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Don't give dust a chance!

Dust is a disperse distribution of solid substances in gases, particularly air, resulting from mechanical processes or from the swirling up of deposits.

With this rather complicated definition a very specific type of hazardous substance is paraphrased which is accorded a particular significance in many branches of industry. In mining, quarries and tunnelling, in the use of dust or powder-like raw materials in the glass and ceramics industry, in metal foundries, in the manufacture and processing of building materials, in the mechanical machining of different raw and finished products, for example as a result of grinding, but also in maintenance and cleaning work in areas with a high accumulation of dust: in all these processes, fine and finest solid particles occur which are released into the air at the workplace and can therefore be inhaled by the people employed there.

The health hazard caused by the inhalation of dust is however usually dramatically underestimated by employees and the responsible management staff in the plant. On the one hand dust is often only considered to be "annoying dirt", which from time to time needs to be swept away or disposed of – as long as one can still see one's hands in front of one's eyes, everything is ok.
On the other hand the matter of dust is old hat, the proverbial "hellholes" belong to the past at any rate, or maybe not?

To be able to effectively confront such catastrophic prejudices and thereby facilitate an effective dust control, a deeper knowledge of the type and mode of action of the different types of dust is necessary.

What dusts are there actually?

As already defined, **dust consists** of fine, solid particles distributed in the air that are caused by mechanical machining (milling or surface machining) or by the swirling up of deposits (e.g. by blowing off dust with pressurised air or dry sweeping using a broom). **Fumes** count among dusts in the broad sense. They are formed as a result of chemical or thermal processes (e.g. welding) and also consist of fine solid particles distributed in the air.

Fibre dust is a description of airborne particles made from inorganic or organic substances which have an elongated shape. Fibres which have a length of > 5 µm, a diameter of < 3 µm and exceed a length-diameter ratio of 3:1 play a particular role since only they can penetrate into the deeper respiratory passages.

Dust entering the air at the workplace is inhaled when breathing and thereby reaches the different areas of the respiratory organs. Larger particles are already segregated in the upper air passages, i.e. in the nose and throat, while only the smaller particles reach the deeper respiratory passages, the alveolus or pulmonary alveoli. To assess the health hazard, therefore, in addition to the concentration of particles (dust mass per m³ breathable air in [mg/m³]) the particle size in particular is also of significance.
Two size categories are thereby differentiated: the **inhalable** and the **respirable** fraction. Inhalable dust refers to the entire inhalable proportion of the dust through the mouth and nose. Repirable dust relates to the proportion of the respirable dust which can reach the pulmonary alveoli due to its small particle size (fig. 1 and 2)..

The individual hazardous substances can, in each case depending on how they originate, occur in entirely different particle fractions and be individually limited in these fractions via the occupational exposure limit (OEL) according to their toxic properties. The assessment of dust that is hazardous to health at the workplace therefore, in addition to the proportions of inhalable and respirable dust, also calls for the knowledge on the distribution of the hazardous substance within the individual fractions. A differentiation must be made according to particle size, shape and material composition (fig.3).

Occupational exposure limits for different varieties of dust have so far been determined according to this principle for the inhalable or for the respirable dust fraction. Irrespective of this there are general upper limits for the inhalable and respirable fraction of dust without specific toxic effect. In the EU no binding OEL has so far been determined for inhalable and respirable dust. However, for inhalable dust a OEL of 10 mg/m³ applies in the majority of EU member states whereas the national values for respirable dust are in a range from 3 to 6 mg/m³. An overview of the internationally applicable OEL´s for dust can be found in www.dguv.de/ifa/de/gestis/limit_values/index.jsp (fig. 4).

How do dusts enter the body and what effect do they have?

Humans have a respiratory system with an effective self-clearance mechanism. This filter system copes with "normal grime" effortlessly and protects humans quite perfectly. However, it is not adequately designed for excessive stress as a result of dusts. An essential function in the self-clearance of the respiratory passages is played by the microscopically-small cilia which can be found inside the bronchia and their finer branches, the bronchioles. With continuous directed movements they transport the dust particles deposited in the bronchial mucus back to the upper respiratory tract where they can then be coughed up.

As a result of inhaling large quantities of dust or of toxic dust, this clearance mechanism can be disrupted or at least be greatly impaired for a long time. The consequences are irritations or inflammations of the upper respiratory passages, increased mucous secretions and a tickly cough, bronchitis and inflammations of the bronchia and of the pulmonary tissue. In these cases, it is much easier for toxic, carcinogenic and allergenic dust particles such as, for example silica dust, heavy metal oxides, welding fumes, wood or flour dust, to deploy their harmful effect in the respiratory passages and in other organs of the body.

Tobacco fumes particularly impair the clearance mechanism of the lungs. Smoking can lead to the destruction of the bronchial mucosa with the irreversible loss of cilia and adenocytes of the respiratory passages that form mucous. The transport of the mucous with the dust particles segregated in it out of the respiratory passages comes to a standstill. Smoking therefore is harmful not only as a result of the toxic substances in the tobacco smoke such as tar constituents, carbon monoxide, formaldehyde, benzene, heavy metals and nicotine. It also disables the self-clearance mechanism of the lungs and thereby multiplies the harmful effect of the inhaled dust.

What regulations are there on dust protection?

The fundamental approach for dust protection is determined in the Chemical Agents Directive 98/24/EC dated 7 April 1998. Accordingly it should be tested whether substances with a lower risk to health can be used (principle of substitution). However, silica as a raw material cannot be replaced in many branches of industry since silicon dioxide is the basic component for an entire series of mineral raw materials and products. Other frequently used hazardous dusts (e.g. lead oxide in glazes and engobes) can sometimes be replaced by other less harmful compounds.

If hazardous substances cannot be substituted, protective measures are to be taken. The order of precedence of the protective measures is also defined in the Chemical Agents Directive. Work methods are to be designed in such a way that hazardous vapours and suspended particles are not released. Leaking of generated dust can be prevented, for example, by means of dust-tight systems or vacuum operation. The design of the working process is therefore to be reviewed. For example, the use of moistened raw materials can drastically reduce the production of dust. Another possibility is the use of raw material granulates with a corresponding lower tendency to dust formation.

According to the current state of the art the release of dust is unavoidable in many production areas. For this reason capture must be as complete as possible already at the emission point or point of origin. There are already suitable extraction systems, for example, for ceramic presses, for bagging units for powdery substances or tools and systems for the machining of natural stone. The effectiveness of extraction systems must be supported with corresponding ventilation technology and adequate venting of the work areas. Substances which tend to produce dust must be immediately disposed of by suitable means (vacuum cleaners or sweeping vacuum machines with deduster) in the event of repair works. Brooms or even pressurised air are not suitable and are to be strictly banned from such areas!

If the OEL´s, despite exploiting all technical and organisational protective measures, are not complied with, for example during maintenance and repair work, then personal protective measures are necessary, for example wearing dust masks.

In any event employees must be trained in accordance with the Chemical Agents Directive about hazards and protective measures: the preparation of operating instructions and corresponding instruction by supervisors are compulsory. Further organisational measures in the event of dust exposure include the execution of specific occupational health check-ups or the minimisation of exposure by restricting the duration of stay of the employees (e.g. in a partially or fully-automated raw material dosing system).

What is the situation in practice?

The relatively extensive and thus general provisions of the Chemical Agents Directive 98/24/EC are further substantiated in the EU member states in national legislation. These regulations, however, often are not sufficient to solve urgent dust problems in operational practice. For this reason the Expert Committee for glass and ceramics have prepared "Ten golden rules for dust control", which should provide plants with a simple, clear and above all user-friendly guideline. These rules can be used by the responsible parties in the plant for the risk assessment, for training purposes and in daily work.
If the rules are observed by the employees, they will achieve a major contribution to the reduction of dust exposure and thus improve the protection of health in the plants.