The Future Development and Trend of Resource Recycling Technology

Introduction

Traditional and high-tech industries in Chinese Taipei are forced to spend huge labor and capital on the final treatment of wastes produced from production processes, and the normal operations of these businesses are even affected, as a result of the increasingly demanding environmental awareness and policies these years. Therefore, resource recovery of wastes is one of the best solutions, especially when preliminary achievements in the development of resource recovery technologies have been made.

From the viewpoint of ecology, low-carbon requirements and resource recovery are natural trends in the future, and the prospect of the resource recovery industry is very promising. However, to understand the property of wastes and value-added technologies is the prerequisite to resource recovery in order to maximize the advantages of resource use, to minimize impacts on environment, and so to achieve sustainable development of industries.

Waste treatment has been expanded from source control in the past into resource reuse and sustainable development following the rise of the environmental awareness across the globe. Due to the overuse in the past few decades, resources on the earth are drying out, whether coal, petroleum or natural gas. Based on the current consumption rate, the remaining petroleum and major metals will be used up within the next five decades. For this reason, waste reuse and development has become the mainstream in the future. Therefore, countries in the world have gradually made the effective use of resources the new direction of environmental policies and the focus of environmental management.

Current status of technology development

Governments and industries across the globe have embarked on the study and development of waste recovery technologies when environmental awareness has been growing increasingly keen these years. By solving waste treatment problems with waste recovery, waste can be reduced, recovered, stabilized and made harmless. Also, the impacts on environment can be reduced and waste can be turned into valuable materials by means of resource recovery, thus reducing the manufacturing cost of industries.

Current resource recovery technologies fall into two stages: (1) Recycle and reuse: usable wastes are directly used in the original production processes or become useful materials of other production processes after waste exchange. (2) Renewal and recovery: wastes are turned into other valuable products according to their characteristics with the existing ceramic technologies and chemical engineering technologies. While resource recovery technologies are well developed overseas, Chinese Taipei can import these technologies and localize them according to the characteristics of waste. To maximize the recycle and reuse of industrial waste by resource recovery, and to pursue the general goal of zero waste, the current development of the resource recovery and reuse technologies of major wastes is described below.

1. Resource recovery technology of lamps containing mercury (fluorescent lamps)

Though the use of lamps containing mercury (fluorescent lamps) is increasing across the globe, the strong accumulation and concentration effects of mercury bring far-reaching
influences on living organisms. Therefore, proper recycle and management of lamps containing mercury is necessary. Stabilization, solidification, thermal desorption and distillation are the common methods for treating lamps containing mercury. Moreover, these methods are proven effective for treating volatile metals.

2. EAF-dust recycling technology

The domestic EAF steel output is about 6 million tons a year. This also produces about 135,000 tons of EAF-dust. As the particles of EAF-dust are fine and the dust itself contains rich heavy metals like zinc, lead, cadmium and chromium, it has thus been classified as a hazardous industrial waste. There are two methods for recycling EAF-dust, the pyrometallurgy and hydrometallurgy. The former is the commonest practice to recycle metallic zinc, while the latter is seldom used for recycling metallic zinc in EAF-dust in commercial practice.

Related studies and treatments of recycling zinc in EAF-dust have evolved from the landfill, solidification, cement additives, brick-making material and magnetic materials in the past to the plasma melting, such as volume reduction, charcoal reduced iron, and evaporation-condensation, at present.

3. Li-battery recycling technology

The global demand of small secondary Li-battery in 2005 reached 6.1 million pieces according to estimation. When compared to traditional batteries, Li-battery is more hazardous and may thus cause pollution and a waste of resource. Advanced countries are aware of the importance of Li-battery. Currently, common methods for recycling Li-battery include the pyrometallurgy and hydrometallurgy. (1) Pyrometallurgy: Metals containing in Li-batteries are separated for recycling by means of kilning. As the treatment of Li-batteries is dangerous, it is necessary to isolate them from water and air. In general, it is practiced in the presence of gas nitrogen or argon. (2) Hydrometallurgy: after discharging, shell-removing and cutting, fragments of Li-batteries are placed in the absorption chamber where inorganic acidic solvent is sprayed on them. Then, the electrolyte solution and metallic Li are extracted and absorbed before purification for regeneration and reuse. Metals in the residue are separated according to their characteristics and purified before regeneration and reuse. Li-batteries are put inside salt solution or connected to a load for discharging.

4. Recycling and reuse of CRT

The cathode ray tube (CRT) is commonly used on computer monitors and TVs. In general, the glass section on the exterior of a CRT, such as the screen or surface panel, contains a large amount of barium oxides; and the interior of a CRT, such as the cone and neck glass, contains lead oxides.

There are two major types of CRT glass, the scarped CRT glass from manufacture and the end-of-life CRT glass. The former can be reused as the raw materials for making new CRTs. However, the reuse potential of CRT glass is reduced when the glass containing barium oxides and the glass containing lead oxides are mixed together. Moreover, as the content of lead oxides has been diluted, the reuse volume is lowered. Therefore, to maximize the reuse of scarped CRT glass in raw materials for making new CRTs, it is necessary to separate properly the glass containing lead oxides. As the end-of-life CRT glass has been used, it is reused in terms of the panel glass and cone glass. As the panel glass is lead-free, it has a wider scope of reuse.

5. Reuse of organic and polymer materials
In addition to the traditional liquidation and coal gasification of materials, carbonation has become a new trend for recycling organic and polymer materials. Major methods include direct carbonation, liquidation and coal gasification. The carbonation falls into the low-temperature and high-temperature carbonation. In low-temperature carbonation (200-500°C), as it consumes great activation energy for carbonized reaction at low temperature, the reaction speed is very slow. In high-temperature carbonation (800°C), the speed of diffusion controls the process.

**Future trend**

Resource recovery is an innovative industry and a natural trend. The UNEP has switched from waste disposal and treatment to resource recovery, life cycle assessment, clean production and environment-friendly products. Europe has entered the stage of clean production and environment-friendly products, while Southeast Asian countries and comparatively backward states are still at the end of the waste disposal and treatment stage, and developing countries have been promoted to the middle resource reduction, recycle, regeneration and reuse stage. The four advantages of Chinese Taipei’s current recourse recovery technology and recourse recovery industry overseas expansion are shown in Table 1. The smart use of these advantages will help us to develop the overseas resource recovery market.

To improve the resource recovery technology and to enhance the additional value of waste are the direction for developing resource recovery. If domestic recycle recovery businesses can refine the precious metals in waste to 99% purity and ship them to Europe, the USA and Japan to refining metals of higher purity (99.9-99.99%), they can make a profit of 2-10 folds. In the future, we can recycle waste overseas for primary regeneration before shipping it back to Chinese Taipei for refining it into recycled products of high economic value. Then, we can expand the market with the advantage differences of different countries and keep high-value products and advanced technologies in Chinese Taipei to form a full-direction strategy.

The end-of-pipe treatment will gradually become the final action in the world, and resource recovery has become the main theme of environmental technology. Therefore, the automation of resource recovery technologies and facilities which are free of secondary population, energy-saving, easy-to-operate and maintain; and the value addition of regeneration products will be the future trend of technology development.

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<th>Advantages</th>
<th>Note</th>
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<td>Policy support</td>
<td>Resource recovery has been classified as a focused emerging industry with a stabilizing foundation. Environmental protection and resource recovery are also defined as the sunrise industry in China. Therefore, the potential of resource recovery is promising.</td>
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<td>Trend formation</td>
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<td>Aggressive R&amp;D</td>
<td>The EPA and NSC have invested many R&amp;D resources in zero waste and resource recovery technologies. Most universities are equipped with optical, electrical, magnetic, material and energy analyzing equipment. Businesses also have great desire to enhance quality and value.</td>
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<td>Good environment</td>
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<td>Practical technology</td>
<td>Chinese Taipei has gradually cultivated talents in environmental resource and material engineering with strong fundamental power and great plasticity.</td>
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<td>Abundant talents</td>
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Deploying overseas

It needs channels for releasing capital and resources, and technology accumulated and talents will go overseas.

Conclusion

The economy of the BRIC rises rapidly across the globe. However, the resultant environmental problems, such as pollution and resource consumption, come in rapid succession. It is time to consider overseas expansion. Many economies are developing vigorously the resource recovery, regeneration, recycle and reuse of waste. Besides establishing laws and regulations, they promote technologies for resource recovery, regeneration, recycle and reuse of waste by setting up demonstration sites.

Before we can develop novel resources, the sustainable use of existing resources will be the lifeline of maintaining the sustainable development of human economic activities. In the trend of low carbon need, a recycling society thus formed. The resource recovery, recycle and reuse of waste not only allow us to extend the limited resources on earth, but also help us reduce the load of pollution. To pursue sustainable development, countries of the world have embarked on the R&D of resource regeneration technologies and the development of the resource recovery industry in hopes to ensure the sustainable use of resource on earth.