Organic Waste as a Renewable Energy Source

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Abstract. The problem of recycling organic waste is a relevant one, as the accumulation of industrial, domestic and agricultural pollution that negatively affects the biosphere continues. It causes pollution of air, water, land and adversely affects human health. In developed countries resources are increasingly being reused and it's called "recycling economy". Recycling involves reuse or recycling of production or waste. Two points there are particularly significant: turns waste into a resource; prevents the costs that society would incur in their polygon burial. Food waste effluents are huge. Food waste taken to landfills rots, attracting disease carriers. Greenhouse gases - carbon dioxide and methane - are released in rotting processes with negative local and global effects (climate impacts).

1. Introduction

The main problem at landfills is the presence of harmful emissions into the environment. Scientists who examined seven landfills in Britain found about 140 different substances within the landfill gas, including alkanes, aromatic hydrocarbons, cycloalkanes, terpenes, alcohols and ketones, chlorine compounds, including organochlorine compounds such as chloroethylene [1]. Landfill gas is the product of natural biological decomposition of organic waste. The presence of methane in landfill gas is about 60%. If methane emissions continue, without regulation by humanity, it will have negative consequences in the future. Methane increases the greenhouse effect of the atmosphere much stronger than carbon dioxide. The effect of a ton of methane entering the atmosphere is approximately equal to 25 tons of carbon dioxide. With the increase in the population of the Earth, methane emissions have also begun to rise, this is due to the unsustainable use of organic waste, they can serve as a resource for the controlled production of methane, which will reduce the rate of emissions to the environment and allow the use available resources rationally [2].

2. Methods

It is possible to dispose of organic wastes with control of methane and other substances release using biogas plants. In this method organic waste is subject of anaerobic decomposition and finally biogas evolution. Such an approach of recycling will not only reduce the removal of organic waste, but will also allow methane to be produced and used for the benefit of society [3]. The main application of methane has been found in the field of power generation at gas turbine plants. With 1 m³ methane it is...
possible to obtain up to 10 kW of electricity [4]. It has also found use in the transport sector. In terms of specific combustion heat, methane exceeds oil by 20%. The higher the specific heat of combustion of the fuel, the lower its consumption. That is why, nowadays, it is possible to observe the use of methane in urban transport instead of gasoline and diesel fuel.

Table 1. Information on biogas value in one ton of waste.

| Description of primary source          | Biogas output (m³/t) | Methane value in biogas, % |
|----------------------------------------|----------------------|----------------------------|
| Permanent livestock slaughter waste    | 260-280              | 50-60                      |
| Pork manure                            | 561                  | 50-60                      |
| Horse manure                           | 200-300              | 50-60                      |
| Grass                                  | 630                  | 70                         |
| Flax stalks                            | 359                  | 70                         |
| Floral scales of cereals               | 432                  | 59                         |
| Tree leaves                            | 210-294              | 58                         |
| Press                                  | 640                  | 50                         |
| Wine plant wastewater                  | 300-600              | 58                         |
| Carbohydrates                          | 750                  | 49                         |
| Lipids                                 | 1440                 | 72                         |
| Proteins                               | 980                  | 50                         |

The work of the biogas unit (figure 1) is based on biological processes of fermentation and decomposition of organic substances under the influence of methane-forming bacteria in anaerobic conditions, specific with the lack of free oxygen, high humidity and 15-20°C temperature environment for psychophilic, 30-40°C for mesophilic and 50-70°C for thermophilic bacteria. Anaerobic fermentation is carried out in a sealed vessel - a reactor (methane tank) usually with the form of cylindrical shape with horizontal or vertical arrangement. For efficient fermentation in the reactor cavity it's necessary to maintain a constant temperature according to the accepted fermentation mode (mesophilic or thermophilic) and to carry out regular mixing of the fermented raw materials. It should be noted that the mesophilic regime requires less heat, but the decomposition of organic substances at this temperature is slower and not completely. The thermophilic mode of raw material processing requires high heat consumption, has a higher rate of decay, a higher yield of biogas and is least harmful to the environment. However, this mode is more complex to implement and monitor. Also to increase the obtained biogas enzymatic additives are used. Enzymes are catalysts of protein origin by which most biochemical reactions are carried out. They play an important role in the metabolism of any living organisms [5].
3. Results
In the official statistics of Russian Federal Service for Supervision of Natural Resources and Federal State Statistics Service there is no data on the management of food waste contained in the municipal solid waste (MSW). And if the morphological composition of MSW can estimate the amount of food waste generated, the amount of this waste aimed at disposal, decontamination and placement is currently unknown [6]

The statistics on the figure 2 show a large amount of organic waste contained at landfill sites. However, the reduction in the growth of exported organic waste in the next few years is not envisaged, on the contrary, the number of landfills is only increasing due to the impossibility of dumping them at existing landfills.
Figure 2. Quantitative content of different fractions in solid municipal wastes of the Russian Federation in 2018.

The percentage of various harmful substances in landfill gas (figure 3) depends on many factors: time of year, compliance with technologies in the construction and operation of the landfill, age of landfill, composition of garbage, climatic zone, air temperature and humidity [7].

Figure 3. Structure of greenhouse gas emissions.
Technologies used at landfill sites involve collection of landfill gas by means of a degassing system. Degassing is one of the types of decontamination, which is the destruction of toxic substances or their removal from the contaminated surface, used to reduce contamination to the permissible rate or complete disappearance. A disadvantage in collecting landfill gas using such technology is that many toxic combustion products are released during combustion. In a normal way, landfill gas must be cleaned before incineration to reduce the risks of toxic substances entering the environment. But today, even knowing how to reduce risks and avoid many problems, landfill sites are not built taking into account all nuances, thus already existing problems are only increasing.

Using a biogas plant for the disposal of organic wastes and the use of the obtained secondary raw materials in the form of biogas and bio-fertilizers (organic fertilizers), which will allow not only to reduce damage to the environment from landfill gas, but also to usefully use the obtained secondary raw materials [8]. Organic fertilizers are one of the most important sources of soil humus replenishment, which determines the main biological indicator of the soil - enzymatic activity [9]. Biogas produced after anaerobic fermentation consists of 63% methane, 33% carbon dioxide and 4% other substances. To obtain pure methane, biogas should be purified from other substances. The obtained raw materials found their application in many industrial directions. Which makes the use of biogas plants even more attractive technology [10].

\[ V_{bio} = M_w \cdot F_s \]

where \( V_{bio} \) - total amount of volume generated from waste; \( M_w \) - waste mass; \( F_s \) - specific content of biogas in one ton of waste.

\[ V_{bio} = 18.6 \cdot 10^6 \cdot 350 = 6.51 \cdot 10^9 \text{ m}^3 \]

\[ V_{methane} = 60\% \cdot V_{bio} \]

where \( V_{methane} \) - methane volume; 60\% - methane share in biogas.

\[ V_{methane} = 60\% \cdot 6.51 \cdot 10^9 = 3.906 \cdot 10^9 \text{ m}^3 \]

\[ E_{en} = V_{methane} \cdot A_s = 3.906 \cdot 10^9 \cdot 10 = 39.06 \cdot 10^9 \text{ kW} \cdot \text{h} \]

where \( E_{en} \) - amount of energy; \( A_s \) - specific energy content in gas volume.

The results may indicate that the disposal of organic waste using such technology has huge energy reserves that can replace harmful electricity production, as not only organic waste but also specially grown agricultural crops can serve as a source for production [11].

4. Conclusion

Up to date, there are directives that include waste management procedures. This order implies reuse, recycling and burial. With the use of biogas plants, it is possible to completely eliminate the last stage of waste management "disposal." By processing, it's possible to reduce the volume of organic waste removal to landfill sites, which will reduce the percentage of methane and hydrogen sulphide release into the environment. For the food industry, gastronomy, large restaurants, catering facilities and food waste processing plants, biogas technology provides a chance for cheap recycling of organic waste and food residues in biogas plants with benefit for agriculture. The energy generated by biogas plants can rightly be considered renewable, as the raw materials for its production are organic waste of mankind and with the growth of population this type of waste will only increase. With the growing demand, the increase in the amount of energy produced, the raw materials can be served by specially grown crops and animal products.

5. References

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