

Municipal Solid Waste Management Processing Energy Recovery Global Examples



P Jayarama Reddy



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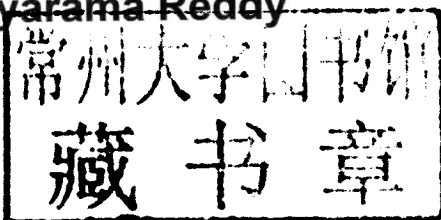
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- Processing
- Energy Recovery
- Global Examples

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Foreword

The book by Dr. P Jayarama Reddy focuses on issues related to municipal solid waste treatment and management. It is a compendium of topics from cradle to grave. To the best of my knowledge this is the first of its kind effort. The author has addressed all issues related to municipal solid waste management. It covers in detail topics starting from characterization of the waste, modes of collection and transfer to technological advances in composting and landfilling. The methods related to producing energy from wastes are discussed at length and provide great insight to the readers.

The best practices followed in developed, developing and underdeveloped countries provides a truly global experience. Examples from Nigeria, Tanzania, Chile, Japan, and Thailand along with the Indian practice have been compiled with utmost care.

The topic of Energy from Municipal Waste is timely and would help practitioners, research scholars and teachers alike in promoting and propagating the concept of 4 R's (Reduce, recover, reuse and recycle). It was a pleasure for me to read this book and I am sure all the technocrats would be benefited by this book. I heartily congratulate Dr. P Jayarama Reddy on this excellent effort by him in bringing out the book on Energy from wastes and hope to see many more such endeavors from him.

Dr. Valli Manickam

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Hyderabad, India.*

Preface

Recovery of energy in the form of heat or electricity and recyclables is an important benefit resulting from the processing of Municipal Solid Waste (MSW). Technologies have been developed utilizing principles of thermal, biochemical or chemical processing of solid waste to derive energy. These technologies are sensitive to the nature and quality of the waste collected. Hence the collected waste requires some kind of pre-assessment as well as treatment to turn into a suitable feedstock. These technologies are operative in many countries around the world to varying level of success.

Today, one of the major concerns of many municipal authorities and urban local bodies responsible for supervising public health and sanitation is the management of MSW. In developing countries, it is more complex and challenging due to many factors: inadequate infrastructure and financing, lack of definite responsibilities and roles of the authorities, insufficient rules, legal framework and poor enforcement. The uncollected waste in cities and towns and uncontrolled disposal of waste at the street corners, public places, city boundaries and the suburbs has threatened the public health and sanitation in several growing cities of the world. As a result, it is hard to find many 'clean and green cities' in most regions of the world. However, the situation has been improving in many countries due to public awakening, legal interventions and governments' initiatives.

The migration of rural people to urban centres has given rise to growth of small and large urban settlements and spreading of city suburban limits resulting in a stressed urban environment. This is particularly visible in the developing countries of the world primarily due to the increasing economic/industrial activity. Some of the regions are rapidly transforming from traditional rural economy to an urbanized one with increased production capacities of goods and services. Marked changes in consumption patterns of the people have been witnessed in recent decades.

Increased urban population has enhanced the demands for consumables resulting in larger generation of wastes both in volume as well as per

capita with less recovery and reuse of solid wastes. This increasing volume of waste demands an effective waste management system in terms of collection capacity, treatment, disposal and aftercare. Thus the necessity for greater investments of human, technological and financial resources for waste management is pertinent in order to maintain a cleaner and sustainable environment. An integrated system of solid waste management in which the waste from its origin to disposal is considered is perhaps the answer.

The challenge of delivering effective and sustainable waste management is an issue which confronts all stakeholders including central and local Governments, the public and professional (private) waste managers and even citizens. Improving awareness of the various waste management options is crucial for the development of a more sustainable approach to waste management, linking public participation and the essential infrastructure expansion to recover '*value*' from the residual waste stream.

The process of 'Composting' waste has been the traditional way of treating solid waste. Composting is now practiced from a simple inexpensive type to a large and expensive type (centralized) depending on the waste quantity, composition and other factors.

'Energy from Waste' has a significant role to play in dealing with the residual municipal waste stream. An Energy from Waste plant, also known as Waste-to-Energy (WTE) plant, operates by taking the waste and converting its hidden energy into a type of usable energy – heat, electricity and transport fuels – just as coal, oil and gas are used as fuels in fossil-fired power stations. WTE can be used with all types of waste from domestic, commercial, industrial, construction and demolition, to sewage and agricultural and so on. The only criterion is that the waste fraction needs to be combustible and/or biodegradable. WTE is now an essential component of a sustained solid waste management programme.

Energy from Waste is the application of sound proven combustion engineering principles to a variety of technologies which reduce and sanitize the residual municipal waste fraction in order to recover '*energy*.' Several waste combustion systems capable of dealing with raw, processed or sorted fractions of MSW, fluidized-bed combustion systems, and processed waste energy recovery options such as refuse-derived fuel (RDF), gasification and pyrolysis are in operation in many countries, mostly developed countries. Biochemical processing technologies such as 'anaerobic digestion', also called 'biomethanation' of waste, wherein 'biogas' is produced is also a proven technology which is widely used

worldwide. The Chemical processing – Esterification – to derive biodiesel from waste cooking oils is emerging as viable technology at commercial scale.

The major objective of this book is to introduce students of Science and Engineering, the waste managers, decision makers, planners and a wider audience to these technologies, the main components of the systems (plants), operational principles and requirements, strengths and weaknesses, working examples from around the world and so on. The treatment and uses of the post-combustion/gasification residues are also described.

In the developed countries as well as in a few developing countries, the MSW services including resources recovery and energy production, by and large, are systematized supported by proper legislations and regulations, pollution control policies and their strict enforcement. Therefore, these services are better placed in developed countries compared to developing countries where legislations and policies are inadequately present. This book covers the status of MSWM both in developed and developing countries, right from the generation of waste to the final step of disposal.

The MSW services in India including the Sources of funding, and Rules, legislation and legal provisions constitute one chapter. The desirability as well as the necessity of inviting Private Sector to participate in delivering MSW services along with the accompanying benefits and issues, the role of NGOs and Resident Welfare Associations (RWAs) is discussed in a separate chapter.

To set up a WTE plant with an appropriate technology, feasibility studies covering several issues, and proper Planning and Execution are essential. These aspects are fully explained to help a planner or an entrepreneur entering this sector. Initiatives taken by some States and the MSW services in three major cities of India – Chennai, Delhi and Greater Mumbai - as case studies are included in the book. Similarly, while briefly elaborating the state of affairs in all the continents - Asia, Africa, Latin America, Europe and North America - one or two countries/ Cities in each continent are chosen for detailed exposition.

The information for certain regions of the world are sufficiently available through survey reports, publications, research documents and websites of several organizations, for example, UNEP, USEPA, World Bank but are scanty in other regions. The conclusions drawn by several researchers are subject to this limitation.

The issues, challenges and opportunities are plenty in MSW which differ from country to country and within a country from city to city. An integrated solid waste management can address many of these challenges resulting in the lessening of air, water and soil pollution, and the associated public health problems. Further, resources of value and 'clean energy' can be recovered from the waste.

This book is a modest attempt by the author for a comprehensive presentation of the MSW issues with emphasis on '3Rs (Reduce, Reuse, and Recycle)' and recovery of 'Energy from Waste'. Annexure, Glossary and References are added at the end for the expediency of the reader.

- Author

Acknowledgement

The author conveys his sincere thanks to Dr. Valli Manickam, Chairperson, Environment Area, Administrative Staff College of India, Hyderabad, India for offering valuable suggestions and for writing foreword.

The author has drawn/quoted substantial material, photos, tables etc., from publications/Survey Reports/Documents released by several Universities/Institutes/Government departments worldwide, and Organisations such as UNEP, The World Bank, UNDP, and USEPA, and prominent NGOs in India and abroad. The author expresses his grateful thanks to the Authors of these references. These are also sincerely acknowledged at the appropriate places and at the end in the text.

The author is personally indebted to many of his close friends, former colleagues and students, and members of his family for their warmth, encouragement and support. He conveys his special love to his grand daughters, Hitha and Tanvi for their willing assistance in computer work and for picking up some photos and pictures; and to the little ones, Diya and Divija, for providing cheer at times of tiredness with their innocent queries.

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-Author

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CHAPTER 1

Basics

1.1 Introduction

The start of civilization has seen human race generating waste such as bones and other parts of animals they slaughter for their food or the wood they cut to make their shelters, tools, carts etc. The advancement of civilization has witnessed the waste generation getting enhanced, and becoming more complex in nature. The beginning of industrial era has had enormous effect on the life styles of people which have started changing with the availability of many consumer products and services in the market. The manufacturing and usage of vast range of products as well as management of the resulting waste give rise to emission of greenhouse gases. This has led not only to the pollution of air and water but has affected the Planet Earth through global warming.

Rapid migration of rural populations to urban centres, in search of better opportunities of livelihood, has resulted in an overwhelming demographic growth in many cities worldwide. This situation is more pronounced especially in Asia and Africa. The projected growth rate in North America is less because it has already recorded a growth rate of > 70%. Also in Europe, the situation is similar. But in Africa and Asia, around 35% of the population presently is urban (Fig.1.1). Asian countries are experiencing an urban growth of approximately 4% per year. This growth rate is expected to continue for several more years, and by 2025, 52% of the Asian population is likely to be living in urban

centres. As in Asia, Africa's population is mainly rural at present. However, Africa is also experiencing a high rate of urbanization at 4 to 5 % per annum, and by 2025, urbanization is likely to be similar to Asia. This high rate of urbanization can lead to serious environmental degradation in and around several cities.

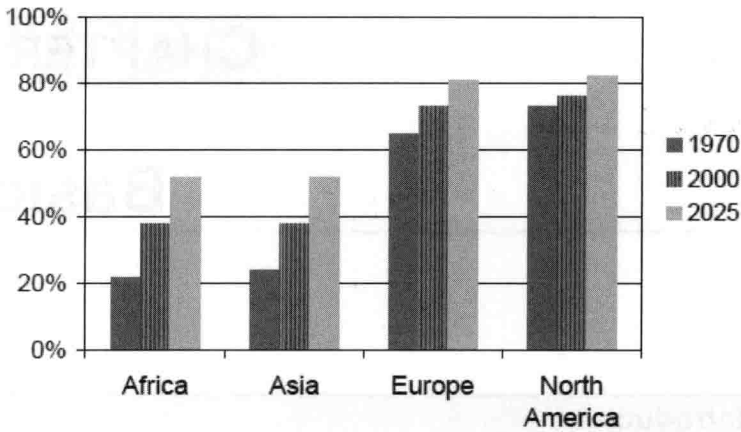


Fig. 1.1 Projected urban growth in different continents (source: UN 1996)

Cities and towns in India, a developing economy, have generated an estimated 6 million tonnes of solid waste in 1947. It has risen to about 48 million tons in 1997; and in 2001, to more than 91 million tons (taking the urban areas only), which comes to 0.12 to 0.6 kilograms per person per day. In contrast, in 2006, a developed country like US has generated more than 251 million tons of municipal solid waste which amounts to approximately 2.1 kilograms of waste/ person/ day. This is in addition to approximately 7.6 billion tons of industrial solid waste generated by industrial units annually. On an average, per capita waste generation in US (a developed country) is very *much higher* than in India (a developing country).

Significance of Waste management: Waste is any garbage or refuse or other discarded material including solid, liquid, semi-solid, or contained gaseous material arising from domestic, community, industrial, commercial, agricultural or human operations. The sludge from a wastewater treatment plant, water supply treatment plant, or air pollution control facility is also considered as waste.

Waste management is a global issue and requires maximum attention. It is highly obligatory to reduce the pollution of air and water, the dreadful effects on human health and to maintain a clean environment. Waste management sector can contribute to greenhouse gas mitigation in ways that are economically viable and meet many social priorities. The adverse effects of global warming are witnessed already around the globe to varying degree in different regions. A safe and sustainable environment is an absolute necessity for a healthy living. The civic society has, therefore, exclusive responsibility of considering waste treatment as a priority issue.

The management of waste involves waste collection, resource recovery and recycling, transportation, and processing or disposal. Of these, the most important one is processing/disposal of waste. The urbanized areas are concerned with the problem of developing cost-effective environmentally acceptable disposal methods of solid waste. The major advantages of a planned approach to waste treatment are (i) reducing pollution and the consequences such as global warming, (ii) keeping the human habitats ranging from small towns to big cities clean and green, (iii) recovering 'resources' which can be recycled into useful products for reuse, and more importantly (iv) processing of wastes into useful clean energy – heat and electric power.

Since the waste can be solid, liquid, gaseous or medical or hazardous substances, each category is treated with different and appropriate method(s). Waste management practices differ in developed and developing countries, in urban and rural areas, and for residential and industrial producers. Waste management has to be viewed as a central element in the sustainable development planning of a city or a town or a community.

Management of non-hazardous residential and institutional waste in metropolitan areas is usually the responsibility of local municipal authorities/urban local bodies, while management for hazardous commercial and industrial waste is usually the responsibility of the producer.