

---

---

## Sludge recovery, recycling, treatment and disposal — Guidance on thermal treatment of sludge

*Valorisation, recyclage, traitement et élimination des boues — Lignes  
directrices pour le traitement thermique des boues*



This document is a preview generated by EKO



**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2021

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

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

Published in Switzerland

# Contents

Page

<b>Foreword</b>	<b>vi</b>
<b>Introduction</b>	<b>vii</b>
<b>1 Scope</b>	<b>1</b>
<b>2 Normative references</b>	<b>1</b>
<b>3 Terms and definitions</b>	<b>1</b>
<b>4 Abbreviated terms</b>	<b>3</b>
<b>5 Sludge properties</b>	<b>4</b>
5.1 General	4
5.2 Physico-chemical characteristics	4
5.2.1 General	4
5.2.2 Dry matter	4
5.2.3 Loss on ignition	4
5.2.4 Calorific value	5
5.2.5 Grease, scum and screening	5
5.2.6 Physical consistency and others	6
5.3 Chemical and microbiological characteristics	6
5.3.1 General	6
5.3.2 Sulfur	6
5.3.3 Phosphorus	7
5.3.4 Nitrogen	7
5.3.5 Chlorine and other halogens	7
5.3.6 Organic micro pollutants	7
5.3.7 Trace elements	8
5.3.8 Pathogens	8
<b>6 Thermal processes fundamentals</b>	<b>8</b>
6.1 General	8
6.2 Drying	9
6.3 Hydrolysis	10
6.4 Incineration	11
6.5 Pyrolysis	12
6.6 Gasification	13
6.7 Thermolysis	14
6.8 Carbonization	14
6.9 Wet oxidation	14
6.10 Melting	15
6.11 Pasteurization	15
<b>7 Technologies</b>	<b>16</b>
7.1 General	16
7.2 Drying	16
7.2.1 Direct dryers	16
7.2.2 Indirect dryers	20
7.2.3 Solar dryers	22
7.3 Hydrolysis	23
7.4 Incineration	24
7.4.1 Fluidized bed furnace	24
7.4.2 Multiple hearth furnace (MHF)	28
7.4.3 Hybrid furnace	31
7.4.4 Others	32
7.5 Pyrolysis	33
7.6 Gasification	33
7.7 Thermolysis	35
7.8 Carbonization	36

7.9	Wet oxidation .....	36
7.10	Melting .....	37
7.11	Pasteurization .....	39
7.12	Emerging technologies .....	40
7.12.1	General .....	40
7.12.2	Oxidation technologies .....	40
7.12.3	Enzymatic sludge hydrolysis .....	41
7.12.4	Plasma gasification .....	41
7.12.5	Ultrasound pretreatment .....	41
7.12.6	Microwave irradiation .....	41
7.12.7	Infrared radiation .....	42
7.13	Design aspects .....	42
7.14	Auxiliary equipment .....	42
7.14.1	General .....	42
7.14.2	Transport, receiving area, storage and feeding systems .....	43
7.14.3	Heat supply and recovery .....	43
7.14.4	Gas cleaning .....	44
7.14.5	Ash and other residues handling .....	44
7.14.6	Wastewater treatment .....	44
7.14.7	Process monitoring .....	44
7.14.8	Safety systems .....	45
<b>8</b>	<b>Operational aspects .....</b>	<b>45</b>
8.1	General .....	45
8.2	Drying .....	46
8.3	Hydrolysis .....	46
8.4	Incineration .....	46
8.4.1	General .....	46
8.4.2	Fluidized bed furnace .....	47
8.4.3	Multiple hearth furnace .....	48
8.5	Pyrolysis .....	49
8.6	Gasification .....	49
8.7	Thermolysis .....	49
8.8	Carbonization .....	49
8.9	Wet oxidation .....	49
8.10	Melting .....	50
8.11	Pasteurization .....	50
8.12	Hazards .....	50
<b>9</b>	<b>Management of energy and secondary resources .....</b>	<b>50</b>
9.1	General .....	50
9.2	Drying .....	51
9.3	Hydrolysis .....	51
9.4	Incineration .....	51
9.5	Pyrolysis .....	52
9.6	Gasification .....	53
9.7	Thermolysis .....	54
9.8	Carbonization .....	54
9.9	Wet oxidation .....	54
9.10	Melting .....	54
9.11	Pasteurization .....	54
9.12	Thermal treatments and circular economy .....	55
<b>10</b>	<b>Management of residues .....</b>	<b>55</b>
10.1	General .....	55
10.2	Flue gas .....	55
10.2.1	Characteristics and parameters .....	55
10.2.2	Equipment .....	57
10.3	Ashes .....	59
10.3.1	Composition/parameters .....	59

10.3.2	Processes and equipment .....	60
10.4	Wastewater .....	61
<b>11</b>	<b>Decommissioning of installations .....</b>	<b>61</b>
11.1	General .....	61
11.2	Specific considerations .....	61
<b>12</b>	<b>Co-management with other organic wastes .....</b>	<b>62</b>
12.1	General .....	62
12.2	Specific considerations .....	63
12.3	Additional storage and transport aspects .....	65
12.3.1	General .....	65
12.3.2	Storage .....	65
12.3.3	Transport .....	66
<b>13</b>	<b>Assessment of sustainability .....</b>	<b>66</b>
13.1	General .....	66
13.2	Environmental aspects .....	67
13.3	Economical aspects .....	67
13.4	Social aspects .....	67
<b>Annex A</b>	<b>(informative) Calorific values calculations .....</b>	<b>69</b>
<b>Annex B</b>	<b>(informative) Various systems to input sludge into a household waste incineration plant .....</b>	<b>70</b>
<b>Annex C</b>	<b>(informative) Case studies .....</b>	<b>72</b>
<b>Annex D</b>	<b>(informative) Regulatory aspects .....</b>	<b>86</b>
<b>Bibliography</b>	<b>.....</b>	<b>89</b>

## 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 documents 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](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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](http://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](http://www.iso.org/members.html).

## Introduction

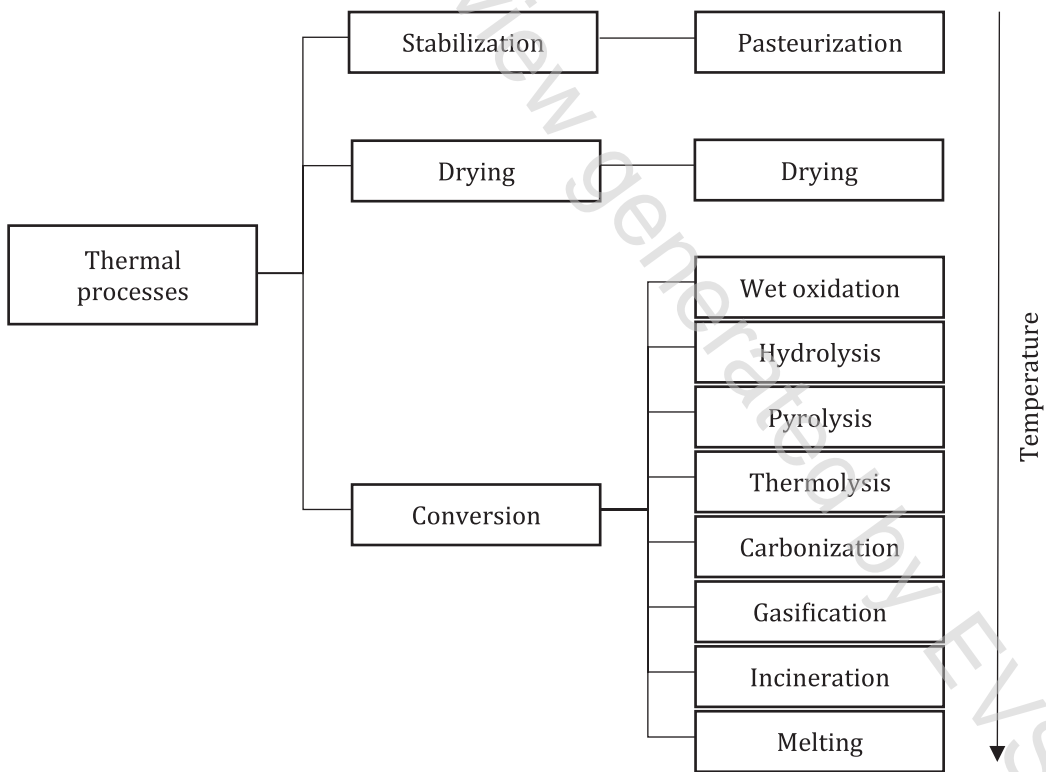
Sludge treatment and management is globally a growing challenge for most countries:

- sludge is a by-product of water treatment process produced in large quantities as new wastewater treatment facilities are built and the existing ones are upgraded to keep up with the population growth;
- sludge treatment and disposal constitutes one of the most significant costs associated with water and wastewater treatment;
- stricter regulations on conventional outlets such as beneficial agricultural land, composting, landfilling require more treatment due to concerns about the long-term impacts on public health and environment;
- sludge is now being considered as a source of renewable energy, and also a source of valuable components such as carbon and nutrients.

The growing trend to recover energy and resources from waste sludge and stricter regulations on outlets have created interest in a number of thermal treatments and may meet, under certain conditions, the circular economy principles.

The objective of this document is to pragmatically present the methods for thermal treatment of sludge by covering the different process fundamentals, the associated technologies and operational aspects, the management of energy, valuables and residues, the aspects related to impacts and integration of installations referring to them.

[Figure 1](#) highlights the thermal processes covered according to their main function and operating temperature.



NOTE The processes listed in the right column and connected to conversion and drying as main functions also achieve the sludge stabilization.

**Figure 1 — Thermal processes covered by this document**





# Sludge recovery, recycling, treatment and disposal — Guidance on thermal treatment of sludge

## 1 Scope

This document describes good practices for the incineration and other organic matter treatment by thermal processes of sludges.

Thermal conditioning is excluded.

This document applies to sludges specifically derived from:

- storm water handling;
- night soil;
- urban wastewater collecting systems;
- urban wastewater treatment plants;
- treating industrial wastewater similar to urban wastewater.

It includes all sludge that may have similar environmental and/or health impacts but excludes hazardous sludge from industry and dredged sludge.

## 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 terminological databases for use in standardization at the following addresses:

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

### 3.1

#### **melting**

thermal treatment which makes sludge or ash temperature raising over melting point of sludge inorganic substances

### 3.2

#### **drying**

thermal treatment for evaporating water from dewatered sludge to control water content by heating

### 3.3

#### **carbonization**

part of *pyrolysis* (3.4), focusing on production of a solid secondary resource so-called bio-charcoal