An Introduction to

Hazardous Waste Incineration

August, 23rd, 2022

UVP
Environmental Management and Engineering

Helga Stoiber

UVP Environmental Management and Engineering (1)

We are a **leading Austrian consulting and engineering company** in the field of waste management, with offices in Vienna, Linz, and Carinthia.

Since the 1990s, we have made the development and analysis of **sustainable waste management options** our responsibility.

Our company provides consulting and engineering services for waste treatment, recycling and recovery, industrial processes, wastewater treatment, air pollution abatement, energy efficiency, monitoring and remediation of landfills.

UVP Environmental Management and Engineering (2)

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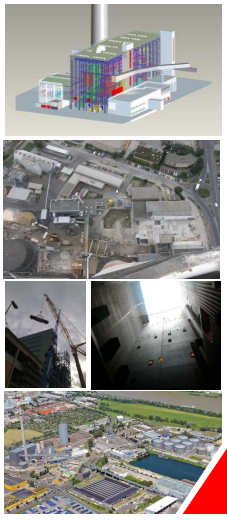
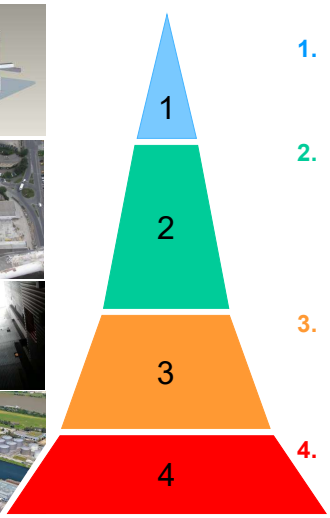
Consulting Engineering and Know-how Transfer for Waste Treatment based on BAT

Technical cooperation with local institutions and firms:





1. Concept
- Analyses of Status-Quo and Prognosis
- Master-Plan for Project Implementation
- General Concept for Project Design

2. Planning, Procurement
- Project Design
- Feasibility Study
- Environmental Impact Assessment
- Basic Engineering
- Tender Documents
- Evaluation of Bids

3. Construction
- Detail Engineering
- Project Control
- Training of Operating Personnel
- Supervision of Start-up

4. Operation
- Maintenance Supervision
- Environmental Audit

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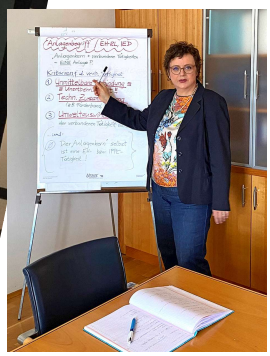
WtE Workshops, Trainings, Capacity Building (4)

Study Tours, Seminars, Lectures, Presentations, Trainings, Workshops, Capacity Building etc.



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White Book on Waste-to-Energy by UVP GmbH

Austria
2nd edition 2009 (German)
3rd edition 2015 (English)
Published by AT Ministry
of the Environment

Slovakia
1st edition 2020 (Slovakian)
Published by ewia a.s.

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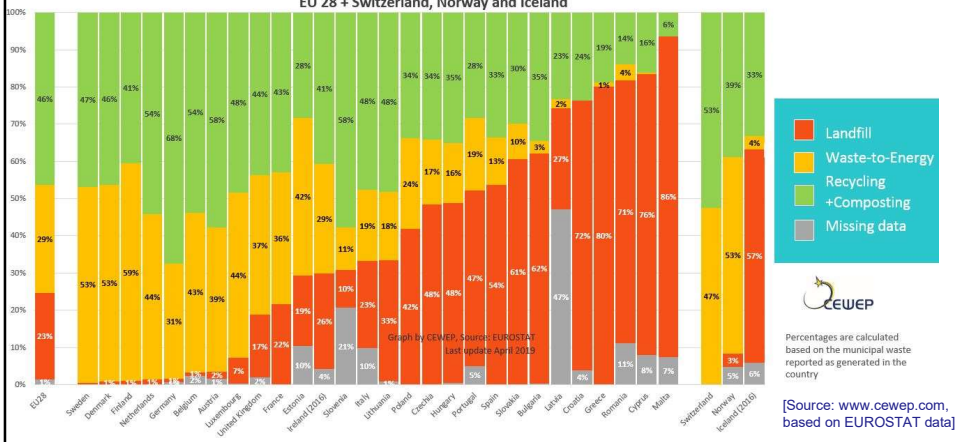
Basic Considerations

Municipal waste treatment in 2017

EU 28 + Switzerland, Norway and Iceland



[Source: www.cewep.com, based on EUROSTAT data]

Waste-to-Energy in Europe in 2017

- WtE Plants operating in Europe (not including hazardous waste incineration plants) : **492**
- Waste thermally treated in WtE plants (in million tonnes): **96**

Data supplied by CEWEP members and national sources

* Includes plant in Andorra and SAICA plant

[Source: www.cewep.com]

CEWEP Confederation of European Waste-to-Energy Plants

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Technology

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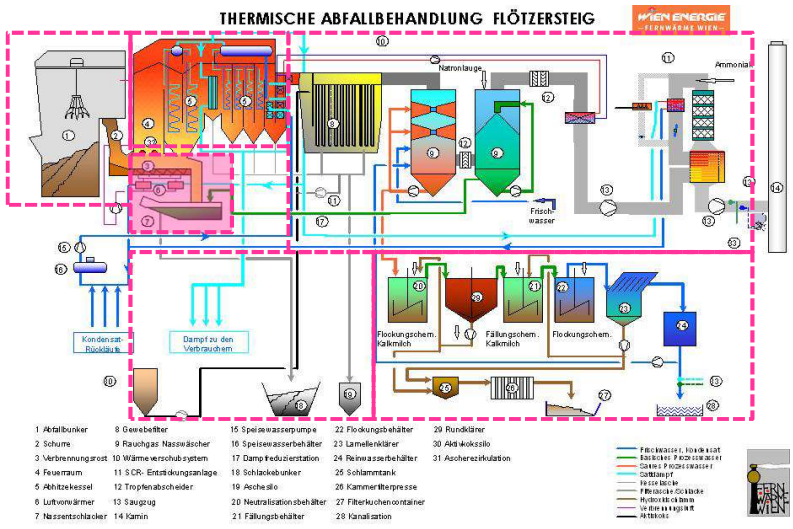


[Source: Wien Energie]

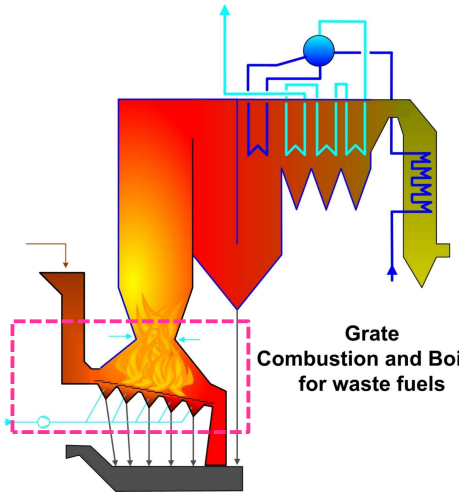
Incineration Technology

- **Grate Firing**
  Standard Process for MSW Incineration
  (Pre-treated) MSW, various waste fractions

- **Fluidized Bed Reactor**
  Bubbling Fluidized Bed (BFB)
  Circulating Fluidized Bed (CFB)
  Pre-treated MSW, various pre-treated waste fractions

- **Rotary Kiln**
  Hazardous Waste

Grate



[©UVP GmbH]

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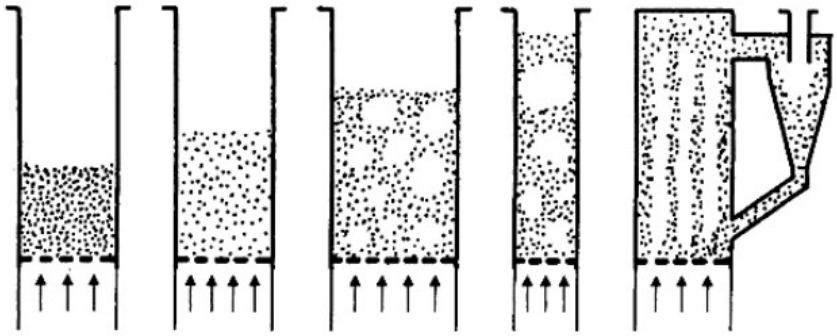
Fluidized Bed (1)



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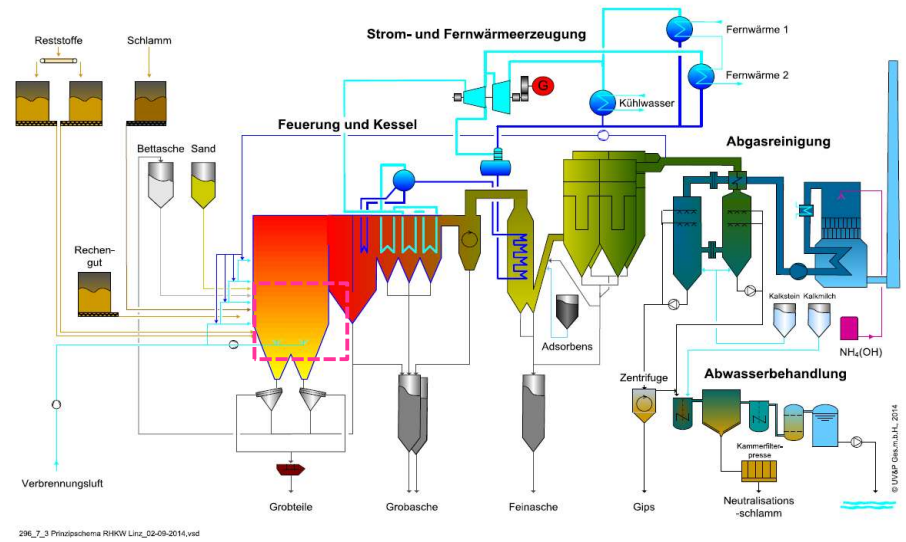
Fluidized Bed (2) – Bubbling FB (BFB)



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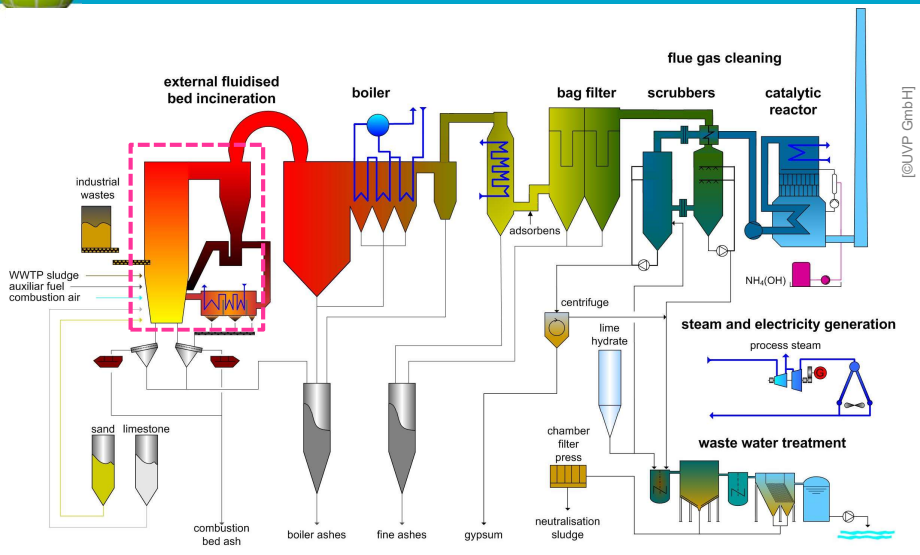
Fluidized Bed (3) – Circulating FB (CFB)



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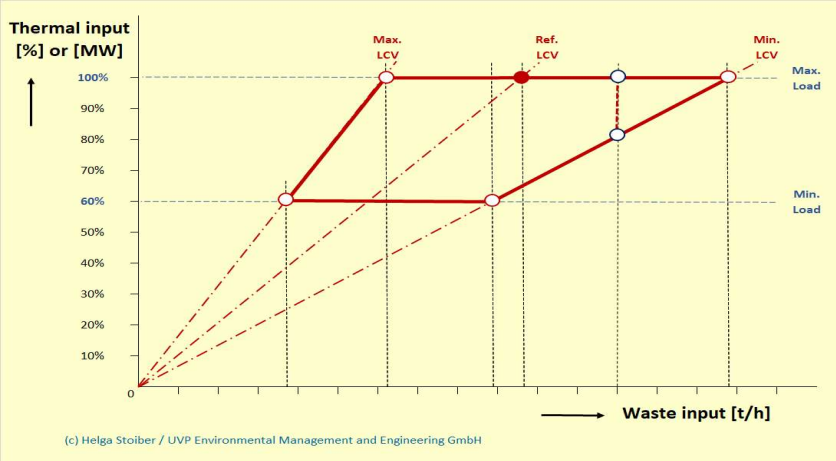
Operating Diagram of a WI Plant



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Techniques to reduce Air Emissions (1)

➢ **Cyclone**	➢ **Coarse Dust** **(no stand-alone de-dusting!)**
➢ **Baghouse filter (Textile filter)**	➢ **Dust,** Adsorbents from dry injection
➢ **Catalytic filter bags**	➢ **PCDD/F,** **NOx** (when NH_3 is added)
➢ **Electrostatic Precipitator (ESP)**	➢ **Dust**
➢ **Direct desulphurisation**	➢ **SOx** (by addition of Mg or Ca based adsorbents directly into the fluidized bed)
➢ **Boiler sorbent injection**	➢ **SOx, HCl, HF** (by injection of Mg or Ca based adsorbents into the post-combustion chamber

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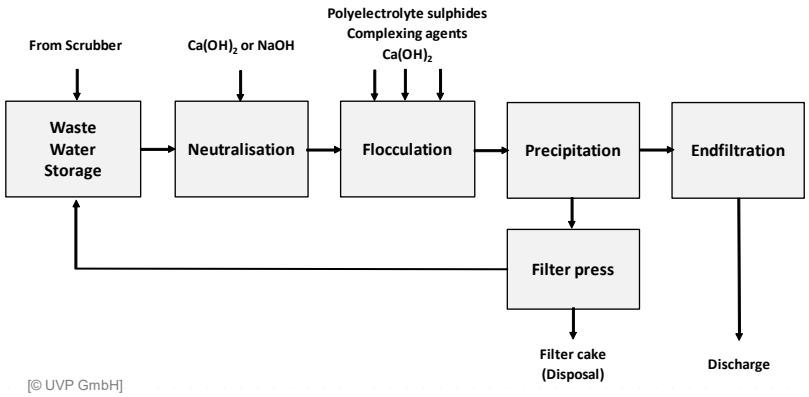
Techniques to reduce Air Emissions (2)

Dry sorbent injection	Injection of a dry sorbent into the flue gas **SOx, HCl, HF** - $Ca(OH)_2$, $NaHCO_3$ **PCDD/F, Hg(0)** - Activated carbon
Fixed bed or Moving Bed Adsorption	**Hg(0)** - Activated carbon, activated lignite...
Flue gas recirculation	**NOx** – Reduction of NOx formation by reducing the O_2 content in the furnace and by cooling
Selective non-catalytic reduction (SNCR)	Reduction of **NOx** by NH_3 injection into the flue gas at 800-1000 °C → N_2 formation
Selective catalytiv reduction (SCR)	Reduction of **NOx** by NH_3 injection into the flue gas at 200-400 °C in the presence of a catalyst → N_2 formation

Techniques to reduce Air Emissions (3)

Semi-wet absorber	**SOx, HCl, HF** - Injection of an alkaline aqueous solution into the flue gas, product is dry
Wet scrubber	**SO_2, HCl, HF, Hg(I, II)** - Water or aqueous solutions/suspensions of alkaline salts or lime are used as absorbent.

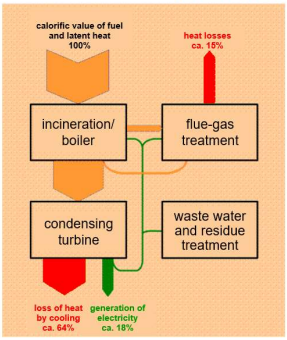
Waste Water Treatment After WI - Example



[© UVP GmbH]

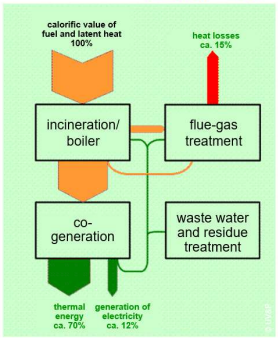
Site-specific Options for Energy Utilization

Condensing Turbine (electricity only)



Energy utilization approx. 20 %

Co-Generation (electricity + heat)



Energy utilization approx. 80 %

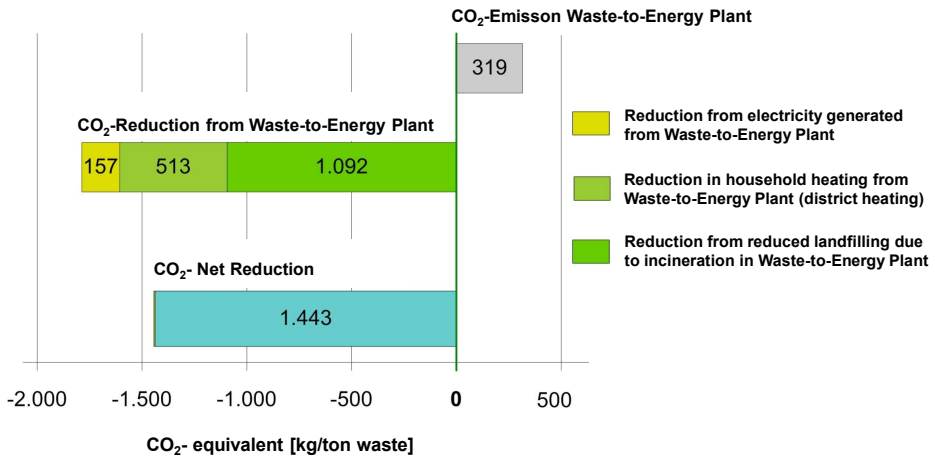
Site selection is crucial for energy efficiency!

Possible energy customers:

- **Process heat** (steam) for nearby industrial sites
- **District heating** for nearby municipalities
- **District cooling** for nearby municipalities
- Heat & electricity use in a nearby **seawater desalination** plant.

[© UVP GmbH]

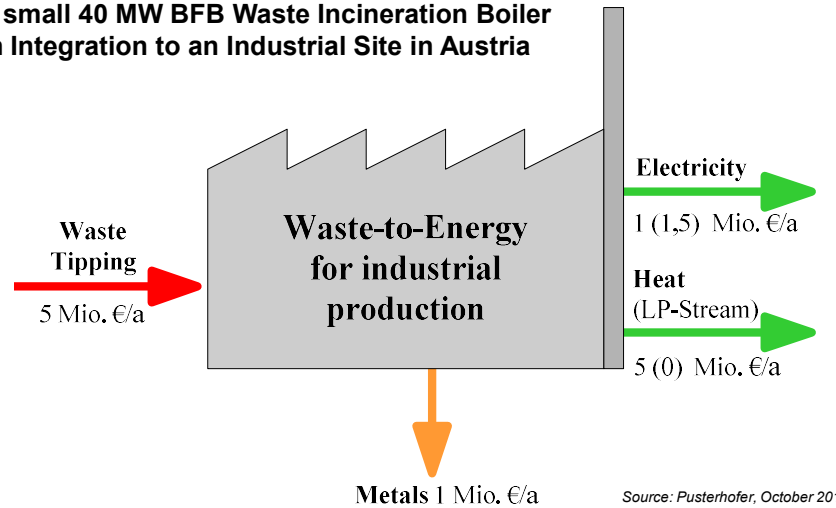
Reduction of Greenhouse Gas Emissions by Municipal Waste Incineration in Vienna



Source: Kirchner, IIR Conference: Efficient future Waste Treatment Technologies, 2008

Revenues - Example from Austria

Typical Revenues in 2014 for Waste-to-Energy in a small 40 MW BFB Waste Incineration Boiler with Integration to an Industrial Site in Austria



Source: Pusterhofer, October 2014

Hazardous Waste Incineration and Hazardous Substances from Waste Incineration

Hazardous Waste – Definition (1)

Annex III of the revised Waste Directive 2008/98 → Waste is classified as hazardous if it contains any of these 15 characteristics :

- HP 1 : Explosive
- HP 2 : Oxidising
- HP 3 : Flammable
- HP 4 : Irritant – skin irritation and eye damage
- HP 5 : Harmful
- HP 6 : Toxic
- HP 7 : Carcinogenic
- HP 8 : Corrosive

Hazardous Waste – Definition (2)

- HP 9 : Infectious
- HP 10 : Toxic for reproduction
- HP 11 : Mutagenic
- HP 12 : Release of acutely toxic gas
- HP 13 : Sensitising
- HP 14 : Ecotoxic
- HP 15 : Waste capable of exhibiting any of the above hazardous properties not directly exhibited by the original waste.

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Special Legal Requirements for Hazardous Waste Incineration: IED Art. 44 (2), „Permit Application“

2. In addition to the requirements set out in paragraph 1, the permit granted to a waste incineration plant or waste co-incineration plant using hazardous waste shall include the following:

(a) a list of the quantities of the different categories of hazardous waste which may be treated;

(b) the minimum and maximum mass flows of those hazardous wastes, their lowest and maximum calorific values and their maximum contents of polychlorinated biphenyls, pentachlorophenol, chlorine, fluorine, sulphur, heavy metals and other polluting substances.

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Special Legal Requirements for Hazardous Waste Incineration: IED Art. 46 (2), „Control of Emissions“

If in a waste co-incineration plant more than 40 % of the resulting heat release comes from hazardous waste, or the plant co-incinerates untreated mixed municipal waste, the emission limit values set out in Part 3 of Annex VI shall apply.

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Special Legal Requirements for Hazardous Waste Incineration: IED Art. 50 (2), „Operating Conditions“

If hazardous waste with a content of more than 1 % of halogenated organic substances, expressed as chlorine, is incinerated or co-incinerated, the temperature required to comply with the first and second subparagraphs shall be at least 1 100 °C.

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Special Legal Requirements for Hazardous Waste Incineration: IED Art. 52 (3), „Delivery and Reception of Waste“

3. Prior to accepting hazardous waste at the waste incineration plant or waste co-incineration plant, the operator shall collect available information about the waste for the purpose of verifying compliance with the permit requirements specified in Article 45(2).

That information shall cover the following:

(a) all the administrative information on the generating process contained in the documents mentioned in paragraph 4(a);

(b) the physical, and as far as practicable, chemical composition of the waste and all other information necessary to evaluate its suitability for the intended incineration process;

(c) the hazardous characteristics of the waste, the substances with which it cannot be mixed, and the precautions to be taken in handling the waste.

Special Legal Requirements for Hazardous Waste Incineration: IED Art. 52 (4), „Delivery and Reception of Waste“

4. Prior to accepting hazardous waste at the waste incineration plant or waste co-incineration plant, at least the following procedures shall be carried out by the operator:

(a) the checking of the documents required by Directive 2008/98/EC and, where applicable, those required by Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste (1) and by legislation on transport of dangerous goods;

(b) the taking of representative samples, unless inappropriate as far as possible before unloading, to verify conformity with the information provided for in paragraph 3 by carrying out controls and to enable the competent authorities to identify the nature of the wastes treated.

The samples referred to in point (b) shall be kept for at least 1 month after the incineration or co-incineration of the waste concerned.

PCDD/F (1)

WHAT ARE "DIOXINS"?

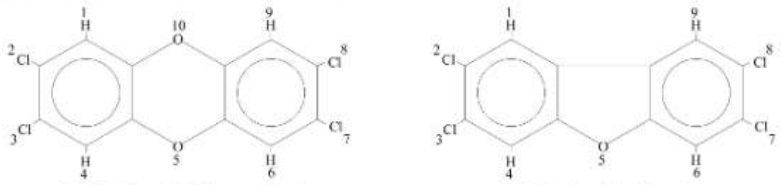
"DIOXINS" have become synonymous with environmental and health risks caused by extremely toxic POP Persistant Organic Pollutants ever since the chemical reactor accident in Seveso in 1976 and the subsequently published book "Seveso gibt es überall" ("Seveso is everywhere").

POLYCHLORINATED DIBENZODIOXINS (PCDDS) AND POLYCHLORINATED DIBENZOFURANS (PCDFS) – often simply referred to as "dioxins" and "furans" – can be found in the natural environment in varying concentrations, also in the atmospheric emission of incineration and smelting processes, in filter dust, cigarette smoke, in areas affected by bush and forest fires, in ambient and indoor air, in agriculturally used soil, in food, and even in human fat tissue.

DIOXINS AND FURANS are present in wastes such as residual municipal waste and sewage sludge and are usually destroyed during incineration. However, they can reappear in small concentrations during the cool-down phase following incineration ("de novo synthesis") and thus in the atmospheric emission from the stack.

PCDD/F (2)

Chemical structure of PCDD and PCDF

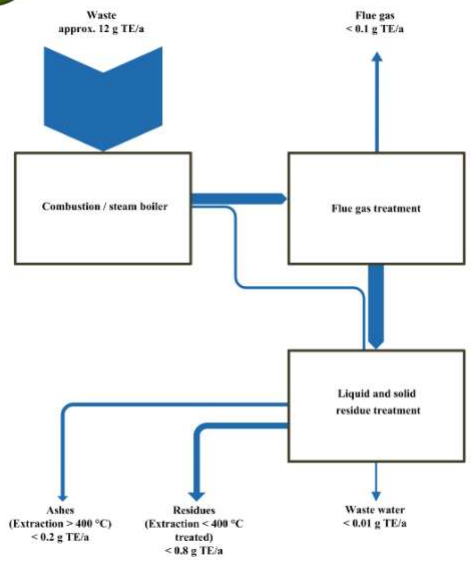


2,3,7,8 – Tetrachloridibenzo-o-Dioxin | 2,3,7,8 – Tetrachloridbenzofuran

Source: Umweltbundesamt, 2006

"DIOXIN VALUES" are indicated using an internationally accepted toxicity model which compares and evaluates the toxicity of the individual isomers against the 2,3,7,8-tetrachlorodibenzo-p-dioxin.
The legal limit value for emissions of dioxin and furan compounds of 0.1 nanograms of TE per standard cubic meter relates to the weighted figure for toxicity equivalents (TE). One nanogram (ng) is one billionth of a gram, or 0.000000001 grams. The emission limit for "dioxins" is also the reference parameter for halogenated and non-halogenated organic substances of a higher molecular weight such as PCBs (polychlorinated biphenyls), PAHs (polycyclic aromatic hydrocarbons) and possibly other POPs.

PCDD/F Balance over a MSWI



The sum of the dioxin emissions is just a fraction of the amount of dioxin contained in non-treated waste

Source: UV&P, 1994

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Thank you for your Attention!

Helga STOIBER
Senior Partner
helga.stoiber@uvp.at

Albert ZSCHETZSCHE
Technical Director
albert.zschetzsche@uvp.at

Heimo ZIMMERMANN
CEO
heimo.zimmermann@uvp.at

Think Globally • Work Locally

A-1020 Vienna,
Lassallestrasse 42 / 12a,
Austria
http://www.uvp.at

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