Chapter

Introductory Chapter: Solid Waste

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1. Introduction

Solid wastes are solid or semi-solid materials that are produced as a result of various activities. They are discarded materials, meaning they are to be disposed of, although some of their components can be used [1]. In this case, the term "waste" is used, not waste, since the latter means that the resources left over from human activities cannot be used. Solid waste is all rotting and non-rotting waste in solid or semi-solid form, including but not limited, trash, unwanted compounds, ash or incinerator residues, street waste, dead animals, demolition and construction waste, sanitation, solid or semi-solid commercial and industrial waste [2].

2. The two major types of solid waste

2.1 Agricultural and animal waste

It includes (remaining crops after harvest - residues from processing grains such as rice. Additionally, peanuts, branches, and leaves of deciduous trees - the manure of animals raised by farmers). Animal and agricultural waste is one of humanity's most ancient forms of solid waste [3].

The first man collected these wastes and used them as fuel before he knew coal. These wastes are still used as fuel in many rural and semi-rural areas in most of the developing countries [4]. Indoor burning of these wastes, whether in open stoves or rural ovens, releases different contaminants in the indoor air, the carbon dioxide and oxides of organic compounds that have been proven to be nitrogen and nitrogen, and some of them are nitrogen compounds are the most important of these pollutants [5]. Field studies have shown high rates of chest diseases such as chronic obstructive pulmonary disease and nasopharyngeal carcinoma as detrimental consequences of these wastes. Besides, agricultural waste has been used for thousands of years as organic fertilizer after composting to improve soil condition and nourish the plants before synthetic chemicals were discovered. Organic fertilizers are still used in many countries after the composting processes have developed. It is now one of the main ingredients used in organic farming [6]. The number of residues left after harvesting the crops depends on the type of crop, the yield per feddan, and the method of harvesting. For example, the amount of waste produced from cotton cultivation ranges from 3 to 5 tons of residues per ton of cotton produced from the field [7]. The quantity of rice straw ranges from 1 to 3 tons of straw per ton of rice produced from the field, and in the case of cultivation of high-yielding rice varieties, the amount of straw ranges from 0.8–2 tons per ton of field rice [8]. The amount of animal manure also varies according to their types and weight. For example, cows produce about 1.4–5 kg of dung. Also, goats and sheep produce from 0.3–0.6 kg/day. Therefore, estimates of agricultural and animal residues differ considerably from one region to another. In this regard, the amount of agricultural waste in the world is estimated at 2000–2500 million tons annually [8].

2.2 Municipal waste

Domestic waste - waste of organizations and agencies Public facilities - waste for hospitals and other care units - industry waste [9]. Demolition and construction - sludge - other waste such as scrap vehicles, used tires, etc., are split according to their sources. The man became familiar with the municipal waste about ten thousand years ago when he began to settle in Human settlements [10]. They started by transforming these settlements into the first cities known to humanity. The problem of municipal solid waste that was dumped in the streets appears. With the world's massive rise in population, the expansion in urban areas, the increase in per capita income, and the change in patterns of consumption, the amount of municipal solid waste has risen dramatically, and its components have changed drastically. In the face of these accelerating changes, the ability of municipalities in most countries of the world to manage waste efficiently declined [11]. The amount of waste generated varies from one country to another, according to living standards and consumption patterns. In the United States of America, the rate of waste generation per capita is estimated at 1.2 kilograms/day, it is assessed at 4.1 kilograms/day in the countries of the European Union. In high-income Arab countries such as the Gulf countries, the generation of municipal waste ranges [12].

The proper management of solid waste requires dealing with it from the perspective of an integrated multi-faceted, multi-components, and interconnected system. Each episode depends on its predecessor, and at the same time, it represents the basis on which it follows. In all cases, it is necessary at every stage to use appropriate means appropriate to the prevailing circumstances, available resources, and existing determinants. Therefore, adopting the best options that meet the technical standards, environmental safety, social compatibility, the lowest possible costs, the highest possible recovery of resources, and compliance with legislation and regulations while being flexible and able to respond to future changes. Thus, it implies a context or life cycle that involves successive stages starting with the generation or reduction from the source, storage, and collection from various sources, and transport to proper locations for interim storage or processing [13]. Then the possibility of recovery of suitable recoverable resources for a variety of uses, and then the final disposal of environmentally safe meth. It involves many other aspects and considerations related to economic, social, planning, environmental health, legislative and institutional factors in addition to technical and engineering considerations for the system. In addition to the technical and engineering concerns for the system, it includes many other aspects and considerations related to economics, social, planning, environmental, health, legislative, and institutional factors [14].

Greenhouse gases from waste are a significant factor in climate change. In 2016, 5% of global emissions were generated from solid waste management, excluding transportation. It is estimated that human activities are causing global industrial warming of approximately 1° C, with a weighted margin of 0.8 to 1.2°C [15]. Global warming is likely to reach 1.5° C between 2030 and 2052 if it continues to increase at the current rate [16]. Accordingly, the solid waste issue is one of the most critical concerns facing sustainable development. Therefore, from a resource management point of view, there is an immediate need to deal with solid waste and not waste management [17]. Waste is an essential asset for reusability and recycling and offers new opportunities for so-called green jobs. Integrated solid waste management is the selection and application of appropriate methods, technology, and management to accomplish waste management objectives, taking into account the economic, environmental, social, and legal conditions to achieve sustainability [18]. One of the basic principles in integrated waste management is the principle of using the golden quadruple rules. The reduction is part of those rules to reduce the amount of waste either at the source or at subsequent levels and implies reducing the amount of waste generated at the origin. Construction Producing longer life and reusable materials. As for reuse, it means the direct use of the waste in the form in which it was generated, and in the same process, it was generated without subjecting it to any natural, chemical, or biological treatment that may affect its shape or formation [19]. For instance, empty bottles of drinks are returned to stores in many countries, especially developing countries, which in turn take them back to the manufacturing companies to clean and ensure their protection, then fill them with their products and put them back on the market [19]. Thermal recovery and heat recovery technology are used in many countries, especially Japan, for the safe disposal of solid waste, solid and liquid hazardous waste, hospital waste, and sludge from industrial and sanitary sewage, by burning these wastes under specific operating conditions such as the temperature and duration of combustion, this is to control the emissions and their compliance with environmental laws [20]. This method is characterized by getting rid of 90% of the solid materials and converting them into thermal energy that can be used in industrial processes or generating steam or electric energy [21]. The recycling process involves treating the waste so that it can be used as a raw material in the same process that it is generated or in other processes. Recycling is considered to be one of the best alternatives for managing both municipal and agricultural waste. The recycling of waste depends on the economic viability of these processes and the demand for different products. Among the most popular waste subject to recycling are paper - glass - bone - cloth - plastic - metal waste - organic waste [22].

The manufacture of waste paper is a matter of particular environmental importance because it contributes to reducing the depletion of forests for the use of wood in the manufacture of pulp [23]. This is in addition to the fact that recycling paper waste saves a large amount of water and energy needed to manufacture it from raw materials, as recycling one ton of paper waste will save 4100 kilowatt per hour of energy and 28 cubic meters of water, according to statistics made by the Environmental Protection Agency in the states [24]. As for plastic recycling, before recycling, the plastic is washed with caustic soda with hot water added [25]. After that, the dry plastic is broken and reused in making clothespins, hangers, and plastic electrical hoses, and it is not recommended to use plastic waste in the production of products that interact with foodstuffs. The plastic bags are re-crystallized in the crystal machines. Metal scraps, which are mainly aluminum and steel; Where it can be re-melted in iron foundries and aluminum foundries, and steel is one of the waste that can be recycled by 100%, and for an infinite number of times, and the process of recycling steel requires less energy than the energy required to extract it from alloys, while aluminum recycling costs represent 20 Only 5% of its manufacturing costs, and the aluminum recycling process requires only 5% of the energy needed [26]. Recycling glass, glass from sand is a major energy-consuming industry [27]. The manufacturing process needs temperatures up to 1600° C, and recycling glass requires much less energy. Household organic waste (food residues) represents about 50% of garbage residues, and the handling of organic waste differs in cities than in villages, organic waste is used as food for birds and animals, which is the best way to use organic waste. However, organic waste in cities is a problem of serious health dimensions [28]. Therefore, care should be taken to dispose of these materials safely or make use of them urgently to avoid their spoilage, decomposition, and the toxins and pollutants that remain behind. Therefore, the focus must be placed on spreading awareness of the necessity to separate organic residues from the rest of the waste from the source, so that it can be collected and recycled to produce fertilizer materials for agricultural lands [28].

Converting waste to energy, including municipal solid waste and waste fuels, is a valuable source of renewable energy. Waste-to-energy plants have been successfully operated all over the world, and the advantages of this technology and its environmental efficiency have been confirmed and include the presence of nearly 100 waste-to-energy plants in North America, the presence of more than 500 operating stations in Europe as well as the 1600 operating stations in Asia [29]. A waste-to-energy plant converts solid waste into electrical energy and/or heat - an energy recovery method that is environmentally friendly and cost-effective. When converting waste into energy - or obtaining energy from waste - the plant converts municipal and industrial solid waste into electrical energy and/or heat for use in industrial processing and central heating systems - energy recovery means that take into account environmental safety and low cost [30]. The power plant operates by burning waste at high temperatures and using heat to generate steam. The steam then powers the turbine, which in turn generates electricity. Getting energy from waste is a way to recover valuable resources and not just a means of garbage disposal. It is a way to recover valuable resources. Converting waste to energy is a vital part of the sustainable waste management chain and perfectly complements the recycling process. Today, 90% of the minerals in bottom ash can be reused [31]. The remaining combustion residues can be reused in pavement materials. Europe is a pioneer in this field as 50 tons of waste is converted into valuable energy using waste-to-energy technology, which provides electricity to 27 million people in Europe, and yet 50 percent of municipal solid waste is still placed in landfills. It leads to the release of greenhouse gases such as methane that is 21 times stronger than carbon dioxide [31].

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References

[1] X. Xiong, X. Liu, K.M. Iris, L. Wang, J. Zhou, X. Sun, J. Rinklebe, S.M. Shaheen, Y.S. Ok, Z. Lin, Potentially toxic elements in solid waste streams: Fate and management approaches, Environ. Pollut. 253 (2019) 680-707.

[2] P.J. McMurdie, S. Holmes, Waste not, want not: why rarefying microbiome data is inadmissible, PLoS Comput Biol. 10 (2014) e1003531.

[3] S.D. Abou Hussein, O.M. Sawan, The utilization of agricultural waste as one of the environmental issues in Egypt (a case study), J. Appl. Sci. Res. 6 (2010) 1116-1124.

[4] M.U. Treiber, L.K. Grimsby, J.B. Aune, Reducing energy poverty through increasing choice of fuels and stoves in Kenya: Complementing the multiple fuel model, Energy Sustain. Dev. 27 (2015) 54-62.

[5] W. Du, X. Zhu, Y. Chen, W. Liu, W. Wang, G. Shen, S. Tao, J.J. Jetter, Field-based emission measurements of biomass burning in typical Chinese built-in-place stoves, Environ. Pollut. 242 (2018) 1587-1597.

[6] G. Nahar, D. Mote, V. Dupont, Hydrogen production from reforming of biogas: Review of technological advances and an Indian perspective, Renew. Sustain. Energy Rev. 76 (2017) 1032-1052.

[7] A.E. Maragkaki, T. Kotrotsios, P. Samaras, A. Manou, K. Lasaridi, T. Manios, Quantitative and qualitative analysis of biomass from agro-industrial processes in the central macedonia region, Greece, Waste and Biomass Valorization. 7 (2016) 383-395.

[8] J.E. Bradshaw, Clonal Cultivars from Multistage Multitrait Selection, in: Plant Breed. Past, Present Futur., Springer, 2016: pp. 343-386.

[9] E.S. Windfeld, M.S.-L. Brooks, Medical waste management–A review, J. Environ. Manage. 163 (2015) 98-108.

[10] Doron A. Waste of a nation: Garbage and growth in India. Harvard University Press; 2018

[11] X. Guan, H. Wei, S. Lu, Q. Dai, H. Su, Assessment on the urbanization strategy in China: Achievements, challenges and reflections, Habitat Int. 71 (2018) 97-109.

[12] P. IN-AI, D. Tungtakanpoung, Solid waste logistic system of Uthai Thani municipality, (2020).

[13] J. Pérez, J. Lumbreras, E. Rodríguez, Life cycle assessment as a decision-making tool for the design of urban solid waste pre-collection and collection/transport systems, Resour. Conserv. Recycl. 161 (2020) 104988.

[14] M. Lancaster, Green chemistry: an introductory text, Royal society of chemistry, 2020.

[15] A. Swati, S. Hait, Greenhouse gas emission during composting and vermicomposting of organic wastes–a review, CLEAN–Soil, Air, Water. 46 (2018) 1700042.

[16] O. Hoegh-Guldberg, D. Jacob, M. Taylor, T.G. Bolaños, M. Bindi, S. Brown, I.A. Camilloni, A. Diedhiou, R. Djalante, K. Ebi, The human imperative of stabilizing global climate change at 1.5 C, Science (80-.). 365 (2019).

[17] V. Venkatramanan, S. Shah, R. Prasad, Global climate change: resilient and smart agriculture, (2020).

[18] A.A. Zorpas, Strategy development in the framework of waste management, Sci. Total Environ. 716 (2020) 137088.

[19] A. Akhtar, A.K. Sarmah, Construction and demolition waste

generation and properties of recycled aggregate concrete: a global perspective, J. Clean. Prod. 186 (2018) 262-281.

[20] H.I. Abdel-Shafy, M.S.M. Mansour, Solid waste issue: Sources, composition, disposal, recycling, and valorization, Egypt. J. Pet. (2018).

[21] B. Vaish, B. Sharma, V. Srivastava, P. Singh, M.H. Ibrahim, R.P. Singh, Energy recovery potential and environmental impact of gasification for municipal solid waste, Biofuels. 10 (2019) 87-100.

[22] T. Georgi-Maschler, B. Friedrich, R. Weyhe, H. Heegn, M. Rutz, Development of a recycling process for Li-ion batteries, J. Power Sources. 207 (2012) 173-182.

[23] M. Sun, Y. Wang, L. Shi, J.J. Klemeš, Uncovering energy use, carbon emissions and environmental burdens of pulp and paper industry: A systematic review and meta-analysis, Renew. Sustain. Energy Rev. 92 (2018) 823-833.

[24] M. Abdollahbeigi, An Overview of the Paper Recycling Process in Iran, J. Chem. Rev. 3 (2020) 1-19.

[25] N. Singh, D. Hui, R. Singh, I.P.S. Ahuja, L. Feo, F. Fraternali, Recycling of plastic solid waste: A state of art review and future applications, Compos. Part B Eng. 115 (2017) 409-422.

[26] D. Brough, H. Jouhara, The aluminium industry: A review on state-of-the-art technologies, environmental impacts and possibilities for waste heat recovery, Int. J. Thermofluids. (2020) 100007.

[27] W. Khraisat, W.A. Jadayil, Strengthening aluminum scrap by alloying with iron, Jordan J. Mech. Ind. Eng. 4 (2010) 372-377.

[28] M.C. Manna, M.M. Rahman, R. Naidu, A. Sahu, S. Bhattacharjya, R.H. Wanjari, A.K. Patra, S.K. Chaudhari, K. Majumdar, S.S. Khanna, Bio-waste management in subtropical soils of India: future challenges and opportunities in agriculture, in: Adv. Agron., Elsevier, 2018: pp. 87-148.

[29] J. Malinauskaite, H. Jouhara, D. Czajczyńska, P. Stanchev, E. Katsou, P. Rostkowski, R.J. Thorne, J. Colon, S. Ponsá, F. Al-Mansour, Municipal solid waste management and waste-to-energy in the context of a circular economy and energy recycling in Europe, Energy. 141 (2017) 2013-2044.

[30] L. Makarichi, R. Kan, W. Jutidamrongphan, K. Techato, Suitability of municipal solid waste in African cities for thermochemical waste-to-energy conversion: The case of Harare Metropolitan City, Zimbabwe, Waste Manag. Res. 37 (2019) 83-94.

[31] Q. Alam, K. Schollbach, C. van Hoek, S. van der Laan, T. de Wolf, H.J.H. Brouwers, In-depth mineralogical quantification of MSWI bottom ash phases and their association with potentially toxic elements, Waste Manag. 87 (2019) 1-12.