Leaching and EU landfill legislation in Greece

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Abstract

In Greece, there are considerable amounts of unrecorded solid waste streams, as well as wastes temporarily stored close to industrial sites or illegally disposed elsewhere. Hazardous solid wastes may pose a risk to human health and the environment, if not managed and disposed of safely. Solid waste management systems tend to move from landfill- to resource recovery-based, following the EU's targets and guidelines to divert waste from landfilling and to increase recycling and recovery rates.The current work focuses on recording the National and EU legislation for solid wastes in Greece within the framework of the project "Development of an integrated methodology for the management, treatment and valorisation of hazardous waste - WasteVal".

Keywords: solid waste, Greece, National legislation, EU legislation, classification, characterisation

Introduction

According to the results of the survey on the generation and treatment of solid wastes, carried out by the Greek Statistical Institute, the quantity of industrial wastes generated in 2010 amounted to 70,433,000 tonnes approximately, of which about 292,000 tonnes are hazardous wastes, representing 0.5% of the total amount or26 kg of hazardous wastes per inhabitant. In Greece, 58,520,000 tonnes of solid wastes were disposed or deposited in designated sites or landfills, 6,415,000 tonnes were used for embankment and fill applications, 5,308,000 tonnes were recycled or used for energy and substance recovery, 126,150 tonnes were incinerated for energy recovery and 21,300 tonnes were simply incinerated. However, there are considerable amounts of solid wastes temporarily stored in areas next to industrial sites, as well as illegally disposed of in several other sites, thus posing serious environmental risks (Eurostat, 2014).

Following the European Union's (EU) guidelines, solid waste management systems tend to shift from landfill-based to resource recovery-based (Eurostat, 2014). EU waste management policy aims to reduce the environmental and health impacts of waste and improve resource efficiency. The long-term aim of this policy is to reduce the amount of generated waste and if this is unavoidable to promote the waste use as a resource and thus achieve higher recycling rates.

The current work focuses on recording the current National and European legislation (directives, decisions, regulations, circulars and laws) for solid waste classification and characterization.

Legislation

Waste is defined as “any substance or object included in the European Waste Catalogue (EWC) which the holder discards or intends or is required to discard, and anything which is discarded or otherwise dealt with as if it were waste shall be presumed to be waste until the contrary is proved” (EPA, 2002).

According to Council Decision 2003/33/EC of 19 December 2002 “establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to Directive 1999/31/EC”the fundamental requirements for basic characterization of the waste are:

a) Source and origin of the waste
b) Information on the process producing the waste (description and characteristics of raw materials and products)
c) Description of the waste treatment
d) Data on the composition of the waste and the leaching behaviour, where relevant
e) Appearance of the waste (smell, colour, physical form)

f) Code according to the European Waste Catalogue-EWC (Commission Decision 2001/118/EC)

g) For hazardous waste in case of mirror entries: the relevant hazard properties according to Annex III to Council Directive 91/689/EEC of 12 December 1991 on hazardous waste

h) Information to prove that the waste does not fall under the exclusions of Article 5(3) of the Landfill Directive

i) The landfill class at which the waste may be accepted

j) If necessary, additional precautions to be taken at the landfill

k) Check if the waste can be recycled or recovered.

Table 1 shows the properties of wastes which render them hazardous.Wastes classified as hazardous are considered to display oneor more of the following characteristics (EPA, 2002):

- flash point$\leq 55^{o}C$
- one or more substances classified as very toxic at a total concentration $\geq 0.1\%$
- one or more substances classified as toxic at a total concentration $\geq 3\%$
- one or more substances classified as harmful at a total concentration $\geq 25\%$
- one or more corrosive substances classified as R35 at a total concentration $\geq 1\%$
- one or more corrosive substances classified as R34 at a total concentration $\geq 5\%$
- one or more irritant substances classified as R41 at a total concentration $\geq 10\%$

- one or more irritant substances classified as R36, R37, R38 at a total concentration ≥ 20%
- one substance known to be carcinogenic of category 1 or 2 at a concentration ≥ 0.1%
- one substance known to be carcinogenic of category 3 at a concentration ≥ 1%
- one substance toxic for reproduction of category 1 or 2 classified as R60, R61 at a concentration≥ 0.5%
- one substance toxic for reproduction of category 3 classified as R62, R63 at a concentration ≥5%
- one mutagenic substance or category 1 or 2 classified as R46 at a concentration ≥ 0.1%
- one mutagenic substance of category 3 classified as R40 at a concentration ≥ 1%.

The EWC contains 20 chapters that are based upon the source that generated the waste or upon the type of waste. To classify and describe a waste the most appropriate six-digit code from the EWC must be selected. In addition to the six-digit code, leaching characteristics and composition of the waste must be determined to obtain solid waste characterization (EPA, 2002).

Leaching tests

In order to determine waste chemical composition, EN 13657 and EN 13656 methods are proposed for digestion of raw waste. EN 13657 method is a digestion method for subsequent determination of aqua regia soluble portion of elements (partial digestion of the solid waste prior to elementary analysis, leaving the silicate matrix intact), while EN 13656 method is a microwave-assisted digestion method with hydrofluoric, nitric and hydrochloric acid mixture for subsequent determination of elements (total digestion of the solid waste prior to elementary analysis) (Council Decision, 2003/33/EC).

The evaluation of chemical toxicity is performed using standard leaching procedures. The proposed leaching tests for the characterization of the wastes leachates are dynamic prEN 14405 leaching test (up-flow percolation test for inorganic constituents, a column with an internal diameter of 5 cm and a fellable height of at least 4 times the internal diameter,L/S 0.1 mg/kg, particle size <4 mm, leachant deionized water) and batch EN 12457/1-4 leaching - compliance test for leaching of granular waste material and sludge, leachant deionized water, agitation 10 rpm (part 1: L/S = 2 L/kg, particle size <4 mm, part 2: L/S = 10 L/kg, particle size <4 mm, part 3: L/S = 2 and 8 L/kg, particle size <4 mm and part 4: L/S = 10 l/kg, particle size <10 mm) (NEN 7343, 1995; EN 12357-3, 2002).

Figures 1 and 2 show the devices for prEN 14405 and EN 12457/1-4 leaching tests, whileTable 2 shows the basic characteristics of prEN 14405 and EN 12457-

3leaching tests (NEN 7343, 1995; EN 12357-3, 2002).Table 3 shows the criteria for wastes to be acceptedinlandfills asinert, non-hazardous and hazardous wastes,based on the Council Decision 2003/33/EC.

Conclusions

Solid wastes may pose a risk to human health and the environment, if not managed and disposed of safely. There is a global demand for efficient waste management, which is based on the principles of waste prevention, recycling and reuse with the ultimate goal to eliminate their final disposal. Waste, that cannot be recycled or reused, should be safely disposed ofin landfills after treatment. In Greece, processes, such as reuse and recycling of solid wastes, as well as recovery of metals, elements or energy are limited, but in recent years there is a trend to exploit emerging waste management technologies aiming at valorisation of all these wastes streams.

If wastes are re-processed, reused and recycled, and if one industry's waste becomes another's raw material, then all world regions can move to a more circular economy where waste is eliminated and resources are used in a more efficient and sustainable way.

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Tables

Table 1. Properties of wastes which render them hazardous (EPA, 2002).

H1 “Explosive”	substances and preparations which may explode under the effect of flame or which are more sensitive to shocks or friction than dinitrobenzene
H2 “Oxidizing”	substances and preparations which exhibit highly exothermic reactions when in contact with other substances, particularly flammable substances
H3-A “Highly flammable”	- liquid substances and preparations having a flash point below 21°C (including extremely flammable liquids), or - substances and preparations which may become hot and finally catch fire in contact with air at ambient temperature without any application of energy, or - solid substances and preparations which may readily catch fire after brief contact with a source of ignition and which continue to burn or to be consumed after removal of the source of ignition, or - gaseous substances and preparations which are flammable in air at normal pressure, or - substances and preparations which, in contact with water or damp air, evolve highly flammable gases in dangerous quantities
H3-B “Flammable”	liquid substances and preparations having a flash point equal to or greater than 21°C and less than or equal to 55°C
H4 “Irritant”	non-corrosive substances and preparations which, through immediate, prolonged or repeated contact with the skin or mucous membrane, can cause inflammation
H5 “Harmful”	substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may involve limited health risks
H6 “Toxic”	substances and preparations (including very toxic substances and preparations) which, if they are inhaled or ingested or if they penetrate the skin, may involve serious, acute or chronic health risks and even death
H7 “Carcinogenic”	substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce cancer or increase its incidence
H8 “Corrosive”	substances and preparations which may destroy living tissue on contacts
H9 “Infectious”	substances containing viable micro-organisms or their toxins which are known or reliably believed to cause disease in man or other living organisms
H10 “Teratogenic”	substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce non-hereditary congenital malformations or increase their incidence
H11 “Mutagenic”	substances and preparations which, if they are inhaled or ingested

	or if they penetrate the skin, may induce hereditary genetic defects or increase their incidence
H12	substances and preparations which release toxic or very toxic gases in contact with water, air or an acid
H13	Substances and preparations capable by any means, after disposal, of yielding another substance, e.g. a leachate, which possesses any of the characteristics listed above
H14 “Ecotoxic”	substances and preparations which present or may present immediate or delayed risks for one or more sectors of the environment

Table 2. Basic characteristics of EN 12457-3 and prEN 14405 leaching tests

	EN 12457-3	**prEN 14405**
Massof sample	100g	~ 500g
Leaching solvent	Deionized water	Deionized water
Liquid/Solidratio per stage, L/S (Lkg^{-1})	2 and10	0.1 – 0.2 – 0.5 – 1 – 2 – 5 and 10
Time per stage	6 and 18h	~ 21 days
Way of mixing	Rotational, 10 rpm	Continuousupward flow, ~ 10 mLh^{-1}

Table 3. Criteria for wastes acceptable at landfills for inert, non-hazardous and hazardous wastes, according to the Council Decision 2003/33/EC.

	Inert waste			**Non-hazardous waste**			**Hazardous waste**		
L/S (L kg^{-1})	2	10	0.1	2	10	0.1	2	10	0.1
Component	mg kg^{-1} dry substance		mg L^{-1}	mg kg^{-1} dry substance		mg L^{-1}	mg kg-1 dry substance		mgL^{-1}
As	0.1	0.5	0.06	0.4	2	0.3	6	25	3
Ba	7	20	4	30	100	20	100	300	60
Cd	0.03	0.04	0.02	0.6	1	0.3	3	5	1.7
Cr total	0.2	0.5	0.1	4	10	2.5	25	70	15
Cu	0.9	2	0.6	25	50	30	50	100	60
Hg	0.003	0.01	0.002	0.05	0.2	0.03	0.5	2	0.3
Mo	0.3	0.5	0.2	5	10	3.5	20	30	10
Ni	0.2	0.4	0.12	5	10	3	20	40	12
Pb	0.2	0.5	0.15	5	10	3	25	50	15
Sb	0.02	0.06	0.1	0.2	0.7	0.15	2	5	1
Se	0.06	0.1	0.04	0.3	0.5	0.2	4	7	3
Zn	2	4	1.2	25	50	15	90	200	60
Chloride	550	800	460	10,000	15,000	8,500	17,000	25,000	15,000
Fluoride	4	10	2.5	60	150	40	200	500	120
Sulphate	560	1,000	1,500	10,000	20,000	7,000	25,000	50,000	17,000
Phenol index	0.5	1	0.3	-	-	-	-	-	-
DOC	240	500	160	380	800	250	480	1,000	320
TDS	2,500	4,000	-	40,000	60,000	-	70,000	100,000	-

Figures

Figure 1. Experimental setup for the dynamic leaching test prEN 14405.

Figure 2. Devices forEN 12457/1-4 leaching tests.