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Applying science to solve real world problems

Minimisation of Dust Emissions

Introduction

The control of dust emissions during the handling and transportation of bulk materials is an important consideration in the design and operation of all industries handling particulate materials. Management of excessive airborne dust has become a key priority with the enforcement of modern health & safety and environmental policies. This is of particular concern to the coal industry because of the large volume handled and the relatively low density of coal particles that easily become airborne. Thus, major coal mining companies like Rio Tinto and transport companies such as Queensland Rail were in the firsts to investigate the development of a dust management plan a number of years ago. It has now become a key priority for the entire coal chain from mine to port, be it to limit coal loss in dust form with corresponding loss of throughput, minimize fouling of ballast and reduce re-ballasting cycle, comply with dust levels from enforced environmental regulations or maintain an image of good corporate citizenship by responding to community concerns. However, regulations are not limited to the coal industry and all industries handling dry and fine materials have the obligation to either prevent the issue by reducing/avoiding dust generation or containing it by implementing additional methods of extinguishing the dust generated.

Figure 1: Watering of coal stockpiles to reduce airborne dust.

Definition of dust

When considered in respect to environment or health, dust is generally defined as solid particles ranging in size from below 1 µm up to at least 100 µm, although dust particles are frequently found with dimensions considerably <1 µm. However, for these, movement with the air is more important than sedimentation through it, thus limiting their adverse effect on both environment and health. In general, dust is divided into four categories according to their equivalent diameter, TSP (Total Suspended Particles), PM10, PM2.5 and PM1 corresponding to particles smaller than 10 µm, 2.5 µm and 1 µm, respectively. Those categories are defined by the size of the particles able to reach different locations into the body corresponding to inhalable, thoracic, and respirable dust fraction.

Dust management solutions

While 10 years ago, dust management strategies were rather reactive, nowadays, companies can no longer afford to try to fix the problem once it has happened but need to prevent the problem from happening in the first place. This new approach resulted in the rise of integrated dust management solutions. Currently, the main challenge consists of allowing major increases in Industry throughput with virtually no increase in dust emission levels. Even more challenging would be to reduce the current amount of generated dust even further to account for the reinforcement of the current regulations likely to occur in the short future as a response to the pressure of action and community groups. Achieving those challenges requires input from both scientific and field research activities.

Watering and surface treatment

Watering is nowadays still the most common method applied to control airborne dust. In fact, increase of moisture content is generally considered as the best practice to limit dust emission during operations involving loaders, loading and unloading from stockpiles and train loading. A combination of chemical suppressant and watering is also common method to reduce dust lift-off from the surface of coal stockpiles. The dust emissions from other operations including rail transport, stacking, reclaiming, ship loading and transfer chutes can also be significantly reduced by keeping the material to an appropriate moisture level. In this case, “appropriate” depends on the unique characteristics of the bulk material.

In fact, the efficiency of watering measures relies on the characterisation of dust emissions for each particular bulk material. Two tests are commonly performed. Where the wind erosion potential of a product is to be determined, for instance to assess dust emission from a storage stockpile or coal train, wind tunnel tests are performed. Those tests permit characterisation of dust emissions for various wind speeds, product moisture contents and surface treatment.

Where the material is not static, for instance during loading or unloading operations, the potential emission characteristics of a particulate material are often determined by using rotating drum tests, which were originally developed to compare the dustiness of various coals (AS 4156.6 “Coal Preparation – Part 6: Determination of dust/moisture relationship for coal”). In those tests, the rotating material continuously cascades, thus generating airborne dust caught in a stream of air and transported to a collecting bag. The drum tests permit determination of the relationship between dustiness and moisture content. One of the key characteristics for each material is the Dust Extinction Moisture (DEM) level, which defines the minimum moisture content for which dust emissions are virtually zero. The DEM level can also be determined in combination with binding substances, which increase the wetting behaviour and decrease the amount of additional water required to reach a zero dust emission level.

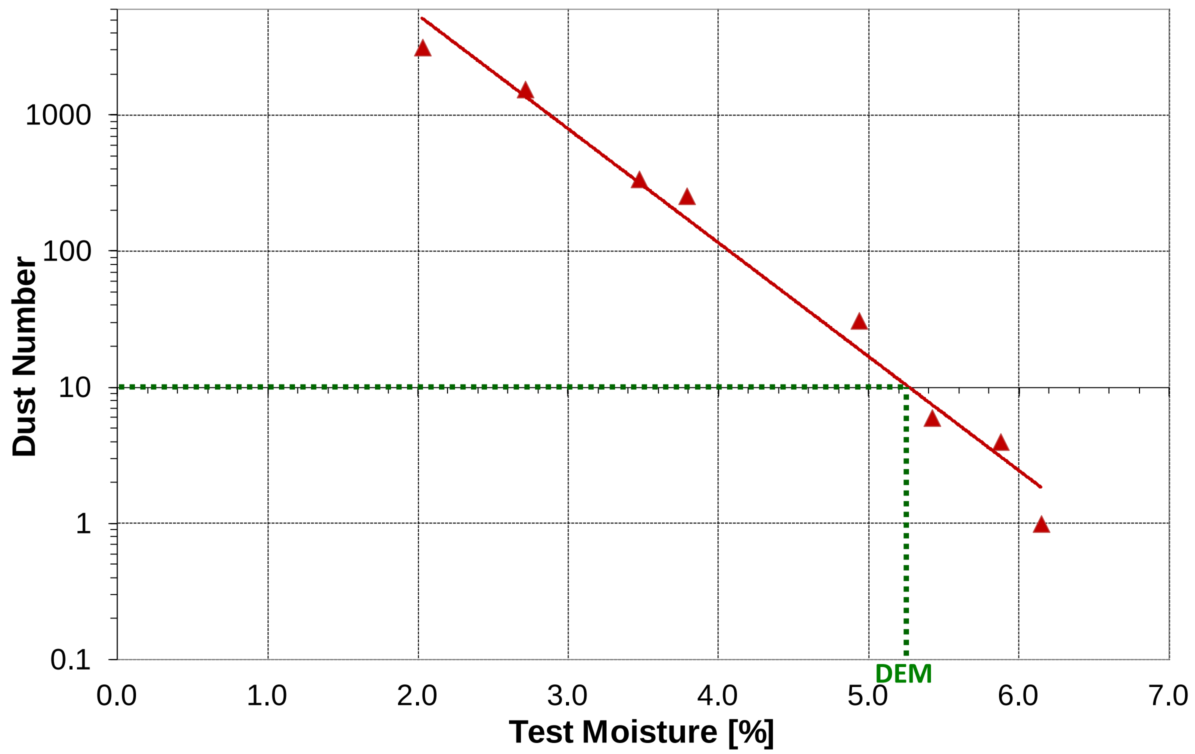

Figure 2: Dust moisture relationship and DEM value obtained from the dustiness test method described in AS 4156.6.

Design improvement to minimize dust generation

To avoid additional costs relating to actively controlling the dust, it is often possible to optimize a handling, transfer or transportation system design with the goal of reducing the amount of dust generated and becoming airborne. While it is evident that selecting an enclosed system, for instance a pneumatic conveying system, over an open system such as a belt conveyor will permit to control the emissions of dust, it is not always evident that the design of handling system can be optimised from the material flow point of view to limit the level of dust released. This is the case for instance of a transfer chute. While designing a transfer chute for a dusty material, particular consideration should be given to keeping the material in form of a concentrated stream and limiting impacts on the walls. Another example is bin design. A bin that is funnel-flowing will tend to generate dust due to material suddenly collapsing in the rathole formed above the hopper outlet. In contrast, the discharge of a bin designed to mass-flow will usually lead to little dust emissions.