
Predelava, recikliranje, obdelava in odlaganje blata - Informacije o postopkih in tehnologijah za pridobivanje/predelavo anorganskih snovi in hrani I(ISO/TR 22707:2023)

Sludge recovery, recycling, treatment and disposal - Information on the processes and technologies for inorganic substance and nutrient recovery (ISO/TR 22707:2023)

Valorisation, recyclage, traitement et élimination des boues - Guide sur les procédés et les technologies de récupération des substances inorganiques et des nutriments (ISO/TR 22707:2023)

Ta slovenski standard je istoveten z: FprCEN ISO/TR 22707

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ICS:

13.030.20 Tekoči odpadki. Blato Liquid wastes. Sludge

kSIST-TP FprCEN ISO/TR 22707:2025 en,fr,de

TECHNICAL REPORT

**ISO/TR
22707**

First edition
2023-07

Sludge recovery, recycling, treatment and disposal — Information on the processes and technologies for inorganic substance and nutrient recovery

*Valorisation, recyclage, traitement et élimination des boues — Guide
sur les procédés et les technologies de récupération des substances
inorganiques et des nutriments*

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Reference number
ISO/TR 22707:2023(E)

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 275, *Sludge recovery, recycling, treatment and disposal*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Inorganics and nutrient recovery is necessary to build a sustainable society; there are many studies and plants all over the world that demonstrate this concept. Above all, phosphorus recovery systems to produce fertilizer material are increasingly common and other nutrients recovery systems are now being developed.

This document provides a selected overview of various technologies and is based on country standards and guidance documents already in existence or under preparation, and documents provided by private organizations.

As inorganics and nutrient recovery knowledge and technology is developing rapidly, this document will therefore be reviewed regularly to reflect the advancing nature of the industry and technology.

[Annex A](#) provides examples of sewage sludge composition, which can help determine which element(s) can be recovered. [Annex B](#) provides case studies of nutrient recovery, including practical and emerging ones.

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Sludge recovery, recycling, treatment and disposal — Information on the processes and technologies for inorganic substance and nutrient recovery

1 Scope

This document provides information on the processes and technologies for inorganic substance and nutrient recovery from sludge.

This document is applicable to sludge and products from urban wastewater collection systems, night soil, wastewater treatment plants for urban and similar industrial waters. It includes all sludge that can have either similar environmental or health impacts, or both.

Hazardous sludge from industry and dredged sludge are excluded from this document.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

ammonia stripping

method that removes ammoniacal compounds from water by making it alkaline and of aeration

3.2

calcium phosphate

salts that consist of calcium ions and phosphate ions

Note 1 to entry: Hydroxyapatite (HAP) is a form of calcium phosphate.

3.3

centrate

liquid product from a centrifugal dewatering device

3.4

hydroxyapatite

HAP

sparingly soluble salt that is generated from phosphate and calcium ions

Note 1 to entry: The general chemical formula of HAP is $\text{Ca}_{10}(\text{OH})_2(\text{PO}_4)_6$.

3.5

incineration ash

residue of combustion

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3.6

nutrient

element required by living organisms throughout the course of their lives in small quantities for a range of physiological functions

3.7

seed crystal

crystal employed as a nucleus to generate and grow crystals in the crystallization process

3.8

struvite

compound which is precipitated by magnesium addition to water with high concentration of phosphate and ammonium ions

Note 1 to entry: The chemical formula of struvite is $\text{MgNH}_4\text{PO}_4 \cdot 6\text{H}_2\text{O}$.

4 Methods of nutrient recovery from sludge

There are four methods for nutrient recovery from sludge, which are whole use, cleaning, separation and extraction.

- a) **Whole use:** Whole use of sludge is a simple use method in which sludge, which is typically aerobically or anaerobically treated (e.g. compost), is directly applied to land as fertilizer or soil improver. This method can minimize the loss of the nutrients in the treatment process and can achieve the highest potential of utilizing the nutrients in sludge.
- b) **Cleaning:** Cleaning is the process in which sludge has contaminants such as plastics or heavy metals removed by mechanical treatment or chemical extraction. The cleaned sludge can be handled in the same way as whole use.
- c) **Separation:** Separation is the process in which sludge is divided into two or more different parts. Sludge is separated by physical or chemical parameters such as size, shape, specific gravity difference and chemical affinity. All or only the least contaminated part of separated sludge can then be utilized. In this method, sludge contains various nutrients.
- d) **Extraction:** Extraction is the way in which only the target element is taken out as a compound using chemical actions. Fewer nutrients in sludge are made available or utilized through extraction processes than in whole use, cleaning and separation methods. However, the process has some advantages:
 - reduces the storage volume of the nutrient;
 - prevents contamination of the recovered material by hazardous elements;
 - stabilizes the recovered materials as a chemical compound;
 - improves the value of the recovered materials.

Precipitation, including stripping processes, can decrease the volatile nutrient content.

This document is focused on nutrients which can be recovered by extraction.

5 Phosphorus recovery

5.1 General

Phosphorus is an essential element for plant growth and is an important ingredient of chemical fertilizer products. The dry solid contents of sludge normally include more than 1,0 % phosphorus and it can reach 5,0 % of sludge under certain operating conditions, such as biological dephosphorization or anaerobic-anoxic-oxic processes.

On the other hand, the supply of phosphate ore in the global market is strongly influenced by political and economical issues and often gets unstable, as it is quite unevenly distributed globally. Therefore, studies and commercialization of phosphorus recovery from sludge is the most progressive area in inorganic and nutrient material recovery.

Phosphorus can be recovered from sludge using various chemical compounds. The phosphorus recovery process that is described in [Clause 5](#) is summarized in [Figure 1](#).

For case studies, refer to [Clauses B.1](#) to [B.11](#).

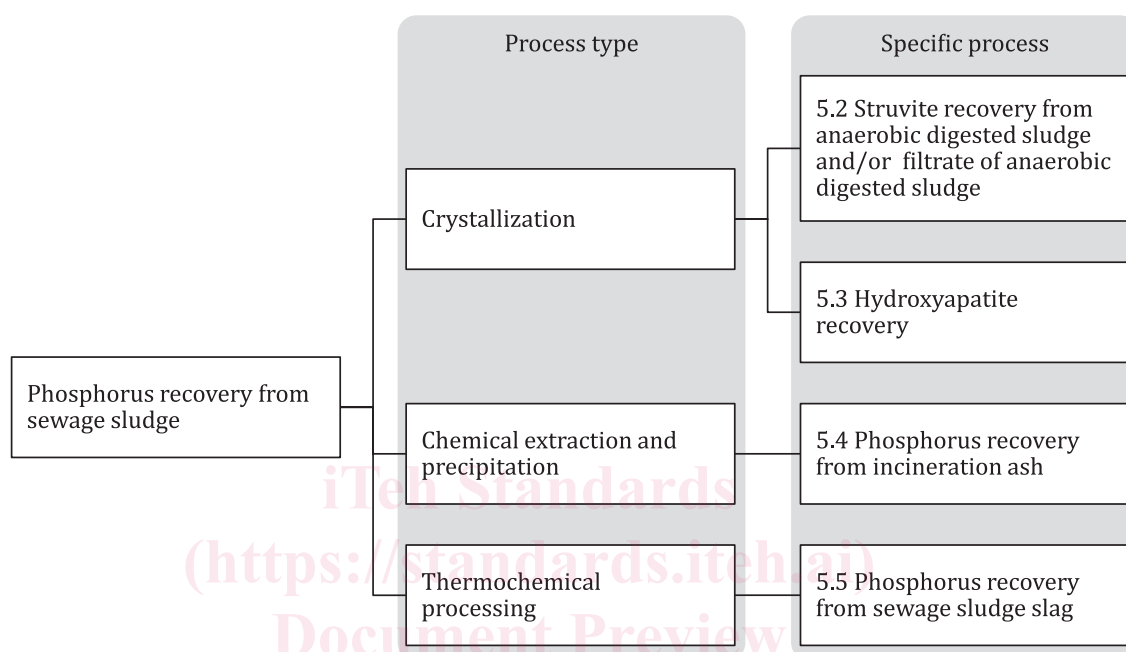


Figure 1 — Summary of phosphorus recovery process

5.2 Struvite recovery from either anaerobic digested sludge or filtrate of anaerobic digested sludge, or both

5.2.1 Principle

The principle of the struvite recovery process are based on the chemical precipitation carried out in a crystallizer followed by particle separation. The chemical reaction for struvite is:



This reaction is the same as the scale formation which is frequently observed in anaerobic sludge treatment facilities. The difference of struvite recovery from scale formation is well-controlled chemical dosing, pH control and particle separation. After the application of this process, much less scale formation is likely to occur in treatment facilities.

Recovered struvite can be used as delayed release fertilizer because of its low solubility.

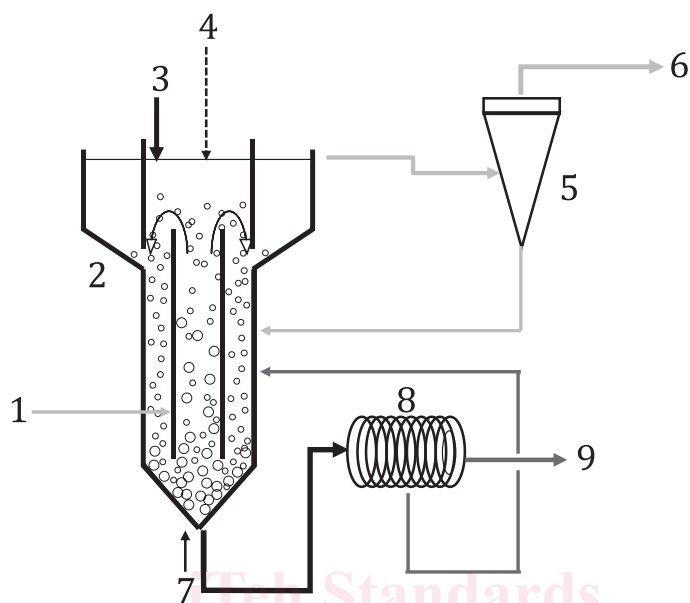
There are two types of crystallizer processes: agitation by air or mechanical agitation.

Both methods of crystallization are employed in commercial operations. Wastewater employed for this process is a filtrate of anaerobically digested sludge (ADS) or ADS itself and industrial wastewater containing phosphate and ammonium. Under optimum operating conditions, dissolved phosphorous recovery can reach more than 80 % using this process.

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5.2.2 Schematic diagram

Schematic diagrams for an air fluidized crystallizer and a mechanical agitator are shown in [Figures 2](#) and [3](#). An influent such as a filtrate of ADS, and/or ADS, is mixed in the reactor with magnesium (Mg) salt and struvite granules (as seed crystal). Alkalising chemicals such as sodium hydroxide solution can be added for pH control.



Key

- 1 ADS or ADS liquor
- 2 phosnix reactor
- 3 $\text{Mg}(\text{OH})_2$
- 4 NaOH
- 5 liquid cyclone

- 6 treated sludge or liquor
- 7 air
- 8 rotary sieve
- 9 struvite

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Figure 2 — Schematic diagram of a fluidized bed reactor