplement to an underground dedusting.

Wet scrubbers are usually employed for processes that generate a low quota of dust and in countries where operations are less strictly regulated.

Dry filter systems are required for all types of work with a high dust incidence. Rigid-body filters are needed to cope with toxic and carcinogenic silica particles.

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This article is based on a paper presented at the 5th Freiberg International Technical Symposium on Dust and Dust Control and a German version is published in GeoResources Zeitschrift 1-2022:

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Source of the Article

Both, R. (2022): Developments in Dust Control Technology in the international Mining and Tunnelling Industry. GeoResources Journal (1-2022), pp. 52–54. Online: https://www.georesources.net/download/GeoResources-Journal-1-2022.pdf

This article has been assigned to the special topic ‚**Focus on people**' in GeoResources Journal issue number 1-2022.