



## A. Introduction

Wood pellets are usually made from wood waste such as shavings from planing and sawing, and also from bark. The comminuted wood flour is compressed under high pressure.

When storing pellets, two largely underrated hazards arise:

- a) Formation of a hazardous explosive atmosphere
- b) Formation of significant quantities of carbon monoxide (CO) that pose a threat to life

This occurs regardless of the size of the facility. Accordingly, these hazards exist even in small facilities (e.g. for storing pellets in cellars of family homes).

This paper does not address the carcinogenic effect of wood dusts.

**Note:** when storing wood pellets there is generally no hazard resulting from carbon dioxide (CO<sub>2</sub>).



Container for pellets in private property

Ignition source	Safety measures
Smouldering fires caused by ingress of smouldering material	Check of incoming goods (also in regard to odour, moisture etc.)
Mechanical spark formation or hot surfaces during conveying	Spark detection and exfiltration at transfer points
Self-ignition caused by excess moisture (see number B.2)	Check the moisture in the product and limit storage time

Table 1: Industrial use of wood pellets



## B. Formation of a hazardous explosive atmosphere

Dispersion of dust, e.g. when storing or retracting from storage, can cause the formation of a hazardous explosive atmosphere which can lead to a dust explosion if ignited.

### B.1 Measures to avoid an explosion

As part of a hazard assessment, measures should be identified and implemented that

1. lead to the avoidance of a hazardous explosive atmosphere,
2. where this is not possible, avoid effective ignition sources,
3. if it is not possible to reliably rule out effective ignition sources, limit the effects of an explosion to an acceptable level  
(constructive explosion protection)

Re 1.) When conveying wood pellets, abrasion effects, for example can lead to the formation of dust, which in turn can be dispersed. Therefore, in practice, it is possible to avoid hazardous explosive atmospheres in small containers only, e.g. in private property, by using high-quality (low-dust) pellets. In storage containers where the LEL is likely to be exceeded, a dust explosion can result if an effective ignition source is present.

Re 2.) Basic measures include explosion-protected devices, machines, plants and lighting as well as a ban on open flames and hot surfaces. Measures to prevent electrostatic charging and discharging should also be taken, e.g. equipotential bonding, earthing. The key ignition sources in practice during industrial use of wood pellets and the typical proven preventive measures derived from these are listed in Table 1 (adjacent column).

Re 3.) Constructive protection measures include explosion pressure relief in combination with explosion decoupling, for example.

People who can enter the danger zone should be informed about the hazards and instructed in the behaviour required. The danger zones (explosion risk and CO hazard) should be marked; see Appendix.

### B.2 Moisture content of pellets

The pellets are hygroscopic, which means they draw in water from the ambient air.

The moisture content of the pellets should not exceed 10%. Beyond this point the risk of self-ignition increases and combustible gases can form as a result of biological processes. A local increase in humidity, caused e.g. by condensed water, also presents a hazard. Moistening pellets to trap dust is therefore not advised. If pellet fires are extinguished with water, the pellets will expand significantly, which can cause the storage container to rupture.

The formation of CO is also promoted by humidity.



## C. Formation of CO by wood pellets

In the production of wood pellets, processes are initiated that lead to the release of CO. As a result of these processes, CO continues to be formed and released months after the manufacture of the pellets. Different layers (refilling on top of remaining pellets, different batches etc.) promote the formation of CO.

Studies and investigations<sup>1</sup> have determined that CO concentrations that pose a threat to life can accumulate in the storage space, and that the release of CO increases with storage temperature and humidity.

### C.1 Properties of CO

- CO is
  - NOT visible
  - has NO smell
  - can NOT be tasted.
- CO is a toxic gas and has no irritant effect; in other words, there are no warnings.
- CO has roughly the same specific weight as air.
- If present in the room, CO will not accumulate exclusively either at ceiling or floor height.

### C.2 Life-threatening effect of CO<sup>2</sup>

If CO enters the bloodstream via respiration, it binds firmly to the red blood pigment, haemoglobin (Hb). The main role of Hb is to carry oxygen around the body. The complex of CO and Hb is called carboxyhaemoglobin (CO-Hb).

Above a level of around 60% CO-Hb in the blood, the transport of oxygen around the body by the blood is so severely impaired that death through asphyxiation occurs.

The level of CO-Hb in the blood and thus the degree of CO poisoning are dependent among other things on the duration of exposure and on the concentration of CO in the ambient air.

Spending time in the storage room can therefore pose a threat to life.

This potential hazard is frequently underestimated by professional, industrial and private users of wood pellets.

### C.3 Measures to avoid hazards caused by CO

As part of the occupational risk assessment/evaluation, it should be ensured that nobody is exposed to dangerous concentrations of CO.

Zones that may have concentrations of CO should therefore be marked and provided with warning signs.

Only if the CO concentration is below 30 ppm (threshold limit value (TLV) or maximum allowable concentration (MAC)) there is no health risk.

If storage zones are to be entered, safety measures are required.

These include, for example

- Release system (permits for accessing/entering)
- Ventilation
- Measuring safe levels (CO monitor)
  - Entry only when the level is below 30 ppm
  - While in the store the CO concentration must be measured continually
- Trained supervisor/safety guard present at all times
- Rescue and recovery equipment

#### Important:

- In general 15 minutes of ventilation are not sufficient to guarantee a non-hazardous, breathable atmosphere.
- Sensors can lead to faulty measurements<sup>3</sup> as a result of cross sensitivities. The manufacturer of the gas monitor provides information about this.



## D. Appendix

Example for labelling

### Safety instructions for pellet store $\leq 10$ tons<sup>4</sup>



No access for unauthorised persons!  
Keep door closed at all times!



Possible threat to life due to high CO concentration!  
Do not enter during the first 4 weeks after filling.



Ensure constant external ventilation, e.g. via vented cover, opening or fan!  
Provide cross-ventilation between vented covers/opening and entry door before entering. Then measure safe levels.  
Keep door open while in the room!



Before entering and filling, switch off heating [pellet conveying] and secure against being switched back on!



No open flames; smoking, fire and other ignition sources prohibited!



Entry only under the supervision of another person located outside the storage room!  
In case of accidents, call the emergency services (insert emergency number) immediately!  
Do not enter storage without a mobile CO monitor!  
Injury hazard due to moving components, e.g. conveying screws or agitators!

If the occurrence of a hazardous potentially explosive atmosphere cannot reliably be avoided, marking as an explosion-risk zone is also required:



Explosion-risk zone!  
Danger of explosion due to dispersed dust!



## E. Further reading:

Guideline: Storage and Handling of Wood Pellets, Resultat Kontrakt (RK) Report, Wolfgang Stelte, December 2012

» [https://www.teknologisk.dk/\\_media/52682\\_RK%20report%20storage%20and%20handling%20of%20pellets.pdf](https://www.teknologisk.dk/_media/52682_RK%20report%20storage%20and%20handling%20of%20pellets.pdf)

UK Health and Safety Executive, RR1077 – Safe storage of wood pellet and wood chip fuel

» <https://www.hse.gov.uk/research/rrhtm/rr1077.htm>

Kommission Arbeitsschutz und Normung (KAN), KANBrief 2/19, Safe storage of wood pellets

» <https://www.kan.de/en/publications/kanbrief/the-office-work-of-today/safe-storage-of-wood-pellets>

Health & Safety Authority (Republic of Ireland), Safety Alert – Wood Pellets: Toxic Carbon Monoxide Poisoning

» [https://www.hsa.ie/eng/safety\\_alerts/2018/wood\\_pellets\\_toxic\\_carbon\\_monoxide\\_poisoning/](https://www.hsa.ie/eng/safety_alerts/2018/wood_pellets_toxic_carbon_monoxide_poisoning/)

Exposures to Carbon Monoxide from Off-Gassing of Bulk Stored Wood Pellets, Lydia Soto-Garcia, Xinrui Huang, Devraj Thimmaiah, Alan Rossner, and Philip K. Hopke, Energy Fuels 2015, 29, 1, 218–226, Publication Date: December 16, 2014

» <https://pubs.acs.org/doi/10.1021/ef5021186>

UK Health and Safety Executive; – Safety alert; Risk of carbon monoxide release during the storage of wood pellets

» <https://www.hse.gov.uk/safetybulletins/co-wood-pellets.htm>

Carbon Monoxide (CO) HAZARDS from Wood Pellet Storage, New York State Department of Health's , Bureau of Toxic Substance Assessment ([www.health.ny.gov](http://www.health.ny.gov))

» [https://www.health.ny.gov/environmental/emergency/weather/carbon\\_monoxide/docs/pellets.pdf](https://www.health.ny.gov/environmental/emergency/weather/carbon_monoxide/docs/pellets.pdf)

(German publication with German-language sources only)

» [https://www.dguv.de/medien/ifa/de/pub/grl/pdf/2017\\_120.pdf](https://www.dguv.de/medien/ifa/de/pub/grl/pdf/2017_120.pdf)

» <https://www.dguv.de/medien/fb-handelundlogistik/pdf-dokumente/holzpellets.pdf>

» <https://www.dguv.de/ifa/forschung/projektverzeichnis/ifa1121.jsp>

- 1 Free State of Saxony, final report on the special campaign "Storage of Wood Pellets", February – May 2013
- 2 German Social Accident Insurance (DGUV) Trade and Logistics division, leaflet FBHL 005 Kohlenmonoxid bei Transport und Lagerung von Holzpellets im gewerblichen Gebrauch [Carbon monoxide in the transport and storage of wood pellets in commercial use], published 07/2017
- 3 Richard Pyrek, Manfred Hirschall, Michael Scherb: "Pellets: Maßnahmen zur Vermeidung einsatztaktischer Fehlscheidungen aufgrund von Fehlmessungen" [Pellets: measures for avoiding tactical wrong decisions caused by faulty measurements] in Deutsche Feuerwehr-Zeitung [German fire service journal] issue 4/18
- 4 Based on "Portrait: Deutscher Energieholz- und Pellet-Verband e. V." at [VDI-Verbrauchertipps Heizen mit Holzpellets | VDI](https://www.vdi-verbraucher-tipps.de/Heizen_mit_Holzpellets)

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