Annex B

Sorting and Recycling Technologies

There are many variations or combinations of sorting and recycling technologies worldwide for municipal solid waste (MSW). Mechanical treatment and biological treatment are the two main core technologies.

Mechanical Treatment Technologies

2. The main purpose of mechanical treatment is to reduce the size of waste to the range of 10 to 40 mm (normally not exceeding 50 mm). Typical mechanical treatment technologies include the following -

a. Size reduction – Shredder, hammer mill, ball mill, rotating drum, and wet rotating drum with knives to reduce the size of waste.

b. Size limit – Drum sieve, star screen and flip flop, the former two are used to screen out the particles by their size limit for later processing, e.g. biological treatment; while the flip flop usually is used to remove inorganic contaminants such as glass and sands based on their density difference.

c. Metals recovery – Magnetic separator for ferrous metals, and eddy current separator for non-ferrous metals.

d. Paper and plastics recovery – Air separator to sort paper and plastic by their light weight, and wet separator to recover further paper and plastic by their low density.

e. Sorting by weight – Ballistic separator employs the flinging action to separate the lighter organic materials that travels shorter distance from the heavier materials. However, the selection is not precise and thus generally is used as a pre-sorting process.

Biological Treatment Technologies

3. Biological processes make use of microbes to degrade the organic materials, and in the process generate either biogas or compost. At the same time, it reduces the size and stabilizes the organic waste further. Composting and anaerobic digestion are the two major biological treatment processes.

4. **Composting** – It refers to biological degradation process by which the bacteria break down the organic fraction of the waste in the presence of oxygen to produce a bio-stabilized material i.e. compost that can be used as fertilizer, soil cover for landfill, etc. It can also be applied as post-treatment to stabilize or post-refine the residue generated from anaerobic digestion. This post-refining process takes about a month and it improves the compost quality to meet the final designated use. Typical composting techniques include the following -

a. **Windrow composting** – This is an open operating system which is suitable for large volumes of waste and where space is not a constraint. Organic waste piled in rows like windrow and is turned frequently to maintain aerobic conditions. The typical retention time ranges from eight to 12 weeks. The operation can generate odour problem and is thus not suitable for densely populated city, like Hong Kong.

b. **Aerated static pile composting** – This process is similar to windrow, but instead of turning the pile to maintain air supply, pipes are laid to pull air through the pile of waste. To control the odour, negative pressure is applied in the composting hall. The typical retention time also ranges from eight to 12 weeks, but can be shortened to three to five weeks by controlling the turning intervals. A large space is required for this kind of technology.

c. **In-vessel composting** – This is a high-technology system in which composting is carried out in a controlled and enclosed structure such as a tunnel or channel, container or vessel. All critical environmental conditions are monitored automatically, and the system is suitable when odour and leachate controls, and space are of major concerns. All these added controls render the system rather expensive. The three common in-vessel composting systems that are available for MSW treatment are tunnel, intensive composting and drum systems.

The typical retention time for these systems is three to 14 days.

5. **Anaerobic digestion (AD) –** It is a biological degradation process that takes place in an oxygen depleted environment, under which methane-rich biogas, as well as residual solids that can be used for composting are produced. Typical AD techniques include the following -

a. **Dry AD** – The Dry AD can be operated in thermophilic or mesophilic modes for waste that contain between 15% to 45% total solid (TS) contents. It is generally a single-stage process, and employs plug-flow principle.

b. **Wet AD** – The Wet AD can also be operated in thermophilic or mesophilic modes, but is suitable for waste that contains less than 15% TS content. The system can be designed as a single-stage or two-stage process. The Wet AD generally yields more biogas than a Dry AD because the organic waste portion is more homogenous in nature and has less contaminant. However, the process generates a large amount of wastewater that required additional treatment.

Combination of Sorting and Recycling Technologies

6. The combination of the above two main treatment technologies gives rise to the following variations –

a. **Mechanical Treatment alone (MT) –** This process employs various mechanical equipment such as magnets, screen and trommels, etc. to separate mixed MSW into different fractions according to their physical properties. It can facilitate the recovery of recyclables such as metals, paper and plastics by various kinds of physical forces, and speed up the biological treatment for the organic waste.

b. **Mechanical and Biological Treatment (MBT) –** This process employs mechanical treatment to pretreat the waste by reducing the size of waste and removing contaminants before the waste enters into the later biological treatment stage for generation of biogas by AD or compost by composting.

c. **Biological and Mechanical Treatment (BMT) –** This process is a reverse version of MBT, and produces different kinds of end products, i.e. refuse derived fuel. The biological treatment is to bio-stabilize the entire waste fraction by mainly removing the moisture content and at the same time reduces the putrescible portion of the waste. The mechanical treatment that follows is to recover dry recyclables and lastly to form refuse derived fuel.

d. **Mechanical Heat Treatment (MHT) -** Unlike MBT or BMT, MHT does not employ biological treatment but instead uses heat to reduce the overall moisture content and at the same time sanitize and stabilize the waste. Mechanical treatment then can be followed to recover recyclables. Since the heated waste has a relatively high calorific value, it can also be further processed as refuse derived fuel.