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Karakterizacija blata - Higienski vidiki - Priprava

Characterization of sludges - Hygienic aspects - Treatments

Charakterisierung von Schlämmen - Hygienische Aspekte - Schlammbehandlung

Caractérisation des boues - Aspects hygiéniques - Traitements

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Characterization of sludges - Hygienic aspects - Treatments

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Charakterisierung von Schlämmen - Hygienische Aspekte - Schlammbehandlung

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Foreword

This document (CEN/TR 15809:2008) has been prepared by Technical Committee CEN/TC 308 “Characterization of sludges”, the secretariat of which is held by AFNOR.

The status of this document as CEN/TR has been chosen because much of its content is not completely in line with the practice and regulations in each member state.

This document gives general principles about hygienic aspects. Other guides on good practice for the use of sludge (Guides 2, 4, 5, 6, 7, 8) contain the specific recommendations based on the hygienic aspects described in this guide.

Introduction

This Technical Report has been prepared within the framework of CEN/TC 308 on characterization of sludges. This document concentrates on hygienic aspects for good practice concerning treatment of sludge, but acknowledges that existing national regulations remain in force.

The use of sewage sludge on land is controlled within the EU by the sludge directive (86/278/EEC [1]) “on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture”. Regarding the purpose of the directive, it states:

— whereas the aim of this Directive is to regulate the use of sewage sludge in agriculture in such a way as to prevent harmful effects on soil, vegetation, animals and man, while encouraging its correct use;

Regarding hygiene, it requires:

— whereas sludge must be treated before being used in agriculture; whereas Member States may nevertheless authorize, on certain conditions, the use of untreated sludge, without risk to human or animal health, if it is injected or worked into the soil;

— whereas a certain period must elapse between using the sludge and putting stock out to pasture or harvesting fodder crops or certain crops which are normally in direct contact with the soil and normally consumed raw;

— whereas the use of sludge on fruit and vegetable crops during the growing season, except for fruit-tree crops, must be prohibited.

86/278/EEC defines 'treated sludge' as:

— sludge which has undergone biological, chemical or heat treatment, long-term storage or any other appropriate process so as significantly to reduce its fermentability and the health hazards resulting from its use;

EU Member States have enacted the directive into their national legislations with conditions that are no less stringent than the directive. In many cases they have more detailed treatment requirements than those written in the directive.

The European Commission has said repeatedly that 86/278/EEC, which was the first soil protection directive, has been a success because there have been no cases of adverse effect where it has been followed.

Sludge treatments and practices that control health risks can also affect odour; in the public’s mind they are linked.

When making choices in sludge management the hygienic aspects should be considered alongside the environmental impacts of the treatment such as energy use or emissions and the benefits of the final product.

1 Scope

This CEN Technical Report gives information about principles to be followed in different sludge treatment processes to reach specified hygienic requirements.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1085:2007, *Wastewater treatment — Vocabulary*

EN 12832:1999, *Characterisation of sludges — Utilization and disposal of sludges — Vocabulary*

CEN/TR 15473, *Characterization of sludges — Good practice for sludges drying*

EN ISO 22000, *Food safety management systems — Requirements for any organization in the food chain (ISO 22000:2005)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12832:1999, EN 1085:2007 and the following apply.

3.1
Critical Control Point (CCP)
step [in a process] at which control can be applied and is essential to prevent or eliminate a hazard or reduce it to an acceptable level

3.2
HACCP (hazard analysis and critical control point)
system that identifies, evaluates, and controls hazards which are significant for safety

3.3
HACCP plan
document prepared in accordance with the principles of HACCP to ensure control of hazards which are significant for safety in the segment of the chain under consideration

3.4
hazard
potential source of harm

3.5
hazard analysis
process of collecting and evaluating information on hazards and conditions leading to their presence to decide which are significant for safety and therefore should be addressed in the HACCP plan

3.6
hygienic safety
intended degree of safety

3.7
hygienisation
process that leads to reduced levels of pathogens in order to prevent infections, and their spreading in the exposed human, animal or plant population

3.8
monitor
act of conducting a planned sequence of observations or measurements of control parameters to assess whether a CCP is under control

3.9
risk
combination of the probability of occurrence of harm and the severity of that harm

3.10
safety
freedom from unacceptable risk

3.11
validation
obtaining evidence that the elements of the HACCP plan are effective

3.12
verification
application of methods, procedures, tests and other evaluations, in addition to monitoring to determine compliance with the HACCP plan

4 Hygienic considerations

4.1 General

Untreated sludge from wastewater treatment may contain different types and species of pathogens for humans, animals and plants. The occurrence of such pathogens depends on the type and origin of the raw materials and on the health situation with respect to the presence of diseases in the involved populations. This does not only apply to sewage sludge, but also to wastewater, biogas residues, animal manure and other organic fertilisers and compost of human, animal and plant origin. Environment *per se* is not sterile. Soil is more than a mineral support on which plants grow, it is an ecosystem with its own indigenous flora and fauna. Among this microflora are several potential pathogenic as well as toxigenic bacteria and fungi that can be found in varying concentrations such as *Listeria monocytogenes* or *Clostridium tetani*. There are also competitors and predators of the pathogens with which this guide is concerned. Hygienic considerations include aspects of microbiology, virology, parasitology and epidemiology.

4.2 From concept to good practice

In the framework of HACCP concept, the intended field of application of sludge has to be defined, followed by the determination of the existence and the types of pathogens in sludges, as well as the identification of the possible ways of transmission to humans, animals or plants.

If the interpretation of this analysis (based on the level of risk for health in regard of the uses of sludges) demonstrates the need for treatment, the process should be capable of reducing the hazard to an acceptable level of risk by inactivating the selected pathogens to a defined extent. The treatment process should be validated by a representative indicator organism covering the types of pathogen identified.

4.3 Aspects of microbiology, virology and parasitology

Besides the indigenous microbiological flora and populations of viruses including protozooic and metazooic organisms, untreated sewage sludge may contain a variety of pathogens for humans, animals and plants as well as other undesired organisms which may present an environmental hazard. The species and numbers of indigenous flora as well as the pathogens and undesired elements depend on the origin and treatment of the wastewater. Basic data concerning the occurrence of bacterial, viral and fungal pathogens as well as parasites have been given in the past by several authors [2, 3, 4]. From this variety of bacterial pathogens *Salmonella* spp. are the most relevant since they can infect or contaminate nearly all living vectors from insects to mammals. Amongst the viral pathogens, noroviruses, enteroviruses and rotaviruses are the most relevant ones from the point of view of environmental risks. Special regard must be paid to the parasitic pathogens, not only to eggs of round- and tapeworms but to *Giardia lamblia* and especially *Cryptosporidium parvum*. Nearly all gut related pathogens of farm animals could be found in slaughterhouse effluents. Wastewater from households or industry containing plant material may contain plant-pathogenic viruses, fungi, bacteria, parasites and undesired weeds. This may cause an additional phytohygienic risk if untreated material is used in agriculture as a fertiliser [5]. However, in most cases, the concentration of the relevant pathogens in the sludge is moderate or small. Consequently, risk related treatment, storage and utilisation basically determines the hygienic safety of the final product.

The health of the population (humans, animals, plants) has to be taken into account both in the risk assessment and in establishing a HACCP-concept.

4.4 Aspects of epidemiology

The epidemiological aspects of sewage sludge mean that hygienic safety must be considered during all steps of treatment, transport, storage and utilisation. The right balance between the advantages of organic fertilisers based on sewage sludge and the requirements to achieve the degree of hygienic safety necessary for the intended application has to be made. Different European experiences with strategies for proper use of sludge show that epidemiological risks can be minimized.

Three aspects of hygiene have to be considered related to different epidemiological pathways:

— one aspect concerns the occupational health aspects in transport, storage, treatment and utilisation.

NOTE 1 The occupational health aspects are covered by Directive 2000/54/EC [6] and related national legislation, and are not covered in this context.

— the second aspect concerns two vectors: transmission of pathogens directly to susceptible hosts or indirectly via living and non living vectors (e.g. food, animal feed, or contaminated equipment).

NOTE 2 The direct or indirect transmission of zoonotic agents to farm animals is generally regarded as the most relevant risk factor of agricultural utilisation of untreated or insufficiently treated sludge. This direct relationship between fertilizing with sewage sludge and infection in cattle fed with forage after sludge spreading was first demonstrated for *Salmonella* [7]. The transmission of parasites was observed much earlier. *Transmission to humans via products based on sludge or containing insufficiently treated sludge by applying them to plants in households or in home-gardens is a relatively rare event. The risk of infection of persons exposed to salmonellae after sludge application to farmland is minimal and no different from that of the nonexposed population [8].*

Indirect transmission to humans is of special importance, because the introduction of pathogens into the food chain via contaminated fertiliser leading to contaminated animal feed resulting in infection of farm animals or excretion of pathogens is of basic epidemiological significance. This is mainly due to contamination of meat and meat products during slaughtering and processing as well as contamination of plants and plant products by manure of animals excreting the above mentioned organisms. The risk of transmission of pathogens to human food by living vectors such as insects, rodents and birds from processing, handling and agricultural utilisation of organic fertilisers is also regarded as a risk factor [9].

— the third aspect concerns the introduction of organisms in the environment during transport, treatment, and storage but mainly during utilisation.

NOTE 3 This may be closely related to health aspects if pathogens are introduced into the biocenosis, and then carried by birds or rodents. This could include the introduction of resistance genes into the biocenosis, a potential risk that applies to treated wastewater as well. Antibiotic resistant bacteria may be present in sludge, and therefore could contribute to the presence of so called “community acquired multiresistant bacteria” in human populations. However, it is likely that other ways of transmissions are of primary importance [10].

Epidemiological risks arise because pathogens may survive for a considerable period of time in excreta, manure, sludge and the environment [2]. A compilation of general epidemiological risks due to handling and the utilisation of organic wastes as fertilisers in agriculture is given in Table A1.

4.5 Definition of the hygienic objective of treatment

The hygienic objective of treatment is to be defined for the treatment. The definition of this objective is on the authority of each country regulation. The principle is to determine the microorganisms you want to inactivate and the microorganisms you accept there are remaining.

An example for inactivation of remaining type of organisms is given in Table 1. Suggestions for test organisms for validation of treatment processes are given in Table 2.

Table 1 — Hygienic objectives

NOTE Pathogenic prions are not covered by this approach, if present in the sludge other treatment options as given below must be considered.

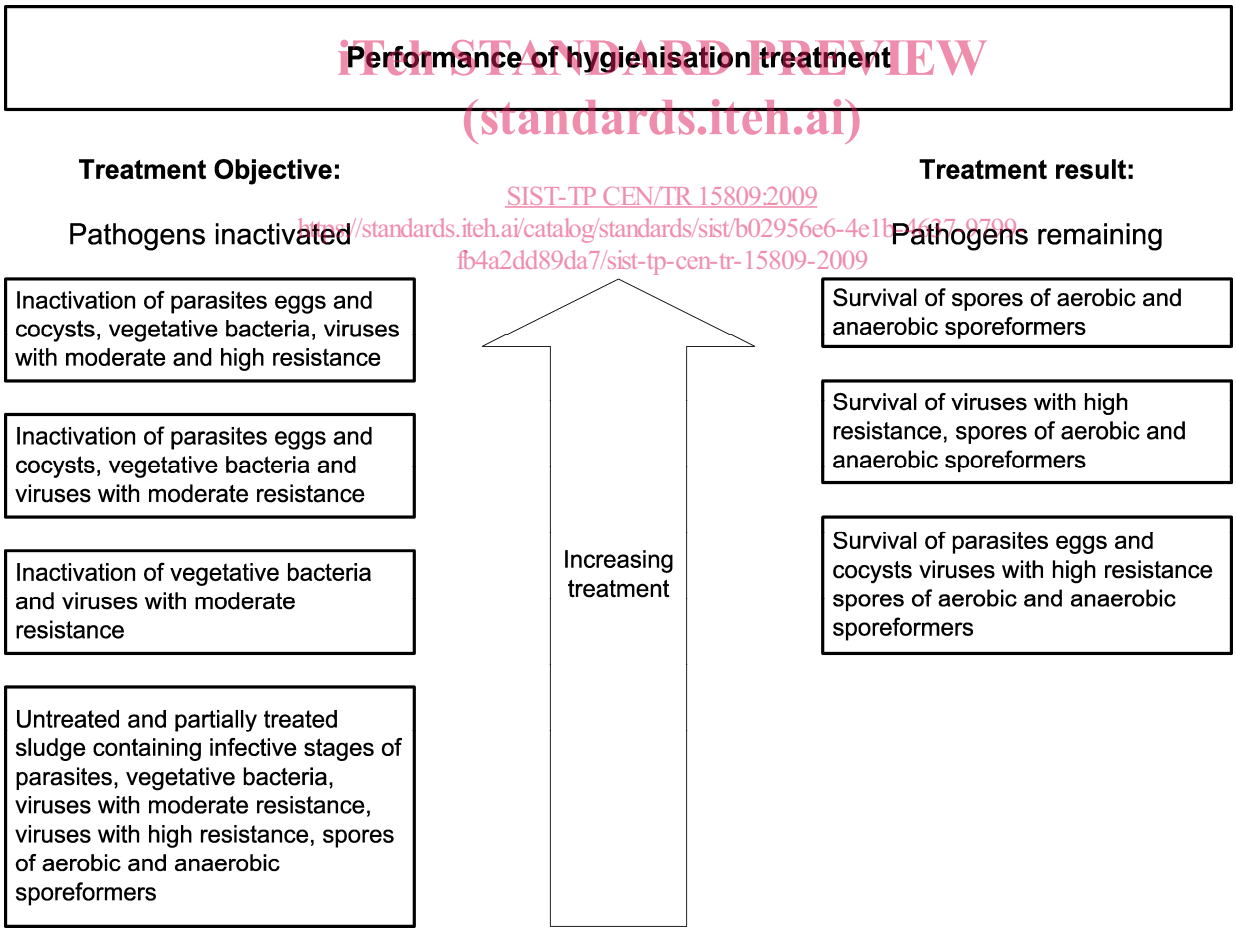

Table 2 — Possible test organisms for validation of treatment processes in relation to the intended hygienic level (informative)

Pathogens inactivated	Possible test organisms	Minimal reduction to be reached in the validation
Vegetative bacteria Virus with moderate resistance	For biotechnological and chemical treatment: *Salmonella senftenberg* W 775, H_2S negative For thermal or other physical treatment: *Enterococcus faecalis* ATCC 2912 [a]	At least 5 log for all test organisms
Vegetative bacteria Virus with moderate resistance Infectious parasitic stages	For chemical treatment: *Salmonella senftenberg* W 775, H_2S negative and eggs of *Ascaris suum* For biotechnological and thermal or other physical treatment: *Enterococcus faecalis* ATCC 2912 [a]	At least 5 log for *Salmonella senftenberg* and *Enterococcus faecalis* At least 99,9 % inactivation of the eggs
Vegetative bacteria Virus with moderate and high resistance Infectious parasitic stages	For biotechnological and chemical treatment: Bovine parvovirus strain Haden For thermal or other physical treatment: Bovine parvovirus strain Haden or Coliphage T1 [a]	At least 3 log for Bovine parvovirus At least 5 log for Coliphage T1

[a] If validation is done by input-otput analysis for determining a reduction rate in the indigenous bacteria and/or viruses the parameters "E. coli", "Enterococci" or "Coliphages" may be used instead.

Generally, treatments used to stabilise sludge have the effect of enhancing the natural decay in the indigenous as well as in the pathogenic micro-organisms present and generally to restrict regrowth within certain limits. The effect depends on their biological properties. The factors leading to the inactivation can be chemical, physical or biological in nature. Every treatment may have some effect on the beneficial soil conditioning properties of the sludge (e.g. loss of nutrients, loss of organic matter, loss of beneficial organisms).

Wastewater treatment results in sludge. Untreated sludge may contain pathogenic vegetative bacteria, as well as bacterial spores, viruses with different chemo- and thermoresistance, as well as infectious stages of different parasites (see Tables A2 to A4 in Annex A). This is the material related to the highest epidemiological risk in this context.

5 General methodologies and tools to define the hygienic effect of treatment, and to manage the hygienic safety

5.1 General

An appropriate approach for good health practices should:

a) identify the relevant pathogens and the thresholds that ensure sanitary protection of the exposed population. This can be done with a health risk assessment;

b) include HACCP with process validation;

c) monitor contamination levels in sludge before use in general.