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Recycling of Electric and Electronic Wastes Nowadays

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Editorial

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Editorial

Waste electrical and electronic equipment (WEEE) is one of the largest amount generated streams constituting 8% of municipal wastes. These wastes are heterogeneous material and contain different materials and components. In order to develop an economic and ecological recycling system, it is important to identify and quantify precious materials and dangerous substances, and in addition, to understand the physical characteristics of this secondary resource, which is, part of the urban mine. WEEE categories valid from August 15th 2018 are: 1. Equipment of heat exchange, 2. Screens, monitors and equipment including screens with a surface upper than 100 cm2, lamps, 4. Large equipment, 5. Small equipment, 6. Small IT and telecommunications equipment and 7. Photovoltaic panels. According to the United Nations Environment Program, the whole world generates 50 million t/y of WEEE which corresponds to an average consumption of more than 7.1 kg/inhabitant *a. While the United Nations University estimated around 41.8 million tons of WEEE discarded in in last decade, which corresponds to 6 kg / inhabitant *a. (*Thomas Pretz*).

In 2017, China is expected to be the largest producer of WEEE in the world. China will overtake the United States in coming years. The most recent data from the Chinese Ministry of Industry and Information Technology (MIIT) indicates that more than 100 million washing machines, televisions, refrigerators and air conditioners and more than 70 million mobile phones have been disposed of each year in the country.

Europe generates about 15.6 kg / inhabitant of WEEE, compared to 5.9 / year kg / inhabitant in the world, while France generates 21.5 kg / inhabitant / year of WEEE. Around 35% of the WEEE has been recycled by specialized WEEE treatment centers. Of the remaining 65%, around 6.15 million tons: 3.15 million tons were recycled in Europe in a non-proper way; 1.5 million tons were exported; 0.75 million tons were sorted to recover precious materials, 0.75 million tons were thrown in the garbage. It is important to note that one ton of WEEE treated effectively, makes it possible to conserve 605 kg of CO_2, 153 kg of plastic, 432 kg of scrap, 152 liters of crude oil (*https://www.elise.com.fr / waste-recycles / recycling-deee.html*). 196 treatment centers have been identified in France, 617,401 tons of WEEE treated in the last five years. The treatment rate was estimated about 80%, recycling 11%, elimination 8%: energy recovery, 1% and reuse 0% (*https://www.ecologic-france.com/2013-03-15-14-48-27.html*).

Regarding professional WEEE, more than 42 ktons was treated in 2015, around 80% is recycled, an increase of 47.9% compared to 2014. Unlike the household WEEE sector, a significant proportion of professional tonnages is declared re-used (9.3%). Indeed, professional equipment, and in particular computer equipment, having a duration of use shorter than their lifetime. It is an interesting deposit for re-use, both in terms of quality and quantity. The treatment rate of this part of is about 79%: material recycling is 9%: preparation for reuse is 6%: disposal is 4%: energy recovery, and 1% for reuse of parts.

The treatment method analysis by country of waste destination shows that reuse by complete device is carried out for 37% of tonnages outside the European Union and 51% in France. The other types of treatment (reuse of parts, recycling, and energy recovery) and disposal take place almost only in the EU. All treatments combined, the share of WEEE treated outside the EU decreased (3.5% compared to 7.6% in 2014), for the benefit of treatment in France (86.1% against 80.1% in 2014).

In France, the French Environment and Energy Management Agency (Ademe) has carried out an inventory of sorting centers for electrical and electronic waste. From their reports, more than 50% of the sorting sites are positioned on the manual processing mode (*Erwann Fangeat, Ademe*). This processing mode is more applied for sorting the mixture of

small appliances and TV screen streams. It is used at different activity levels depending on the flow. Ademe reported that the tonnage processed from dismantled screens is around 1,750 t / site / year.

WEEE Treatment

The best option for WEEE handling is the recycling. The printed circuit board is the most important components that can be interested for recycling. This part of WEEE becomes one of the most attractive and profitable market, because it contains more than 50 valuable elements of Mendeleev periodic table to recover. In the practice of WEEE recycling, selective dismantling is an essential process for reuse components, release dangerous components for a specific treatment and dismantle components of high market value and high quality materials such as electronic cards, cables and plastics to simplify their subsequent recovery.

Most recycling plants use manual dismantling. Five treatment paths are applied to WEEE in order of priority: reuse, recycling, energy recovery and disposal (landfill or incineration). The sequence of treatment steps followed by the majority of WEEE recycling industries is as follows: Dismantling, manual sorting, grinding, electromagnetic separation, optical sorting (for electronic cards), separation of non-ferrous metals, and separation of plastics (by sink float or optical sorting). Today, certain technologies for sorting brominated plastics are in development.

The first step in small electronic appliances treatment is to manually remove polluting elements that can disrupt the treatment process such as ink cartridges and ink cartridges, batteries and accumulators, vacuum bags (harmful to people working on tools recycling performance), mercury lamps, external power cables and oils. After cleaning, the depolluted stream is treated manually or mechanically to sort and recover the different materials contained.

Mechanical Processes

Depending on the physical and physicochemical properties of the different products present in WEEE, physical sorting techniques allow separation or isolation with a view to their reuse or appropriate treatment or elimination. Most of these techniques are used in the recycling industries to separate plastics, metals and wood and purify effluents. Several processes have been developed to improve the quality of the recovered products. Currently, the sensor sorting technique is integrated into these processes, with devices such as REDWAVE equipment which is integrated into the sorting of WEEE to recover the fractions of different plastics. REDWAVE separation is based on a near infrared (NIR) spectrometric identification of the main polymers of the plastic, followed by the air-blown particle in a dedicated container. This equipment can be programmed to isolate one or more specific polymers in an overall flow passing in front of the sensor.

Manual sorting steps are added to extract any pollutants that may still be contained in the crushed fractions. Tools using the electromagnetic properties of metals make it possible to separate the metal fractions from each other and from other fractions (over band, magnetic drum, eddy current). Tools using the mechanical properties of the materials make it possible in particular to separate plastics between themselves and other fractions, but also non-ferrous metals between them (flotation, dry or wet densimetric table, etc.) Tools coupling spectrographic analysis, color, etc. and mechanisms for isolating the desired fractions such as blowing nozzles make it possible to sort specific fractions such as electronic cards, types of glass, types of plastics, etc. New treatment methods are in development and some are emerging for master the depollution of mercury contained in the lamps of flat screens and allow the recovery of liquid crystals and strategic metals contained.