

A PRODUCT FOR WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT REUTILIZATION AND PROCESS FOR PREPARATION THEREOF

FIELD OF THE INVENTION:

5 The present invention relates to the bulk E-waste treatment and more particularly, to a process for environmentally sustainable reutilization of E- waste and/or Waste Electrical and Electronic Equipment (WEEE hereinafter). In addition, the invention also relates to WEEE brick adapted to treat the bulk WEEE material for sustainable environmental reutilization.

DESCRIPTION OF RELATED ART:

Discarded electrical and electronic devices become a prime source of Waste Electrical and Electronics Equipments (WEEE). WEEE normally contain chemical substances such as, for example, lead, cadmium, lead oxide, silver oxide, nickel-metal hydride, brominated flame retardants, toxic gases, toxic metals, Polychlorinated Biphenyls (PCB's), acids and plastics.

15 These chemical substances, if not treated properly, are highly dangerous and hazardous to humans, plants and animals that greatly disturb the flora and fauna of the environment.

Various practices for E-waste disposal including but not limited to landfilling, incineration, soaking in open acid baths, magnetic separation and recycling are known. However, these procedures are not without pollutants such as obnoxious gas or greenhouse gas (GHG)

20 emissions, emission of carcinogens or teratogens and leaching of chemicals into the soil and ground water. Also, these procedures are unsafe, time consuming, costly, requiring large amount of energy consumption and specifically need special machinery or skilled workers.

Efforts are being made for recycling E-wastes for utilization in various value added applications. For example, European patent, EP1428586 (A1) to Barker describes a method for

the disposal of discarded electrical and electronic equipment. The method comprises steps such as, for example, dismantling the equipment as necessary, segregating the parts into those containing glass and other items, melting the glass parts and mixing all together to encapsulate the waste parts in the molten glass to form pebble shaped ingots. The ingots are then used as ballast or as a building aggregate.

In addition, few efforts are seen in the art for reutilization of WEEE in building construction. For example, M. Dondi et.al (2009, Waste Management 29:1945–1951) describes a process for re-use glass of TV and PC monitors in the manufacturing of clay bricks and roof tiles. The process consists of steps like clay grinding, mixing of clay, glass, and water followed by successive storage for 7 days. The process also discloses the steps of body preparation, shaping, drying, and firing through a simulation, on a laboratory pilot line, of the industrial processing of clay bricks and roof tiles. Reference may be made to F Andreola et. al (2010, Second International Conference on Sustainable Construction Materials and Technologies) where in the Waste Electrical and Electronic Equipment (WEEE) glasses are used in construction sector as secondary raw material.

However, the methods or processes available in the prior art require heat or chemical treatment of wastes to make them suitable and sustainable raw material in building construction. Also, these methods normally include steps of extraction, re-cycling, shredding, segregation or disposing that are inefficient, costly, time consuming and non-environment friendly.

A simple, more efficient, non-polluting, environment friendly, expeditious process and apparatus for bulk E-waste treatment for sustainable environmental reutilization of E-waste and/or Waste Electrical and Electronic Equipment (WEEE) is needed.

SUMMARY OF THE INVENTION:

A Waste Electrical and Electronic Equipment (WEEE) brick and a process for preparation of WEEE brick adapted to treat a bulk WEEE material for sustainable environmental reutilization is disclosed. WEEE brick comprises a first part and a second part. The first part is adapted to be sequentially filled with at least two layers. The second part is defined from a second piece to include at least two panels adapted to close the first part. Alternately, the second piece includes a single panel. First part and second part are securely coupled to define the WEEE brick.

Preparation of WEEE brick to treat a bulk WEEE material for sustainable environmental reutilization includes an initial step of forming the first part and second part of the WEEE from a suitable material. The suitable materials are selected from one or more of the following mild steel, bronze, aluminium, metal, plastic, alloys and combination thereof. Alternatively, pre fabricated panels of gravel, cement or mortar, ceramics molding, soil, clay, thermoplastic polymers, composites, fiberglass and molding sand can be used as and/or in place of the panel. In next step, WEEE material is categorized into a small WEEE material and a large WEEE material.

In next step, a binder/filler material is filled in a predefined proportion inside the first part of the WEEE brick. The binder material is selected from a group of epoxy resin, mortar mix, silicone sealant, reactive acrylics, polyurethanes adhesives, Reactive Hot Melt Polyurethanes (RHMUs), cyanoacrylates, polyvinyl acetates, hydrocarbon rubber based sealants, glue and cement with gravel, sand and coarse aggregates. In next step, the categorized WEEE material is filed in a pre-defined sequence and proportion inside the first part of the WEEE brick. Any precious metals and components can be extracted in this step before inserting the WEEE

material. The binder material is allowed to settle, expand, cure and harden partially for a predefined amount of time in next step. The first part is securely coupled to the second part to complete the WEEE brick preparation. Outer surface of prepared WEEE brick is corrugated with furrows or punch marks for enamel painting and rubber lamination.

5 Depending upon the nature or type of binder material used, each layer can be cured further after placing or embedding of WEEE and before the application of another layer, with sprinkling of fresh water or by hydrating. This is done to enable the escape of any entrapped air and/or to prevent development of cracks or fissures and bubble formation.

10 The process of the present invention does not require any chemical or physical treatment of the waste material thereby avoids emission of obnoxious gas or greenhouse gas emissions. Therefore, the process of the present invention is environment friendly. The process utilizes all E-waste and/or Waste Electrical and Electronic Equipment (WEEE) selected from electrical or electronic materials that are damaged, discarded, old, obsolete and outdated in design. It also includes wastes selected from electrical/ electronic scraps, rejects from electrical/ electronic
15 manufacturing process, historical electrical/ electronic wastes, orphaned and ‘end of life’ electrical/ electronic products. The process is safe, economical & capable of mass production on a large scale.

STATEMENT OF THE INVENTION:

20 A process for preparation of Waste Electrical and Electronic Equipment (WEEE) brick adapted to treat a bulk WEEE material for sustainable environmental reutilization is disclosed. The brick comprises a first part and a second part such that the first part is sequentially filled

with a binder/filler material followed by filling with a WEEE material. The second part is securely coupled to the first part to form the WEEE brick.

BRIEF DESCRIPTION OF DRAWINGS:

- 5 The above mentioned and other features, aspects and advantages of the present invention will become better understood with regard to following description, appended claims and accompanying drawings, wherein like reference numerals refer to similar parts throughout the several views where:
- FIG. 1 is a perspective view of a preferred embodiment of a WEEE (E-waste and/or Waste
10 Electrical and Electronic Equipment) brick constructed in accordance with the present invention;
FIG. 2A is a top view of a first piece of the WEEE brick of FIG. 1 in a non-welded state;
FIG. 2B is a top view of a second piece of the WEEE brick of FIG. 1 in a non-welded state;
FIG. 3 is a front view of the first piece of FIG. 2A filled with an E-waste and a binder/filler material;
- 15 FIG. 4 is a perspective view showing a process of transforming the first piece of FIG. 2A into a first part;
- FIG.5 is a perspective view showing a process of transforming the second piece of the FIG. 2B into a second part;
- FIG. 6 is a top perspective view of the first piece of FIG. 2A partially filled with the binder/filler
20 material; and
- FIG. 7 is a top perspective view showing a process of joining the first piece to the second piece to form the WEEE brick of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION:

Although specific terms are used in the following description for sake of clarity, these terms are intended to refer only to particular structure of the invention selected for illustration in the drawings, and are not intended to define or limit the scope of the invention.

5 Referring to FIG. 1, a WEEE (E-waste and/or Waste Electrical and Electronic Equipment) brick 10 in accordance with a preferred embodiment of the present invention is shown. WEEE brick 10 preferably has a rectangular configuration defined by a plurality of flat panels adapted to be welded in a predefined form. WEEE brick 10 includes a first pair of
10 opposed panels 12, 12', a second pair of opposed panels 14, 14', a top rectangular panel 16 and a bottom rectangular panel 16'. In this one preferred embodiment, panels 12, 12', 14, 14', 16 and 16' are made of mild steel. It is understood, however, that panels 12, 12', 14, 14', 16 and 16' can be made from any other material viz. bronze, aluminium, metal, plastic, alloys and combination thereof in other alternative embodiments of brick 10.

However, it is understood here that panels 12, 12', 14, 14', 16 and 16' can be
15 prefabricated out of a mold in other alternative embodiments of WEEE brick 10 wherein the mold is made from one or more materials of the following gravel, cement or mortar, ceramics molding, soil, clay, thermoplastic polymers, composites, fiberglass and molding sand.

In this one preferred embodiment, dimensions of the WEEE brick 10 are (9" X 4.5" X 3"), however, it is understood that dimensions of WEEE brick 10 may vary in other alternative
20 embodiments of brick 10 per intended use. Brick 10 may have other shapes in other alternative embodiments such as for example square, conical, round and trapezoid.

Referring to FIG. 2A and 2B, WEEE brick 10 comprises a first piece 18 and a second piece 20. First piece 18 is defined by panels 14, 14', 12' and 16'. Panels 14 and 16' define a fold

22 adapted to facilitate folding of panel 14 over panel 16'. Panels 14' and 16' define a fold 24 adapted to facilitate folding of panel 14' over panel 16'. Panels 12' and 16' define a fold 26 adapted to facilitate folding of panel 12' over panel 16'. Second piece 20 is defined by panels 12 and 16. Panels 12 and 16 define a fold 28 adapted to facilitate folding of panel 12 over panel 16.

5 Referring to FIG. 3, first piece 18 is filled with a large WEEE material 30 that is preferably added over a binder/filler material layer 34. In next step, first piece 18 is filled with a small WEEE material 32 that fills the void space between the contents of large WEEE material 30. In this one preferred embodiment, WEEE materials 30, 32 are added with binder material 34 in an approximate ratio of about 60:40. However, it is understood that ratio of WEEE material
10 30, 32 and binder material 34 may vary per intended application in other alternative embodiments of brick 10. Any precious metals and components can be extracted at this stage before inserting the WEEE material 30, 32.

Referring to FIGS. 4 and 5, a preferred process for the construction of WEEE brick 10 from first piece 18 and second piece 20 is described. In the preferred process a first part 36 is
15 formed from first piece 18 and a second part 38 is formed from second piece 20 including at least two panels 12, 16 to close the first part 36. In this one preferred embodiment, first and second parts 36, 38 are repetitively coated with an anti oxide paint (primer) preferably on the inner surfaces of first and second parts 36, 38.

First part 36 adapted to be sequentially filled with at least two layers, wherein a first layer
20 is of binder material 34 and a second layer is of WEEE 30, 32 materials deposited on the first layer.

In a first step, panel 14 is folded at fold 22 as indicated by arrow "a". Panel 14' is folded at fold 24 with respect to the bottom panel 16' as indicated by arrow "a". Rare panel 12' is folded

at fold 26 with respect to the bottom panel 16' as indicated by arrow "b". Panels 14, 14' and 12' are folded substantially normal to bottom panel 16'.

In next step, panel 14 is connected to panel 12' at a first connecting edge 40. Panel 14' is connected to panel 12' at a second connecting edge 42. In this one preferred embodiment, edges 40, 42 are adapted to be connected via a joining process such as welding. However, it is understood that edges 40, 42 can be connected by other suitable methods, such as for example, arc welding, brazing, riveting, adhesive bonding, soldering, metal seaming, screw bolting, press fit, snap fit or any other type of mechanical fastening. In next step, panels 12, 16 of second piece 20 are folded at fold 28, as indicated by arrow "c", to form second part 38 as shown in FIG 4.

Referring to FIG. 6 and 7, first part 36 advantageously includes an open portion 44 adapted to fill with a binder material to a form binder layer 34 that is preferably deposited on bottom panel 16'. First part 36 includes a plurality of connecting edges namely 46, 48, 50, 52 and 54. Second part 38 also includes a plurality of connecting edges 56, 58, 60, 62 and 64. In this one preferred embodiment, edge 46 connects to edge 56, edge 48 connects to edge 58, edge 50 connects to edge 60, edge 52 connects to edge 62 and edge 54 connects to edge 64 by welding. However, it is understood that edges 46-64 can be connected by other suitable methods, such as for example, arc welding, brazing, riveting, adhesive bonding, soldering, metal seaming, screw bolting, press fit, snap fit or any other type of mechanical fastening.

In another embodiment, WEEE brick 10 may comprise a first part 36 and a second part 38, wherein first part 36 is sequentially filled with at least two layers and second part 38 defined from a second piece 20 includes a single panel adapted to close the first part 36. First part 36 and second part 38 are securely coupled to define the WEEE brick 10.

Now referring to FIGS. 1 to 7, a preferred process for bulk E-Waste treatment for sustainable environmental reutilization (BEWTSER) of E-waste and/or Waste Electrical and Electronic Equipment (WEEE) as an alternative building material in infrastructure development and building construction or construction of any small or big structure(s) or members, the

5 process includes the steps of:

- a) forming a first part 36 and a second part 38 from a suitable material;
- b) categorizing the WEEE waste material 30, 32;
- c) filling the categorized waste in a pre-defined sequence in a predefined proportion inside first part 36;
- 10 d) filling the first part 36 with predefined binder material 34 in a predefined proportion;
- e) allowing binder material 34 to settle, expand, cure and partially harden for a predefined amount of time;
- f) closing first part 36 with second part 38 of predefined size to form WEEE brick 10 of the present invention;
- 15 g) preparing outer surfaces of WEEE brick 10 by corrugating with furrows or punch marks; and
- h) coating WEEE brick 10 with a coating material; and
- i) laminating with rubber material for aesthetics and corrosion prevention.

The preferred process for treating E-waste to form a WEEE brick 10 in accordance with the present invention is described hereinafter:

- 20 In first step a) of preferred process, WEEE brick 10 is fabricated from mild steel panels 12, 12', 14, 14', 16 and 16'. Panels 12, 12', 14, 14', 16 and 16' are folded and welded together at their connecting edges to form first and second parts 36, 38. First part 36 preferably has open

end 44 for filling with the predefined raw material, E-waste and/or Waste Electrical and Electronic Equipment (WEEE) 30, 32 in accordance with the present invention.

In next step b), all E-waste and/or Waste Electrical and Electronic Equipment (WEEE) 30, 32 are selected from electrical or electronic materials that are damaged, discarded, old, obsolete and outdated in design. WEEE 30, 32 is also selected from electrical/ electronic scraps, rejects from electrical/ electronic manufacturing process, historical electrical/ electronic wastes, orphaned and 'end of life' electrical/ electronic products. However, it is understood here that batteries except wet batteries, for example, lead acid and nickel metal hydride cells type, bio medical wastes and radioactive materials or parts are specifically excluded from WEEE 30, 32 in the process of the present invention. The E-waste is dismantled, cut or broke only for size reduction purposes.

In next steps c) and d), first part 36 is filled with binder material layer 34 followed by loose packing with E-waste and/or Waste Electrical and Electronic Equipment (WEEE) 30, 32. In this one preferred embodiment, WEEE 30, 32 are in proportion of about 70-80% of the total size of first part 34 and binder material layer 34 is in a proportion of about 20-30% of total size of first part 34. In step e), binder material layer 34 is allowed to settle, expand, cure and harden partially for a predefined amount of time. In this one preferred embodiment, the time required for the binder material to settle, expand, cure and harden partially is about 5-6 hours. However, it is, understood that the time required for binder material to settle, expand, cure and harden partially may vary depending upon the type or nature of binder material used for preparation of WEEE brick 10.

In next step f), first part 36 and second part 38 are closed or sealed by welding to form WEEE brick 10 of the present invention. In next steps g) and h), outer surfaces of WEEE brick

10 are corrugated with furrows or punch marks and coated with a coating material is selected from one or more of the following enamel paint, anti oxidizing primer paint. However, it is understood that outer surfaces of WEEE brick 10 can be uncorrugated in other alternative embodiments of WEEE brick 10 wherein the panels are made of one or more materials of the following gravel, cement or mortar, ceramics molding, soil, clay, thermoplastic polymers, composites, fiberglass and molding sand.

In next step i), the outer surfaces of WEEE brick 10 are laminated with rubber coating. However, it is understood that the outer surfaces of WEEE brick 10 can be coated with other suitable agents, such as for example, plastic enamel, layer of Plaster of Paris/POP, cloth, fabric, leather or any other decorative cover.

Depending upon the nature or type of binder material 34 used, each layer can be cured further after placing or embedding of WEEE 30, 32 and before the application of another layer, with sprinkling of fresh water or by hydrating. This is done to enable the escape of any entrapped air and/or to prevent development of cracks or fissures and bubble formation. The process of the present invention utilizes E-waste or WEEE 30, 32 as raw material in construction activity, for example, preparation of bricks, building material, doors, furniture, walls, road and highway blocks etc.

The process of the present invention does not require any chemical or physical treatment of the waste material thereby avoids the emission of obnoxious gas or greenhouse gas emissions. Therefore, the process of the present invention is environment friendly. The process utilizes all E-waste and/or Waste Electrical and Electronic Equipment (WEEE) that is selected from electrical or electronic materials that are damaged, discarded, old, obsolete and outdated in design. It also includes wastes selected from electrical/ electronic scraps, rejects from electrical/

electronic manufacturing process, historical electrical/ electronic wastes, orphaned and 'end of life' electrical/ electronic products. Larger of the external casings and covers of waste material are used as empty receptacles to house the smaller WEEE pieces. The process is safe, economical & capable of mass production on a large scale.

5 The invention is further illustrated hereinafter by means of examples.

EXAMPLE 1

WEEE brick panels 12, 12', 14, 14', 16 and 16' were prepared from mild steel (MS) sheet. MS sheet was procured & cut to approximately 0.8-1.2 mm and to the size 9.0+ x 15.0+ square
10 inch. Joints/edges 22, 24, and 26 of panels 12', 14, 14' and 16' were arc welded to form a first part 36 that has cuboid shape, with single or two panel sides in open configuration. Panels 12 and 16 are folded at edge 28 to form second part 38. First and second parts 36, 38 are repetitively coated with an anti oxide paint (primer), preferably on the inner surfaces of first and second parts 36, 38. On complete drying, the first bottom layer (approx.1/4 inch depth) of mortar 34 i.e.
15 mixture of cement, coarse aggregates and water was applied. After about 120-150 minutes of setting time, larger pieces, covering or casing of WEEE 30 were inserted into the semi soft layer of Mortar 34. The fresh water was sprinkled over the semi soft layer of Mortar 34 after approximately 12 hours to encourage curing and reduce chances of development of cracks or fissures.

20 Subsequently, the second layer of mixture of Mortar 34 having higher amount of water content was poured atop the first mortar layer 34, to ensure that the spaces within larger pieces, covering or casing of WEEE 30 were filled. After about 120 minutes, additional smaller pieces or covering or casing of WEEE 32 were inserted into second layer of Mortar 34. The fresh water

was sprinkled after approximately 12 hours, to encourage curing and reduce chances of development of cracks or fissures. In this way, process of filling of Mortar 34, insertion of WEEE 30, 32 and fresh water sprinkling was repeated. The resultant mixture is allowed to settle for 3-4 days. Finally, on the third or fourth day, ¼ inch layer of Mortar 34 was filled as an upper most layer and allowed to cure completely. Edges 46-54 of first part 36 were then welded along the respective edges 56-64 of second part 38 to complete the WEEE Brick 10.

EXAMPLE 2

WEEE brick panels 12, 12', 14, 14', 16 and 16' were prepared from raw clay/soil. Clay was molded using molds in Brick Kilns stacks by partially filing the prepared clay to the extent of ½ inch from the side and bottom panels of the mold to form a first part 36 that has an empty cuboid shaped structure. The empty cuboid shaped structure was dried, heated and fired and/or baked in the Kiln to about 600 to 1100 degree Celsius or higher. An empty cuboid shaped structure defines an open end 44. The molded cuboid shaped structure was filed with 70-80% of WEEE material 30, 32 and 20-30% cement 34. Further cement 34 was filed in the cuboid shaped structure and leveled off. In next step, a second part 38 was applied to complete the cuboid shape of WEEE brick 10. The formed WEEE brick 10 was cured under plastic sheet covering and sprinkled with fresh water after about 12-24hrs.

EXAMPLE 3

WEEE brick panels 12, 12', 14, 14', 16 and 16' were prepared from plastic. The sheet of plastic was procured & cut to approximately 1.0 -2.0 mm and to the size 4.5x3.0x9.0 inches. The

WEEE brick 10 of the preferred dimensions can be made in accordance with the preferred process of the present invention.

The embodiments of the invention shown and discussed herein are merely illustrative of modes of application of the invention. Reference to details in this discussion is not intended to limit the scope of the claims to these details, or to the figures used to illustrate the invention.

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WE CLAIM:

1. A Waste Electrical and Electronic Equipment (WEEE) brick (10) comprising:
a first part (18) comprising at least two layers, wherein first layer of said at least
5 two layers comprises one or more electrical and electronic equipment waste materials, and
wherein second layer of said at least two layers comprises a binder material;
a second part (20) comprising at least two panels, wherein said second part is
configured to close the first part(18) to define said WEEE brick.
- 10 2. The WEEE brick as claimed in claim 1, wherein said first layer and said second layer are
fixed with each other.
3. The WEEE brick as claimed in claim 1, wherein the first layer is adapted to be deposited
on the second layer.
- 15 4. A Waste Electrical and Electronic Equipment (WEEE) brick (10) comprising:
a first part (18) comprising at least two layers, wherein first layer of said at least
two layers comprises one or more electrical and electronic equipment waste materials, and
wherein second layer of said at least two layers comprises a binder material;
20 a second part (20) comprising a single panel, wherein said second part (20) is
configured to close the first part to define said WEEE brick (10).
5. A process for preparation of Waste Electrical and Electronic Equipment (WEEE) brick
(10) adapted to treat a bulk WEEE material for sustainable environmental reutilization, the
25 process comprising steps of:
a) forming a first part (18) and a second part (20) of the WEEE brick from suitable
material;
b) categorizing the WEEE material;
c) filling a binder/filler material in a predefined proportion inside the first part (18) of the
30 WEEE brick;

d) filling the categorized WEEE material in a pre-defined sequence and proportion inside the first part (18) of the WEEE brick;

e) allowing the binder material to settle, expand, cure and harden partially for a predefined amount of time;

5 f) closing the first part (18) with the second part (20) of predefined size to form the WEEE brick (10);

g) preparing outer surfaces of the WEEE brick (10) by corrugating with furrows or punch marks;

h) coating the WEEE brick (10) with a coating material; and

10 i) laminating with rubber material for aesthetics- and corrosion prevention.

6. The process for preparation of the WEEE brick (10) as claimed in claim 5, wherein the suitable material for forming the first part (18) and the second part (20) is selected from one or more of following mild steel, bronze, aluminium, metal, wood, plastic, alloys, composites, clay,
15 cement, fiberglass, ceramic, and combination thereof.

7. The process for preparation of the brick (10) as claimed in claim 5, wherein the binder material is selected from a group of epoxy resin, mortar mix, silicone sealant, reactive acrylics, polyurethanes adhesives, Reactive Hot Melt Polyurethanes (RHMUs), cyanoacrylates, polyvinyl
20 acetates, hydrocarbon rubber based sealants, glue and cement with gravel, sand and coarse aggregates.

8. The process for preparation of the brick (10) as claimed in claim 5, wherein the proportion of the binder material is about 20-40% of the first part (18) of the WEEE brick(10).
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9. The process for preparation of the brick (10) as claimed in claim 5, wherein the time required for the binder material to settle, expand, cure and harden partially is about 5-6 hours.

10. The process for preparation of the brick (10) as claimed in claim 5, wherein the proportion of the WEEE material is about 60-80% of the first part of the WEEE brick (10).
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11. The process for preparation of the brick (10) as claimed in claim 5, wherein the coating material is selected from one or more of the following enamel paint, anti oxidizing primer paint.
- 5 12. The process for preparation of the brick (10) as claimed in claim 5, wherein the brick (10) is adapted to be corrugated with furrows or punch marks for enamel painting followed by rubber lamination.