International Conference on Economic Engineering and Manufacturing Systems
Braşov, 24 – 25 November 2011

CONTRIBUTIONS TO THE RECYCLING OF ASBESTOS CEMENT AND PLASTIC WASTE

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Abstract. Identifying alternatives to landfill must be a priority of the waste management systems in European countries in the context of the new directive on waste, where recycling represents the core operation. With regard to asbestos-containing waste, recycling at this time is not permitted by law, HG 124/2003 stipulating that "in order to protect human health and the environment, from January 1, 2007, all marketing activities and the use of asbestos and products containing asbestos are prohibited". This article presents the results of research undertaken by the author during doctoral training, towards recycling of cement and plastics as polymer matrix composite. Tests realized on the new product, based on a modern and complex methodology with high accuracy results, denied the alleged toxicity of asbestos after its embedment in a polymer mass and may provide important arguments for flexibility in profile legislation, having as a purpose the allowance of unrestricted marketing for the resulting product.

Keywords: recycling, asbestos cement waste, plastic waste, polymer matrix, and asbestos cement composites

1. Introduction

Waste management is particularly important in the analysis of the environmental status of any territory, given the pressure they exert on local systems, human health, environmental costs or the aesthetics and economic value of landscapes. As a result of industrial development and of an accelerated urbanization process, collection, processing, storage and final disposal of waste has become a major challenge of the present. Not generating waste is practically impossible in the present circumstances and therefore the issues regarding collection, transport, storage and final disposal require attention and involvement of local authorities responsible and of the entire society. Controlled or uncontrolled accumulation of all categories of waste leads to increased territorial disparities or environmental conflicts and can also lead to excessive and uncontrolled consumption of space and indirectly, of resources. In this respect, the European Union has established a long-term strategy that aims to stimulate overall recovery and recycling activities, in order to reduce the quantities of waste requiring disposal and the environmental risks associated with this operation. However, despite obvious progress in the implementation of European policy during the last 30 years, some problems still remain today representing a real challenge to policy makers, among them mentioning:

- *quantities of generated waste continue to grow in most European countries;*
- *community and national prevention of waste have never been fully achieved;*
- *in many member states (including our country), land filling is the main form of waste "disposal";*
- *community standards regarding the processes of recycling and waste recovery are not available, leading to different operating modes among member countries and often unfair competition;*
- *member states have in many cases different approaches in solving waste management problems, which is stimulated to some extent by different interpretation possibilities that are allowed by legislation in its current form.*

As for the strategic vision regarding **waste management at a national level** [1], one can say that it started from a scarcely encouraging reality, which explains the slow and delayed progress:

- *increase in the amount of waste generated annually;*
- *mixed collection is the most common form of collecting, accounting for about 96% of the total quantity of municipal waste;*
- *in the structure of municipal waste in Romania, the biggest share have household waste (about 81%), within which street, construction and demolition waste have about the same share - 12% and 11%;*
- *about 98% of municipal waste (which include construction and demolition waste) are disposed of in landfills and only a small percentage is*

capitalized;

- *in 2010, only 30 compliant municipal landfills were operating;*
- *the most generated waste is industrial, particularly from extractive activities (88%), followed by the energy industry, waste which raises obvious management difficulties and whose management is the sole responsibility of its generator.*

Given the new strategic objectives set at European level, namely to make Europe a recycling society, on the one hand, and the precarious situation in waste management at national level, in the near immediate future, the recovery and recycling of waste in Romania will have to increase considerably.

2. The situation of asbestos cement and plastic waste management from WEEE and end of life vehicles (ELV)

Considering the studies that have proven harmful effects of asbestos on human health, member states have implemented procedures that give priority to the removal from use of asbestos containing materials (Council Directive 87/217/EEC, Directive 83/477/EEC, HG 124/2003, Government Decision 1875/2005). As for waste containing asbestos, they are classified as hazardous waste and the only accepted form of disposal at the current level in the EU is storage [2-6].

In Romania there are only two hazardous landfills that receive waste containing asbestos for storage, their capacity is definitely insufficient given the fact that in the near future, large amounts of asbestos contained in buildings will reach end of life. In the year 2009, the total quantity of asbestos waste generated in Romania was 19968.56 tons. Research in inerting and recycling this waste is carried out mainly at laboratory scale and appropriate technologies are applied in isolated cases, from economic considerations and due to legislation restrictions.

Plastic waste also poses serious problems in their management, despite the fact that they are not considered dangerous, problems arise mainly from the massive quantities generated and from the fact that they are not biodegradable and their main form of disposal remains land filling. Plastic recycling represented a long debated issue on the political and economic agendas of the last decade, obvious progress being achieved in this respect, especially for waste consisting entirely of plastic, as is the case of packaging. As for mixed waste, recycling plastics is done at low level, due to technical and economic considerations. Two of the categories of waste containing significant fractions of plastics are electrical and electronic equipment waste (WEEE) and end of life vehicles (ELV).

The WEEE plastics are found in a proportion of about 21%, covering a wide range of organic polymers (polypropylene, styrene, polyvinyl chloride, polyethylene terephthalate, etc.). Considering the fact that in Romania, in 2008 only 33% of the entire volume of the collected WEEE has been treated, compared to EU average of 75%, it can be said that WEEE recycling and recovery activities will be encouraged considerably in the following years.

In the ELV, a plastic fraction is estimated at about 10%, in reality very little is reprocessed, mainly due to high processing costs. Objectives achieved concerning WEEE treatment by the year 2008 in Romania have been:

- reuse and recovery: 86.45%;
- reuse and recycling: 83.70%.

3. Contributions to the asbestos cement and plastic recycling

The following material will present the results of the research undertaken by the author during doctoral studies which involved the development of an experimental model of asbestos and plastics waste recycling as polymer matrix composites, in order to produce a new type of material, *safe in terms of toxicity*, chemically stable and economically efficient for some uses.

3.1. Obtaining the polymer composite

In order to obtain the composite has been taken into account the fact that thermoplastic polymers can be conditioned with fillers / reinforcement to improve the rheological and mechanical properties. In many cases, this conditioning is made with limestone, silica, alumina, etc. Mineralogical studies carried out on asbestos often demonstrated that it contains calcite ($CaCO_3$) as the major component of cement, along with silicates. Within the new composite which has been obtained, the presence of asbestos fibers could contribute to the improvement of the thermal and flame retardant properties of the material.

The process of obtaining the composite followed three stages:

- asbestos waste processing;
- plastic waste processing;
- formulation and processing of polymer matrix composite.

Asbestos waste processing

The source of the ground asbestos cement waste, needed in order to conduct the experiments, has been SC REMAT Holding SA Bucharest. Residual asbestos cement plates have been shredded to millimeter sizes and a more advanced grinding to micron size was performed in the processing laboratory. In all phases of handling asbestos cement, rules have been followed in order to protect the health and safety of workers and avoid the risks of exposure to asbestos, procedures regulated by Government Decision 1875/2005 [6].

Plastic waste processing

The source of the plastic waste, needed in order to conduct the experimental study, has been SC REMAT Holding SA Bucharest, a second potential supplier being SA Green Wee International Buzau. Most polymeric material used in creating the composite has been obtained by processing electrical cables waste.

Polymer matrix composites processing

The polymer composites have been obtained by grinding asbestos cement waste encapsulation within a polymer mass derived from various types of plastic waste. The formulation and processing have been done by extrusion and injection [7]. *The share of blended asbestos cement mass varied, as the tests aimed at identifying the best proportion in more alternatives.*

The granulated composite has been obtained by extrusion through a semi-continuous technological process.

Extruded samples have been coded according to compositions PL – A#, where PL– the type of polymer material and A# = asbestos cement content percentages.

After granulation, the composite has been processed as a specimen in the SC Vesta Investment SRL Bucharest, namely SC Romcolor SA Bucharest facilities, through a semi-continuous injection in a technological process.

3.2. Mechanical and toxicological testing of the polymer composite

After obtaining the composite, the product has been studied in two ways:

- mechanical properties study;
- risk analysis of asbestos exposure.

Mechanical properties study

The need of a mechanical characterization of the composite derived from a series of technological and economic aspects, such as:

- knowledge of material performance to establish the operational means and potential applications;
- the possibility of finding new limits of performance variables for a possible extension of the scope of use;
- economic reasons to use the product;
- compliance to certification of products used in construction, for marketing the new product profile.

Two types of tests that have been conducted in this study are the tribological behaviour and tensile strength study.

In the case of the tribological behaviour, by simulating extreme natural conditions (earthquakes, atmospheric turbulence, precipitation, etc.) of high intensity with continuous temporal dynamics, the experiment revealed that a wear residue in amount of 100 mm^3 would be generated by the erosion of a polymer composite in a period of time between 5 and 71 years, depending on the type of the polymer in which the asbestos cement has been encapsulated.

The tensile strength study revealed a high resistance and a reduced brittleness for the composite sharing a high proportion of plastic waste and a small one of asbestos cement respectively lower resistance and increased fragility for the composite sharing more asbestos and less plastic. So, the *composite representing* the best option is that with average proportion of asbestos that will both contribute to the recycling of large quantities of asbestos cement and at the same time will not compromise the mechanical properties necessary to its use in appropriate industrial applications.

Risk analysis of asbestos exposure

Toxicological testing of “polybest” composites lies in the requirement for compliance with health and safety risks from exposure to asbestos, the Government Decision 1875/2005 [6] prefigures that *workers should not be exposed to an airborne asbestos concentration greater than 0.1 fibers/cm^3, measured against a time-weighted average over a period of 8 hours.*

Thus, in order to estimate the risk of airborne asbestos crystals release from mechanical degradation of the “polybest” composite, the following investigations have been undertaken:

- morphological study of the turned surfaces;
- wear residues study;
- air samples analysis from the area of impact.

The first category of tests has been performed on residues obtained by turning specimens that were to be prepared for the wear tests. Turned surfaces have been investigated by optical and electronic microscopy (SEM) to identify possible separation of polymer matrix fibber formation.

A second category of tests has been performed on the mixture of solid residue, silicon paste and water resulting from the wear tests. These samples have been dried and mortared, and then analysed by Fourier transform infrared spectroscopy and scanning electron microscopy (SEM).

A third category of toxicology tests on the new product subjecting it assumed high intensity mechanical actions to determine the rick of asbestiform crystals release in air from composite fragmentation/cracking. The possibility of asbestos fibbers release from the polymers matrix during the impact has been studied by *sampling the air from the area adjacent to the tested specimens and analysing the filtered residue by FT-IR spectroscopy*. Test results, which are found in an analysis report issued by the National Institute of Public Health, revealed the **absence of fibrous asbestiform residues in the air filtering the impact area**.

4. Conclusions

Anlyzing the data presented, can draw the following conclusions:

Controlled or uncontrolled accumulation of all categories of waste leads to increased territorial disparities or environmental conflicts and can also lead to excessive and uncontrolled consumption of space and indirectly, of resources.

In Romania there are only two hazardous landfills that receive waste containing asbestos for storage, their capacity is definitely insufficient given the fact that in the near future, large amounts of asbestos contained in buildings will reach end of life.

Plastic recycling represented a long debated issue on the political and economic agendas of the last decade, obvious progress being achieved in this respect, especially for waste consisting entirely of plastic, as is the case of packaging.

Waste management has a major role in the analysis of the environmental status of any territory and the despite the abvious progress achived the implementation of European policy in this area it continues to present challenges for decision-makers.

uropean and national legislation, strictly regulate exposure to sbestos by banning its use in almost all industries and economic

The new polymer composite could be given the eco-material quality, being a product especially designed to minimize environmental impacts associated with waste disposal, but at the same time maintaining an acceptable level of technical performance.

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