The reduction the load on the MSW landfill by optimizing the waste management system of residential territories

K V Afonin¹, T S Zhilina¹, A A Zagorskaya¹
¹Tyumen Industrial University, Lunacharskogo street, Tyumen 625001, Russia

E-mail: zagorskajaaa@tyuiu.ru

Abstract. The article considers the possibility of reducing the load on municipal solid waste landfills in the real conditions of Tyumen. Analysis of the content of bio fermented components in wastes in Tyumen was carried out. A decentralized scheme for collecting, accumulating and disposing of municipal solid waste (MSW) of multi-apartment buildings for the purpose of generating and using methane is given. It is established that the amount of methane produced is sufficient to compensate for the communal needs of apartment buildings. Reduction of anthropogenic impact of landfills of solid domestic waste is possible with the introduction of utilization and use of biogas at the place of waste generation. A project has been developed for the placement of decentralized MSW processing facilities in the area of the existing residential district. Potential options for utilization of methanogenesis products were selected.

1. Introduction
According to [1], almost all waste of the housing and communal sector in the south of the Tyumen Region is located in the dumps and landfills of municipal solid waste (MSW), the total area of which in the region is 3 880 hectares. The distribution of waste storage facilities by type is shown in Figure 1.
Analyzing the situation with the placement of waste, we can say with confidence that over the past two years the number of unauthorized objects has increased, and the number of officially authorized ones has decreased. This indicates a low environmental and economic efficiency of the existing waste management scheme in the region [2, 3]. The purpose of this research is to consider an alternative scheme of waste management on the example of the city of Tyumen.

2. Materials and methods

The largest MSW landfill in the Tyumen region - Velizhansky, has been in operation since 2010 (Figure 2). Occupies more than 30 hectares and takes about 230 tons of waste [4]. It is located in the agricultural zone of the city of Tyumen, near the large water body - Lake Lipovoye. According to studies [5], the Velizhansky landfill is a serious source of atmospheric pollution and the cause of regular fires.

![Figure 2. Waste Disposal at the Velizhansky landfill: a – according to Google earth, b – waste at the landfill photo of the authors.](image)

The landfill accepts MSW and waste products that are close to them in composition. This object is used only for disposal of waste, does not have a centralized sorting and processing of waste. According to the administrations of municipal districts and urban districts, sorting for the purpose of extracting secondary material resources from MSW throughout the South of the Tyumen region was not carried out [1, 5]. Only in Tyumen the technology of separate collection of municipal solid waste is partially implemented. At the same time, this practice in 2017 had an episodic character with a low level of efficiency. The introduction of separate collection of municipal solid waste in Tyumen in 2017 had no significant impact on the waste management system.

Solid domestic waste has a significant resource value. The Wastes of the Velizhansky polygon [6, 7] contain 75% recycled components, including biologically active (Figure 3).

![Figure 3. The content of fermented components in MSW of the Velizhansky polygon.](image)
This confirms the possibility of methane fermentation of solid waste in order to obtain biogas. However, significant areas occupied by landfills, as well as the lack of control and technological methods of intensification of methanogenesis in the landfill do not allow doing it in natural conditions. The construction of reactors for fermentation requires significant investment and increased requirements for the safety of the facility. All this contributes to the gradual abandonment of centralized waste collection, storage and disposal [8, 10].

3. Results
The concept of processing and use of solid waste at the place of formation is shown in Figure 4.

![Figure 4. The concept of co-utilization of municipal waste of apartment buildings.](image-url)

The presented scheme of waste management involves:
1. Separate collection of municipal solid waste from apartment buildings on specialized place
2. Primary wastewater treatment with the removal of large objects that prevent the transportation of wastewater
3. Grinding and dehydration of a mixture of MSW suitable for fermentation and sewage sludge
4. Production of methane, carbon dioxide and humus-like product as a result of methane fermentation
5. Use of the received products for needs of housing and communal services of the residential district

The introduction of a decentralized scheme solves several pressing problems in the field of housing and communal services:
1. Reduce the amount of waste to be accumulated to 5% of the total mass and, as a result, reduce the load on landfills, thereby minimizing their area and increasing their service life.
2. It will contribute to the elimination of blockages of intra-house and intra-municipal sewerage networks, reducing accidents and ensuring the stable operation of urban networks and sewage facilities.

3. It will produce methane up to 1.5 m$^3$ per day per inhabitant suitable for use in roof boilers [11].

All volume of engineering constructions according to the presented scheme can be placed within the residential district. The architectural concept is presented in Figures 5 and 6.

![Figure 5](image5.jpg)

**Figure 5.** Locations of the installation of decentralized use of municipal solid waste in the quarter (according to Google earth).

![Figure 6](image6.jpg)

**Figure 6.** The project of construction of methanogenesis plants in the existing residential area.
The modeling of methane formation conditions and the calculation of the main characteristics of the process equipment were carried out for the quarter shown in Fig. 5. As a result of preliminary calculations, the overall dimensions of the blocks were determined (Fig. 7), which is included in the technological scheme of co-digestion.

![Diagram](image.png)

**Figure 7.** Prototype of methanogenesis installation

1 – Grinding and dewatering unit; 2 – Methane reactors.

4. Conclusion

The accumulation of waste in the environment dramatically affects all elements of the biosphere: changes in relief, evaporation of moisture and groundwater, the nature of vegetation, surface runoff regimes, accumulation of toxic products in biota and transmission along the food chain [12, 13]. Storage of waste is associated with the alienation of large areas, often not subject to restoration and reclamation after the end of the service life [14]. The total impact of waste causes significant environmental and economic damage [15, 16, 17, 18].

Recycling of municipal solid waste by anaerobic digestion reduces the load on municipal solid waste landfills, which will lead to positive changes in the biosphere as a whole.

Co-processing of municipal waste in apartment houses at the place of education allows us to improve the hydraulic modes and conditions of operation of the system of collection of sewage water due to the extraction of floating large impurities (waste).

In addition, biomethanogenesis products are suitable for use in the national economy, as a source of thermal, mechanical and electrical energy, the catalyst for the growth of plants or soil [19, 20].

Reference

[1] Report "On the environmental situation in the Tyumen region in 2017" 2018 (Department of subsoil use and ecology of the Tyumen region)

[2] Lebedeva A A, Lebedev D A 2015 Indicators of the condition of the system of managing waste. *Innovative science* 5 pp 229-231

[3] The regional cadaster of waste in Tyumen region 2015 (Tyumen)

[4] Hygienic aspects of waste production and consumption, and protecting the health of the population of the region. *Labor medicine and human ecology*, 2015 - №3
[5] Zhilina T, Afonin K, Zagorskaya A 2017 Reduction of environmental impact of solid domestic landfills of residential area due to their recycling. MATEC Web of Conferences. "International Science Conference SPBWOSCE-2016 "SMART City"." p 07004.

[6] Afonin K V, Zhilina T S, Zagorskaya A A 2017 Processing of waste of residential areas in order to obtain secondary energy and material resources Bulletin of the engineering school of the far Eastern Federal University 4 (33). pp 65-73.

[7] Marakulina S P, Choi V E and Emelyanova D A 2018 The use of the system of internal drainage to remove organic waste from the buildings System technology 27

[8] Chudakova O G, Bloodless D V, Methanetank as a device for obtaining fuel from industrial waste. Bulletin of Kazan technological University 19(18)

[9] SP 32.13330.2012 Sewerage. Pipelines and wastewater treatment plants

[10] Azarov T B, Buslaeva D G, Zagorskaya A A, Zhilina T S, Afonin K V 2017 The Use of biogas for heating residential houses Engineering science in Russia and abroad 2

[11] Skipin L and others 2016 Biogeochemistry of heavy metals in trophic chain in terms of the south of Tumen region Procedia Engineering 165 pp 860-868.

[12] Kalyuzhina E A, Samarskaya N S, 2014 Environmental features of the effects of polygons of solid domestic wastes on the condition of the environment in the regions of their location. Engineering Bulletin of the Don 3

[13] SP 2.1.7.1038-01 "Hygienic requirements to the device and the maintenance of ranges for municipal solid waste" (approved. resolution of the Chief state sanitary doctor of the Russian Federation of may 30, 2001 N 16)

[14] Sharova O A 2014 Influence of solid domestic waste landfill on the state of groundwater (for example, landfill R. P. Krasny Yar, Astrakhan Region) Bulletin of the Tambov University. Series: Natural and Technical Sciences 19 (5)

[15] Ernst Ulrich von Weizsäcker, Anders Wijkman 2018 A Report to the Club of Rome.

[16] Zhukova N S, Samarskaya N S 2014 Environmental and economic peculiarities of the system for hardening waste consumption Engineering Bulletin of the Don 3

[17] Dzhamalova G A 2013 Biotesting of quality of disturbed geotechnogenic ecosystems of the MSW landfill News of the Russian State Pedagogical University A.I. Herzen pp55-62

[18] Bashirov V D and others 2014 Modern technologies for the security and processing of solid domestic wastes News of the Orenburg State Agrarian University pp 77-80.

[19] Baramzin K N and others 2017 Efficiency of modernization of MSW landfills Investment valuation 3(17) pp 9-31.

[20] Mochalova L A 2017 System of handling municipal waste: foreign and domestic experience. News of the Ural State Mining University 3(47) pp 97-101.