Technical Session
on
Healthcare Waste Management
- Treatment of infectious and sharp waste -

Global Learning Event – WASH in hcf in Kathmandu
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Incineration

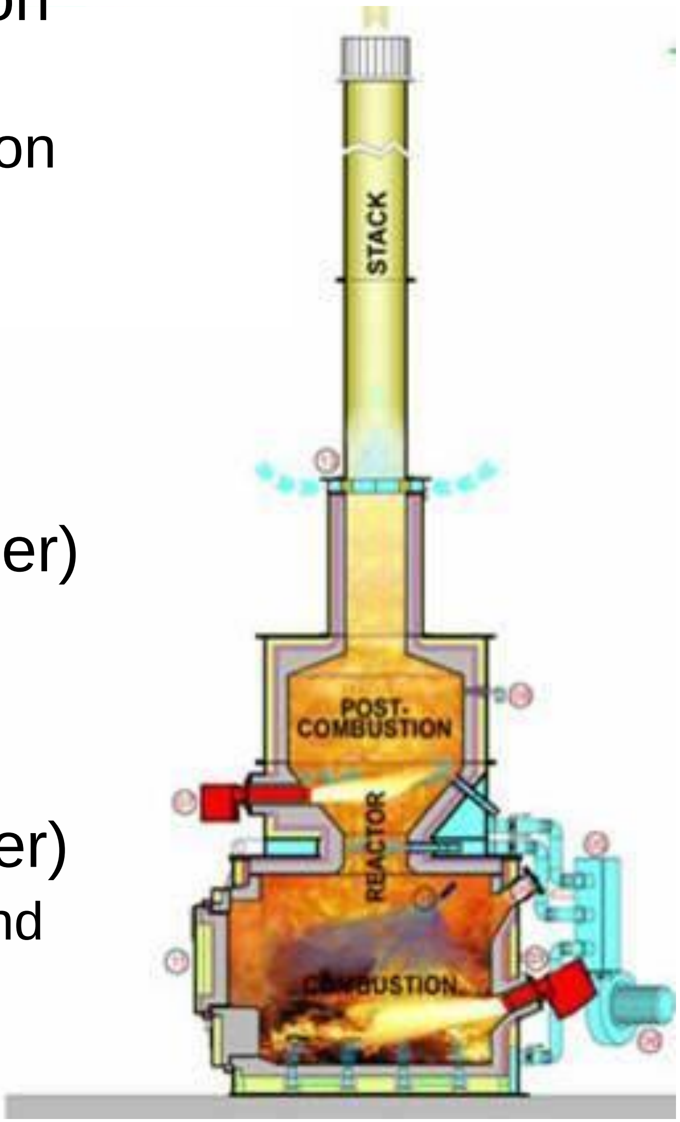
Incineration and incineration can often not be easily compared. A clear distinction must be made between simple field incinerators and high-tech, central household waste or special hazardous waste incinerators.

De-Montfort Incinerator

Waste treatment center, Augsburg with houshold waste and special waste incinerator.

Incineration process

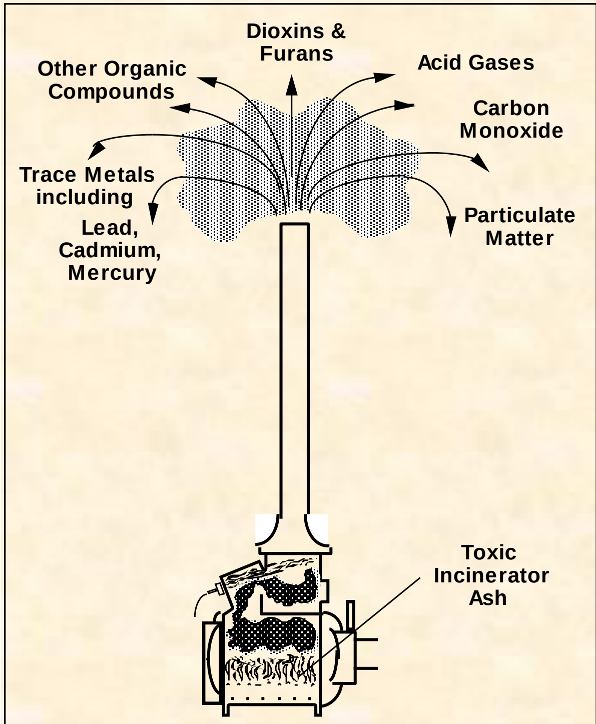
- Three main factors for the incineration process - “3 T's“:
  - Time waste remains in the combustion chamber,
  - Temperature of incineration,
  - Turbulence of air and gasses in the combustion chamber.
- Primary combustion (primary chamber)
  - Decomposition of all combustibles
  - Gasification / partial combustion
  - Burning of carbon
- Post combustion (secondary chamber)
  - Complete combustion of all unburned and partially burnt waste into gas form
  - Destruction of pathogens



Emission rates factors

Emission rates from incinerators are variable and depend highly on:

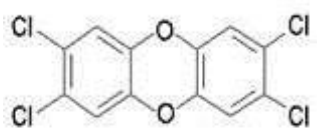
- Kind of waste to be incinerated (often very wet),
- Correct operation (often problems due to lack of operator's training),
- Combustion process, often problems cause:
  - Low temperatures (<800 C)
  - Short residence times (< 1 second)
  - Low turbulence
- Maintenance and repair
- Pollution controls

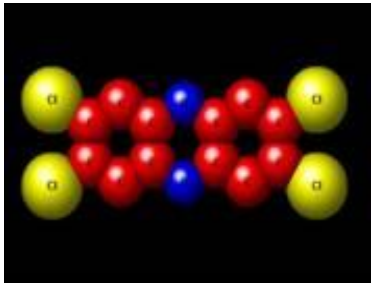


Dioxin and Furans

Dioxin generation:

- Dioxin has no commercial use. It is a toxic waste product formed when waste is burned and when other organic chemicals that contain chlorine are present (e.g. PVC).
- It is formed when flue gas is cooled down to a temperature of around 450 to 200°C.
- Hazards
  - bio-accumulative and are highly toxic.
  - can cause reproductive and developmental problems,
  - damage the immune system,
  - interfere with hormones and
  - cause cancer.





Disposal of fly and bottom ash

- Needles and glass do often not burn and are a physical risk during the disposal.

- The incinerator ash may content heavy metals and other toxic items.
- The ash provides ideal conditions for the synthesis of PCDD/PCDF as it often stays for a long times in the temperature range of 200-450 °C.
- Incinerator ash from incinerators should not be disposed of on unsecured landfills and fly ash must be disposed of in hazardous waste landfills.

Stockholm Convention

- Stockholm Convention on Persistent Organic Pollutants (POPs): 180 member countries
  - Countries have to take measures to further reduce releases of dioxins and furans "with the goal of their continuing minimization and, where feasible, ultimate elimination."
  - Source with "the potential for comparatively high formation and release" of dioxins & furans: Medical Waste Incinerator
    - "[P]riority consideration should be given to alternative processes, techniques or practices that have similar usefulness but which avoid the formation and release of … [dioxins and furans]."

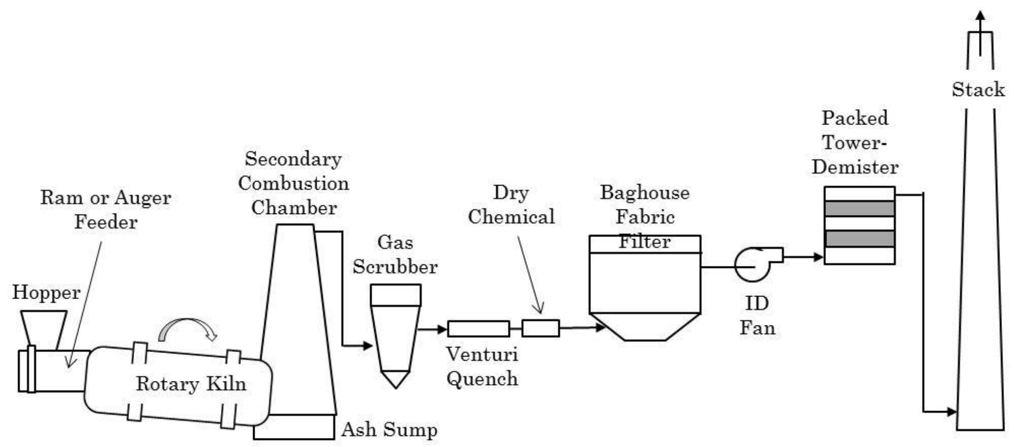
Stockholm and Basel Convention

- Health care waste management practices seek to implement
  - environmentally sound management of hazardous waste or other waste (ESM) ,
  - Best Environmental Practices (BEP) and
  - Best Available Techniques (BAT) in accordance with the Basel and Stockholm Conventions and relevant national regulations and requirements.

Emission control Stockholm Convention

- Best Available Technology (BAT)
  - emission of lower than 0.1 ng Toxic Equivalents (TEQ) /m³ of dioxins and furans.
  - primary measures for incinerators are two burning chambers (850 °C / 1100°C),
  - auxiliary burner
  - 2 seconds' residence time of air in the 2nd chamber,
  - sufficient oxygen conter
  - high turbulence of

    exhaust gases.

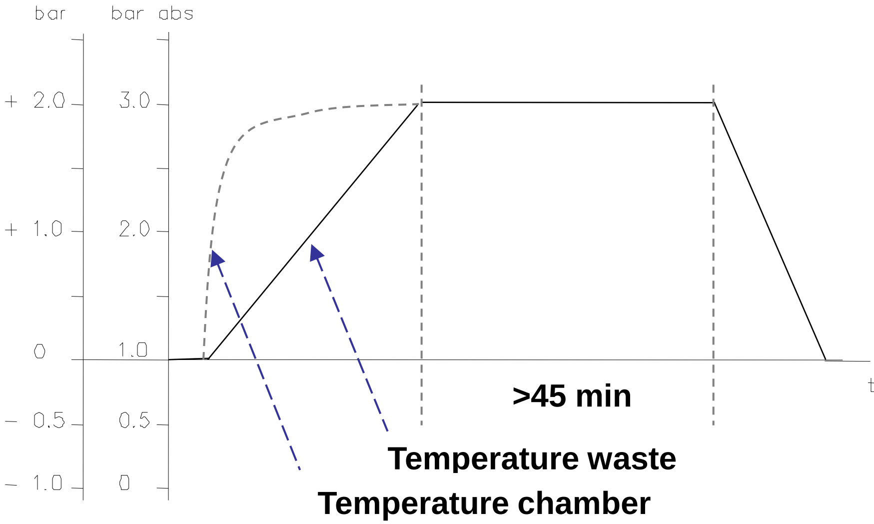


Alternative non-burn treatment techs

- Non-Burn Thermal Technologies
  - Autoclaves
  - Hybrid Steam System
  - Microwave Units
  - Frictional Heat Treatment
- Chemical Technologies
  - Alkaline Hydrolysis

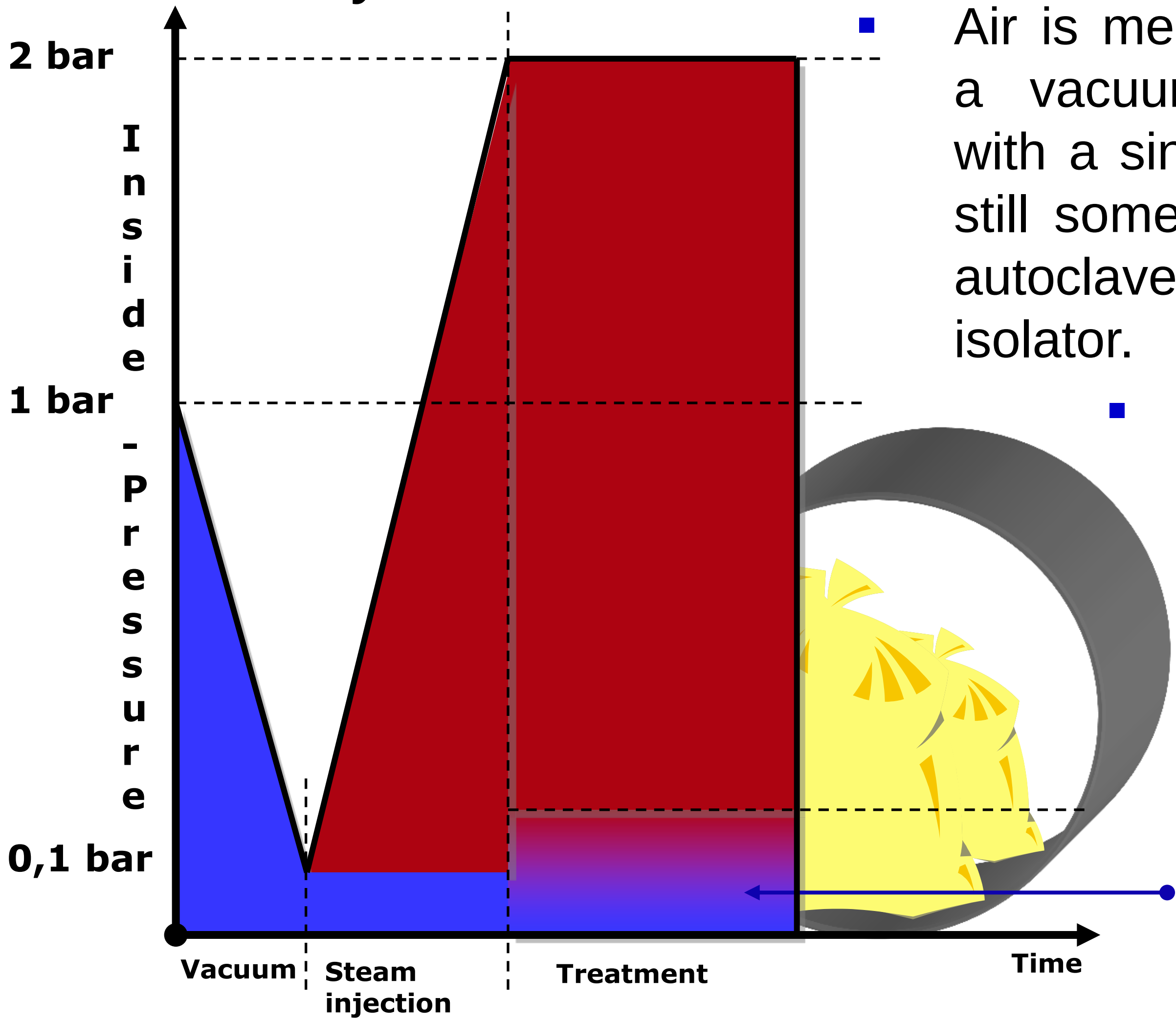
Autoclave: Non-vacuum gravity systems

- Process cycle - gravity autoclave:
  - Steam is inserted until air is removed,
  - Air is removed via valves due to the density difference of air and steam,
  - Needs long treatment time due to still existent “cold islands”,
  - Long process time (norm. >2h) due to long pre-heat and cool down phase.



Autoclave: Pre-vacuum systems

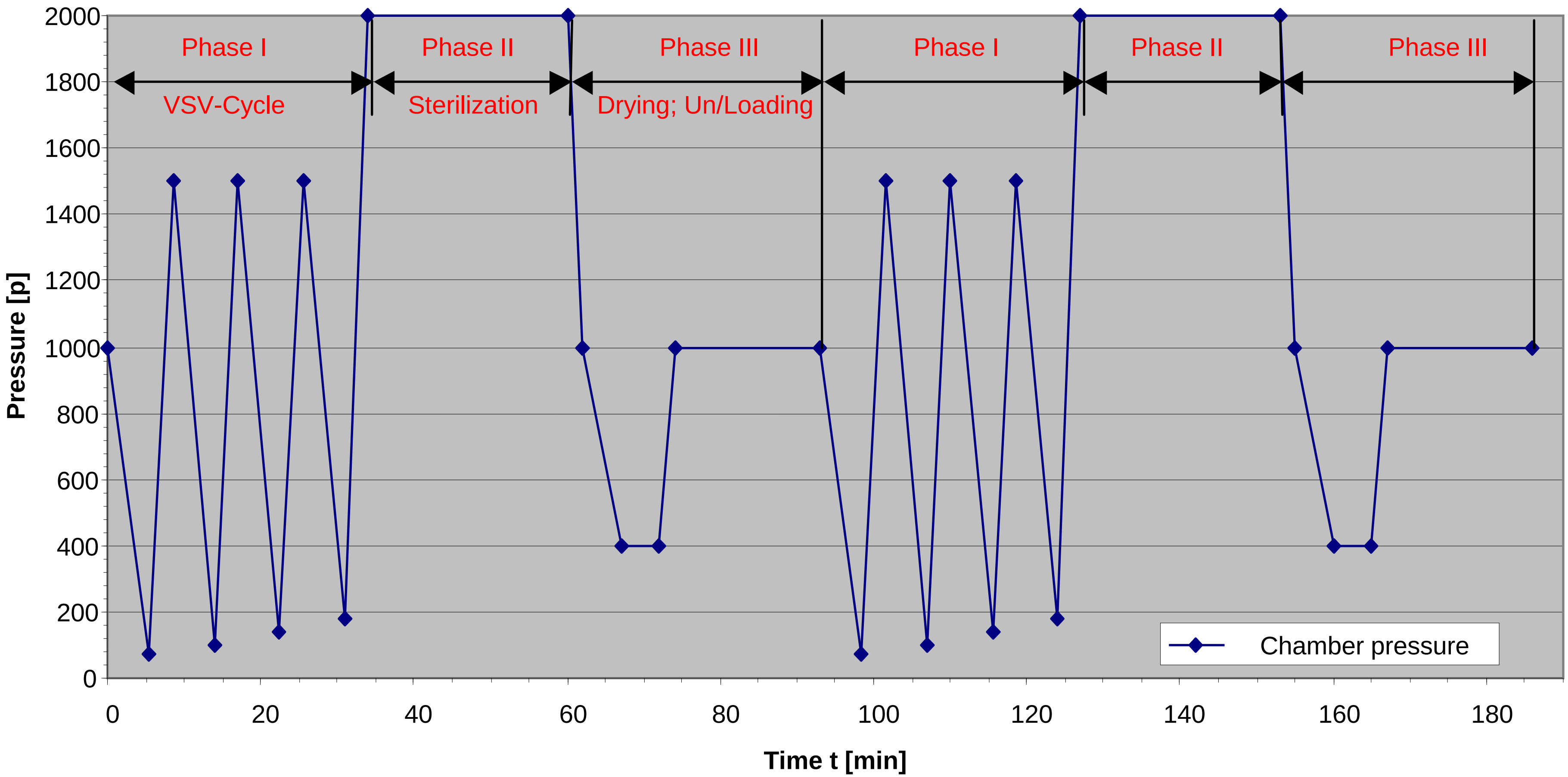
- Process cycle:



- Air is mechanically removed by a vacuum-pump. By working with a single pre-vacuum cycle, still some air will remain in the autoclave and can act as an isolator.
  - To minimize this problems longer treatment times are required. **In some countries this cycle is not accepted**.

Air is more heavy then steam and will settle at the ground

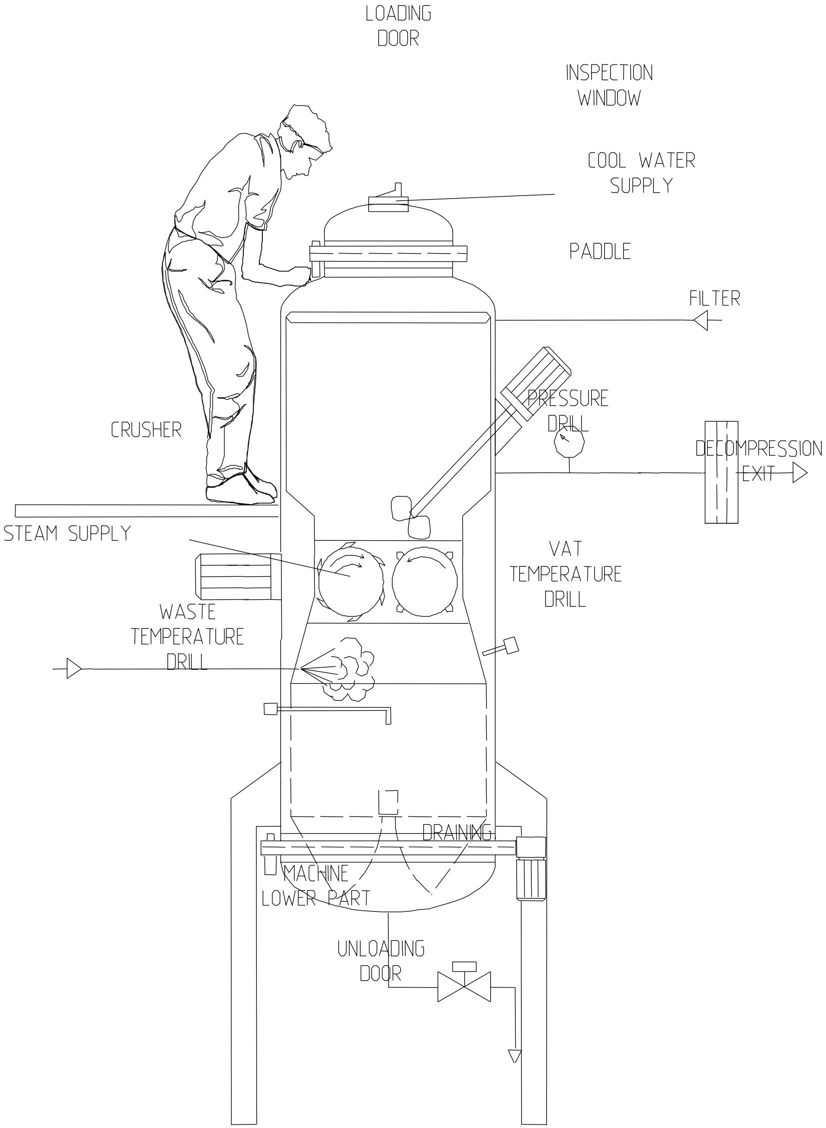
Autoclave: Fractionated systems



Through a fractioned vacuum-steam cycle, a steam atmosphere of 99 % can be guaranteed (Phase 1). During the disinfection (Phase 2) hospital waste is treated by saturated steam under pressure (Temperature >=121°C).

Example of a Hybrid Steam System

Hybrid vertical autoclave used in Albania, Argentina, Brazil, China, Cyprus, Ecuador, Egypt, Honduras, Jordan, Lebanon, Mexico, Nigeria, Panama, Syria, UAE, Venezuela and other countries

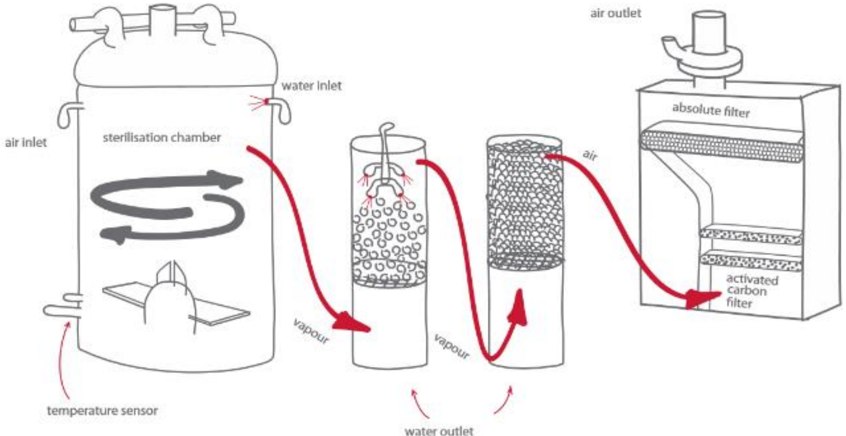


Microwaving systems

- In modern non-vacuum system, waste must be shredded prior to the disinfection process.
- The shredded waste gets in the treatment chamber and will be transported by a screw for a defined time. Here, it will be penetrated by steam at a temperature of about 100 – 105°C.
- The steam will be produced by microwaves or the transporting screw will be heated by thermal oil.

Frictional Heat Treatment Systems

- Heat is provided by heaters or generated by a high-speed rotor operating at high speeds (typically 1000 to 2000 rpm).
- Frictional heating supplemented by resistance heaters to heat the waste up to approximately 150°C.
- Waste is rendered into a small unrecognizable pieces.
- The whole process takes place at atmospheric pressure.



Automated chemial treatment

- Ozone
  - In automated systems, waste is fed into the system and is shredded.
  - Ozone is mixed with aerosolized water creating a fog in the treatment chamber.
  - A catalytic converter and heater are used to decompose any residual ozone.
- Sodium Hydrochloride
  - using oxidation power of Sodium Hypochlorite in a controlled and automated reactor.
  - Final waste is neutralization with Sodium Thiosulfate (no chlorine in the waste)

Monitoring of steam based technologies

- To guarantee full decontamination of infectious material, the process needs to be validated and tested regulary on efficiency using:
  - biological, chemical and physical test parameters.
- This is determined by the ability of the heat to penetrate the waste load.

WHO (2016). Decontamination and reprocessing of medical devices for health-care facilities.

Further reading

WHO, 2014. *Safe management of wastes from health-care activities.* http://www.who.int/water_sanitation_health/publications/wastemanag/en/

UNEP (2012). Compendium of Technologies for Treatment/Destruction of Healthcare Waste. (http://www.unep.org/ietc/Portals/136/News/Publication%20of%20Healthcare%20Waste%20compendium%20of%20technologies/Compendium_Technologies_for_Treatment_Destruction_of_Healthcare_Waste_2012.pdf accessed December 2016).

UNEP (2012). Application of the Sustainability Assessment of Technologies Methodology: Guidance Manual. (https://wedocs.unep.org/rest/bitstreams/17340/retrieve accessed January 2016).

UNEP (2007). Guidelines on Best Available Techniques and provisional guidance on Best Environmental Practices relevant to Article 5 and Annex C of the Stockholm Convention on Persistent Organic Pollutant. (http://www.unep.org/tools/default.asp?ct=chem accessed January 2017).

UNEP (2004). Stockholm Convention on Persistent Organic Pollutants. (http://chm.pops.int/TheConvention/Overview/tabid/3351/Default.aspx accessed June 2016).

UNEP (2003). Technical Guidelines on the Environmentally Sound Management of Biomedical and Health-Care Waste. (http://archive.basel.int/pub/techguid/tech-biomedical.pdf accessed January 2017.