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Requirements for treatment and disposal of waste printed circuit board

废电路板处理处置要求

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3 Terms and definitions

3 adopts the terms of GB/T 29769 and adds six of its own.

3.1 waste printed circuit board: a circuit board produced in production, in daily life or in other activities that has lost its original value in use, or that has not lost it but has been discarded or abandoned. A note adds that this includes offcuts, defective boards and boards recovered from the dismantling of waste electrical and electronic products.

3.2 treatment: the dismantling, crushing, separation and recovery of waste printed circuit boards, with a note that this includes the recovery and use of materials and of energy. The definition is marked as adapted from GB/T 23685-2009, 3.9.

3.3 disposal: incineration, landfill or another method that alters the physical, chemical or biological character of the waste so as to reduce its quantity or remove its harmfulness, or the final placing of the waste in a landfill that meets environmental protection requirements. Marked as adapted from GB/T 23685-2009, 3.10.

3.4 waste resin powder: the resin-based material obtained by crushing and separating waste printed circuit boards that carry no components or from which the components have been removed.

3.5 pyrolysis: the process in which the organic fraction of a waste printed circuit board is decomposed by heat under oxygen-free or oxygen-deficient conditions.

3.6 waste resin powder resource utilization: the form of use in which waste resin powder is

processed together with other organic or inorganic materials and additives, in a set proportion, into a material or a product.

4 Treatment and disposal processes for waste printed circuit boards

4 lists the process steps, which include but are not limited to dismantling and sorting, crushing, separation, pyrolysis, pyrometallurgy and hydrometallurgy, followed by resource utilization of the waste resin powder or by landfill or incineration as co-processing in pyrometallurgy. Examples of complete process routes are given in Annex A, where the route based on pyrolysis is shown as Figure A.1.

5 Treatment requirements for waste printed circuit boards

5.1 dismantling and sorting. Boards may be treated by heating, by mechanical milling or by soaking in or spraying with an acid solution so that the solder comes away and the components can be stripped off; components, solder and bare boards are then collected separately. Dismantling is to take place in a complete plant or a building fitted with waste gas collection, and the waste gas is to be drawn off under negative pressure or by extraction and sent to the waste gas treatment system. The components produced are to be collected and managed by category, with a detailed record and ledger of type, weight or number and destination.

5.2 crushing. The equipment is to be energy-efficient and fitted with noise and vibration reduction. Waste gas and dust from dry crushing are to be collected and sent to the waste gas treatment system; where wet crushing is used the waste water is to be collected and treated and the crushed material dewatered thoroughly, for instance by filter pressing.

5.3 separation. Gravity separation and multi-stage shaking tables are recommended, the equipment is to be energy-efficient, the shaking table water is to be recirculated, and the copper separation rate of the crushed material is to be not less than 80 %.

5.4 pyrolysis. The plant is to be well sealed, to have automatic monitoring, and to comprise a pyrolysis furnace, a furnace for burning the pyrolysis gas and matching waste gas treatment equipment for scrubbing, cooling, denitrification and dust removal; continuous feeding and discharge are recommended. Pyrolysis is to be carried out with no oxygen or with an oxygen concentration below 1 %, and the pyrolysis gas is to stay in the incinerator for not less than 2 s at a temperature of not less than 1100 °C. Electrostatic and gravity capture of the pyrolysis volatiles are recommended, as is high-efficiency alkaline scrubbing of the pyrolysis gas. The pyrolysis rate is to be not less than 98 % and the dehalogenation rate of the pyrolysis gas not less than 99 %, after which the pyrolysis residue may pass to the next metallurgical step; both rates are calculated according to Annex B. The waste gas from pyrolysis is to receive further treatment to control dioxins, hydrogen bromide and other pollutants.

5.5 pyrometallurgy. Top-blown or side-blown bath smelting is recommended, with a smelting furnace (Ausmelt, Isasmelt or side-blown type), waste gas treatment equipment and auxiliary equipment. The proportion in which the boards are blended with other copper-bearing material is chosen according to circumstances and the smelting temperature is to be not less than 1150 °C; where the boards have to be crushed and granulated, magnetic separation to remove scrap iron is recommended before crushing and granulation. The waste gas is again to be treated further for dioxins and hydrogen bromide.

5.6 hydrometallurgy. Where the boards are the main feed for the electrolytic refining of copper and the recovery of precious metals, energy-efficient equipment and clean production processes are to be chosen and the waste gas collected and treated centrally. Gold, silver, platinum and palladium may be recovered by leaching, extraction, stripping, displacement and reduction; the leaching and extraction agents are to be of low toxicity, chemicals forbidden by the State are not to be used, and sealed piping and automated equipment are recommended for reagent transfer. The leachate left after components have been stripped in an acid solution is separated and purified and the metals or salts recovered by electrolytic refining or chemical synthesis, with the equipment and reagents chosen according to 5.6.1 and 5.6.2.

5.7 resource utilization of waste resin powder. Before use the powder is to be pre-treated, with multi-stage separation to recover the metals and remove impurities; the pre-treated product is to have a moisture content below 3 % and a resin plus glass fibre content of not less than 98 %, and the leaching concentration of heavy metals from it is to meet the requirements of GB 18599 for class I general industrial solid waste. The pre-treated powder may then serve as a functional filler, mixed evenly in a set proportion with wood fibre, thermoplastic resin, binders and one or more modifying additives and processed into wood-plastic products, resin-plastic products, resin sheet, glass-magnesium composites, waterproofing materials and other recycled building materials.

5.7.3 requires the harmful substance content of those recycled building materials to stay within the limits of Table 1, with formaldehyde emission tested according to GB 18580 and soluble heavy metals according to GB 28481. Table 1 sets limits for formaldehyde and for soluble lead, cadmium, chromium and mercury, in two columns for outdoor and indoor application. In this extraction the two columns can be paired only for the formaldehyde row; the four heavy metal rows show a single value each, and it cannot be established whether that value is a cell spanning both columns or the remains of a pair. The figures are therefore not reproduced here.

6 Disposal requirements for waste printed circuit boards

6 provides that waste resin powder or other treatment products that cannot be put to resource use are preferably co-processed in pyrometallurgy or sent to a compliant landfill. Where the powder is co-processed in pyrometallurgy, the proportion added is to match the

capacity of the waste gas treatment equipment of the smelter.

7 Environmental protection requirements

7.1 refers pollution control in the recovery and treatment of the boards to GB/T 32357, waste gas and waste water discharge to GB 8978, GB 9078 and GB 16297, and the residues from pyrometallurgy and hydrometallurgy to GB 5085.7, the residue being managed as hazardous waste or as general industrial solid waste according to its properties.

7.2 refers noise pollution control at every process step to GB 12348.

7.3 requires the enterprise to set up a pollution prevention system, to maintain the environmental protection installations periodically, and to keep complete records of waste water treatment, waste gas treatment and solid waste treatment and disposal. An environmental risk emergency plan and emergency measures for environmental incidents are to be established or completed.

8 Safety requirements for the treatment and disposal process

8.1 covers dust explosion protection. An enterprise whose dismantling, crushing or separation steps involve combustible dust is to identify the dust explosion hazard areas, and the engineering and process design, production, storage, equipment operation and maintenance are to meet GB 15577. Cyclones, bag or cartridge filters, bucket elevators and other equipment at risk of dust explosion in the separation step are to meet GB 15577 and to use one or more of explosion venting, explosion suppression, explosion isolation and explosion resistance, isolation alone not being sufficient. Where venting is used the vent is to face a safe direction and its size is to meet GB/T 15605.

8.2 covers pyrolysis safety. Where the pyrolysis unit is heated with natural gas, the automatic control system is to give alarms for natural gas overpressure, natural gas underpressure, air underpressure, ignition failure and flame-out, and to have protective functions such as a safety shut-off valve. The device that captures the pyrolysis volatiles is to carry flammable and explosive safety signs, and shielding and isolation are recommended.

8.3 covers metallurgical safety. In pyrometallurgy the floor below and around the smelting furnace, the areas where molten metal ladles and slag pots are lifted and where the ladle and slag pot cars run, is to be free of standing water, and damp goods and other flammable or explosive material are not to be stored there. In hydrometallurgy the steps that use acids, alkalis and other corrosive substances are preferably equipped with highly automated, well sealed equipment with splash and corrosion protection.