SLOVENSKI STANDARD
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Trdno alternativno gorivo - Smernice za varovanje zdravja na delovnem mestu

Solid recovered fuels - Guidelines on occupational health aspects

Feste Sekundärbrennstoffe - Leitlinien über berufsbezogene Gesundheitsaspekte

Combustibles solides de récupération - Lignes directrices relatives a la santé au travail

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Solid recovered fuels - Guidelines on occupational health aspects

Combustibles solides de récupération - Lignes directrices relatives à la santé au travail

Feste Sekundärbrennstoffe - Leitlinien über berufsbezogene Gesundheitsaspekte

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Foreword

This document (CEN/TR 15441:2006) has been prepared by Technical Committee CEN/TC 343 “Solid recovered fuels”, the secretariat of which is held by SFS.

This informative Technical Report was prepared by CEN/TC 343 Solid recovered fuel, working group 3 – Sampling, sample reduction and supplementary methods. It was produced under the Mandate M/325 to CEN on solid recovered fuels to provide the European Commission with a report on aspects of occupational safety and health regarding the different stages of SRF production and use in order to decide whether there is a need to develop a referring standard.

Introduction

Production, handling, storage, trade, sampling or analysis of SRF can be accompanied with certain health risks, not only by hazardous chemical products, but by biological agents, too. In addition, the risk of concomitance of hazardous waste in the input material cannot be excluded. These risks will be described in this Technical Report.

The safety data sheet (SDS) for chemical products due to ISO 11014-1 is a means of transferring essential hazard information (including information on transport, handling, storage and emergency actions) from the supplier of a chemical product to the recipient of this product. For non-hazardous substances or products there is a gap in information duties. Solid recovered fuels are derived from non-hazardous types of waste, so prima facie there seems to be no need for preparing a SDS for SRF. In addition, the SDS due to ISO 11014-1 would not cover environmental or health risks in the stage of SRF *production*.

1 Scope

This Technical Report considers aspects of occupational safety and health within the scope of CEN/TC 343: production and trade of solid recovered fuels.

2 Normative references

Not applicable

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
actinomycete
0,5 µm to 1,5 µm long, gram-positive, rod-shaped bacteria that form long threads; their cells are also called “spores”

3.2
bacteria (sing. bacterium)
simple prokaryotic micro-organism, mainly formed as balls or straight, curved or curled rods, with a width less than 1 µm and a length of 1 µm to 5 µm, some of them forming endospores to resist adverse environmental conditions like UV radiation, heat, dryness and chemical disinfectants

3.3
biological agent
micro-organisms, including those which have been genetically modified, cell cultures and human endoparasites, which may be able to provoke any infection, allergy or toxicity

3.4
colony forming unit (CFU)
descendants of a single or of several agglutinated micro-organisms growing on a solid culture medium showing a typical appearance in colony form and often in colony colour, too

3.5
dust
solid particles dispersed into the air

3.6
endotoxin
degradation product of gram-negative bacteria

3.7
endotoxin unit (EU)
endotoxin activity; 1 ng endotoxin corresponds to 2 EU - 50 EU, in dependence on the reference standard

3.8
exogenic-allergic alveolitis (EAA)
allergic reaction to exposure especially to thermoactinomycetes, can become chronic or fatal; also known as *farmer’s lung*

3.9
exposure risk
risk of exposure to biological agents, chemical substances or other risk factors like heavy metals, dust or fire

3.10
fungi (sing. fungus)
eukaryotic, unicellular to filamentous organism that produce extracellular enzymes and absorb their nutrition; fungal cells form threads (molds) or chains of bubbles (yeasts) up to 10 µm in diameter

3.11
germ
endemic or opportunistic pathogen

3.12
inspirable dust
particles in the region of 7 µm to 20 µm that can penetrate the bronchioles

3.13
micro-organism
microbiological entity, cellular or non-cellular, capable of replication or of transferring genetic material

3.14
mold (mould)
fungal threads ("hyphae") forming a weave ("mycelium"), which builds up spore carriers ("conidiophores"), that release the 2 µm to 8 µm small asexual fungal spores ("conidia"), which are spread by the air

3.15
MVOC
microbial volatile organic compounds, mainly produced by molds and bacteria, like dimetyldisulfid, isobutanol, 1-octen-3-ol, 3-methyl-1-butanol, 3-methylfuran and 3-octanone

3.16
mycotoxin
toxins formed by fungi, like aflatoxin, ochratoxin and others

3.17
ODTS (organic dust toxic syndrome)
pulmonary mycotoxicosis, non-allergic, also known as *grain fever*, primarily caused by inhalation of microbially contaminated dust and under others endotoxins

3.18
PM_{10}, $PM_{2,5}$
particulate matter with a diameter of 10 µm respectively 2,5 µm, summarized as fine dust

3.19
primary measures
serve for direct prevention and elimination of emission at the source

3.20
protease
enzyme which decomposes proteins by breaking the linkage between amino acids

3.21
pulmonary alveoli
terminal parts of the lung, where the gas exchange between alveolar air and pulmonary capillary blood takes place

3.22
respirable dust (RD)
particles in the region of 0,5 µm to 7 µm (50 % cut-point of 4 µm) that can penetrate to the pulmonary alveoli

3.23
secondary measures
technical, organisational and personal-related measures to reduce employees' exposure to biological agents or hazardous substances

3.24
yeast
fungal cells forming chains of bubbles

4 Health risk factors

4.1 Exposure to health risk factors

Employees have contact to SRF and its components at different workplaces. Therefore, there may be an exposure to biological agents, chemical substances or other health risk factors like heavy metals, dust or fire risk, see Table 1.

Table 1 — Exposure to health risk factors at different workplaces in the life-cycle of SRF

Potential exposure to	Biological agents	Dust / fine dust	Allergenic chemicals	MVOC/ VOC	Risk of fire or explosion
Production	yes	yes	yes	yes	yes
Storage	yes	yes	yes	yes	yes
Handling	yes	yes	yes	yes	possible
Trade	possible	possible	possible	possible	possible
Sampling	yes	possible	yes	yes	possible
Analysis	yes	possible	yes	yes	possible

4.2 Biological agents

4.2.1 Definition and description

4.2.1.1 General

Biological agents, in the meaning of Directive 2000/54/EC on the protection of workers from risks related to exposure to biological agents at work, include mainly micro-organisms like bacteria, fungi (yeasts, molds) and viruses, and also, genetically modified micro-organisms (GMO), cell cultures and human endoparasites which may be able to provoke any infection, allergy or toxicity. As several microbial metabolic and degradation products are able to cause such reactions in man, they are covered by the defintion of “biological agent”, too. With regard to a potential exposure at working places in the SRF life-cycle, the following biological agents are of special interest:

— bacteria;

— fungi;

— microbial metabolic and destruction products:

— endotoxins;

— glucans;

— mycotoxins;

— microbial volatile organic compounds (MVOC).

4.2.1.2 Bacteria

Bacteria do not have a real nucleus with a nucleus membrane and chromosomes, therefore they are called “procaryotes”. Their cells are mainly formed as balls or straight, curved or curled rods, with a width less than 1 µm and a length of 1 µm to 5 µm. Due to their behaviour in a special staining procedure, they are distinguished into Gram-negative and Gram-positive bacteria. Under optimum living conditions, bacteria can multiply very rapidly by cell division. Some bacteria form endospores to resist adverse environmental conditions like UV radiation, heat, dryness and chemical disinfectants. The very small cells of actinomycetes (0,5 µm to 1,5 µm long, Gram-positive, rod-shaped bacteria that form long threads) are also called “spores”.

4.2.1.3 Fungi

In contrast to bacteria, fungi have real nuclei and chromosomes and therefore belong to the “Eucaryotes” group. Fungal cells form threads (molds) or chains of bubbles (yeasts) up to 10 µm in diameter. Fungal threads (“hyphae”) form a weave (“mycelium”), which builds up spore carriers (“conidiophores”). These carriers release the 2 µm to 8 µm small asexual fungal spores (“conidia”), which are spread by the air.

4.2.1.4 Microbial metabolic and destruction products

Several microbial metabolic and destruction products are capable of causing an allergic or toxic effect in exposed people, see Table 2.

Table 2 — Health related microbial metabolic and destruction products

Substances	Description
Endotoxins	Endotoxins are part of the outer membrane of the cell wall of Gram-negative bacteria. Endotoxins are invariably associated with Gram-negative bacteria whether the organisms are pathogens or not. Although the term "endotoxin" is occasionally used to refer to any cell-associated bacterial toxin, it is properly reserved to refer to the lipopolysaccharide complex associated with the outer membrane of Gram-negative bacteria such as *E. coli*, *Salmonella*, *Shigella*, *Pseudomonas*, *Neisseria*, *Haemophilus*, and other leading pathogens. Endotoxins remain associated with the cell wall until disintegration of the bacteria.
Glucans	(1→3)-β-D-glucan is a polyglucose compound in the cell wall of fungi and some plants and bacteria, which is released during disintegration of the cells.
Mycotoxins	Some fungi produce mycotoxins which have a high toxicity to humans, like Aflatoxin produced by *Aspergillus flavus* or Ochratoxin produced by *Aspergillus* and *Penicillium species*.
Microbial volatile organic compounds (MVOC)	Some micro-organisms produce microbial volatile organic compounds (MVOC). Up to now, about 30 MVOC produced by molds have been identified. The most important are dimetyldisulfid, isobutanol, 1-octen-3-ol, 3-methyl-1-butanol, 3-methylfuran and 3-octanone. Bacteria and actinomycetes, too, produce MVOC, especially dimethyldisulfid and isoprene.

4.2.2 Health effects

Biological agents can cause different harmful effects on human health, especially infections. Other effects are toxic reactions, allergy and sensitization. Details are given in Annex A.

Depending on the level of risk of infection, biological agents are classified in four risk groups (Directive 2000/54/EC), see Table 3. Immunologic deficiencies, pregnancy or lactation are not considered.

NOTE SRF are produced from non-hazardous waste, which normally do not contain micro-organisms of risk group 3 or 4

Table 3 — Classification of biological agents to risk groups (RG) and examples

RG	infection/ human disease	exposure risk	availability of effective prophylaxis or treatment	examples (B = bacteria, F = fungi, V = virus)
1	unlikely	insignificant	not necessary	**F**: Penicillium-species, Aspergillus-species except *A. fumigatus* (see RG2); (though sensitizing!)
2	can cause human disease and presents a hazard to employees	unlikely	usually available	**B**: *Staphylococcus aureus* (infection of wounds etc.), *Clostridium tetani* (tetanus) **F**: *Aspergillus fumigatus* (pulmonal aspergillosis) **V**: *Hepatitis A Virus* (HAV) (acute hepatitis)
3/ 3**	can cause severe human disease and presents a serious hazard to workers	may present a risk [a]	usually available	**V**: HIV (AIDS), HBV (hepatitis B., chronic liver disease)
3** Certain biological agents classified in group 3 which are indicated in the appended list to Directive 2000/54/EC by two asterisks (**), may present a limited risk of infection for workers because they are not normally infectious by the airborne route.				
[a] E.g. used syringes containing residues of infected persons' blood.				

Gram-negative **bacteria** like *Enterobacter*, *Salmonella* or *Klebsiella* species can cause different kinds of infections. *Enterobacter aerogenes* and *Enterobacter cloacae* sometimes cause meningitis, inflammation of the urinary passage or the airways. *Salmonella typhi* (*Salmonella enterica subsp. enterica Serovar typhi*) can cause typhus, *Salmonella enteritidis* (*Salmonella enterica subsp. enterica Serovar enteritidis*) can cause salmonellosis of the intestinal tract (enteritis). Only one of the four *Klebsiella-species*, *Klebsiella pneumoniae*, is of hygienic relevance. *K. pneumoniae* belongs to man's regular intestine flora and is usually innocuous, but can harm persons with immunologic deficiencies by inflammation of the urinary passage or the airways (Friedlaender's pneumonia).

Infections caused by **molds** – soonest by inhalation – are very rare and mainly affect people with local or systemic immunologic deficiencies (e.g. HIV-positive tested persons, persons after transplantation, people affected by mucoviscidosis or diabetes mellitus). The infection – so called mycosis – depends in addition on

the pathogenic potential and virulence of the mold. Therefore, some molds are classified in Risk Group 2 (opportunistic pathogens), others in Risk Group 3 (endemic pathogens). Table 4 shows infection diseases caused by *Aspergillus fumigatus* – which is most common in waste management plants – and the referring risk person groups. Further molds causing infections and the referring risk groups are reported in some reports given in the bibliography.

Table 4 — Infection diseases caused by Aspergillus fumigatus and referring risk groups

Infection disease	Risk person groups
Mucor infection in lung, paranasal sinus, central nervous system, eye, skin	people with immunologic deficiencies
Invasive pulmonal aspergillosis	people with immunologic deficiencies
Invasive aspergillosis of paranasal sinus	people with immunologic deficiencies
Invasive aspergillosis (infection of vessels, liver, heart, eye, nervus opticus, central nervous system, medulla, skin)	people with immunologic deficiencies
Aspergillom (lung and paranasal sinus)	patients with bronchial enlargement, caverns, cysts following a precedent lung disease
Sinusitis (paranasal sinus inflammation)	-
Allergic bronchopulmonal aspergillosis	atopics (= people with predisposition for type I-allergies)
Otitis externa (inflammation of the external ear)	-

4.2.3 Sources of biological agents

Waste, especially household waste, is contaminated with different kind of micro-organisms and other biological agents. Except viruses, micro-organisms can proliferate during holding time in the waste collection bin (or bag), and especially molds and actinomycetes multiply rapidly while degrading fairly biodegradable organic residues. In addition, large amounts of odour substances are produced and emitted. The degradation processes continue during transport and storage of the untreated waste.

Biological agents are not only a problem of mixed household waste, even separately collected glass waste and paper waste (an important SRF input waste stream) contain high amounts of micro-organisms. Another input waste stream for SRF-production is separately collected package waste. This material is often – even visibly – contaminated with molds and bacteria, but with mycotoxins like aflatoxin B1 (carcinogen) or ochratoxin A (suspected carcinogen), too. These mycotoxins are heat-resistant, and bacterial (and fungal?) spores can even survive thermal treatment of polymers.

4.3 Chemical substances

4.3.1 general

Chemical substances that can pose a risk to employees in the SRF life-cycle are:

— dust;