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HOUSEHOLD MEDICAL WASTE-THREAT TO THE ENVIRONMENT AND HUMAN HEALTH

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ABSTRACT

Household medical waste, which can reach up to 0.1 % of the mixed municipal solid waste stream, does not differ in composition and properties from medical waste generated in hospitals. The risk, associated with the entry of medical waste originating from households in the components of the environment is of crucial significance, since there is still not enough data available to predict the long-term effects of its impact on human and other organisms. The current lack of an integrated system for household medical waste management – from separate collection at the generation source to their final disposal – is a prerequisite for contamination of the recyclable fractions of the mixed solid waste stream and the occurrence of adverse effects upon the environment and human health. A comparative study of the technologies for household medical waste treatment – incineration, treatment in autoclaves, microwave disinfection and chemical disinfection – was carried out. Results from the investigation show that the most environmentally sound solution for household medical waste disposal is the incineration.

Keywords: medical waste, classification, problems for human health and the environment, disposal.

INTRODUCTION

Household medical waste is solid or liquid waste, generated as a result of medical activities carried out at home. This group includes infectious waste, used sharps, waste pharmaceuticals, waste containing hazardous substances and preparations, waste containing heavy metals [1]. Medical waste from households is classified as hazardous on the basis of one or a combination of more properties – presence of infectious microorganisms, cytotoxicity, genotoxicity, mutagenicity, reproduction toxicity and presence of toxic chemicals which are oxidizing, irritating, corrosive or flammable. These properties are described by an appropriate risk phrase. In case of improper storage and disposal of these waste types, depending on their quantity and characteristics, they pose a risk to the environment and human health [2].

Infectious waste is waste that is suspected to contain pathogens (disease-causing bacteria, viruses, parasites or fungi) in sufficient concentration or quantity to cause disease in susceptible hosts. This group of waste includes waste contaminated with blood and other body fluids from infected patients such as sheets, gowns and gloves.

Sharps wastes are items that could cause cuts or puncture wounds. In most European countries used sharps contaminated with blood are considered infectious waste. Used syringes, needles, insulin pens and other sharp objects should be disposed of in puncture resistant waste containers.

Waste pharmaceuticals include expired and unused pharmaceutical products. Pharmaceutical compounds are developed and manufactured for specific biological effects, being administered for human and animal healthcare [3]. Because of their physicochemical and biological properties, when released into the environment. They could cause serious impacts on non-target species [4]. They contain active pharmaceutical ingredients such as diclofenac, ibuprofen, oxazepam,

titanium dioxide, atenolol, codeine phosphate, triacetin, etc., some which are classified as harmful and toxic to aquatic organisms, capable of causing adverse effects in the aquatic environment (R51/53, R52/53), irritating to eyes, respiratory system and skin (R36, R37, R38), having potential carcinogenic effect (R40). Cytotoxic drugs have mutagenic, carcinogenic and teratogenic properties [5].

In order to prevent risks to the environment and to human health, household medical waste should be collected separately from the mixed municipal solid waste stream.

EXPERIMENTAL

A comparative study of the technologies for household medical waste treatment – incineration, treatment in autoclaves, microwave disinfection and chemical disinfection, was carried out. The main parameters of the disposal processes, as well as their advantages and

Table 1. Comparative analysis of technologies for household medical waste disposal.

Treatment method	Temperature., °C	Specific parameters	Advantages	Disadvantages
Incineration [7, 8]	850-1100	minimum 2s retention time in the secondary combustion chamber	- high levels of disinfection ; - inactivates almost all infectious and pharmaceutical waste; - waste volume reduction up to 90 - 95 %	- not all cytotoxic drugs are inactivated [6]; - high maintenance costs; - a waste gas treatment system is necessary
Autoclave [9]	120-160	- conducted with steam under pressure of about 200 kPa; - 30 min recommended temperature exposure time	- if proper precautions are taken to exclude hazardous materials, the emissions from autoclaves are minimal	- the technology does not reduce the volume of treated waste unless a shredder or grinder is added
Microwave disinfection [10]	110	- microwave energy at a frequency of about 2450 MHz and a wavelength of 12.24 cm	- minimal emissions	- possible odour emissions; - not suitable for blood and chemicals disposal
Chemical treatment [11]	-	- chemical reagents are used - ClO_2, peracetic acid, aldehydes, quarternary ammonium salts and phenolic compounds	- high levels of disinfection - disinfectants have relatively low prices; - substantial waste volume reduction (60 – 90 %)	- use of hazardous Substances; - not appropriate for disposal of pharmaceutical, chemical and some infectious waste

disadvantages, are analyzed and summarized.

Based on the comparative analysis a recommendation for the most suitable method for household medical waste disposal is made.

RESULTS AND DISCUSSION

Incineration of medical waste is appropriate only if the heating value of waste exceeds 8370 kJ/kg. Although the heating value of plastic medical waste can exceed 16 740 kJ/kg, certain medical wastes have high moisture contents and a much lower calorific value (Table 2), which shows that in order to achieve a higher total heating value of the medical waste it should be mixed. Waste, subjected to incineration should contain more than 60 % of combustible components and less than 5 % incombustible fraction. The moisture content should be less than 30 %.

Temperatures in the two combustion chambers of incinerators vary between 850°C and 1100°C. Using less than the stoichiometric amount of air in the primary chamber decreases turbulence resulting in less particulate matter pollution. Incineration of household medical waste ensures inactivation of pathogens, waste volume reduction (90 – 95 %), heat recovery and transformation of the treated waste in a form suitable for landfilling.

Steam sterilization (treatment in autoclave) consists of exposing medical waste to saturated steam under pressure in an autoclave. In addition to the basic performance parameters, a biological or chemical indicator should be used in order to ensure that the autoclave reaches the necessary conditions for sterilization. Autoclave treatment does not eliminate or minimize the risks related to the presence of hazardous chemicals in the waste stream.

Table 2. Heating Values of Various Healthcare Waste Components [12].

Component	Heating value
	MJ/kg
Plastics	32-46
Swabs, adsorbents	13-28
Alcohol, disinfectants	25-32
Bedding, paper, fecal matter	9-19
Gauze, pads, garments, cellulose	13-28
Sharps, needles	0-0.1
Fluid, residuals	0-5
Pharmaceutical products	5-18

Poorly segregated waste may emit low levels of alcohols, phenols, formaldehyde and other organic compounds in air, condensate or the treated waste [13].

Microwave disinfection involves treatment of medical waste during which water contained in the waste and in the microorganisms is rapidly heated up by microwave energy at a frequency of about 2450 MHz and a wavelength of 12.24 cm [14]. This results in destruction of all infectious organisms. The process is carried out in closed containers at atmospheric pressure and temperature below the normal boiling point of water. Electricity is the only power source for microwave disinfection and therefore air emissions are minimal in comparison to other medical waste disposal technologies.

Household medical waste could also be disposed of through treatment with chemical reagents such as ClO_2, peracetic acid, aldehydes, quarternary ammonium salts and phenolic compounds. All of these pose serious occupational hazards and most can have adverse environmental impacts. Not all commonly used disinfectants are capable of inactivating certain microorganisms, bacteria and viruses. Therefore, chemical disinfection should not be used as a primary treatment method for medical waste.

CONCLUSIONS

Based on the investigation of alternatives for household medical waste treatment and disposal, the following conclusions can be made:

Environmentally sound management of household medical waste requires implementation of a separate collection system at the source of their generation.

The results from the comparative analysis of household medical waste treatment technologies show that incineration is the most appropriate option for their disposal, ensuring highest level of protection of the environment and human health.

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