Waste Management xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Waste Management

journal homepage: www.elsevier.com/locate/wasman

Classification and management of asbestos-containing waste: European legislation and the Italian experience

Federica Paglietti, Sergio Malinconico *, Beatrice Conestabile della Staffa, Sergio Bellagamba, Paolo De Simone

INAIL – Italian Workers' Compensation Authority – Research Division, DIT – Department for Technological Innovations and Security Equipment, Products and Human Settlements, Asbestos and Decommissioned Mines Team, Italy

ARTICLE INFO

Article history:
Received 29 July 2015
Revised 13 January 2016
Accepted 15 February 2016
Available online xxxx

Keywords:
Waste
Asbestos
European Waste Catalogue
Landfills

ABSTRACT

Objective: Production of a new classification of Asbestos Containing Products (ACPs), materials (ACM) and Asbestos Containing Waste (ACW), in addition to a correct identification of landfills where ACW should be disposed of in Europe.
Methods: Analysis of the European and Italian legislation, study of waste classification and management in the main European countries, data analysis of mapping of Italian landfills and quantification of ACW disposed there.
Findings: Classification according to unique criteria (physical state, substances with which asbestos minerals have been blended, function of the asbestos, etc.). Highlights of cases of incorrect management of ACW in Europe, specifying the Italian ones. Considering the significant inconsistencies between the European and national regulations and the actual implementation of those regulations, this paper provide some precise indications for the proper assignment to ACW of the European Waste Catalogue (EWC) codes.

Lastly, suitable types of landfills at which ACW should be disposed of have been identified, in order to assisting the persons involved in ACW management to avoid undue exposition and their improper disposal.
Conclusion: This study reports a useful manual for classifying worldwide ACPs based on their physical state and considering the substances with which the asbestos minerals have been blended. Moreover several clear tables allow the asbestos remediation and waste management operators to suitably classify and dispose of ACW.

1. Introduction

Asbestos comes from the Greek ἄσβεστος (ásbestos), which means "unquenchable, inextinguishable".

The definition of asbestos, found in the Italian *Dictionary of traded goods and commodities* (1972), is: "a mineral that, when adequately prepared, provides fire-resistant and flexible fibers that can be spun and woven and which feature a high dielectric stiffness and chemical resistance" (Nuovo dizionario di Merceologia e Chimica Applicata, 1972).

From a strictly mineralogical point of view, there is not a group of minerals that goes under the name "asbestos", but there are various mineral types that can be distinguished based on their crystal and chemical characteristics.

According to the European applicable legal references, the general term "asbestos" is used to identify six naturally occurring silicate minerals belonging to the serpentine (Chrysotile) and amphibole (Amosite, Crocidolite, Tremolite, Anthophyllite and Actinolite). They can all exist in several different crystalline forms,

Abbreviations: ACM, Asbestos Containing Materials; ACPs, Asbestos Containing Products; ACW, Asbestos Containing Waste; CAS, chemical abstract service; CCMI, Consultative Commission on Industrial Change; EC, European Community; EESC, European Economic and Social Committee; EWC, European Waste Catalogue; HVAC, Heating, Ventilating, and Air Conditioning; IARC, International Agency for Research on Cancer; ILO, International Labour Organization; n.e.c., not elsewhere classified; PPE, Personal Protective Equipment; WHO, World Health Organization.

* Corresponding author.
E-mail addresses: f.paglietti@inail.it (F. Paglietti), s.malinconico@inail.it (S. Malinconico), b.conestabiledellastaffa@inail.it (B.C. della Staffa), s.bellagamba@inail.it (S. Bellagamba), p.desimone@inail.it (P. De Simone).

http://dx.doi.org/10.1016/j.wasman.2016.02.014
0956-053X/

but only the fibrous forms are classified as asbestos (Directive 2003/18/EC, 2003).

Chrysotile (serpentine)	CAS No. 12001-29-5 and 132207-32-0
Actinolite	CAS No. 77536-66-4
Amosite (Cummingtonite – Grunerite)	CAS No. 12172-73-5
Anthophyllite	CAS No. 77536-67-5
Crocidolite (riebeckite)	CAS No. 12001-28-4
Tremolite	CAS No. 77536-68-6

Based on numerous epidemiological studies carried out since the 1960s and proving the carcinogenic nature of these fibers, all the above-mentioned asbestos minerals have been classified as carcinogens by the International Agency for Research on Cancer (IARC) (ATSDR, 2001; IARC, 2012, 1987, 1977, 1973).

Asbestos was classified under 67/548/EEC (until 1 June 2015, the safety data sheets for substances shall contain the classification according to both Directive 67/548/EEC and EC Regulation 1272/2008 of June 2015) as a category 1 carcinogen with the risk codes R 45 T (toxic: may cause cancer) and R 48/23 (toxic: danger of serious damage to health by prolonged exposure through inhalation) (Regulation (EC) No. 1272/2008; Council Directive 67/548/EEC, 1967).

EC Regulation 1272/2008 "on classification, labeling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006", changed the asbestos classification in (Table 1):

- Category: Carcinogen 1A – known to have carcinogenic potential for humans, classification is largely based on human evidence.
- Hazard class and categories: STOT RE 1 – specific target organ toxicity, repeated exposure.
- Hazard statement codes:
  - H350: may cause cancer (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard).
  - H372: causes damage to organs (state all organs affected, if known) through prolonged or repeated exposure (state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard).

Exposure to asbestos occurs through inhalation of fibers primarily from contaminated air in the working environment, as well as from ambient air in the vicinity of point sources, or indoor air in housing and buildings containing friable asbestos materials. The highest levels of exposure occur during the repackaging of asbestos containers, mixing with other raw materials and dry cutting of ACPs with abrasive tools.

Exposure can also occur during the installation and use of ACPs and maintenance of vehicles. Friable Chrysotile and/or amphibole-containing materials are still onsite in many buildings and continue to give rise to exposure to both Chrysotile and amphiboles during maintenance, alteration, removal, demolition. No data is available in Italy during the management and disposal of ACW at remediation sites or landfills.

The world is steadily retreating from dependence on asbestos. In 2006, the International Labour Organization (ILO) and World Health Organization (WHO) jointly declared that the most efficient way to eliminate asbestos-related diseases is to stop using all types of asbestos. Nevertheless, current use varies widely. Some countries have imposed strict regulations to limit exposure, others have adopted bans, and yet others have intervened less and have continued to use varying quantities of asbestos. The global burden of asbestos diseases over time will be uneven, reflecting the extent and patterns of asbestos use (Ro-Ting et al., 2007; Nishikawa et al., 2008; Dos Santos Antao et al., 2009; WHO, 2006, 2010; Driscoll et al., 2005; Kameda et al., 2014; Mensi et al., 2015).

Several studies show a clear association between deaths from the studied diseases and historical asbestos consumption, especially for all mesotheliomas in both sexes and asbestosis in men. In addition, it is believed that several thousands of deaths can be attributed to other asbestos-related diseases, as well as to non-occupational exposures to asbestos. The burden of asbestos-related diseases is still rising, even in countries that have banned the use of asbestos in the early 1990s (Fig. 1). Globally, each year,

Table 1
Classification of asbestos source (Annex VI of the CLP regulation, EC 2008).

	Index no.	International chemical identification	CAS No.	Classification	Labeling		Notes
				Hazard class and category code(s)	Hazard statement code(s)	Pictogram, signal word code(s)	Hazard statement code(s)
List of harmonised classification and labeling of hazardous substances	650-013-00-6	Asbestos	12001-28-4 132207-32-0 12172-73-5 77536-66-4 77536-68-6 77536-67-5 12001-29-5	Carc. 1A STOT RE 1	H350 H372[b]	GHS08 Dgr	H350 H372[b]
List of harmonised classification and labeling of hazardous substances from Annex I to Directive 67/548/EEC	650-013-00-6	Asbestos	12001-28-4 132207-32-0 12172-73-5 77536-66-4 77536-68-6 77536-67-5 12001-29-5	Carc. Cat. 1; R45 T; R48/23	T R: 45-48/23 S: 53-45		E[a]

[a] Note E: substances with specific effects on human health) that are classified as carcinogenic, mutagenic and/or toxic for reproduction in categories 1 or 2 are ascribed note E if they are also classified as very toxic (T+), toxic (T) or harmful (Xn). For these substances, the risk phrases R20, R21, R22, R23, R24, R25, R26, R27, R28, R39, R68 (harmful), R48 and R65 and all combinations of these risk phrases shall be preceded by the word 'Also'.

[b] The route of exposure should be indicated in the hazard statement only if it is conclusively proven that no other route of exposure can cause the hazard. Under Directive 67/548/EEC the route of exposure is indicated for classifications with R48 when there was data justifying the classification for this route of exposure. The classification under 67/548/EEC indicating the route of exposure has been translated into the corresponding class and category according to EC Regulation No. 1272/2008, but with a general hazard statement not specifying the route of exposure, as the necessary information is not available.

Please cite this article in press as: Paglietti, F., et al. Classification and management of asbestos-containing waste: European legislation and the Italian experience. Waste Management (2016), http://dx.doi.org/10.1016/j.wasman.2016.02.014