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Techniques of Renewable Energy Generation from Waste

Jyoti Choudhary

Lecturer, Dept. of Civil Engineering, Govt. Polytechnic College, Alwar, Rajasthan

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ABSTRACT

Renewable energy, green energy, or low-carbon energy is energy from renewable resources that are naturally replenished on a human timescale. Renewable resources include sunlight, wind, the movement of water, and geothermal heat.[1][2] Although most renewable energy sources are sustainable, some are not. For example, some biomass sources are considered unsustainable at current rates of exploitation.[3][4] Renewable energy is often used for electricity generation, heating and cooling. Renewable energy projects are typically large-scale, but they are also suited to rural and remote areas and developing countries, where energy is often crucial in human development.

Keywords- *renewable energy, waste, generation, sustainable, heat, recovery*

INTRODUCTION

A brief description of the commonly applied technologies for energy generation from waste is as follows

Anaerobic Digestion/Biomethanation

In this process, the organic fraction of the waste is segregated and fed into a closed container (biogas digester). In the digester, the segregated waste undergoes biodegradation in presence of methanogenic bacteria and under anaerobic conditions, producing methane-rich biogas and effluent. The biogas can be used either for cooking/heating applications, or for generating motive power or electricity through dual-fuel or gas engines, low-pressure gas turbines, or steam turbines. The sludge from anaerobic digestion, after stabilization, can be used as a soil conditioner. It can even be sold as manure depending upon its composition, which is determined mainly by the composition of the input waste.

Combustion/Incineration

In this process, wastes are directly burned in presence of excess air (oxygen) at high temperatures (about 800°C), liberating heat energy, inert gases, and ash. Combustion results in transfer of 65%–80% of heat content of the organic matter to hot air, steam, and hot water. The steam generated, in turn, can be used in steam turbines to generate power.

Pyrolysis/Gasification

Pyrolysis is a process of chemical decomposition of organic matter brought about by heat. In this process, the organic material is heated in absence of air until the molecules thermally break down to become a gas comprising smaller molecules (known collectively as syngas).

Gasification can also take place as a result of partial combustion of organic matter in presence of a restricted quantity of oxygen or air. The gas so produced is known as producer gas. The gases produced by pyrolysis mainly comprise carbon monoxide (25%), hydrogen and hydrocarbons (15%), and carbon dioxide and nitrogen (60%). The next step is to 'clean' the syngas or producer gas. Thereafter, the gas is burned in internal combustion (IC) engine generator sets or turbines to produce electricity.

Landfill Gas recovery

The waste dumped in a landfill becomes subjected, over a period of time, to anaerobic conditions. As a result, its organic fraction slowly volatilizes and decomposes, leading to production of 'landfill gas', which contains a high percentage of methane (about 50%). It can be used as a source of energy either for direct heating/cooking applications or to generate power through IC engines or turbines.

Analysis of Key Aspects of Waste to Energy Technologies

	Criteria	Incineration	Anaerobic Digestion	Gasification/Pyrolysis
A	Feedstock			
	Industrial			
	Liquid	Not suitable	Suitable	Not suitable
	Solid	Suitable	Not suitable	Suitable
	Urban			
	Liquid	Not suitable	Suitable	Not suitable
	Solid	Suitable	Suitable	Suitable
	Farm			
	Poultry	Suitable	Suitable	Suitable
	Cattle	Suitable	Suitable	Suitable
B	Technology features			
	Technology status			
	Industrial	Proven	Proven	Emerging
	Urban	Proven	Proven	Emerging
	Farm	Proven	Proven	Proven
	Energy efficiency	85-90% (Based on calorific value)	50-60% (Based on volatiles)	90-95% (Based on calorific value)
C	Operating conditions			
	System configuration	Complex	Simple	Complex
	Process Flexibility	Low	Good	Low
	Modular	Yes	Yes	Yes
D	Capital, O & M costs			
	Relative capital cost	Very high	Medium-high	Very High
	O & M	High	Low	Limited
	Commercial viability	Less viable than others owing to costly downstream air pollution control	Readily viable	Varies considerably
	Captive power requirements	Significant (25-30%)	Low (5%)	Variable (5-20%)
	Area requirements	Elaborate	Compact	Compact
E	Environmental impacts	Can be minimized, but requires expensive technology investments	Minimum	Can be controlled to a significant extent
F	Socio-economic impacts			
	Public acceptability	Not fully satisfactory	Satisfactory	Satisfactory
	Waste disposal	Complete, except for ash to landfill.	Complete except for sludge stabilization	Complete, except for ash

DISCUSSION

In the northern provinces of Vietnam, some of the garbage can be reused as RPF (fuel from old plastic and paper). This is a biofuel, so the heat source is similar to coal. The use of pellet waste as RPF can be widely used globally to replace a part of traditional fuels such as coal or oil because it is cheap but suitable for the ecological environment.

According to Ms. Yuri Takano - Chief Representative of IKE Garbage Treatment Company (Japan) in Hanoi, RPF technology has appeared in Japan for 30 years. Most waste such as fabrics, from paper to rubber, will be sold and used for recycling. However, not all components are fully recyclable and when collected will be destroyed. Therefore, RPF is the most effective waste treatment technology.

Compared to burning coal, using RPF as fuel will emit half of CO2, 90-100% of SO2 and over 95% of ash after burning. Therefore, RPF incineration can turn plastic waste into an environmentally safe combustion fuel and there is no need to extend the life cycle of batteries in landfills or in overloaded industrial incinerators.

Recovery and recycling methods

Waste from solar panels greatly affects environmental problems because the structure contains lead, cadmium and other toxic chemicals. Therefore, the recovery of waste from solar panels has its own regulations and is clearly stipulated by the government through Decree 08/2018/ND-CP guiding the implementation of the Law on Environmental Protection 2019 that has just been issued on January 10, 2018

Waste combustion methods

This is one of the common methods used to dispose of waste in developed countries. However, waste incineration is still controversial and is only considered a temporary method in the transition to other renewable energy sources because this process can cause black smoke and emissions, air and noise pollution, affecting human health and the surrounding environment.

However, this transition requires higher cost investments, technological innovations and waste management methods, creating certain challenges.

Pyrolysis method

The difference of pyrolysis from other techniques is that the processing of various solid wastes occurs at high temperatures but without oxygen or in an inert gas environment. This means that the decomposition process requires lower temperatures and has lower emissions of pollutants unrelated to combustion.

RESULTS

Encourage the application of incineration technology to generate electricity

The method of incineration of waste generation is widely applied in many countries around the world with about 1000 factories, of which Europe accounts for 38%, Japan 24%, the US 19% and East Asia 15%. This method offers higher economic efficiency and more advantages than other waste treatment methods. It is to make use of available raw materials, reduce the area of land used for landfill and have less adverse impacts on the environment.

Promote the development of the environmental industry

With more than 15 million tons of waste each year, Vietnam is facing a serious waste disposal problem. This situation is forecast to continue to increase by more than 10% per year. However, this is also an opportunity for Vietnam to take advantage of and recycle this huge amount of waste into new renewable energy sources, while reducing pollution and protecting the environment.

CONCLUSION

There is, no doubt, an obvious need to reduce, reuse and recycle wastes but recovery of energy from wastes is also gaining ground as a vital method for managing wastes and Middle East should not be an exception.

Wastes can be transformed into clean and efficient energy and fuel by a variety of technologies, ranging from conventional combustion process to state-of-the-art plasma gasification technology. Besides recovery of energy, such technologies leads to substantial reduction in the overall waste quantities requiring final disposal.

Waste-to-energy projects provide major business opportunities, environmental benefits, and energy security. There are many types of waste that can be converted into renewable energy including municipal solid wastes, crop residues and agro-industrial wastes.

Let us explore some of major types of wastes that can be converted into energy in the MENA region:

1. Municipal Solid Wastes

Atleast 150 million tons of solid wastes are collected each year in the MENA region with the vast majority disposed of in open fields and dumpsites. The major energy resource in municipal solid waste is made up of food residuals, paper, fruits, vegetables, plastics etc. which make up as much as 75 – 80 percent of the total MSW collected.

Municipal wastes can be converted into energy by thermochemical or biological technologies. At the landfill sites the gas produced by the natural decomposition of MSW (called landfill gas) can be collected, scrubbed and cleaned before feeding into internal combustion engines or gas turbines to generate heat and power.

The organic fraction of MSW can be biochemically stabilized in an anaerobic digester to obtain biogas (for heat and power) as well as fertilizer. Sewage sludge is a big nuisance for municipalities and general public but it is a very good source of biogas, which can efficiency produced at sewage treatment plants.

2. Agricultural Wastes

Agricultural wastes includes encompasses all kind of crop residues such as bagasse, straw, stem, stalk, leaves, husk, shell, peel, pulp, stubble, etc. Large quantities of crop residues are produced annually in the MENA region, and are vastly underutilised.

Dates, wheat and barley are the major staple crops grown in the Middle East region. In addition, significant quantities of rice, maize, lentils, chickpeas, vegetables and fruits are produced throughout the region, mainly in Egypt, Tunisia, Saudi Arabia, Morocco and Jordan.

Current farming practice is usually to plough these residues back into the soil, or they are burnt, left to decompose, or grazed by cattle. Agricultural residues are characterized by seasonal availability and have characteristics that differ from other solid fuels such as wood, charcoal, char briquette. Crop wastes can be used to produce biofuels, biogas as well as heat and power through a wide range of well-proven technologies.

3. Animal Wastes

The MENA countries have strong animal population. The livestock sector, in particular sheep, goats and camels, plays an important role in the national economy of respective countries. Many millions of live ruminants are imported each year from around the world. In addition, the region has witnessed very rapid growth in the poultry sector.

The biogas potential of animal manure can be harnessed both at small- and community-scale. In the past, this waste was recovered and sold as a fertilizer or simply spread onto agricultural land, but the introduction of tighter environmental controls on odour and water pollution means that some form of waste management is now required, which provides further incentives for waste-to-energy conversion. The most attractive method of converting these waste materials to useful form is anaerobic digestion.

4. Wood Wastes

Wood processing industries primarily include sawmilling, plywood, wood panel, furniture, building component, flooring, particle board, moulding, jointing and craft industries. Wood wastes generally are concentrated at the processing factories, e.g. plywood mills and sawmills. In general, processing of 1,000 kg of wood in the furniture industries will lead to waste generation of almost half (45 %), i.e. 450 kg of wood.

Similarly, when processing 1,000 kg of wood in sawmill, the waste will amount to more than half (52 %), i.e. 520 kg wood. Wood wastes has high calorific value and can be efficiency converted into energy by thermal technologies like combustion and gasification.

5. Industrial Wastes

The food processing industry in MENA produces a large number of organic wastes and by-products that can be used as biomass energy sources. These waste materials are generated from all sectors of the food industry with everything from meat production to confectionery producing waste that can be utilised as an energy source. In recent decades, the fast-growing food and beverage industry has remarkably increased in importance in major countries of the region.

Since the early 1990s, the increased agricultural output stimulated an increase in fruit and vegetable canning as well as juice, beverage, and oil processing in countries like Egypt, Syria, Lebanon and Saudi Arabia. Wastewater from food processing industries contains sugars, starches and other dissolved and solid organic matter. A huge potential exists for these industrial wastes to be biochemically digested to produce biogas, or fermented to produce ethanol, and several commercial examples of waste-to-energy conversion already exist around the world.

CONCLUSION

An environmentally sound and techno-economically viable methodology to treat wastes is highly crucial for the sustainability of modern societies. The MENA region is well-poised for waste-to-energy development, with plentiful availability of waste-to-energy feedstock in the form of municipal solid waste, crop residues and agro-industrial waste.

The implementation of advanced waste-to-energy conversion technologies as a method for safe disposal of solid and liquid wastes, and as an attractive option to generate heat, power and fuels, can greatly reduce the environmental impacts of wastes in MENA countries.

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