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Pollution Control in Building Material Industries

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Abstract
In this work, the wastes resulting from building and construction sectors are divided into two main versions. First, wastes resulting from mining of building material during their manufacturing. Second, wastes resulting from construction process and activity. A survey about mining industries as feeding industry to building and construction sector has been done. Another survey was done for different kinds of pollutants and their effects on the environment in the near future and on the long run. It differentiates between pollutants by their sources and effects. Feeding industries pollutants are mentioned according to the national and international statistical data and technical reports. The kind of wastes and their amounts were evaluated. The most common examples of industrial hazardous waste were included and the source of each was explained. The data were collected by author. The precautions and Laws for pollution control in Egypt are also discussed in this work. Finally the results are discussed. Materials recycling, materials replacement and green building procedures are the best methods for reduction and elimination of pollution resulting from construction sector wastes. Recommendations emphasizing on the pollution control and the importance of environmental protection according to national and international waste management programs.

1. Introduction

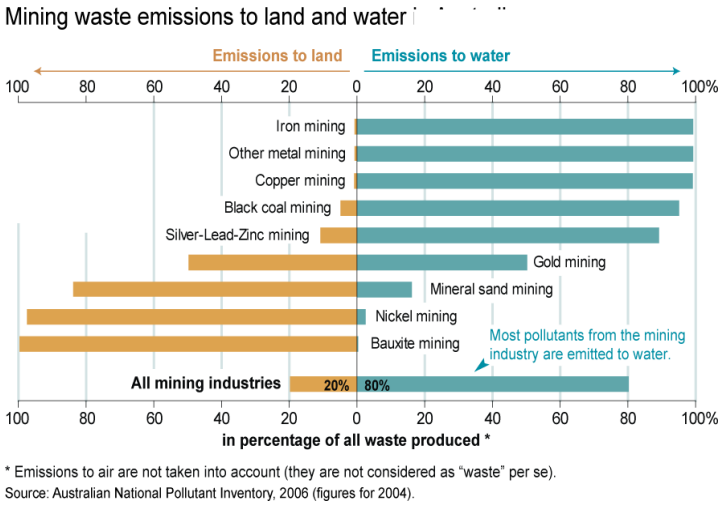

Fig (1). *Waste emission to the environmental (land &water)*

Extraction is the first phase of hardrock mining which consists of the initial removal of ore from the earth. It is the initial attempt at liberating and concentrating the valuable mineral from the extracted ore. After the beneficiation step, the remaining material is often physically and chemically similar to the material (ore or mineral) that entered the

The extraction and beneficiation of minerals generates large quantities of waste.Mineral processing waste streams typically bear little or no resemblance to the materials that entered the operation, producing product and waste streams that are not earthen in character, these wastes cause pollution to air, water and land. Fig (1) shows Waste emission to the environmental (land & water) resulting from different types of minerals

1.1. Negative Impacts of Wastes

The amount of wastes resulting from construction process isincreased rapidly every year.According to the last statistical analysis, it is about1228 million ton per year distributed to all construction sectors. Fig (2) shows the amount of wastes in eachbuilding sector.

Building and construction sector waste can cause short and long term public health problems as well as serious deteriorations in the environmental quality [18], [19]. Fig. (3) shows the impacts of wastes

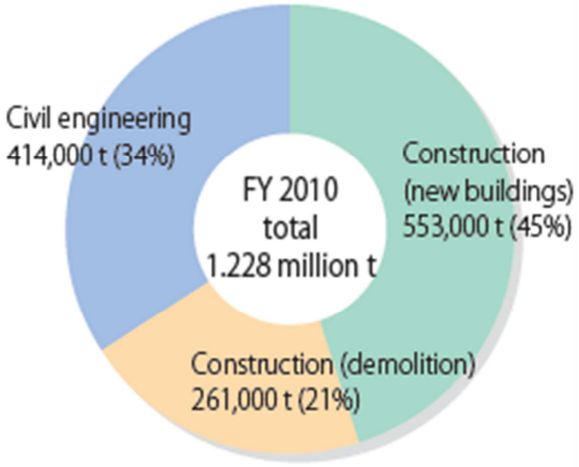

Fig (2). *The amount of wastes in eachbuildingsector*

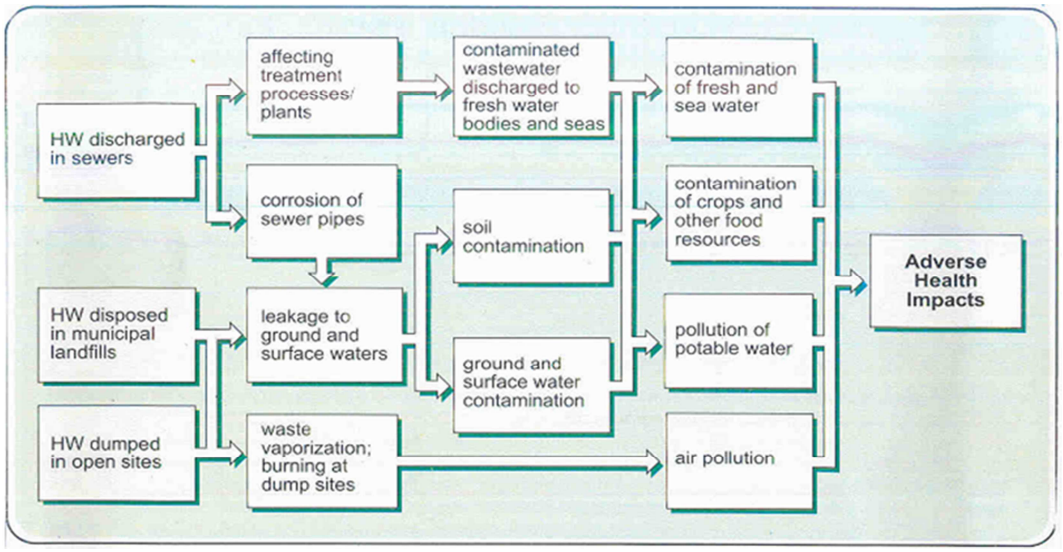

Fig (3). *Environmental impacts of hazardous wastes*

1.2. Classification of Hazardous Wastes

Solid, liquid, or gaseous wastes are considered hazardous if they possess one or more hazardous characteristics which may be summarized as: -

1-Ignitability (capable of burning or causing fire); for example waste ethyl ether, methanol, acetone, toluene, benzene, peroxides.

2-Corrosivity (able to corrode steel or harm organisms because of extreme acidic or basic properties); for example waste sodium hydroxide and sulphuric acid.

3-Reactivity (reacts violently with air and/or water to liberate or produce toxic gases), such as waste cyanide solutions.

4-Toxicity (containing substances which are poisonous); for example waste chromium (VI), arsenic, cadmium, and other heavy metals.

5-Ecotoxicty (due to its bioaccumulation and persistence in the environment); for example PCB waste (poly chlorinated Biphenyls), DDT (p, p`-Dichlorodiphenyltrichloroethane)[4]: [9]

1.3. Construction & Demolition Wastes Materials

Construction and demolition (C&D) materials consist of the debris generated during the construction, renovation, and demolition of buildings, roads, and bridges. C&D materials often contain bulky, heavy materials that include:

- concrete,
- wood (from buildings),
- asphalt (from roads and roofing shingles),
- gypsum (the main component of drywall),
- metals,
- bricks,
- glass,
- plastics,
- salvaged building components (doors, windows, and plumbing fixtures), and
- trees, stumps, earth, and rock from clearing sites. Fig (4) shows volume and weight percentages of the Construction and demolition wastes.

Reducing and recyclingC&D materials (Construction and demolition) conserves landfill space, reduces the environmental impact of producing new materials, creates jobs, and can reduce overall building project expenses through avoided purchase/disposal costs

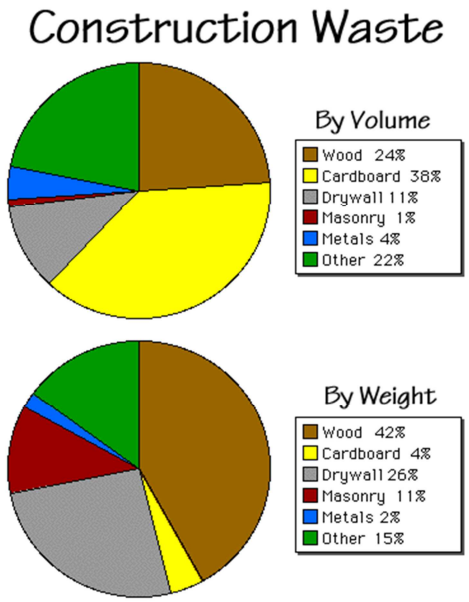

Fig (4). *Volume and weight percentages of the construction and demolition wastes*

Typesof hazardous waste in feeding industries to building and materials.

The most common examples of industrial hazardous waste include:

*Acid and alkali wastes mainly generated from surface treatment and metal finishing processes, production of chemicals, paper, petrochemicals and pharmaceuticals.

*Sludge from industrial wastewater treatment containing heavy metals such as lead, mercury, hexadecane chromium, zinc, copper, nickel, cadmium, arsenic. Theseare generated from a wide range of processes most commonly from chlorine production, pigment and paint manufacture, textiles, wood preservation, metal plating, tanning, smelting and refining of metals[11): (17)].

*Slag containing heavy metals from metal smelting furnaces, most commonly from smelters of lead, aluminum and copper.

*Oil wastes such as used lubrication oils, hydraulic fluids generated in almost all industrial plants from machinery repair and maintenance.

*Halogenated solvent wastes most commonly generated by metal cleaning, textile and leather de-oiling processes.

*Non- Halogenated solvent wastes, such as spirit, toluene, benzene, xylene, ethanol most commonly generated by the manufacturing of paints, inks, adhesives and resins

*PCBs (polychlorinated biphenyl) present in electrical capacitors, vacuum pumps, plasticizers, fire retardants, cutting oils and hydraulic fluids.

*Empty chemicals and oil containers, any materials contaminated with chemicals or oil (rags, sand, etc.).These examples of industrial wastesmight not be recognized as being hazardous by generators, despite the fact that they possess one or more hazardous characteristics[12), (23)].

1.4. Wastes in Feeding Industries to Construction Sector

In this section, the type and amount of wastes and pollutant resulting from the most important mining industriesare discussed. Such as Iron extraction, steel industries, Aluminum industries, cement industries, cook industries and phosphates industries [13):(20)]. The amount andkind of wastes specially hazardous wastes resulting from production of one tone are mentioned.The most important industries are analyzed and the contribution of each product in building sector are shown in fig (5) this diagram illustrates a variety of common building applicationsfor industrial materials. Note that the availability of specificindustrial materials can vary regionally.

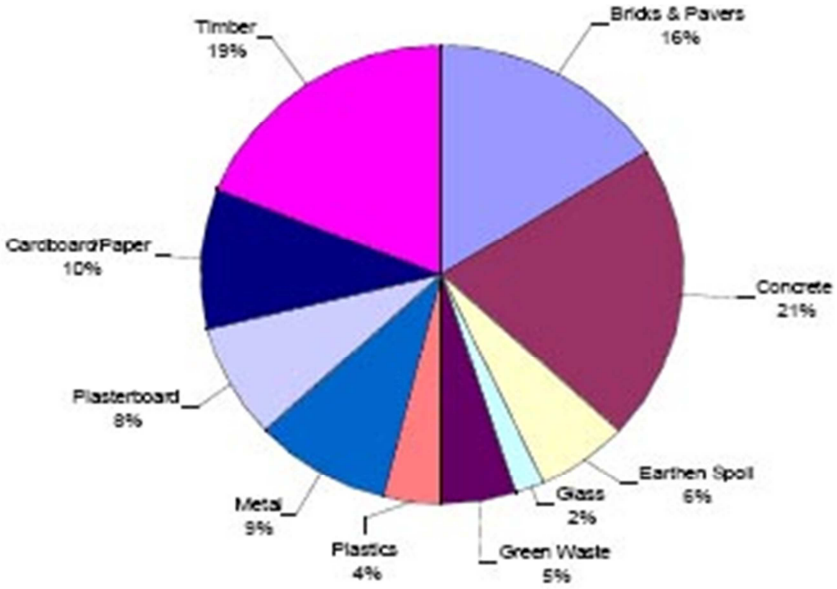

Fig (5). *Volume percentages of the materials used in construction & building sectors.*

1.5. Cook Industry

Cook industry is one ofthe most harmful feeding industries. It is feeding industry in steel making, paintingand chemical industries. Table (1)shows the liquid wastes resulting from cook industry, while table (2) shows the solid wastes resulting from cook industryin (kg/ton).

A) Production of cook

Table (1). *The liquid wastes resulting from cook industry*

Contents	Amount (kg/ton)
Ammonia	0.990
Cyanide	0.05
Phenols	0.19
Sulphuric	0.18
Suspension products	0.04

Table (2). *The solid wastes resulting from cook industry (kg/ton)*

Steps	Waste particles	Carbon mono oxide	Organic compounds	Nitrogen oxides
Crushing	0.37	-	-	-
Heating	1.75	-	-	-
Extraction	0.58	0.03	1.25	0.02
Handling	0.03	-	-	-

1.6. Iron Industries

Iron industriesare the most important industry in different constructions applications, Table (3)The particles resulting from preparation of 1 ton of iron ores. The type and amounts of wastes is completely different when manufacturing steels from scrape at casting ships as shown in table (4).

Table (3). *The particles resulting from preparation of 1 ton of iron ores*

Operation	Particles generated (kg/ton)
Transportation from mining	0.05
Crushing	0.1
Dry grinding	40
Wet grinding	-
Drying of grinded ores	9

Table (4). *The wastes in production of iron in casting ships (kg/ton)*

Product type	Slag	Sands	Iron
Molds	142	600	33
Final products	134	600	32

1.7. Aluminum Industry

Aluminum industry has minimum amount of hazardous wastes because of electrical cells used in extraction of aluminum. Table (5)shows wastes inAluminum industries, but the amount of wastes are strong function in manufacturing method as shown in Table (6).

Table (5). *Wastes in Aluminum industries*

Operation	Amount(kg/ton)	Notes
Production of alumina from bauxite	2000	
Production of Aluminum from alumina	66	Cyanide and fluoride compounds, and dusts
Production of Aluminum from scraps	traces	Very small particles

Table (6). *Wastes dependence on the method of manufacturing*

Operation	Particles (kg/ton)
Biro furnaces	7.3
Bush furnaces	0.9
Reflective furnaces	2.2

1.8. Cement Industry

Cement industry contains all types of hazardous wastes and in all forms such as solid, liquid and gaseos. Table (7) and table (8) show solid and liquid wastes per ton respectively.

Table (7). *Solid wastes in cement industries*

Operation	Particles (kg/ton)
Dry grinding	187
Dry method in clinker production	57
Wet method in clinker production	51
Clinker grinding	21

Table (8). *Liquid wastes in cement industries*

Contents	Particles (kg/ton)
Soluble particles	6.66
Suspended particles	0.19
Alkali particles	1.38
Potassium	3.3
Sulphuric compounds	6.67

Gases resulting from fuel burningSulphur oxides, nitrogen oxide- carbon oxides

1.9. Phosphate Industry

Phosphate industry causes the air pollution Table (9)shows gas wastes in Phosphate industry, this industry have a lot of applications in chemicals necessary for building and construction industry in all stages from soil treatment tofinishing and painting.

Table (9). *Gas wastes in Phosphate industry*

Contents	Particles (milligram / liter)
Chlorides	1574
Sulphates	2186
Hg	0.0001
Cadmium	0.0005
Nickel	0.2
Zinc	5
PH	6.5:8.5
Suspended particles	30
Dry particles (Cr, Cu, Zn, Hg, Pb)	95ppm

1.10. Glass Industry

Finally the kind and amount of wastes resulting from glass industries arealso discussed because the glass industries will become one of the most important industries in Egypt in the near future.Egypt is very rich in highly qualified types of sands.The dependence of pollution up on the method of treatment and the kind of the process appears clearly. Table

(10) shows the wastes in Glass industries and classify them according composition and/or physical properties.

Table (10). *Wastes in Glass industries*

Wastes	Percentage% in mixture	Notes
Liquid wastes	20	Suspension particles from silica- calcium carbonate-sodium carbonate
Solid wastes	5:40	Glass particles reduced to 5% in automatic method while 40% in manual or blowing methods
Gases	20	Silicon oxides-lead oxides-Nitrogen oxides- sulphur oxides- selenium

2. Results & Discussion

Reduction or elimination of wastes resulting from the building and construction sector are the most important aim in green building procedure, it can be done byrecyclingof wastes or replacement of hazardous material to eliminate wastes from sources as follow:-

2.1. Material Recycling

A practice that can be encouraged at the building site byusing separate containers for various materials. Reusing or recycling C&D materials(Construction and demolition)onsite can reduce materialhauling and disposal costs. These savings, applied to the total projectcost, make it possible to do more work with the same budget. Inaddition, C&D materials (Construction and demolition)recycles will often charge less to accept recyclablematerials that have already been separated from non-recyclablematerials, so they make good economic sense for builders and project owners. Fig (6) shows flow chart illustrating the main requirements of the waste classifications. Prior to the final disposal of hazardous waste off-site, waste generators are required to implement the necessary procedures to ensure the proper management of such waste within their industrial establishment, in order to comply with the requirements of Law 4/1994 and its Executive Regulations. Such procedures involve the reduction of hazardous waste at source, identification, safe on site storage, labeling reporting and on-site treatment: -

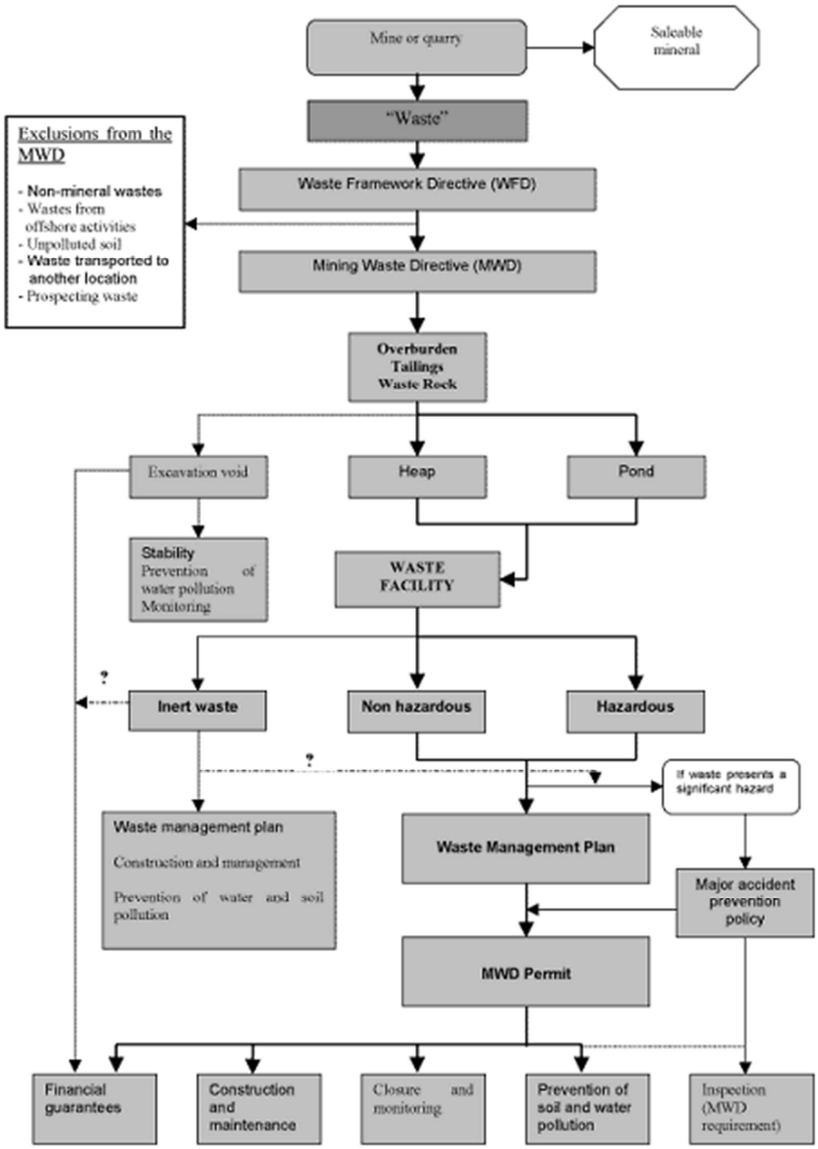

Fig (6). *Flow chart illustrating the main requirements of the waste classifications*

1-reduction of hazardous waste at source

Take all necessary requirements to minimize the generation of hazardous waste, quantitatively by reducing the waste quantities generated at source, and/or qualitatively, by generating waste that is less hazardous. This reduction could be achieved by implementing waste minimization schemes, such as ones for improving the utilized technologies, adopting cleaner technologies, selecting substitutes for products, and/or using less harmful raw materials.

2-Identification of hazardous waste

Industrial facilities are required to establish complete description lists for hazardous wastes generated from the different industrial processes indicating their quantities and composition, for the purpose of identification hazardous waste generation, it is useful to keep in mind, the use of hazardous substances as input material for industrial processes most likely results in the generation of hazardous waste.

3-Hazardous waste segregation

Hazardous waste must be separated at source from other types of non-hazardous waste (municipal waste). In addition, the different types of hazardous waste must not be mixed together in order to avoid any undesired harmful interaction between the different types of wastes.

4-On-site storage of hazardous wastes

Hazardous wastes generators should ensure the safe temporary storage of the hazardous waste on-site until final disposal. The waste storage areas should be determined, they are away from public places in order to prevent any harm to the public or those persons exposed to the waste. These sites should be clearly designated and equipped with the necessary safety and protection equipment such as fire extinguishers, absorbing materials and first aid equipment. Emergency plans should also be developed to confront any likely accidents particularly spills and fire.

Hazardous waste storage containers must be madefrom suitable materials and be properly sealed to avoid leakages of spills into the surroundings.

5-Labeling of hazardous waste storage containers

Clear signs and labels must be placed on hazardous waste storage containers, indicating the

content of the container and the associated hazards, if improperly handled.

6-Collection of hazardous wastes

In cases of treatment /disposal of hazardous wastes carried out off-site, the industrial establishments aredeliver their wastes only to licensed contractors for transport.

7- On-site treatment/ recycling/reuse of hazardous wastes

Treatment of hazardous wastescan be done for the purpose of recycling/reuse or disposal. If treatment is carried out on-site, approved treatment system and the technical specifications of the treatment units and their operational programs must be recorded.

8-Hazardous waste register

All establishments handling hazardous wastes are required to keep a record of the generated wastes, the method of disposal and the parties who will receive this wastemust be registered.

Data must be included in the hazardous waste register:-

*Name and address of the establishment

*Name and job title of the person responsible for filing the register

*The period covered by the current data

*A comprehensive list of the types and quantities of hazardous wastes resulting from the different activities

*Method of disposal of the resulting hazardous wastes

*The parties contracted with to receive the hazardous wastes

*Date on which the form is filled

*Signature of the officer in charge [27), (28)]

2.2. Material Replacements

Some industrial materials, such as fly ash and slagcement used as supplementary cementations materialin concrete, offer significant performance benefitsover virgin materials. Other industrial materials, such asfoundry sand, perform just as well as—and in some casesbetter than—virgin materials in building applications. Coalbottom ash used as bedding material for green roofs are lighterweightthan alternatives, an important quality in this application.Fig (7)shows waste reduction and elimination scheme

Fig (7). *Waste reduction and elimination scheme*

2.3. Green Building

Greenor sustainablebuilding is the practice of creating and usinghealthier and more resource-efficient methods of construction,renovation, operation, maintenance, and demolition. Designing withindustrial materials and recycling C&D materials (Construction and demolition)generated from projectsleads to more sustainable buildings. Most green building certificationsgive points for these practices; two of the best-known certification

systems are the U.S. Green Building Council's Leadership in Energy andEnvironmental Design (LEED) green building rating system and theGreen Building Initiative's Green Globes TM green building rating system.

Legal Framework for Hazardous Waste Management InEgypt

Law 4/1994 for the environmental and its Executive Regulations (ER) present the primary overall legal framework for the management of hazardous waste. In

addition, Laws 93/1962 and 48/1982 specify the limits for hazardous wastewater discharge into the public sewers and River Nile and waterways, respectively.

According to Law 4/1994. It is prohibited to import hazardous waste or allow its entrance into Egypt. Moreover, Egypt is a party of the Basel Convention on TheTrans-boundary Movement of Hazardous Waste. In this respect, the export of this type of waste from Egyptian industrial establishments, for the purpose of treatment or recycling, is to take place only upon the approval of the Egyptian Environmental Affair Agency (EEAA)[20), (25).

Under developmentis a system for permitting of industrial establishments generating and handling hazardous waste, following the stipulation of law 4/1994 and its ER. This is carried out by the Ministry of Industry in cooperation with EEAA, and is expected to become operational in the near future. Granted permits would include details of on-site management practices, and would present a further requirement for compliance, in addition to those presented above, which are currently used as the basis for the enforcement of law 4/1994. The hazardous waste classification lists being prepared by the Ministry of Industry, and Ministry of Petroleum in cooperation with EEAA and the Ministry of Health, determine the different types of hazardous wastes generated within the industrial sector and other sectors. These lists will facilitate the identification process of such wastes by the industrial establishments [2): (5).

3. Conclusions & Recommendations

1. Many industrial materials are used to replace non-renewablevirgin materials that must be mined and processed for use.
2. Conserves natural resources and reduces the energy use and pollutionassociated with these activities.
3. Substituting coal fly ash(an industrial material) for portland cement in concrete saves the energyand greenhouse gas emissions associated with producing cement.
4. Thebeneficial use of industrial materials results in less material being sentto disposal facilities, which saves landfill space and further reducesgreenhouse gas emissions and other pollutants.

Waste management activities that can be implemented immediately by the industrial establishments

1. Identification of generated hazardous waste.
2. Segregation of hazardous waste at source.
3. On-site safe storage.
4. Proper labeling of hazardous waste registration.
5. Hazardous waste minimization.
6. Training and awareness for workers handling these wastes.
7. Sending used wastes to recycling companies. [2):(5)
8. Using wet, electrical,or less pollutant methods in manufacturing.
9. Recycling of wastes in production areas.
10. Use filters for air purifications according to national standards automation for process.
11. following the standard roles in waste management for hazardous and non-hazardous materials.

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