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Solid waste management

THERMAL DECOMPOSITION OF HOSPITAL WASTE

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Abstract. This paper presents data from inventory study related to the assessment of hospital wastes in Bulgaria. On the base of the data obtained and word and country experience the advantages and disadvantages of thermal treatment of hospital wastes are discussed. It is stated that depending on the burning equipment used technological conditions for burning process and cleaning systems for control dust and gas emissions incineration installations could be used effectively for thermal deactivation and decomposition of solid wastes. Different examples are given from the practice on the way to give evidences related.

Keywords: hospital wastes, thermal treatment, dangerous substances in the waste gases.

AIMS AND BACKGROUND

Thermal processing is defined as a method whereby waste is minimised in terms of quantity and is rendered toxic-free. This method is applicable to all types of waste containing organic substances, with its widest use relating to the decomposition of waste generated by hospitals, domestic and hazardous waste.

The objective of the present piece of the work is to evaluate the opportunities for thermal decomposition of waste generated by hospitals with the aim of rendering them toxic-free, minimising their quantity and selecting most appropriate method and facilities that will safeguard the protection of environment and human health alike.

The above-mentioned objective will be based on the world-famous scientific experience and experience gained by the Bulgarian researchers.

Waste generated by hospitals is a substance, object or part of an object, resulting from preventive activities, healthcare, laboratory diagnostics and other activities which provide for the hospital operation, and which have no further application. It is also the type of waste that the hospital authorities are willing or obligated to get rid of.

According to Regulation 1 on separate collection and temporary storage of solid waste generated by hospitals dated 1998, issue of the Ministry of Healthcare, hospital waste falls into two groups[1]:

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First Group: Waste which lacks the characteristics of hazardous waste, such as:

1. Used paper from office activities and regular visits of hospitalized patients
2. Used paper and foodstuffs plastic packages;
3. Patients' waste foodstuffs;
4. Kitchen waste foodstuffs;
5. Glass tubes (ampullae), banks and phials;
6. Tools for medical purposes and laboratory glassware (following sterilisation).

Second Group: Hazardous Waste:

1. Waste from surgeries, amputated limbs, organs and parts from amputated limb, placentae;
2. Gauze, bandages, swabs and other sorts of textile polluted with liquids of biologic origin;
3. Hypodermic needles stored in a plastic container;
4. Plastic and rubber blood transfusion sets, drainage sets, urinals and urinal pipes, breathing sets;
5. Plastic packages from reagents, solutions and blood banks;
6. Syringes;
7. Remains from test animals;
8. All types of domestic waste from isolation wards and hospitals with the exception of used glassware and metal objects;
9. Medicines with expired date.

Table 1. Morphological composition of the main hospital waste

Dressing materials	Medical consumable	Biological and infectious wastes	Glass and metal
1. Gauze	1.Plastic banks	1. Human body parts	1. Ampulla
2. Bandage	2.Plastic syringes	2. Abortions and dead borns	2. Bank
3. Cotton	3. Synthetic gloves	3. Blood	3. Syringes
4. Blood	4. Wrapping paper	4. Plasma	
5. Plasma	5. Plastic packing	5. Lymph	
6. Medicines	6. Rubber packing	6. Placenta	
7. Lymph	7. Polyethylene packing	7. Syringes	
8. Ampullas	8. Expired medicines	8. Ampulla	
	9. Syringes		
	10. Needles		
	11. Hemodialisis systems		
	12. Urine bags		
	13. Blood-transmission bags		
	14. Catheter		
	17 Pipette endings		
	18. Others		

The thermal distillation of hospital waste has necessitated the determination of waste morphological composition, chemical composition of flammable components and average elemental composition of flammable mass (Tables 1-6).

Table 2. Material composition of the hospital wastes, decomposed through thermal treatment

Material	%
Polyvinylchloride	15.0
Polypropylene and polyethylene	35.0
Rubber and latex	4.0
Polyester and polycarbonate	0.5
Polyamides	0.5
Polystyrene	0.1
Dressing – textile	21.2
Biological material	6.3
Glass	10.0
Metal	2.1
Paper	5.0
Others	0.3
Total	100.0

Table 3. Typical elements composition of the hospital waste wurning mass

Element	%
C	49.79
H	9.95
O	30.36
N	0.82
Cl	7.55
S	0.02
P	0.06
Ca	0.10
K, Na	0.02
Others	1.33
Total	100

Table 4. Chemical composition of the hospital waste burning components

Component	Chemical formula	Composition (%)
1	2	3
Polyvinyl-chloride	$[-CH_2-CHCl-]_n$	C=38.4 H=4.8 Cl=56.8
Poly-propylene	$[-CH-CH_2-CH-CH_2-]_n$ CH_2 CH_2	C=87.8 H=12.2
Polyethylene	$[-CH_2-CH_2-]_n$	C=85.7 H=14.3
Polyester	$[-CH_2-CH_2O-]_n$	C=54.5 H=9.1 O=36.4
Poly-carbonate	$[-OQOCO-]_n$; Q– phenol	C=54.5 H=3.9 O=41.6
Polystirene	$[-CH-(C_6H_5)-CH_2-]_n$	C=92.3 H=7.7
Polyamides	$[-NHQCO-]_n$ $[-NHQNHCOQ'-]_n$ Q and Q′ – radicals	C=42 H=5.3 O=28.1 N=24.6
Paper	· 90% cellulose$[-CH_5O_5]_n$ · filler: $Ca(SO_4)_2$; $CaCO_3$; TiO_2	C=12.4 H=5.1 O=82.5
Chloroprene latex	· 60% rubber $[C_5H_8]_n$ · 40% chloroprene CH=Ch-CCl-CH_2 · fillers and stabilizers ZnO, MgO, $Ca(OH)_2$	C=72.5 H=8.9 Cl=18.6

to be continued

Continuation of Table 4

1	2	3
Cotton textile	· 90% cellulose $(CH_5O_5)_n$	C=12.3
	· 2% nitrogen containing substances	H=5.0
	· 1% pectin and pentozan	O=81.5
	· 0.3-1% fats and waxes	N=1.2
	· 0.1-0.2 % mineral salts	
Biological material	· proteins	C=18.25 H=10.05
	-CO-NH-CH-CO-	O=65.4 N=2.65
	R-	Ca=1.4 P=0.8
	-NH-CH-CO-	K=0.27 Na=0.26
	R-	Cl=0.25 S=0.21
	· fats –RCOOR-	Mg,Fe=0.01 Zn,Si=0.001
	· carbohydrates	Al, Br, Cu, F, I,
	$C_{12}H_{32}O_{11}+(C_6H_{10}O_5)_x$	Mn=0.0001
	· salts	As, B, Pb, Ti=0.00001
		Sn=0.000001

Table 5. Hospital waste quantities in different world regions

Region	Quantity (kg/bed/day)
North America	7-10
Western Europe	3-6
South America	3-3.5
East Asia	1.8-4
East Europe	1.4-2
East Mediterranean	1.3-3

Table 6. Hospital waste sources in the Republic of Bulgaria on 31.12.1998

Waste source	Number
Hospitals	276
Ambulatory	3587
Nurseries	741
Sanatorium and resort places	98
Other health and care places	125
Hospital and Sanitary Beds Fund, number of beds	110536

Note: Hospital wastes from vet clinics, polly-clinics, private medical, dental and vet clinics, orphanages and retired people homes should be added to these sources.

RESULTS AND DISCUSSION

Data analysis indicates that a hospital waste management system need to be established, irrespective of the waste source, quantity and composition[2,3]. Table 7 shows a comparison between the two principal hospital waste processing methods. It also illustrates the waste deposition and incineration.

Table 7. Basic parameters of the "Disposal" and "Burning" of hospital wastes

Parameters	Way of treatment	
	disposal	burning
Level and time term for the decomposition	complete for 100 years	complete for 1 year
Impact upon the environment and upon humans' health	strong impact upon the environment and upon humans' health	minimum negative impact upon the environment
Quantities clinics waste	big quantities	small quantities
Usage of the secondary resources, contained in the metals	not applicable	heat, metals, slag
Necessity to store the wastes separately	not obligatory	obligatory
Level of danger	availability of pathogenic components in the waste disposed	waste left after burning is sterile
Transportation cost	high	small
Size of the site	big area	small area

Data obtained from Table 7 thereof show that the thermal processing method should become a method of choice in comparison to the method of deposition.

The operational, technical, environmental and economical parameters of the wide variety of thermo-chemical and plasmo-chemical methods for waste processing used worldwide necessitate the application of hospital waste thermal treatment facilities via pyrolysis with subsequent incineration of gaseous, liquid and solid semi-products resulting from pyrolisis (Table 8).

Table 8. Permissible Levels Standards (Threshold Limit Values) of dangerous substances in the waste gases from the incinerators for thermal waste treatment

Dangerous substances	Threshold limit values	
Total dust	30	mg/m^3
CnHm	20	mg/m^3
HCl	60	mg/m^3
HF	4	mg/m^3
SO_2 (SO_2+SO_3)	0.2	mg/m^3
NO_2 (NO+NO_2)	0.4	mg/m^3
Cd	1.0	mg/m^3
Ta	0.05	mg/m^3
Hg		
Sb		
As		
Pb		
Cr	total	
Co	0.5	mg/m^3
Cu		
Mn		
Ni		
W		
K		
Furans and dioxins, total	0.1	ng/m^3

Figure 1 shows the principal diagram of an incineration set for thermo-chemical processing of hospital waste via pyrolysis, manufactured by the "HAVAL" company[4]. The set features an inert atmosphere and T = 450–550°C and real incineration of T = 1250° C, τ = 2-4 s and oxygen medium for complete incineration.

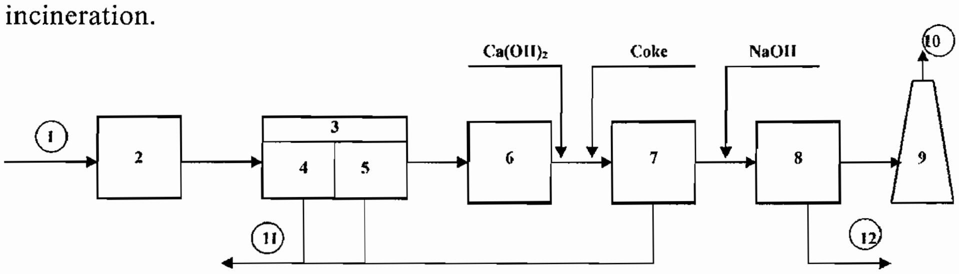

Fig.1 Principal scheme of installation for thermal treatment of hospital waste
1 – inlet hospital waste; 2 – stack; 3 – waste gases to the atmosphere; 4 – solid waste to the depot; 5 – waste waters to the purifying systems; 6 – storage area; 7 – incinerator; 8 – carbonising chamber; 9 – thermo-regulator; 10 – heat-exchanger; 11 – dry filter; 12 – wet filter

The energy of gases generated during incineration will be used for producing hot water which will subsequently be used.

The facility comprises a complex gas processing system, which is a combination of dry filter and wet dust and gas manifold where absorption and adsorption are coupled a chemical interaction.

After passing through the carbonization furnace and the thermo-reactor, the furnace gases get cooled. Coke and CaO are added to the gases before their entry into the dry bag filter to effect a chemisorption of a substantial part of gas polluters and aerosols, including furans, dioxins, and heavy metals, and improve the cleaning properties of the bag filters. Then the furnace gases report to the wet filter (absorption column with a filling) where the acid furnace gases are neutralised and purged of HCl, HF, SO_x and NO_x through a water solution of NaOH.

Waste gasses are released through a stack into the atmosphere. Continuous automatic control should be exercised over the gases so as to ensure that the latter meet the admissible emission norms, set out in Table 8.

Solid waste which make up less than 8% of the weight of hospital waste subjected to incineration, comes from the incinerator and the dry filter. In this case this is inert and non-toxic waste which can be dumped onto the domestic waste landfills.

When becoming saturated with salts, the absorption solution should be released from the system and sent to the cleaning facility on a regular basis.

CONCLUSIONS

The quality of hospital waste and the existing practices of waste disposal pose a hazard to environment and people alike.

The major part of hospital waste falls into the group of hazardous waste, which in turn makes the selection of a suitable waste processing method even more imperative.

Evaluation of the hospital waste decomposition facility through a multi-stage, multi-zone thermal processing method and purge of hospital gases indicates that waste can be rendered innocuous, thus having no negative impact on environment and people, irrespective of the waste quantity and composition.

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