A Technology of Wastewater Sludge Treatment

R A Gizatulin[1,a], V V Senkus[2,b], A V Valueva[1,c], A S Baldanova[1,d], I F Borovikov[3]

[1] 652050, Kemerovo region, Yurga, Leningradskaya str.26 Yurga Technological Institute branch of Tomsk Polytechnic University
[2] 654041, Kemerovo region, Novokuznetsk, Kemerovo State University
[3] The Moscow State Technical University of N.E. Bauman, Moscow, 5, 2nd Baumanskaya

[b] email: SenkusVV@suek.ru, [c] email: valueva@tpu.ru, [d] email: ab214286@gmail.ru

Abstract. At many communities, industrial and agricultural enterprises, treatment and recycling of wastewater sludge is an urgent task as the sludge is poured and stored in sludge banks for many years and thus worsens the ecology and living conditions of the region. The article suggests a new technology of wastewater sludge treatment using water-soluble binder and heat treatment in microwave ovens.

Introduction

When urban wastewater is being purified a great amount of sludge is produced (from 0.5 to 1% of the whole amount of wastewater) and stored in sludge banks of wastewater treatment plants.

The wastewater sludge stored in wastewater treatment plants is a complex mixture which consists of biologically harmless substances composed with polluting toxic organic and nonorganic components. Before utilizing wastewater sludge for any purpose it is necessary to treat it.

The purpose of the research

The purpose of the research is determining process parameters to provide effective wastewater treatment and produce a product which is fit for its purpose.

Research methods and material

The research has been carried out in a laboratory of Novokuznetsk Institute (branch) of Kemerovo State University. A press-mould for deliquification has been constructed (Fig.1).

Samples of wastewater sludge with 80% of moisture content were taken at a Novokuznetsk wastewater treatment plant ZAO “Vodokanal” [1].

The following components have been mixed to prepare the bed:

wastewater sludge from Novokuznetsk wastewater treatment plant with 75-80% of moisture content;

sawdust (milled wooden exhaust or straw) which are required to support life and development of sludge strains when the product is moisturized and humus content is increased;

slaked lime for deacidization and elimination of smell;

cellulosic glue used as a bonding.

Table 1 shows percentage content of the bed components.

Table 1 Bed components

Sample №	Content, %			
	Wastewater sludge	Sawdust	Lime	Bonding
1	100	-	-	-
2	95	-	-	5
3	90	5	5	-
4	85	5	5	5
5	80	10	10	-
6	75	10	10	5
7	75	15	10	-
8	70	15	10	5
9	70	20	10	-
10	65	20	10	5
11	65	25	10	-
12	60	25	10	5
13	60	30	10	-
14	55	30	10	5

The stuff was mixed and pressed under 60-100 kg/cm2, the obtained product with moisture content of 10-15% was sterilized by heating it up to 100–200 ° C in microwave ovens during 3-5min which reduced moisture content and incapacitated microbial flora. The end product is packed into waterproof package which provides easy transportation and land application with further dissolution (Fig.1).

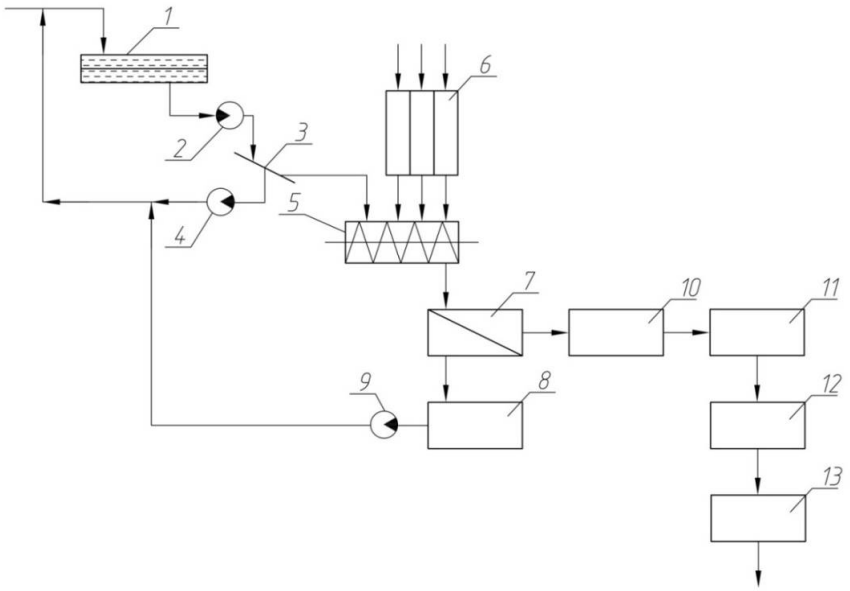

Figure 1. Process diagram of wastewater sludge treatment: 1 – aerotank, 2,4,9, - pumps, 3 – press-filter, 5 – mixing drainage, 7 – roll press, 8 – exhaust water collector, 10 - pressed pellets, 11 – packing machine, 12 – microwave oven, 13 – finished product storage.

Table 2 shows the main characteristics of the end product and the press.

Table 2 The main characteristics of the end product and the press

The main characteristics and dimensions	Values
The product	
Starting material moisture content	76–80 %
Starting material fraction size	up to 1 mm
Pressed pellet shape	round
End product dimensions	22 mm 60 mm
Admitted impurities to the starting material	45 %
Losses, %	до 50 %
Heating time, min	5 min
The press	
Press dimensions -diameter -length	 32 mm 150 mm
Water hole	3 mm
Material	steal

Results and discussion

The end product is shown in Fig.2.

Figure 2. End product

The end product has been tested for strength, moisture resistance, transportation reliability, heavy metals content and coliforms [2].

Samples containing bonding have greater strength than those without bonding. (Fig. 3). Samples 5 and 6 which include 10% sawdust have the greatest strength, sample 6 is stronger due to the bonding.

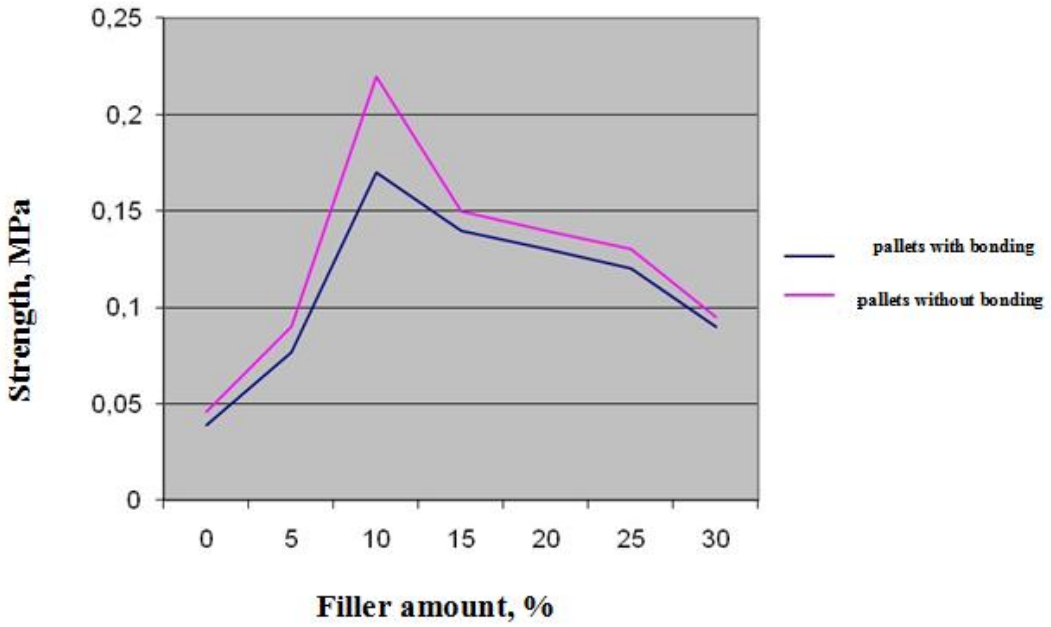

Figure 3. Strength of the end product samples

To test for strength during transportation the samples were loaded into a container and transported down urban and country roads during several hours. Samples № 1, 2, 3, 4, 13, 14 have been damaged and disintegrated. Samples № 5, 6, 7, 8, 9, 10, 11, 12 were not damaged.

To test moisture resistance the samples were dipped into water. After some minutes samples № 1,2 split, the rest of the samples did not change their shape after a month of dipping but they mellowed from a slight mechanical impact [2].

Chemical analysis for heavy metals has been carried out in a Western-Siberian Test Center, OOO "Akvatest" has performed a test for coliforms. The results are shown in Table 3.

Table 3 Chemical composition of wastewater sludge before and after treatment

Substances	Maximum allowable concentration in soil	Wastewater sludge before treatment	Wastewater sludge after treatment
Zink, mg/kg	4000	96.7	93.4
Cadmium, mg/kg	30	0.119	0.09
Lead, mg/kg	1000	11.38	10.2
Copper, mg/kg	1500	4.72	2.9
Mercury, mg/kg	15	0.117	0.08
Arsenic, mg/kg	20	0.41	0.27
Chromium, mg/kg	1200	1.82	0.7
Nickel, mg/kg	400	2.62	2.27
Coliforms in 1 gramm	0	2380000	0

The obtained research results show that adding 10-25% of saw dust or furnace dust into the bed reduces the content of heavy metals to maximum allowable concentration and heat treatment in microwave oven neutralizes bacterial pollution [3-9].

Conclusions

Analysis of the obtained results leads to the following conclusions [3]:

1. The strength of the samples which contain bonding is greater than that of the samples without bonding;
2. Samples with strength less than 0.1MPa are destroyed by transportation and by soaking. Thus the optimal strength of the samples is 0.1Mpa and higher which can be achieved by adding 10-25% of a filler;
3. Tight packing reduces olfaction;
4. Adding saw dust into the bed reduces the content of heavy metals and heat treatment in microwave oven neutralizes bacterial pollution;
5. When using the product as a fertilizer it is recommended to harrow 5-10 days after application or use pallets for winter crops.

References

[1] Potokina M V Wastewater treatment and recycling of sludge and settling J International scientific conference “Sustainable development Rational nature management Health technologies. (2012).
[2] Potokina M V Developing a technology of palletizing of wastewater watered sludge and settling J Modern problems of methodology and innovative activity Conference proceedings GU branch of KuzSU Novokuznetsk (2011).
[3] Potokina M V Senkus V V A method of calculating technology parameters for producing fertilizers from wastewater sludge J AgroEcoInfo 1 (2014).
[4] Galevsky G V, Rudneva V V, Garbuzova A K, Valuev D V, Titanium carbide: nanotechnology, properties, application, J. IOP Conference Series: Materials Science and Engineering 91 (2015)
[5] Il'Yaschenko D P Chinakhov D A Danilov V I Schlyakhova G V Gotovshchik Yu M Physical nature of the processes in forming structures, phase and chemical compositions of medium-carbon steel welds J IOP Conference Series: Materials Science and Engineering 91 (2015)
[6] Valuev D V, Danilov V I,Ivanov Yu F On the causes of formation of non-optimal structures in a pressure-treated low-carbon steel J Russian Physics Journal (2007) 8-12
[7] Kryukov R E, Kozyrev N A, Galevsky G V, Bendre Y V, Goryushkin V F, Valuev D V Some aspects of oxidation-reduction reactions under carbon-bearing flux welding J IOP Conference Series: Materials Science and Engineering. 91 (2015)
[8] Saprykina N A, Saprykin A A, Borovikov I F, Sharkeev Y P Influence of layer-by-layer laser sintering conditions on the quality of sintered surface layer of products IOP Conference Series: Materials Science and Engineering 91 2015
[9] Valuev D V, Danilov V I Reasons for negative formation of structures in carbon steel processing of pressure J Proceedings - 2012 7th International forum on strategic technology, IFOST 2012 2 (2012) 151-154