

# Review of Available Technology for Co-combustion of Medical Waste in WTE Plants

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## Executive Summary

Hospital and medical wastes are disposed in tens of thousands of dedicated incinerators or are autoclaved to destroy pathogens and then landfilled. However, over a hundred cities which have waste to energy (WTE) power plants fueled by municipal solid waste (MSW), use these plants to co-combust medical wastes. This report identified forty-one such plants, located in a dozen nations, which in total co-combust 3.75 million tons of MSW and about 90,000 tons of medical waste annually (2.4% of the MSW). Generally, the medical wastes are collected at the point of origin in puncture resistant, leakproof and sealed containers which are transported to WTE plants and are transferred and introduced to the furnace by a separate electromechanical system which is described in this paper. Three technology providers of these systems are introduced. The report concludes with a description of dedicated medical waste incinerators which can be located at a WTE plant and utilize a common air pollution control (APC) system.

## 1. Introduction

The risks associated with the handling of medical waste can generally be reduced by avoiding contact with the waste and ensuring good storage conditions through the use of: dedicated containers and the provision of washing/disinfection facilities; sealed and robust combustible containers, e.g. for sharps and biological hazard materials; automatic furnace-loading systems, e.g. dedicated bin lifts; segregated storage and transfer areas (especially where co-incineration with other wastes takes place); refrigerated or freezer storage, if required (Neuwahl et al).

The technology providers listed in the following sections were contacted for further details; additional information received will be used to update this report.

## 2. List of Existing Plants

Table 1: WTE Guidebook from July 2015 (Table 7); 41 Co-combustion plants of medical wastes used in Europe (ISWA, 2004)

<b>Country, plant name/location</b>	<b>Medical waste treated (ton/year)</b>	<b>Percent of annual MSW capacity</b>
Austria, Zwentendorf	800	0.25
Belgium, Brugge	3525	2.02
Belgium, Gent	475	0.50
Belgium, Houthalen	1700	2.46
Belgium, Thurmaide	22157	8.53
Czech Republic, Brno	250	0.24
Denmark, Århus	361	0.20
Denmark, Hjørring	479	0.78
Denmark, København	1942	0.48
Denmark, Svendborg	400	0.74
France, Douchy les Mines	530	8.98
France, Villefranche sur Saône	287	0.37
Germany, Kempten	514	0.67
Germany, Krefeld	1263	0.36
Germany, Neustadt	668	1.12
Germany, Völklingen	2270	1.08
Great Britain, Shetland Islands	16	0.07
Italy, Cremona	529	0.81
Italy, Desio (MI)	3152	6.43
Italy, Ferrara	613	2.99
Italy, Granarolo Emilia (BO)	2481	1.35
Italy, Melfi PZ	2000	4.26
Italy, Modena	5000	4.10
Italy, Ospedaletto (PI)	3525	6.08
Italy, Padova	2992	4.96
Italy, Piacenza	750	0.67
Italy, Ravenna	9	0.01
Italy, Rufina/Pontassieve	31	0.31
Italy, Schio (VI)	700	8.18
Italy, Terni	200	4.44
Italy, Valmedrara (LC)	5600	8.99
Italy, Vercelli	2600	4.42
Netherlands, Amsterdam	9733	1.11
Norway, Bergen	1300	1.24
Norway, Frederikstad	760	0.95
Norway, Lenvik	120	2.38
Norway, Oslo (Klemetsrud)	1677	1.13
Norway, Spjelkavik	210	0.61
Sweden, Karlskoga	200	0.47
Sweden, Malmö	1700	0.44
Switzerland, Lausanne	6000	5.00
<b>Total medical wastes co-combusted:</b>	<b>89,519 tons</b>	<b>2.40 %</b>

Table 2: Another WTE co-combusting medical wastes in Germany

Country, Plant name/location	MSW and medical waste treated (ton/year)	Contact info
Germany, Abfallheizkraftwerk der MVA Bielefeld-Herford GmbH, Bielefeld-Heepen	400,000 and 2,000 (0.5% of MSW)	info@interargem.de

### 3. Regulations Related to Healthcare Waste

Table 3: Collection and disposal of different categories of medical wastes

No.	Health Care Waste	Collection	Disposal
1	Infectious health-care waste (Waste containing pathogens which can be disseminated in the environment and pose infectious risk to population)	Immediate collection at the point of origin in proofed containers, flagged with biohazard symbol. Container (hospital box) with inert double plastic bag (strong, leak proof, puncture proof)	Hazardous/Medical waste Incineration  Alternate technique: autoclave sterilization, microwave or advanced steam treatment.
2	Sharps (Needles, scalpels, lancets, infusion sets, broken vials and ampoules)	Collection at the point of origin in puncture resistant, leakproof and closable containers	Medical/Municipal waste incinerator.
3	Anatomical and pathological waste (body parts, etc.)	At the point of origin in leak proof and closable container, refrigerated or frozen storage necessary < 15oC	Incineration Alternative techniques: advanced steam (autoclave) or microwave treatment with internal shredding, alkaline hydrolysis
4	Chemical, toxic or pharmaceutical waste, including cytotoxic drugs (antineoplastics) (mostly hazardous)	Separate collection at the point of origin in proofed containers, flagged with danger symbol	Return to pharmacies  Toxic: Incineration Non toxic: Route of general waste
5	Radioactive waste	Collected in lead box (Emmanuel 2012)	Treated as per national guidelines for radioactive waste
6	General non-infectious waste (e.g. glass, paper, packaging material, food).	Collected in plastic bag or container	Treated with general waste

Sources for information in Table 3

<https://susproc.jrc.ec.europa.eu/activities/emas/documents/WasteManagementBEMP.pdf>

Health care waste management in Germany, [www.ijic.info](http://www.ijic.info), ISSN:1996-9783

Guidelines on Best Available Techniques, relevant to Article 5 and Annex C of the Stockholm Convention on Persistent Organic Pollutants.

### 4. Collection, Storage and Transportation of Healthcare Waste

For the collection, storage, transportation and disposal of health care waste special requirements concerning hygiene and personal safety need to be observed, to avoid the potential danger caused by the hazardous components it may contain. Reference to the collection requirements is made in the descriptions given below for each specific waste. Main concerns are the strict separation of the

different waste components, especially the source separation of sharps, the separate collection of waste from cytostatic drugs, the source segregation of infectious material from any other waste, the safe storage and transportation, and the material specific treatment and disposal. Table 4 lists the companies providing collection, transportation and incineration equipment for medical wastes in Germany ((waste incinerator Companies and Suppliers in Germany | Environmental XPRT 2020)

Table 4: List of companies in collection of medical waste

Name of Company	Product	Website	Details/ Comments	Contact Info
Alex Breuer GmbH, Germany	GBOX Dangerous Goods Packaging, Labelling, Healthcare + Biotech Special, Testing Services	<a href="https://www.alexbreuer.de/dangerous-goods-packaging/dangerous-goods-boxes/?lang=en">https://www.alexbreuer.de/dangerous-goods-packaging/dangerous-goods-boxes/?lang=en</a>		<a href="mailto:Info@alexbreuer.de">Info@alexbreuer.de</a>
CMK-Logistik, Germany	Pharma- and Healthcare Logistics	<a href="https://www.worldcourier.com/solutions-clinical-trial-logistics">https://www.worldcourier.com/solutions-clinical-trial-logistics</a>	CMK specializes in infectious substances of class 6.2 ADR of all classifications, as well as the transport of genetically modified organisms and microorganisms.	
World Courier, Norway	Pharma- and Healthcare Logistics	<a href="https://www.worldcourier.com/">https://www.worldcourier.com/</a>		<a href="https://www.worldcourier.com/contact-us-home">https://www.worldcourier.com/contact-us-home</a>
Trans o Flex, Germany	Pharma- and Healthcare Logistics	<a href="https://www.trans-o-flex.com/branchen/pharma/">https://www.trans-o-flex.com/branchen/pharma/</a>		



**Picture 1**

Hazardous Waste  
(Sterilization)



**Picture 2**

Hazardous Waste  
Incineration



**Picture 3**

Container for sharp objects

Figure 1: Packaging devices for healthcare waste  
Source: EMAS and Information Technology in Hospitals

## 5. Introducing Medical Waste into the WTE Furnace

The medical waste bags are transported in special vehicles to the WTE plant, where they are not mixed with other waste. They are loaded mechanically into a conveyer system that elevates the sealed bags to the hopper of the WTE furnace. The medical waste bags are loaded into the furnace through a separate loading system with airlocks. The airlock helps to prevent the possibility of fugitive emissions in the loading area. However, the co-combustion of medical waste with municipal solid waste can be carried out without a separate loading system: for example, an automatic loading system can be used to put the medical waste directly into the feed hopper with the municipal solid wastes (MSW).

National regulations sometimes limit the ratio of medical waste that may be treated in combined incineration (e.g. in France, it has to be less than 10 % of the total thermal load). However, the flue-gases from the different wastes are then treated in the common air pollution control (APC) system. (Neuwahl et al.). Figure 2 is a schematic diagram of the loading system for introducing medical wastes into the WTE furnace (e.g at the Piazenza WTE in Italy).

1. Elevator for lifting medical waste bags
2. and 3
3. Dual bell system for introducing bags to the furnace
4. Gravity-fed introduction of bags into the furnace chamber

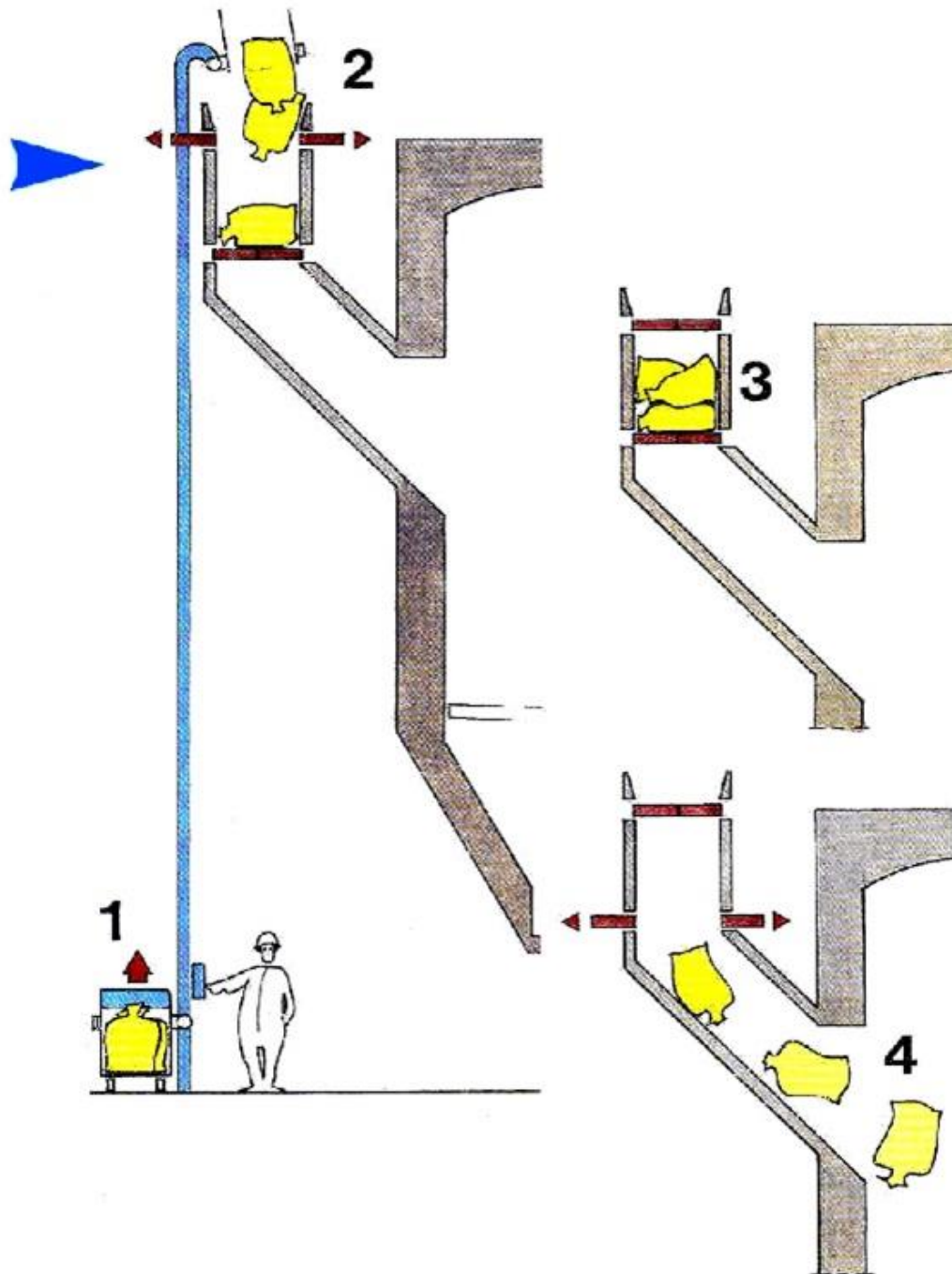


Figure 2: Types of systems used to load medical wastes into the WTE furnace  
 Source: (Neuwahl et al.)

Table 5 shows companies providing systems for loading medical wastes in WTE furnaces.

Table 5: List of technology providers of loading systems

Name of Company	Product	Website	Details/ Comments	Contact Info
Michaelis Environment Technology Group, Germany		<a href="https://michaelis-systems.de/en/produkte/verbrennung">https://michaelis-systems.de/en/produkte/verbrennung</a>	The future-proof furnace type must be able to accept a wide variety of fuels. In addition, decentralized systems will increasingly be the first choice. Michaelis has developed and patented a feed system for these requirements.	<a href="mailto:info@michaelis-systems.de">info@michaelis-systems.de</a>
Matthews Environmental Solutions, UK	Ram Loader	<a href="https://www.todayswastematerials.com/waste-incineration/incinerator-specification/auto-loading/">https://www.todayswastematerials.com/waste-incineration/incinerator-specification/auto-loading/</a>	Supplies a ram loader is a hydraulically driven loading device designed to power the waste into the incinerator via an interlocked hydraulic charge door. For large plant installations and intensive operations, we offer a range of automatic options that are designed to reduce the necessity for manual loading	<a href="mailto:sales@matwuk.com">sales@matwuk.com</a>
Inciner8, UK	Auto Loaders	<a href="https://www.inciner8.com/autoloaders.php">https://www.inciner8.com/autoloaders.php</a>	The chute loading mechanism is driven by a powerful hydraulic ram, delivering a measured waste load into the main combustion chamber at 750°C. This is achieved through a pre-set cycle of around 20- 30 seconds per load, creating a managed mechanical flow of waste into the incinerator	Through request form

## 6. Air Pollution Control (APC) Systems

Modern WTE plants are equipped with Air Pollution Control systems that must meet the very stringent EU standards. For example, the EU dioxin standard is 0.1 nanogram of TEQ dioxins per standard cubic meter of stack gas. These APC systems can easily handle the additional load of medical wastes co-combusted with MSW.

## 7. Dedicated Medical Waste Incinerators

This section provides information on companies that provide small medical waste incineration furnaces

Table 6: Providers of medical waste incinerators

Name of company	Product	Website	Details/ Comments	Contact Info
IFZW International, Germany	Medical waste incinerator systems with or without filter technology	<a href="https://www.ifzw.de/index.php?id=20&amp;L=1">https://www.ifzw.de/index.php?id=20&amp;L=1</a>	Manufactures Medical waste incineration systems. Haven't found something on attachments for co-incinerations, will be worth calling and inquiring.	<a href="mailto:info@ifzw.de">info@ifzw.de</a>
Michaelis Environment Technology Group, Germany			The future-proof furnace type must be able to accept a wide variety of fuels. In addition, decentralized systems will increasingly be the first choice. Michaelis has developed and patented a feed system for these requirements.	<a href="mailto:info@michaelis-systems.de">info@michaelis-systems.de</a>
Ruppmann Verbrennungs				<a href="http://www.ruppmann.de">www.ruppmann.de</a>

anlagen Stuttgart, Germany				
Atlas Incinerators ApS	Transportable Containerized Incinerators	<a href="https://www.environmental-expert.com/companies/atlas-incinerators-aps-32023/">https://www.environmental-expert.com/companies/atlas-incinerators-aps-32023/</a>	Our design and engineering team have always focused on easy to operate designs, so the typical maintenance headaches incinerators often have with items like filters and exhaust fans do not exist on our incinerators. Our incinerators are also the most environmentally friendly designed marine incinerators, thanks to our unique three chamber design.	<a href="mailto:atlas@atlasinc.dk">atlas@atlasinc.dk</a>
FOR.TEC. FORNITURE TECNOLOG ICHE S.R.L., Italy	For. Tec. - Model EXCE OS - Hospital and Industrial Waste Incinerators	<a href="https://www.environmental-expert.com/products/for-tec-model-exce-os-hospital-and-industrial-waste-incinerators-294576">https://www.environmental-expert.com/products/for-tec-model-exce-os-hospital-and-industrial-waste-incinerators-294576</a>	Every EXCE OS oven has a gas post-combustion chamber, fabricated to respect working parameters imposed by the REGULAMENTATION 2000/76/EC, such as: - Working temperature: >850 °C > 1100 °C according to waste category - Working temperature: >850 °C > 1100 °C according to waste category - Time contact gas: 2 seconds - Free oxygen level: 6% - Easy installation and maintenance	<a href="mailto:info@fortec-inceneritori.it">info@fortec-inceneritori.it</a>
TECAM Environment Technology Efficiency, Spain	Tecam Group - Waste Incineration Systems for Hazardous Waste	<a href="https://www.environmental-expert.com/products/tecam-group-waste-incineration-systems-for-hazardous-waste-312067">https://www.environmental-expert.com/products/tecam-group-waste-incineration-systems-for-hazardous-waste-312067</a>	Tecam Group designs, assemblies and installs equipment for Industrial Waste Incineration and Pyrolysis, specifically, static and rotary kilns and incineration plants to eliminate different nature of waste (solid waste, liquid waste and sludge) in one same kiln from municipal and industrial origin. Waste Incineration technology can be installed in several industries to treat hazardous waste, refining residues, chemical waste, pharmaceutical waste, hospital & medical waste, waste water plant sludge, NORM (natural radioactive) waste, etc.	<a href="mailto:info@tecamgroup.com">info@tecamgroup.com</a>
Dutch Incinerators BV, Netherlands	Rotary Kiln, Mobile and Stationary Incinerator	<a href="https://www.environmental-expert.com/companies/dutch-incinerators-bv-88094/products">https://www.environmental-expert.com/companies/dutch-incinerators-bv-88094/products</a>	Dutch Incinerators is an EPC-contractor, dedicated to the engineering, procurement, construction, installation and commissioning of turnkey solutions for thermal waste processing and waste handling infrastructures on an industrial scale.	Through request form
ATI Environment, France	Model HP - Incinerators	<a href="https://www.environmental-expert.com/companies/ati-environnement-78080/products">https://www.environmental-expert.com/companies/ati-environnement-78080/products</a>	ATI ENVIRONNEMENT designs and manufactures incinerators for waste treatment and filtration system. We are specialized in treatment of hospital and industrial wastes.	Through request form
Incinco Limited, United Kingdom	kiln and incinerator manufacturer	<a href="https://www.incinco.com/medical-and-medical-waste">https://www.incinco.com/medical-and-medical-waste</a>		<a href="mailto:enquiries@incinco.com">enquiries@incinco.com</a>



INCINCO, Japan

Type of Technology: Reciprocating or riddling grate dual-chamber incineration

Process Description: The Incinco incinerators are dual-chamber incinerators fueled by oil, gas or LPG. The incinerators can be manually or automatically fed via auto feeder (ram loader) and can be supplied with an automatic bin tipper system. They have an ash grate and trolley for easy deashing and the larger units are fitted with reciprocating and riddling grates which can also incorporate a submerged ash conveyor allowing automatic ash removal. The secondary chamber has a full two-second residence time at temperatures in excess of 1400°C. The operation is automated. Incinco's hospital incinerators range in size from 25 kg/hr to over 2000 kg/hr.

To meet emissions regulations, Incinco provides a range of flue gas cleaning equipment from wet scrubber systems to fully integrated ceramic pod dry filtration systems. Incinco also provides a full range of monitoring equipment for real time information on emissions. Some of the incinerators installed in developing countries do not have air pollution control devices capable of meeting the Stockholm Convention guidelines.

Incinco has supplied 10,000 incinerators worldwide since 1922. Some are found in Algeria, Bangladesh, Ethiopia, Ghana, Iraq, Kosovo, Libya, Nigeria, Pakistan, Qatar, Seychelles, Sri Lanka, UK, and Vietnam.

Waste heat recovery systems provide either hot water or steam via a single or double pass tube boiler. Boilers are integrated within the overall unit structure and are commonly used as a method of heat reduction before gas cleaning.

Incinco is a kiln and incinerator manufacturer founded in 1922. Contact Information: Incinco Limited, United Kingdom Email: [enquiries@incinco.com](mailto:enquiries@incinco.com), [www.incinco.com](http://www.incinco.com) (Emmanuel 2012)

Medical waste incinerators may generate more hydrochloric acid than municipal solid waste, so flue gas cleaning systems must be adjusted accordingly. Exhaust and flue gases from the incineration must be appropriately treated and cleaned and protective measures must ensure that no health risks or any negative impacts on sensitive media such as the soil, ground water or sites of special value do occur (Emmanuel 2012).

Table 7 List of technology providers for Flu-gas treatment

Name of Company	Product	Website	Details/ Comments	Contact Info
ERG (Air Pollution Control) Ltd, UK	Automatic packages	<a href="https://www.environmental-expert.com/products/erg-solid-waste-incineration-systems-444508">https://www.environmental-expert.com/products/erg-solid-waste-incineration-systems-444508</a>	Features Include: Automatic load & de-ash units available, 40-1000 kg/hr unit, batch or continuous operation on larger units offered, Integral control panel with remote mounting option	<a href="mailto:info@ergapc.co.uk">info@ergapc.co.uk</a>

## 8. References

Major principles, approaches and techniques for managing healthcare and hospital waste are provided. In the publications of:

- World Health Organization (WHO):

"Safe management of wastes from health-care activities" 2nd edition (2014)

"WHO core principles for achieving safe and sustainable management of health-care waste" (2007)

- United Nations Environment Programme (UNEP)

"Compendium of Technologies for Treatment/Destruction of Healthcare Waste" (2012)  
(waste incinerator Companies and Suppliers in Germany | Environmental XPRT 2020)

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[http://wedocs.unep.org/bitstream/handle/20.500.11822/8628/IETC\\_Compndium\\_Technologies\\_Treatment\\_Destruction\\_Healthcare\\_Waste.pdf?sequence=3&isAllowed=y](http://wedocs.unep.org/bitstream/handle/20.500.11822/8628/IETC_Compndium_Technologies_Treatment_Destruction_Healthcare_Waste.pdf?sequence=3&isAllowed=y).

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Themelis, N. J.; Diaz Barriga, M. E.; Estevez, P.; Velasco, M. G. (2013): Guidebook for the Application of Waste to Energy Technologies in Latin America and the Caribbean

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