Focus ome 15

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Summary of Results
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The Future of Solid Waste

Key ideas

1. There is a need for waste management solutions based on efficient recycling and treatment strategies to replace end-of-pipe solutions.

2. The recovery of recyclable materials from unsorted waste plays an important role in waste management. Municipal solid waste is made up of approximately 60%-75% potentially recyclable material.

3. The increased worldwide demand for raw materials and the corresponding increase in commodity prices have led to a growing interest in the recovery of secondary raw materials from municipal solid waste.

4. Active landfill gas collection and recovery is a recognized method for reducing greenhouse gas emissions.

Introduction

Climate protection and the efficient use of resources are major challenges facing modern society. There is a need for waste-management solutions based on efficient recycling and treatment strategies to replace end-of-pipe solutions. Depending on the economic development of a country, its inhabitants produce from 70 kg to 800 kg of municipal solid waste (MSW) per year. The amount of waste generated is often directly linked to income level and lifestyle, a problem also faced by industrialised economies, which have to find ways to avoid, minimise and recycle waste. The worldwide output of MSW is about 5 to 6 million tonnes per day. Most of this waste pollutes the environment, is buried in dumps or is disposed of to a greater or lesser extent in sanitary landfills. Decomposition of the biodegradable fraction of this waste results in methane emissions that account for an estimated 10% of anthropogenic methane emissions worldwide. In many places, waste is simply burned outdoors, thus representing a further source of air pollution. Only a small fraction of waste is burned in modern incinerators equipped with state-of-the-art air filters. The recovery of recyclable materials from unsorted waste plays an important role in waste management. Municipal solid waste contains about 60% to 75% potentially recyclable material. Appropriate collection systems enable a substantial proportion of this waste to be recycled for reuse as secondary raw materials and refuse-derived fuels.

Brief Review of Key Applications

▪ **Collection and transport:** Domestic waste and recyclables are collected in different containers or bags at source, or are decentralised in containers and recycling stations. The containers are emptied into special trucks and refuse collection vehicles equipped with packer blades to compress the waste (front loader, rear loader or side loader). The waste is taken directly to treatment or recycling plants. However, if the distance to the landfill is greater than approximately 30 km, the waste is taken to a transfer station, where it is transshipped into larger units for further transport. The collection of recyclables is carried out in different ways. Different systems can be used, depending on the recycling process:

- Mixed collection of recyclables: In this system, the dry recyclables, paper, packaging made from plastic, metal and beverage cartons are collected together and then sorted.

- Single collection of recyclables: If certain recyclables are not allowed to be mixed with others, they are collected separately in a single container or bag. Biowaste used for the production of soil conditioner or fertilizer should not be mixed with other substances. Mixing increases the risk of contamination with pollutants (e.g. heavy metals), which makes the products unmarketable.

▪ **Material recovery facility:** Certain materials, such as paper and cardboard, must be collected separately and processed prior to recycling. This is necessary primarily because the commodity market demands non-mixed secondary raw materials, and also because they can become so heavily contaminated with household waste that they are no longer directly marketable. To ensure these quality requirements are met, the recyclables must be processed at a material recovery facility.

- Near-infrared spectroscopy

- Air classifiers

- Magnetic separator

- Eddy-current separators

▪ **Biological treatment of biowaste:** Composting is the degradation and/or conversion of biowaste by microorganisms with atmospheric oxygen (aerobic). The main end products of this process are compost, carbon dioxide and water. The resulting compost can be used in agriculture. The degradation and/or conversion of biomass during the fermentation process (anaerobic) takes place in the absence of free oxygen. The organic substrate is converted through various intermediate stages into biogas (methane and carbon dioxide). Non-degraded substrate constitutes the fermentation residue. The fermentation of waste has a long tradition in agriculture and the treatment of sewage sludge. New technologies are being developed so that biowaste collected from homes and the food-processing industry can be used. Different process combinations are used. A distinction is made between mesophilic (30°C-40°C) and thermophilic (55°C-65°C) processes, high solids digestion (>15% DS) and low solids digestion (<8% DS), single-stage and multistage facilities, as well as continuous and discontinuous facilities. The choice of process depends on the nature of the feedstock and economic considerations.

▪ **Pretreatment of municipal solid waste:** The mechanical biological treatment of MSW is designed to prepare it for disposal in landfill sites. The aim of this biological treatment is to stabilise the waste as far as possible through technically assisted biodegradation. The idea is to reduce emissions of landfill gas as far as possible and to minimise the organic load (BOD) in the leachate. In addition, recyclables (e.g. metals) and high-calorific-value fractions (e.g. plastics) are extracted for use as secondary raw materials and refuse-derived fuels, respectively.

▪ **Incineration of municipal solid waste:** During thermal treatment, waste is incinerated under optimum conditions. An incineration plant consists of five main areas: the waste pit for interim storage and homogenisation; the combustion line for incineration of the waste on moving grates at around

1,000°C; the afterburning chamber for burning the resulting combustion gases at 850°C; the steam boiler to use the energy content of the gases for steam generation (electricity, heat recovery); flue gas cleaning to remove the pollutants that could not be destroyed by incineration or that were generated during the process. The most technically complex part of a waste incineration plant is exhaust gas cleaning. The first step involves the removal of particles from the exhaust air. In multistage scrubbers, gaseous pollutants and heavy metals are absorbed by means of water, caustic soda and lime. Nitrogen oxides are removed by selective catalytic and non-catalytic reduction. At the end of the exhaust gas cleaning stage, the exhaust air is conducted through an activated carbon filter, which adsorbs the remaining contaminants. The slag generated by the thermal treatment process is reused in road construction and to fill disused mine shafts. Due to their high pollutant content, flue ash and other residues of exhaust air cleaning must be disposed of in special underground salt mines.

- **Sanitary landfill:** Landfill emissions can be reduced by installing vertical and/or horizontal gas wells for the active collection of landfill gas. The collected landfill gas is burned at high temperatures in a flare (1,200°C) or, after cleaning, used in a combined heat and power plant (CHP). The polluted leachate is collected in a drainage system running underneath the landfill and treated on site or in a central wastewater treatment plant. On-site processes consist of nitrification and de-nitrification in combination with filtration processes (ultra- and nano-filtration, reverse osmosis).

Some Key Trends

- **Recycling:** The increased worldwide demand for raw materials and the corresponding increase in commodity prices has led to a growing interest in the recovery of secondary raw materials from municipal solid waste. In certain high-income countries, more than 50% of MSW is already being recovered. Many countries are only just beginning to implement systems for sorting and recovering waste, while others are already reaping the benefits of such initiatives. Brazil, for example, collects and recycles more than 90% of its discarded aluminium beverage cans. In many cases, however, such quotas are only achieved as a result of the grey economy.

- **Climate protection:** The Kyoto Protocol defines the clean development mechanism (CDM) as one means of reaching the reduction targets set for climate protection. Active landfill gas collection and recovery is a recognised method for reducing greenhouse gas emissions under the terms of the CDM. The reductions achieved in this way (CO2-equivalents) are entitled to be traded as certified emission reductions (CERs). A substantial proportion of the costs incurred in upgrading landfill sites can be financed this way.

Perspectives

- A wide range of low-tech and high-tech processes are in use throughout the world for the treatment and recovery of municipal solid waste.

- The technologies and organisational structures employed in waste management have evolved to such a high level that they are capable of making a significant contribution to climate protection and the preservation of natural resources.