Good to know

What is dust/fume?

Dust/fume is finely distributed solid particles in the air, which are caused by thermal processes such as welding.

What causes dust/fume?

In welding technology dust/ fume and thus hazardous substances are produced

due to the use of

- base materials
- filler materials
- impurities
- ambient air

during processes such as

- evaporation
- condensation
- oxidation
- decomposition
- pyrolisis
- combustion

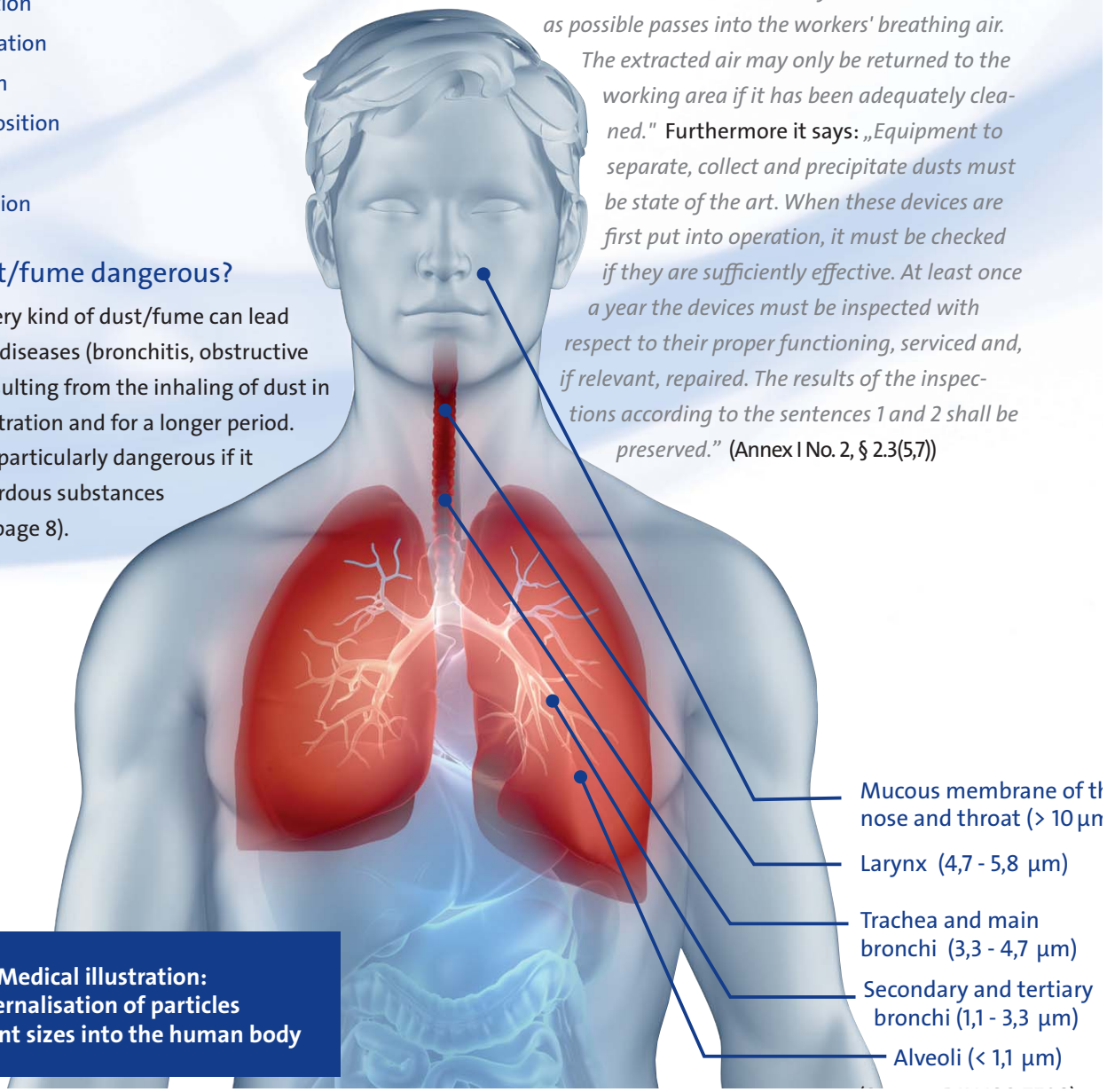
Why is dust/fume dangerous?

In general, every kind of dust/fume can lead to respiratory diseases (bronchitis, obstructive bronchitis) resulting from the inhaling of dust in a high concentration and for a longer period. Dust/fume is particularly dangerous if it contains hazardous substances (see table on page 8).

German framework regulation Ordinance on Hazardous Substances (GefStoffV) [1]

When it came into effect on January 1st, 2005, the Ordinance on Hazardous Substances restructured the occupational safety for activities involving hazardous substances as implementation of several EC directives. Welding fume is considered a hazardous substance, thus the Ordinance on Hazardous Substances applies.

Particles contained in welding fume are inhalable and respirable and in case of chromium-nickel steel, they are carcinogenic. The Ordinance on Hazardous Substances [1] requires a local extraction: *„"Dusts shall be collected and disposed of safely at the place of its origin. The extracted air shall be conducted in such a way that as little dust as possible passes into the workers' breathing air. The extracted air may only be returned to the working area if it has been adequately cleaned."* Furthermore it says: *„Equipment to separate, collect and precipitate dusts must be state of the art. When these devices are first put into operation, it must be checked if they are sufficiently effective. At least once a year the devices must be inspected with respect to their proper functioning, serviced and, if relevant, repaired. The results of the inspections according to the sentences 1 and 2 shall be preserved."* (Annex I No. 2, § 2.3(5,7))



Medical illustration: Internalisation of particles of different sizes into the human body

Air circulation when dealing with carcinogenic substances

If activities are carried out in a working area involving hazardous substances of category 1 or 2 which are carcinogenic, mutagenic or have a negative impact on fertility, the extracted air there must not be returned into the working area. This does not apply if the air has been adequately decontaminated of such substances using processes or devices recognised by the authorities or the statutory accident insurance institutions. The air must then be conducted or cleaned in such a way that hazardous substances that are carcinogenic, mutagenic and toxic to reproduction do not pass into the breathing air of other workers." (§ 10(5) GefStoffV)

If the welding fumes contain carcinogenic parts – such as nickel compounds or chromates – the exhaust air has to be led to the outside. In exceptional cases, the cleaned air can be returned if the requirements of the TRGS 560 [3] *„Technical Rules for Hazardous Substances - Air return when handling carcinogenic, mutagenic substances and substances toxic to reproduction"* are met. According to this, the concentration of hazardous substances in the air which is returned into the working area (returned cleaned air) must not exceed a tenth of the former TRK (technical guideline concentration) value.

Tips for users

In order to fulfill the requirements, the operator has mobile dust extractors as well as central stationary devices at his disposal. The dust extractors certified by IFA (formerly BGIA) (in accordance with the international standard DIN EN ISO 15012-1) and the central devices corresponding to TRGS 528 fulfill the legal bases [2].

Extract from TRGS 528 [2]

4.5 Air return: (1) Extracted air may only be returned to the working area if it has been adequately purified. Ventilation systems with air return may be used if they are type-approved or if individual measurements are conducted to check the required effectiveness. Instructions on the fresh air fraction in room ventilation systems are given in BGR 121 "Workplace ventilation – ventilation measures". (2) At workplaces where welding work or allied processes involving the emission of carcinogenic or mutagenic substances or substances toxic to reproduction of category 1 or 2 are performed (especially with the use of chromium- and nickel-bearing materials) extracted air must not be recirculated.

This does not apply if type-approved welding fume extraction devices of the welding fume separation classes W2 or W3 are used. *For instructions concerning the welding fume separation classes see DIN EN ISO15012- 1 "Health and safety in welding and allied processes – Requirements, testing and marking of equipment for air filtration – Part 1: Determining the separation efficiency for welding fume"* (Issue: February 2009).

TRGS

The Technical Rules for Hazardous Substances (Technischen Regeln für Gefahrstoffe -TRGS) reflect the state of the art, **occupational medicine** and **work hygiene** as well as other established results of **occupational research** regarding work with hazardous substances including their classification and labelling. They are determined and adjusted by the **Committee on Hazardous Substances (Ausschuss für Gefahrstoffe - AGS)** and announced by the **German Federal Ministry of Labour and Social Affairs** in the Joint Ministerial Gazette (Gemeinsames Ministerialblatt) according to the Ordinance on Hazardous Substances.

1 Ordinance on Hazardous Substances
http://www.teka.eu/gefstoffv

2 TRGS 528 (Welding work)
http://www.teka.eu/trgs528

3 TRGS 560 (Air recirculation)
http://www.teka.eu/trgs560

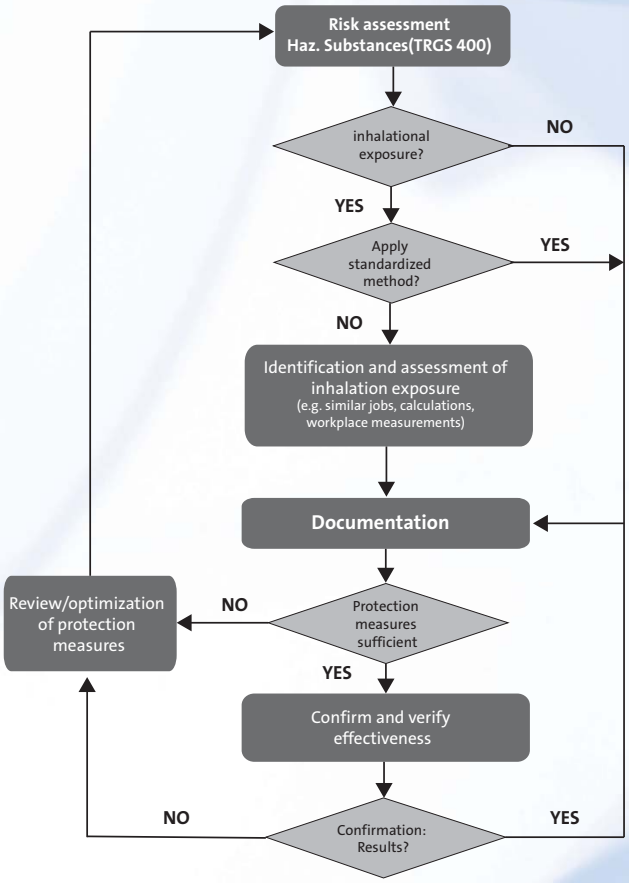
Good to know

Occupational exposure limits

Occupational exposure limits serve to **protect the employees and their health** against the dangers of inhalation of substances (TRGS 900). They came into effect in 2005 and replaced the maximum workplace concentration values that applied until then.

TRGS 400 clearly states that the **employer** needs to carry out an **assessment of the risks** and that the necessary protective measures must be taken **before starting the work** with hazardous substances (§ 3.1(2)). **The employer always has the overall responsibility** (§ 3.1(6)).

TRGS 402 informs about the measures which can be taken by an employer in order to comply with the occupational exposure limits. The decision tree on the right can be used as a first clue.



(Source: TRGS 402)

Hazardous substance	Chemical symbol	Occupat. exposure limit * (in mg/m³)	Health risk*
Aluminium oxide	Al_2O_3	1,25 (A) / 10 (E) **	Fibrosis, neuropsychic symptoms
Barium compounds	Ba	0,5 (E)	Acute toxicity
Lead compounds	Pb	0,15	Damage to brain, kidneys, nervous system
Chromium (III) compounds	Cr	2	Skin damage
Chromium (VI) compounds	Cr (VI)	0,001 (E) ***	Carcinogenic
Cobalt (compounds)	Co	0,005mg/m³ (A) ****	Carcinogenic
Ferric oxide	Fe_2O_3	1,25 (A) / 10 (E) **	Siderosis
Formaldehyde	CH_2O	0,37	Potentially carcinogenic
Carbon dioxide	CO_2	9100	Damage to nervous and circulatory system
Carbon monoxide	CO	35	Damage to cardiovascular system
Manganese oxide	Mn	0,02 (A) / 0,2 (E)	Damage to central nervous system/resp. tract
Nickel	Ni	0,006	Potentially carcinogenic/skin damage
Nickel compounds	NiO u.a.	0,006 ****	
Phosgene	$COCl_2$	0,41	Damage to lung
Nitrogen dioxide	NO_2	0,95	Lung-function abnormalities
Nitrogen monoxide	NO	2,5	Impact on vascular and nervous system
Zinc oxide	ZnO	0,1 (A) / 2 (E)	Metal fume fever/ skin damage
Tin compounds	Sn	8 (E) *****	Toxicity

* The information is taken from GESTIS substances database of the Institute for occupational safety and health (Institut für Arbeitsschutz – IFA) of the German Social Accident Insurance. We do not assume any liability for the accuracy of the data and for possible typing and transmission errors. In case of doubt, please consult the GESTIS database and/or a member of the IFA.
** General occupat. exposure limit
*** Assessment standard (BM) after TRGS 561
**** Tolerance concentration (TK) after TRGS 561
***** Recommendation by AGS and EU

Good to know

Types of filters

Prefilters and particulate filters are classified into 17 different filter classes according to their separation efficiency ranging from the coarsest filter to the finest filter U17:

- **ISO Coarse: COARSE DUST FILTERS**
- **ePM10, ePM2.5, ePM 1: FINE DUST FILTERS**
- **E10, E11, E12, H13, H14, U15, U16, U17: PARTICULATE FILTERS**

(ISO 16890 and EN 1822-1:1998)

Depending on the norm the initial separation efficiency or the fractional separation efficiency are used as a performance criterion under standard load.

Initial separation efficiency: Ratio between the passing and the filtered material with a new filter.

Fractional separation efficiency: Separation efficiency of a filter concerning the particles of one specific size group (fraction).

Directly relevant norms			Related norms			
DIN EN 779	DIN EN 779	EN 1822-1:1998	ZH 1/487	US MIL-STD	DS 3928	DIN EN 60335
Coarse dust filter	**Fine dust filter**	**EPA, HEPA, ULPA** Initial separation efficiency **A** **DEHS, MPPS** **approx. 0,1-0,3 µm**	**Dust eliminating** Medium transmittance level **D** **Quartz dust** **90% 0,2 µm**	**Particulate filter** Initial separation efficiency **A** **DOP 0,3 µm**	**Particulate filter** Initial separation efficiency **A** **NaCl** **DOP 0,3 µm**	**Particulate filter** Transmittance level **D** **Paraffin oil** **61% < 1 µm**
ISO Coarse ePM10 <50%	**ISO ePM10** ePM10 >= 50%	**E10** A (integral)>85%	The specified limits may vary considerably depending on the materials.	95%	**EU10** A > 95 %	**L** D < 1%
	ISO ePM2,5 ePM2.5,min >= 50%	**E11** A (integral)> 95%	**U** D < 5 %	99,97%	**EU11** A > 99,9%	**M** D < 0,1%
	ISO ePM1 ePM1,min >= 50%	**E12** A (integral)> 99,5%	**S** D < 1%	99,99%	**EU12** A > 99,97%	**H** D < 0,005%
		H13 A (integral)> 99,95% A (local)> 99,75%	**G** D < 0,5 %	99,999%	**EU13** A > 99,99%	
		H14 A (integral)> 99,995% A (local)> 99,975%	**C** D < 0,1 %		**EU14** A > 99,999%	
		U15 A (integral)> 99,9995% A (local)> 99,9975%	**K1, K2** D < 0,05 %, Paraffinöl 90% < 1 EM			
		U16 A (integral)> 99,99995% A (local)> 99,99975%				
		U17 A (integral)> 99,999995% A (local)> 99,9999%				

EN 779:2012	ePM 1	ePM 2,5	ePM 10
M5	5% - 35%	10% - 45%	40% - 70%
M6	10% - 40%	20% - 50%	60% - 80%
F7	40% - 65%	65% - 75%	80% - 90%
F8	65% - 90%	75% - 95%	90% -> 95%
F9	80% - 90%	85% - 95%	90% -> 95%

(Source: Eurovent Recommendation 4/23 (2017))

The previous standard EN 779 has been replaced by the new standard ISO 16890. The adjacent table shows how the old filter classes carry over into the new standard.

Good to know

Particle sizes

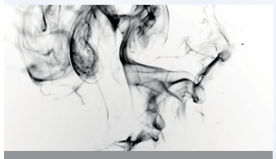
Particles having a size between 1 mm and 0.1 mm can often be seen with the naked eye. Particles smaller than 100 µm (= 0.1 mm) are only visible by means of an optical microscope. These particle sizes correspond to the filter classes G3 and G4.

oarse (>10 µm)

Particles which are smaller than 1 µm (= 0.001 mm) do not sink, but keep on floating permanently. Dust and oil mist produced during metal processing belong to this category. Filters of the filter classes ePM 10 thru ePM 1 are intended to be used for particles between 0.1 µm and 1 µm.

Fine (< 10 µm)

Smaller particles can only be seen with the help of a scanning electrode microscope. To filter these particles the finest filters of the classes E10-U17 must be used. Furthermore, activated carbon filters must be used for particles of 0.01 µm (= 0.00001 mm) and smaller.



tra fine (0,1 µm)

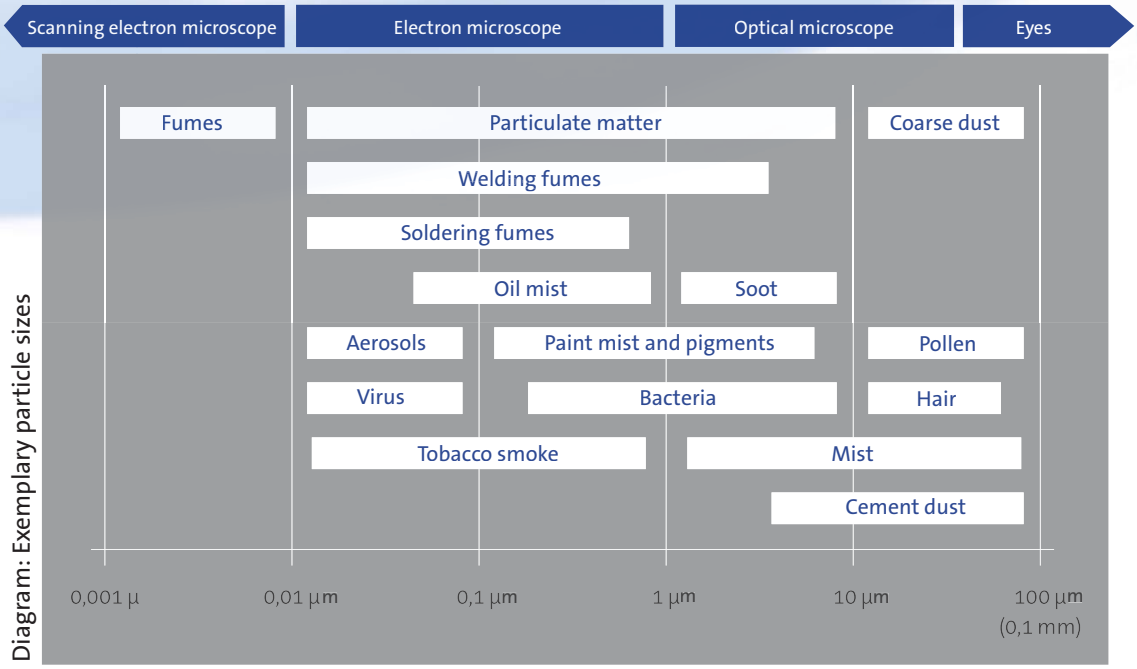
As the right choice of filters depends on many other factors such as the quantity and composition of pollutants and the operating conditions, a professional consultation and perhaps an assessment of the situation on site should take place. For this matter feel free to contact our team by using info@teka.eu.

Our Hotline

+49 28 63 92 82 0

PLEASE NOTE:

The employer must determine the hazard class according to the applied processes and materials with the help of the table. The highest hazard standard class determined for the three listed groups of substances is decisive for the respective process. (Source: TRGS 528, § 3.2.5., Paragraph 1, Issue February 2009)



Settling times

Decisive for the settling time of particles are in particular their size and weight. Small, light particles are held in the air by air vortices. Very small particles are in a permanent state of floating and may be inhaled if they are not extracted.

Inhalation may result in significant damage to the health or even cancer. The chart on the right shows the approximate settling times of particles.

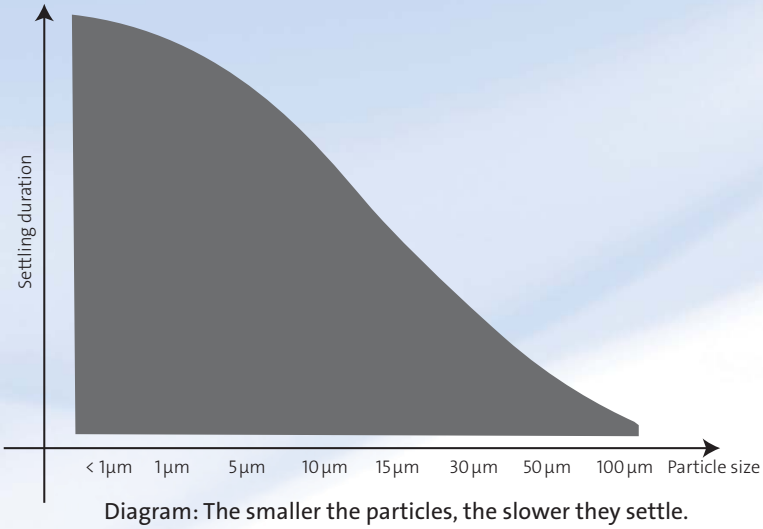


Diagram: The smaller the particles, the slower they settle.

Hazard classes of welding processes

Processes	Emission rate[3] (mg/s)	Hazard classes of the processes		
		Substances impacting the respiratory tract and the lungs	Toxic or toxic irritant substances	Carcinogenic substances
Submerged arc welding	< 1	low	low	low
Gas welding (autogenous process)	< 1	low	low	-
TIG	< 1	low	medium	medium
Laser beam welding without filler material	1 to 2	medium	high	high
MIG/MAG (low-energy gas-shielded welding)	1 to 4	low	medium	medium - high
Manual arc welding, MIG (in general)	2 to 8	high	high	high
MAG (flux-cored wire); flux-cored welding with protective gas, Laser beam welding with filler material	6 to 25	high	high	high
MAG (cored); cored wire welding without protective gas	> 25	very high	very high	very high
Soldering	< 1 to 4	low	medium	medium
Autogenous flame cutting	> 25	very high	very high	very high
Arc spraying	> 25	very high	very high	very high

Source: Technical Rules for Hazardous Substances/Welding work/ TRGS 528, Issue February 2009