



## Recycling and Utilization of the Wastes of Ceramic Products

**Name: Fathy Abdel Wahab Osman**

**Job title: Assistant Professor at ceramic Department, the Faculty of Applied Arts,**

### Introduction

The ceramic industry is among the industrial sectors that produce a lot of wastes; whether gaseous, liquid or solid, which participate in the environmental pollution. The problem of the industrial wastes of the ceramic industry is getting worse due to the increase of production. There are some ideas that have surfaced to reduce this problem; such as using crushed glass which exists in residues as a substitute to sand in paving streets; and the attempt to use these residues in producing clean energy, still, more ideas are expected to appear in the future for waste disposal in a method that will preserve the environment without consuming a lot of power. The concept of sustainability plays a vital role in the ceramic industry, so it is essential that the designer makes an effort to practically apply and establish this concept in the production cycle in both large and small factories.

There is an environmental problem related to the increase of the industrial production in the field of ceramics, as solid wastes resultant of the steps of firing and sorting represent a big problem as well as being an economical burden in large, medium and small factories (studios). These wastes increase in conjunction with the accretion of production, causing a major loss of power, time, effort and space (used store these wastes). Studies must be conducted on how to decrease this loss and how to benefit from recycling solid wastes resulted from the firing and sorting steps of ceramic products; by increasing their proportion used in the ceramic figure mixture without causing any distortion to it, and at the same time attain a better mechanical durability of the body (in large factories).

The research will discuss definitions of the concepts related to recycling, reusing, upcycling and sustainability. It will also discuss the pollution sources in the industry of ceramic products (tiles, sanitary ware, thermals and table ware). The research's practical aspect tackles the issue of how to take advantage of recycling studio ceramic products in creating new artworks with an aesthetic value. Recycling in the ceramic industry saves a lot of power, as this industry consumes a large amount of heating and electricity, part of this power is saved; as well as plenty of raw materials; when these products are reused in the production process, many high aesthetic artworks can be produced this way.

### Research objective:

- Recycling the solid wastes of the ceramic products, as well as increasing their proportion in the ceramic figure in a way close to forming a complete one.
- Reducing the loss of power used in the ceramics industry, as well as minimizing the solid wastes resulted from various production steps, which lead to cutting down the cost of the final product.



- Succeeding in reusing the solid wastes resulting from ceramic products (before and after firing) in creating artworks.

### **Research methodology:**

The research follows the descriptive method to identify the concepts of recycling, reuse and sustainability, while the analytical method is used to clarify the advantages of each of these concepts, as well as analyzing the pollution sources throughout the steps of the production process. The research follows the practical method to conduct virtual experiences.

### **Research academic framework:**

- Studying the concepts and definitions of recycling, reuse, upcycling and sustainability.
- Studying the concept of recycling in the field of ceramic products industry.
- Attempting to recycle a product in the industry (Duravit).
- Practical aspect.

### **Keywords:**

**Recycling – Reuse – Up cycling – Sustainability**

### **Recycling:**

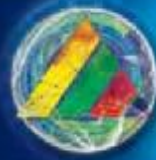
It is the re-use of residues in making other products with less quality than the original product. Its importance lies in preserving the natural resources, eliminating wastes and creating new job opportunities. It has some disadvantages; among which are the workforce cost, the quality of the materials used in waste transformation and the possible aggravation of residues. (internet / 8)

### **The advantages of Recycling:**

- Decreasing the demand on raw materials, hence, preserving the natural resources and reducing consumption; this is done through reproduction, upgrading the efficiency of the production processes and prolonging the lifetime of the product.
- Protecting the environment from the toxic materials and emissions, hence, reducing pollution and global warming.
- Recycling is a tool to implement sustainable development by which we can help preserve the environment for the coming generations. (internet / 11)

### **Reuse:**

It is the usage of the material more than once; this includes normal recycling; when the same material is used for the same purpose, and using it for new purposes. Reuse holds many economical and environmental advantages, which is an encouragement to apply this concept. Reuse means searching for ways for a better recycling “upcycling” to use old products.



### **Upcycling:**

It is the process of transforming the residues and useless products into new materials or products with higher quality or better environmental advantage. This concept is the equivalent of the concept of recycling as an attempt to lower the cost. (Internet / 12)

### **Sustainability:**

It is an environmental term that describes how the biological systems remain diverse and productive over the time. (internet / 12) It is observed that the most important challenge facing sustainability is the elimination of poverty, by the encouragement to follow balanced production and consumption patterns, without the excessive dependence on the natural resources. (internet / 12)

### **A study of the concept of recycling in the field of ceramic products industry**

Pollution can be caused by the industry of ceramic products, it occurs through air emissions, used water and solid wastes (residues)

#### **1st: Air Emissions**

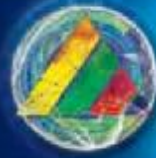
They are produced through the processes of storing and handling raw materials during the production operations (sieving, mixing, weighing, grinding); or during the firing process; drying in the spray dryer (in ceramic tiles production), and during paint spraying and polishing (buffing) of the ceramic tiles.

#### **Harmful emissions can be avoided by:**

- Separating between the storage areas and the operation areas.
- Using closed silos, as well as barriers for raw materials to resist the wind.
- Using closed systems to transfer raw materials.
- Using sacks filters.
- Using compact sheets filters to separate the dust during the painting process.
- Using high pressure hydraulic compressors in the production of ceramic tiles.
- Improving the grinding cycle and the amount of used water.
- Using pressure casting in the production of sanitary ware.

Also, modern technology can be used in the firing process such as rapid firing, using a good isolation system to reduce heat loss, and using kiln refractories such as cordite mullite and re-crystallized silicon carbide. It is preferred to use the initial heating operation of the kiln to avoid transferring from the dryer to the kiln; also, the heat produced from the cooling step can be re-used in the heating preparation step.

Also, Chloride and fluoride are discharged among the firing emissions through Hydrochloric acid (HCl) and Hydrofluoric acid (HF). To reduce these harmful emissions it is recommended that the materials used in painting must not contain lead or toxic metals; and to avoid dyes and



colors that are based on chrome, antimony, barium, lithium, manganese, vanadium and cobalt. (Egyptian Environmental Affairs Agency / 2002)

## **2nd: Used Water**

The water resulted from ceramic products industry contains some soluble and insoluble metals; some of these are heavy metals such as lead and mercury; which is very dangerous to the public health. While other elements, such as calcium, are contained in the working place and are harmful in case of long exposure. Water is a source of pollution in the ceramic products industry, it is used during different production steps (setting, preparation, casting, painting, embellishing, polishing (buffing) and damp grinding), during these processes, water is mixed with suspended moleculars (particles) of paint and ceramic metals, such as: clay and insoluble silica, as well as other soluble materials, such as: lead, zinc, sulfate, boron and small amounts of organic materials. There are other liquid wastes, such as consumed lubrication oils. This can be avoided by using closed circuits, transferring engobes through grids and applying different methods to clear gases, as well as using water treatment methods by sedimentation and filtration. (internet / 9)

## **3rd: solid wastes**

The solid wastes produced from the ceramic products industry are present in:

- Sludge resulted from used water.
- Painting, pargeting and grinding stages.
- Broken products (casting, used plaster molds, drying, firing).
- Broken thermals.
- Solid materials of the gas treatment processes (cleaning flues and removing dust)
- Wrapping process remains (plastic, wood, metals, paper)

This can be solved by improving the production steps, as well as good utilization of the quality control for each step separately, applying modern and advanced technology in casting, using modern painting spray cabins and recycling the sludge resulted from raw materials preparation (dust) in manufacturing breaks. There are some general guidelines that must be followed in the ceramic production industry to protect the environment, health and safety in the field of ceramics.

## **Practicing the recycling of the product in the industry (Duravit)**

The stated goal of Duravit (a German Sanitary Ware factory that has a branch in Egypt) is to reinstall everything back into the production cycle, whenever it is possible. As all materials used in Duravit are recyclable: the sanitary ware can be recycled and used as a wear-resistant material in road construction, some of it can be reused in the factory for more production. Here, the product sustainability is not coincidental; it is planned in advance by the department of the product development. Over the decades, Duravit in Germany has invested a great amount of time, money and effort in research and development; this is the kind of investment that pays off later in favor of the company, consumers and environment.



### The Practical aspect:

The research will tackle the concept of recycling the residues of studio ceramics, as this type of ceramics is based on manual modeling (wheel, pressure, ropes, slats, ceramic sculpturing); it includes a lot of experimenting by creating various shapes, which results in a large amount of wastes caused by different production steps, including before and after firing.

The rummage resulted from the wheel formation can be used during the inventory step; as the formation process produces clay strips that can be recycled by combining them with clay and re-ferment them during the setting and preparation step. But, they can be used in different useful ways through manual formation to produce artworks with high fine values (recycling); this is manifested in the research experiment, as apparent in the following actions:

- **Formation is done on the horizontal surface, as shown in fot. (1)**
- **Formation on a clay cylinder; slats are attached by liquid clay, as shown in fig. (2)**
- **The idea of the artwork is created by emphasizing the possibility of using slats and the diversity of processing, through the artwork shown in fig. (3).**



fot. (1)



fot. (2)



fot. (3)



### Results:

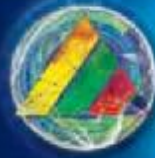
- Ceramic solid wastes can be used after they are well grinded (crushed) to form the heap used in paving streets, they can be mixed with the cement and asphalt concrete, as well as the settling materials, filling materials or the road base layers.
- The proportion of solid wastes can be increased in the structure of the ceramic figure, so that it is close to a full figure form with no distortion; to reach maximum waste recycling in the product.
- Reducing the amount of residues by implementing the methods of clean production in the industrial establishments, through developing the production process, practicing loss control techniques and converting to using substrates that do not cause pollution.

### Results Analyzing:

Studies conducted at the institutes and industrial establishments in the construction field have proved that the best way for this industry to be more sustainable is to utilize the solid ceramic residues in the cement industry, which is a main component in the concrete, this is considered a major power saving element and is of a great importance to the environment. Laboratory results of the practical studies illuminated that the concrete composed of ceramic residues has a higher mechanical tolerance and friction resistant than the normal concrete. Waste loss can be decreased by improving the production steps, good utilization of quality control in each operation separately and implementing modern and advanced technology in the different steps of ceramics production.

### Recommendations:

- Establishing the significant importance of the concept of sustainability in the industry of ceramic products; as a general concept that includes the concepts of designing the life cycle of the product, recycling and reuse of the solid wastes generated through different production steps. As well as contemplating the problem of solid wastes resulted from the firing and sorting steps; which are piled up in large amounts representing a major economical and environmental problem; by using economical methods.
- It is important to reduce the loss of power used in the ceramic products industry and to decrease the amount of solid wastes caused by the production stages, which will lower the cost of the final product.
- Activating the role of the civil organizations and media to raise the awareness of preserving the environment and reducing pollution.
- Improving the production steps, as well as good utilization of the quality control for each operation separately, also, implementing modern and advanced technology in the casting step and using modern paint spray cabinets, among other actions.



#### References:

- 1- Ahmed Hamza “Integrated management for industrial residues and wastes in the Arab Region”, a workshop about recycling and treatment of industrial wastes. Cairo / 2001 / 3 / 1 :2/27
- 2- Dr. Osama Elkholy, Dr. Moustafa Tolba “The Environment and the Issues of development and Industrialization”, World of Knowledge series / issue no. 285 / 2002
- 3- Dr. Ahmed Medhat Islam “Pollution: the problem of the present time”, World Knowledge series / issue no. 152 / 1990
4. Dr. Gehad Abo Elata, Dr. Mohamed Elbeshlawy “The environmental damages caused by ignoring the industrial wastes and residues”, workshop about residues recycling and industrial wastes treatment, Cairo / 2001 / 3 / 1 : 2/27

#### Academic Thesis

- 6- Essam Roshdy Mohamed Elbakry, “Factors of sustainable development in the developing countries” masters degree, Faculty of Engineering, Cairo University, 2006.
- 7- Rimam Mohamed Rihan, “Developing new communities and stabilization as an effective tool in the sustainable urban development”, doctorate degree, Faculty of Engineering, Cairo University, 2002

#### Internet References:

- 8- <http://forum.rjeem.com/t100133.html>
- 9- <http://ifcext.ifc.org/ifcext/sustainability.nsf/Content/EnvironmentalGuidelines>
- 10- <http://www.duravit.com.eg/>
- 11- <http://www.ecomena.org/recycling-ar/> (translated by: Salam AbdelKareem Ababana)
- 12- <https://ar.wikipedia.org/wiki>

#### Governmental Entities:

- 13- Egyptian Environmental Affairs Agency – Ceramics Industry Inspection Guide / 2002