Elektum an Innovative and Sustainable Electricity Generation Method

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Abstract- *The conventional fuels required for production of electricity is decreasing day by day and it is very important to find out alternative sources which can be used as the fuel for the production of electricity especially for developing countries. Through the idea of turning garbage into electricity, we aim at reducing the amount of rubbish going to landfill, controlling pollution and potentially making a significant contribution to the nation's electricity supply. Elektum, the proposed concept discussed in this paper can be adopted to convert any waste into electricity efficiently with little effort.*

Keywords- waste to energy, waste management, energy crisis management, incineration, hot air engine.

I. INTRODUCTION

Electrical energy is universally accepted as an essential commodity for human beings. Future economic growth crucially depends on the long term availability of energy from sources. Electricity is something our modern world demand more and more off every day. The natural resources in the form of fossil fuels are the raw materials from which electrical energy is generated and the day to day life of the people of today's world is solely dependent on the electrical energy. In developing countries, there is not enough generation of electrical energy to keep up with the demand, and there is a scarcity of raw materials for producing the energy. Alternative sources are now explored to prepare for the future dearth of traditional energy sources. The waste materials can be a good source of energy as the amount of waste is increasing every day, and can help in meeting the electrical energy in the world. Many countries are now switching to renewable energy sources, as they are clean and a suitable substitute for fossil fuels. Some parts of the world have already established a few wastes to energy power plants but this is not enough and there is a huge scope of increasing the overall performance of the systems.

II. WASTE RESOURSES IN INDIA

India's garbage generation stands at 0.2 to 0.6 kilograms of garbage per head per day. Also, it is a well-known fact that land in India is scarce. The garbage collector who comes to your house every morning to empty your dustbins inside his truck, takes all the garbage from your neighborhood and dumps it on an abandoned piece of land. Garbage collectors from all parts of the city meet there to do the same. Such a land is called a landfill.

India's per capita waste generation is so high, that it creates a crisis if the garbage collector doesn't visit a neighborhood for a couple of days. Typically, each household waits for the garbage boy with two or three bags of trash. If he doesn't turn up, the garbage becomes too much to store in the house. The household help or maid of the house will then be instructed to take the bags, walk a few yards away – probably towards theend of the lane – and dump the bags there. Seeing one household, all the others in the neighborhood immediately follow suit. This land, at the end of the lane, soon becomes the neighborhood's very own garbage dump – a convenient place to dump anything if the garbage boy doesn't show up. Of course, when the quantity of the waste becomes too much to bear then diseases are feared, the residents would march up to their colony's welfare association and demand for the waste to be cleaned up at once. The waste will then be picked up from there and dumped in another piece of land – this time further away from the colony – probably in a landfill.

People in India also litter excessively. The sweeper again sends all this garbage to the local dump, from where it finally goes to a landfill. At the end of the day, it is safe to say that all garbage gets dumped in a certain piece of land. Once a landfill is completely occupied, a new landfill is discovered in a different part of the city. The Energy Research Institute estimates that 1400 sq. km. of land would be required by 2047 for municipal waste!

III. ELECTRICITY SECTOR IN INDIA

Power development in India was first started in 1897 in Darjeeling, followed by commissioning of a hydropower station at Sivasamudram in Karnataka during 1902. India's installed capacity growth rates are still less than those achieved by China, and short of capacity needed to ensure universal availability of electricity throughout India by 2017.

There is a whole gamut of challenging areas in the power sector that India needs to address on priority in order to meet its growth targets. World over the economic growth is driven by energy, either in the form of finite resources such as coal, oil and gas or in renewable forms such as hydropower, wind, solar and biomass, or its converted form, electricity. This energy generation and consumption powers a nation's industries, vehicles, homes and offices. It also has significant impact on the quality of the country's air, water, and land and forest resources. For growth to be sustainable, it must be both resources efficient and environmentally-safe.

In India, the demand for electricity has always been more than the supply. The importance of electricity as a prime driver of growth is very well acknowledged and in order to boost the development of power system, the Indian government has participated in a big way through creation of various corporations such as, State Electricity Boards (SEB), NTPC Limited, NHPC Limited and Power Grid Corporation Limited (PGCL), etc. However, evenafter this the country is facing power shortage.

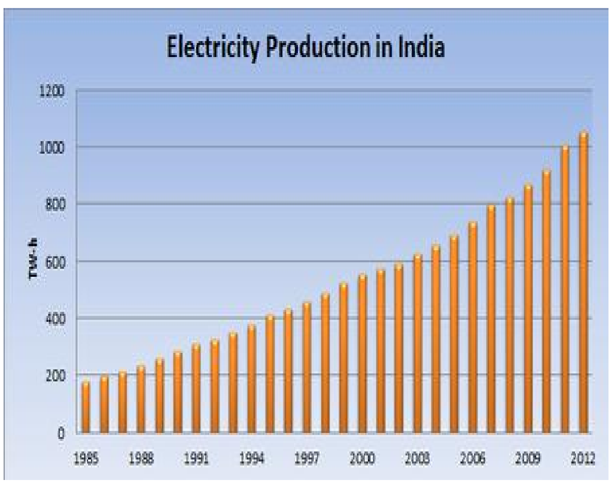

Fig. 1.Electricity production in India

The current power infrastructure in India is not capable of providing sufficient and reliable power supply. Some 400 million people have zero access to electricity since the grid does not reach their areas.

IV. LITERATURE SURVEY

Waste-to-energy (WtE) or energy-from-waste (EfW) is the process of generating energy in the form of electricity and/or heat from the primary treatment of waste. WtE is a form of energy recovery. Most WtE processes produce electricity and/or heat directly through combustion, or produce a combustible fuel commodity, such as methane, methanol, ethanol or synthetic fuels. There are a number of other new and emerging technologies that are able to produce energy from waste and otherfuels without direct combustion. Many of these technologies have the potential to produce more electric power from the same amount of fuel than would be possible by direct combustion. WtE technologies are able to convert the energy content of different types of waste into various forms of valuable energy. Power can be produced and distributed through local and national grid systems. Heat can be generated both at high and low temperatures and then distributed for district heating purposes or utilized for specific thermodynamic processes. Several types of biofuels can be extracted from the organic fractions of waste, in order to be then refined and sold on the market. Through the idea of turning garbage into electricity, we aim at reducing the amount of rubbish going to landfill, controlling pollution and potentially making a significant contribution to the nation’s electricity supply. WtE techniques can be expensive and often limited in the types of waste they can use efficiently.

The United Kingdom and The United States Of America help their nation’s power suppliers to derive electricity they supply to their customers from renewable using the technique waste2tricity. In India WTE method used mainly is incineration which entails burning waste to boil water which powers steam generators that make electrical energy and heat.

Energy can be recovered from waste by various (very different) technologies. It is important thatrecyclable material is removed first, and that energy is recovered from what remains, i.e. from the residual waste. This leaflet covers the following energy from waste (EfW) technologies:

- **Combustion**, in which the residual waste is burned at 850 C and the energy recovered as electricity or heat
- **Pyrolysis and gasification**, where the fuel is heated with little or no oxygen to produce “Syngas” which can be used to generate energy or as a feedstock for producing Methane, chemicals, biofuels, or hydrogen
- **Anaerobic digestion**, which uses microorganisms to convert organic waste into a Methane-rich biogas that can be combusted to generate electricity and heat or converted to bio methane. This technology is most suitable for wet organic wastes or food waste. The other output is a biofertiliser.

Combustion plants are often referred simply as EfW plants. They have a boiler to capture and convert the released heat into electricity and steam, and extensive air pollution control systems that clean the combustion gases to comply with regulatory emission limits before they are released to atmosphere through a chimney. These plant typically use between 50 – 300 thousand tons per year of fuel.

Typical fuels

- Municipal Solid Waste (MSW)
- Commercial & Industrial Waste (C&I)
- Refuse derived fuel (RDF) or Solid Recovered Fuel (SRF)

Outputs

- Electricity or Heat – or both together if a Combined Heat and Power Plant (CHP)
- Bottom ash **-** This is what is left after combustion and it can be used as an aggregate or road bed material. If metal was not removed pre-combustion, it is recycled at this point.
- Fly ash **-** This is the material collected by the pollution control equipment.

Sometimes referred to as ATTs (Advanced Thermal Treatments), **gasification and pyrolysis** plants thermally treat fuels without allowing enough oxygen for complete combustion. They are typically smaller and more flexible than combustion plants and typically consume between 25 and 150 thousand tons of waste per year, although some variations can consume up to 350 thousand tons per year.

Typical fuels

- Municipal Solid Waste (MSW)
- Commercial & Industrial Waste (C&I)
- Refuse derived fuel (RDF) or Solid Recovered Fuel (SRF)
- (Non-waste fuels, e.g. wood / other forms of biomass)

Outputs

- Electricity or Heat – or both together if a Combined Heat and Power Plant (CHP)
- Syngas, which can be purified to produce “biomethane”, biofuels, chemicals, or hydrogen
- Pyrolysis oils – these can be used to fuel engines, or turned into diesel substitute
- Feedstock for the chemical industry – allowing biomass to substitute for oil in the production of plastics

For example

- Bottom ash, Char, or Slag – by-products which can be used for beneficial purposes such as aggregates or road bed material
- (Fly ash produced by some but not all plants)

Biogas/AD plants operate at low temperature, allowing microorganisms to work on the feedstock, turning it into biogas, which is a mixture of carbon dioxide and methane. They are typically much smaller than the combustion or gasification plants. A biogas plant is most appropriate for wet organic wastes, such as food waste, sewage sludge, agricultural residues or energy crops.

Typical fuels

- Food wastes
- Some forms of industrial and commercial waste, e.g. abattoir waste
- Agricultural materials and sewage sludge.

Outputs

- Biogas, which can be used to generate electricity and heat – CHP is the norm for such plants
- Biomethane for the gas grid, with the appropriate gas scrubbing and injection technologies
- Digestive **-** a material which can be used as a useful fertilizer / soil conditioner on agricultural land in lieu of chemical fertilizers appreciate this.

V. DISADVANTEGES OF EXISTING METHODS

The existing wastes to energy techniques have advantages and disadvantages. The advantage is that these techniques give a solution to the growing problems of inadequate waste management and energy crisis. When disadvantages are considered, each of them differs

Combustion results in pollution as it emits toxic gases and all types of wastes cannot be burnt. In this method complete burning of waste is not ensured. Pyrolysis is heating in the absence of air. It requires large oxygen free chambers and excessive heat which are impractical in small scale. Anaerobic digestion has been used to produce biogas used for cooking. It is quite simple to generate electricity from biogas but is less efficient as anaerobic digestion is time consuming and the amount of gas obtained is less, that too for small interval of time. Incineration is another method used to generate electricity which has the disadvantage of the requirement ofhuge plant which is in fact one of the problems with other methods also.

VI. ELEKTUM

Elektum is an innovative and sustainable electricity generation method from waste. The name Elektum is derived from the Greek word 'elektron' for electricity and the Latin word 'purgamentum' for waste. When waste is used for electricity generation, it has a steady and controllable output. This proposed concept can cover the disadvantages of other waste to energy. This method can be adopted to convert any waste into electricity efficiently with little effort. The primary step is incineration which is the waste treatment process. The resultant heat is converted to mechanical energy and is used to drive a generator to produce electricity. During incineration, the waste undergoes oxidation only. The high temperature in the waste burning plant destroys odorous gases and dioxins which are formed as a result of burning. Thus the whole process is free from pollution. The remaining bottom ash is non-hazardous and is typically used in other applications such as an aggregate in concrete or for road building.

This is a potentially more efficient form of electricity generation from waste when compared to existing waste to electricity techniques. This method does not require a huge plant. The outputvoltage can be increased by increasing the capacity of machines used. Due to the following two reasons this method can be considered as an electricity generation method capable of giving sustainable output:

i) The amount of waste from houses and industries is increasing day by day.
ii) The only raw material used is waste.

VII. ELEKTUM: PROCEDURE

This proposed concept is a technique that can be adapted to generate electricity even in houses. The procedure mainly involves three steps.

1. Waste burning plant
2. Hot air engine
3. Generator

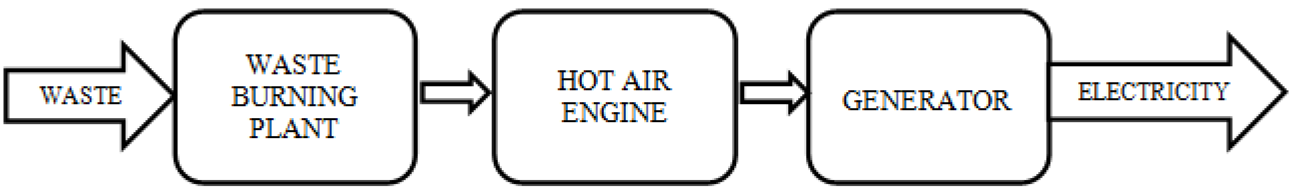

Fig No.2 Block Diagram

The waste is heated in the waste burning plant and the output heat is collected and fed to hot air engine or sterling engine which gives a mechanical output sufficient to drive a generator.

Fig No.3 Waste Burning Plant

The method of using incineration to convert municipal solid waste to energy is a relatively old method of WtE production. The plants called incinerators which are commonly used require fuel and huge space. But the specialty of this plant is that there is no need for any fuel even if the wastes are 60% damp. In towns and cities space is a major problem for constructing the waste burning plant. Even if space is available, the pipe for the smoke has to be elevated much which is expensive. To do away with this we can construct the plant at the top of the terrace. The heat will never affect the concrete or will damage the floor of the terrace. The space needed for the construction of the waste burning plant is only 2 meter square. Heat is collected from the chamber using copper rings. A 100 kg plant can generate 400 degree Celsius of heat. It can be directly given to the input of Sterling or Hot air engine.

Hot air engine uses the expansion and contraction of air under the influence of a temperature change to convert thermal energy into mechanical work. The key parts are: heat source, gas, heat sink, pistons and heat exchanger. The heat source is where the engine gets all its energy from.

Although described as external combustion engines, hot air engines don't have to use combustion but need a difference in temperature between the heat source and the heat sink. There's a volume of gas permanently sealed inside the machine in a closed cylinder. It can be ordinary air, hydrogen, helium, or some other readily available substance that remains a gas as it's heated and cooled through the engine's complete cycle (the repeated series of operations it goes through). Its only purpose is to move heat energy from the heat source to the heat sink, powering the piston that drives the machine. The gas that moves heat is sometimes called the working fluid. The place where the hot gas is cooled before being returned to the heat source is the heat sink. This is typically some sort of radiator (a piece of metal with fins attached), which expels waste heat to the atmosphere. There's one completely internal, piston called a displacer whose job is to move the gas between the heat source and the heat sink. There's also a working piston, which fits tightly into the cylinder, and turns the expansion of the gas into useful work that drives whatever the engine is powering. Also known as the regenerator, the heat exchanger sits in the closed chamber between the heat source and the heat sink. As the hot gas moves past the regenerator, it gives up some of its heat, which the regenerator holds onto. When the gas moves back, it picks up this heat again. Without the regenerator, this heat would be lost to the atmosphere and wasted. The heat exchanger greatly improves the efficiency and power of the engine.

The theoretical efficiency η of the Sterling engine is given by Carnot's Law thus:

$$\eta = (T_h - T_c)/T_h \quad (1)$$

Where T_c is the temperature of the gas when it is cold and T_h is the temperature of the gas when it is hot.

Practical engines with efficiencies of 50% have been produced. This is double the typical efficiency of an internal combustion engine which has greater pumping and air flow losses in the engine and heat losses through the exhaust gases and cooling system.

The generator is driven by the mechanical output from hot air engine. The shaft of the generator is rotated using the mechanical energy to generate emf.

VIII. ADVANTAGES AND DISADVANTAGES

The main advantages and applications are waste management and energy crisis management. The disadvantage is that the implementation cost is high. But once it is installed, what we just need to do is to monitor the wear and tear of machines used. The solution that Elektum brings to the energy crisis and improper waste management are noteworthy. The equipment used are simple with a size that can be easily handled. This can be installed even in houses, schools, hospitals, auditoriums, etc. The main advantage of This proposed concept over other waste to energy techniques are its simple but efficient procedure and that it is capable of generating electricity for small scale applicationsalso. Any type of wastes can be used in this process.

IX. APPLICATIONS

This proposed concept can surely help houses, schools, auditoriums, etc. to meet their needs when mains supply fails or can be accepted as an alternative for conventional electricity supply. When installed with machines having greater capacity and efficiency and if more waste is heated, we can assure ourselves that we need not depend on the existing energy sources and worry about their depletion as we have tons of waste to produce electricity and meet our needs. This proposed concept can contribute much to the prolonged answer seeking question of waste management. It also says itself to be the next generation electricity generation method.

X. CONCLUSION

Electricity is something our modern world demands more and more off every day. On the other hand, garbageis a growing problem for our entire planet. It could be dreams come true if we could turn what we don't want into what we need. This proposed concept is an innovative and sustainable method of electricity generation from waste. The availability of waste is increasing every day. So the raw material is always available. This proposed concept to turn inorganic waste into electricity along with the biogas made from organic waste together can wipe out a huge amount of waste thus deleting the concept of landfill and garbage ultimately.

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