ISSN 2409-9066. Sci. innov. 2017, 13(4): 46—55 https://doi.org/10.15407/scine13.04.046

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ASH AND ASH-SLAG WASTE AS MULTIFUNCTIONAL RAW MATERIAL

The research deals with developing methods for the efficient use of ash and ash-slag waste, in particular, for fixation of municipal wastes (fresh and digested sludge, redundant or deposited sediments), for obtaining of amorphous high-purity silicon dioxide; and for purification of circulating supernatant water of aeration stations.

Keywords: ash, ash slag, filtration, fixation, sorption, and amorphous silica.

Ash slag waste (ASW) from combustion of solid fuels (coal, combustible shale, peat) at thermal stations are among the most heavy-tonnage industrial waste. Approximately, the thermal power plant (TPP) with a capacity of 1 million kW per day burns 10,000 tons of coal producing about 1,000 tons of slag and ash.

Occupying vast areas, they are a source of environment pollution and hazardous to the human health, flora, and fauna. At the same time, their chemical and mineralogical composition is largely identical to that of natural mineral materials, therefore they can be a promising source of raw materials. For instance, iron content in magnesium concentrate of ash slag is much higher than in the extracted natural ore [1]. This means that one can get thousand tons of iron concentrate for the metallurgical industry, which is much cheaper than ore concentrate. The ash-slag waste is used mainly as additives and fillers in the production of building materials: cement, concrete, mortar, bricks, Portland cement, etc. Magnetite microcells that are part of ash waste are used in the manufacture of dyes; as filler of concretes shielding electromagnetic radiation; in powder metallurgy, etc. [1].

Depending on the size of particles, the ash-slag wastes are divided into the ash and the slag: the waste fractions larger than 0.25 mm are referred to the slags and those less than 0.25 mm are classified as the ash. After the removal of small and light fractions carried out by flue gases on the electric filtrate the so—called fly ash having unique adsorption and astringent properties is formed.

It is clear that the ASW properties depend, to a large extent, on the mineral composition of fuel and the method of its combustion, with the products formed differing significantly in content and ratio of the major components. Results of studying the composition of ashes of various origin have been summarized in [2].

Table 1 shows the chemical composition of various ashes. Table 2 features the content of trace elements in the fly ash of the Trypillia TPP.

It is evident that the ashes from the combustion of various coals differ significantly in the com-

Table 1

Chemical Composition of Various Ash Samples

Description	Content, %			
	Generalized results	Ash from Trypillia TPP*		
SiO_2	37—63	66.3	64.9	65.8
Al_2O_3	9—37	5.3	5.1	5.1
Fe_2O_3	4—17	—	0.2	0.5
TiO_2	—	0.4	0.1	0.15
CaO	1—32	10.7	12.8	10.9
MgO	0.1—5	1.4	1.5	1.4
SO_3	0.05—2.5	2.6	2.2	2.4
$Na_2O + K_2O$	0.5—5	4.8	5.1	5.0
Others	N/A	8.7	8.1	8.75

* Three different samples taken during a month and analyzed by X—ray fluorescent method using EXPERT 3L spectrometer.

Table 2

Microelement Content in Fly Ash of Trypillia TPP

Element	Content (ppm)	Element	Content (ppm)	Element	Content (ppm)	Element	Content (ppm)
Microsphere				Ash magnetic fraction			
Ba	325	Ga	6.5	Ba	710	Ga	18
Be	1.6	Cr	95	Be	7.9	Cr	237
Pb	52	Ni	39	Pb	44	Ni	174
Sn	2.5	Bi	<1.5	Sn	5.9	Bi	< 1.5
Ti	3517	Co	7.2	Ti	5817	Co	60
W	<3	Mo	2.4	W	n/a	Mo	6.7
Mn	73	V	151	Mn	2663	V	187
Nb	17	Cu	95	Nb	23	Cu	145
Zn	54	Sr	200	Zn	162	Sr	n/a
Zr	266	Ge	1.4	Zr	<50	Ge	20
Ag	0.32	Sc	12	Ag	0.03	Sc	36
Cd	<0.5	Au	<10	Cd	<0.05	Au	< 10
Y	10	U	<50	Y	n/a	U	< 50
Yb	1	Li	48	Yb	n/a	Li	58
La	21	As	<50	La	n/a	As	< 50
P	100	Sb	<20	P	300	Sb	< 20
Total: ~5223 ppm = ~0.5 %				Total: ~10856 ppm = ~1 %			

position of their mineral part: the ratio of the major elements — silicon, aluminum, iron, titanium, calcium, magnesium, sodium, and potassium (Table 1). The total content of trace elements in TPP ash exceeds 0.5% for the microsphere and 1% for the magnetic fraction.

The fly ash is more homogeneous in terms of composition and properties as compared with the ash dump, so it is more attractive for concrete production. It is also widely used as additive to reduce the cement consumption and heat release in products for hydraulic structures being a substitute for a part of cement and in the cases when cement consumption is required to be less than the minimum allowable for dense concrete. They apply to the preparation of artificial porous fillers — fly ash aggregate and ash gravel, and as corrective additives that reduce and, in some cases, eliminate the necessity of fuel consumption introduced into furnace charge. At the same time, the ash acts on burning additives due to the presence of coke residues in them as well as reduces clay plasticity, dry and burning shrinkage.

The authors [3, 4] have developed and tested in the laboratory and semi—industrial conditions the principle scheme for processing ash—slag wastes and their complete utilization. It has been showed that processing of 100 thousand tons of waste can generate 10—12 thousand tons of secondary coal, 1.5—2 thousand tons of iron ore concentrate, 20—60 kg of gold, 60—80 thousand tons of construction materials (inert mass).

The key idea of proposal that is fundamentally different from the above ones is described in [5]. There is a system of ash discharge with open lighted water ponds that can contact ground waters above which there are certain emission objects (electrochemical plant mud lakes, petrochemical plant settlers and dumps, other landfills and sludge dumps for different purposes). Each source contributes to pollution of groundwater. The peculiarity of ash dumps is that with respect to external effects they simultaneously act as alkaline, reducing, and sorption barriers. This means that passing through ash—slag layer the groundwater stream is purified from many contaminations with a significant demineralization [5]. Based on over 40—year experience of interaction between the TPP ash discharge and the contaminated transit stream, the authors [5] have concluded that the ash barrier properties are obvious and its specific sorption capacity is enormous. This opens up broad prospects for the use of ash as an adsorbent, especially for toxic wastewater.

The unique fly ash properties have been noted during the study of filtrate (concentrate) utilization at the landfill No. 5 of the of Kyiv Solid Waste Deposit (SWD) and during the purification of both model and real wastewater of various composition and origin. It has been showed that mechanical mixing of ash and, for example, concentrate (a product obtained from filtrate purification by reverse osmosis system) leads to the formation of a solid, almost water—insoluble material. The use of ash as adsorbent enables to provide the following extraction of heavy metals on a model system, % wt: Fe — 97.6; Cu — 98.3; Cr—III — 98.7; Zn — 92.4; Mn — 97.2; and Pb — 96.3. A high level of purification has been reported for real industrial wastewater as well [6, 7].

While studying the feasibility of reagent filtrate purification at the landfill No. 5 of the SWD, a formulation was selected (without purification costs taken into consideration), which has made it possible to precipitate the major part of contaminations. The proposed order of reagent introduction and the optimization of filtrate purification conditions enable the formation of a precipitate that practically remains in a fixed state. This is a very interesting practical result showing the possibility to use fly ash as a binder reagent and to obtain, as a result of wastewater treatment, a sediment with reduced toxicity, which is much more separable from the liquid phase.

Various mechanical techniques are used to intensify dehydration: vacuum filtration, filter press, centrifugation, container dewatering, etc., as well as thermal drying and incineration. It has been found that it is possible to achieve a decrease in volume of sludge from wastewater treatment applying the binding properties of TPP fly ash to water absorption, which significantly accelerates the sedimentation of solid phase with a noticeable decrease in the resulting sludge volume.

Table 3 shows the effect of TPP fly ash on sludge dehydration by vacuum filtration and centrifugation. The addition of ash to wastewater to be treated with reagents leads to a significant increase in dehydration of sludge formed. As a result of sludge

Table 3

Effect of TPP Fly Ash on Sludge Dehydration by Vacuum Filtration and Centrifugation Method

Reagents used for filtrate purification *			Method of sludge dehydration	Moisture content in sludge, %
Lime-stone, g	Aluminum sulfate **, ml	Fly ash, g		
5	25	—	I	64
5	25	—	II	61
5	25	10	I	47
5	25	10	II	54

Note. I — vacuum filtration; II — centrifugation; * — filtrate volume is 500 ml, ** — 5% solution

vacuum filtration (residual vacuum is 0.7 kg/cm^2), moisture content in sludge decreases from 63.7 to 46.6%. A noticeable effect of fly ash is reported for sludge dehydration by centrifugation (5000 rpm), as moisture content drops by 6.9%.

The purpose of this research is to formulate approaches for the rational use of TPP ash waste in wastewater treatment and dehydration of sludge of various nature. In addition, it is a raw material for the production of oxides, in particular, high—purity silicon dioxide.

The unique properties of TPP fly ash underlie numerous technical solutions: additional dehydration of fresh, digested, and residual activated sludge, as well as sludge formed as a result of reagent wastewater treatment; purification of industrial wastewater from heavy metals, organic contaminants and mechanical suspended particles; and production of high—purity amorphous silicon dioxide.

USE OF FLY ASH FOR MUNICIPAL SLUDGE FIXATION (FRESH AND DIGESTED SLUDGE, RESIDUAL SLUDGE)

Fresh and digested sludge of municipal wastewater at a humidity of 90% is a liquid mass; at a humidity of 86—90% it has a density of sour cream; at a humidity of 82—86% it is similar to liquid marsh, and at 82% and below, it looks like a slightly wet soil. Residual activated sludge at a humidity of 88—91% resembles sour cream and at 85—87% and below, it is similar to wet soil. The element composition of dry matter of fresh and activated sludge varies widely (Table 4).

The fresh sludge is a gray or light brown gelatinous suspension; the decaying sludge is dark gray or black, with an average humidity of 93.8—95% after settling in the primary clarifiers. The moisture content in fermented sludge in digesters, which are more homogeneous in structure, makes up 97%, in two-stage digesters, 93% in humus tanks, and 95—98% in aerobic compacting stabilizers. The activated sludge is a suspension containing amorphous flakes that include aerobic bacteria and protozoa microorganisms with fine and adsorbed contaminants. When stored and compacted, it decays quickly. The moisture content in activated sludge discharged from secondary clarifiers after aero-tanks is 99.2—99.7%, and after the bio-filters — 96.0—96.5%. After compaction in vertical-type devices, the moisture content of activated sludge is 99.2—99.7%, and in the case of the radial-type devices it is 97% [8].

Table 5 shows the effect of reagents of various nature on fresh sludge filtration at BAS. For the study, 500 ml of fresh sludge was taken with a moisture content of 98.7%. *Praestol 859BS* flocculant was prepared as 0.25% aqueous solution, and iron-titanium coagulant — as 20% solution and used at doses of 1:100 and 1:50, respectively. The most effective was the iron-titanium coagulant that removed 61.9% of moisture from the fresh sludge that is a system where it is difficult to separate water from the solid phase.

Table 4

Element Composition of Dry Matter of Fresh and Activated Sludge

Element	% of sludge dry matter	
	Fresh sludge	Activated sludge
C	35—88	44—76
H	5—9	5—8
S	0—3	1—3
N	2—8	3—10
O	8—35	13—43

Table 6 shows the impact of TPP fly ash on fresh sludge dehydration by centrifugation: in all cases, TPP fly ash presence provides an additional reduction of the moisture content by 3%, on average. This is a very significant decrease if extrapolated to huge volumes discharged into the sludge drying beds every day. At the same time, a growth in mineral component due to the added ash is negligible and, according to laboratory data, is 1—2%.

Table 5

Effect of Reagents of Various Nature on BAS Fresh Sludge Filtration

Reagent	Volume of water loss, ml		Filtration, %
	0.5 hours	1.0 hours	
Fresh sludge	17	38	8
Praestol 859BS flocculant	82	140	28
Iron-titanium coagulant	261	310	62
Sibfloc type coagulant (based on polyethylene oxide)	34	70	14
Sizol—2500 coagulant and flocculant	57	95	19

Table 6

TPP Fly Ash Effect on Fresh Sludge Dehydration by Centrifugation

Reagents used for fresh sludge treatment*	Dehydration conditions	Moisture content in sludge, %
Praestol 859BS flocculant	No ash	71
	5 g ash	68
	10 g ash	67
Iron-titanium coagulant	No ash	62
	5 g ash	60
	10 g ash	58
Sibfloc type coagulant (based on polyethylene oxide)	No ash	85
	5 g ash	83
	10 g ash	81
Sizol—2500 coagulant and flocculant	No ash	80
	5 g ash	78
	10 g ash	76

* in all cases, 5 g limestone was added to 500 ml fresh sludge with a moisture content of 99%. The ready samples were centrifuged at 5000 rpm for 10 min.

The use of TPP fly ash has been found to be effective for dehydrating fermented and residual activated sludge. The use of the reagent method for digested sludge, either separately or in combination with the TPP fly ash also has a positive effect, although it is not so noticeable as for the fresh sludge (Table 7).

USE OF FLY ASH FOR DEPOSITED SLUDGE FIXATION

Today, the main way of handling sewage sludge is its deposition on sludge beds. Although many studies have dealt with the problem of sludge treatment, the situation in this sphere is close to disaster. The Bortnychi Aeration Station (BAS) is one of the classic examples of condition typical for the vast majority of treatment facilities. Every day, about 900 thousand m^3 wastewater containing about 12,000 tons of sludge with a moisture content of 98%, which eventually falls on the sludge bed arrives in BAS. The total area of such beds is 272 hectares. Actually, they have been already full, so the term of their operation is prolonged by building up limiting dams, which, of course, cannot last forever. One of the options for delaying

Table 7

TPP Fly Ash Effect on Digested Sludge Dehydration by Centrifugation

Reagents used for fresh sludge treatment*	Dehydration conditions	Moisture content in sludge, %
Praestol 859BS flocculant	No ash	65
	5 g ash	65
	10 g ash	64
Iron-titanium coagulant	No ash	60
	5 g ash	60
	10 g ash	59
Sibfloc type coagulant (based on polyethylene oxide)	No ash	85
	5 g ash	84
	10 g ash	84
Sizol—2500 coagulant and flocculant	No ash	78
	5 g ash	77
	10 g ash	77

* The study was carried out on 500 ml digested sludge with a moisture content of 95%

the existing threat of barrier dam failure can be to fix the deposited sludge.

In order to check the effectiveness of ash as mineral binder for fixing the BAS sludge, magnesium cement was used. The compressive strength of manufactured samples reaches 200—210 kg/cm^2 in two days after keeping them at ambient temperature.

The sample moisture resistance was estimated by changing the specific electrical conductivity of eluates obtained after keeping the samples during a fixed time under a layer of distilled water (Table 8). Having analyzed the results, one can state that the samples have a fairly high water resistance, at least, for the three months of observation.

The next option foresees the use of deposited sludge with a moisture content of 96% taken from a depth of 1 m, and Trypillia TPP fly ash. Various ash-sludge ratios, order of their mixing, and holding period of ready mixture have been studied. Table 8 shows the moisture resistance of samples obtained under optimal conditions with the use of fly ash from the Trypillia TPP. Evidently, this characteristic is as good as the one of samples obtained with the use of magnesium cement at a significantly higher cost of abrasive reagents.

Thus, the ash waste and, primarily, the fly ash obtained at the TPP, should be considered as raw materials, in particular, binders or sorbents that can be useful for addressing many practical problems, not as man-made waste.

A cycle of research on phenolic plant wastewater treatment has been carried out. This wastewater is considered as alternative source of water supply for the renewal of the cooling cycle and the water treatment for the heat-and-power unit. Immediately before adsorption purification, wastewater was treated with a 6.5% solution of *Sizol* type coagulant flocculant, at a dose of 3 ml of reagent per 1 liter of effluents. The model solution containing 30 mg/l phenol was pretreated in the same way. The resulting precipitate was filtered out; 1 g adsorbent was placed in a flask containing effluents with purified from mechanical admixtures (250 ml). The flasks were continuously shaken for a period from 10 to 120 minutes. After adsorbent separation, the water was analyzed for phenol content by the method [9]. The results obtained on the model solution are showed in Fig. 1. In the case of phenolic plant wastewater, the amount of residual phenol in purified water was estimated after each experiment (Table 9).

Fig. 1 shows that for all adsorbent samples, in the first 20—40 minutes, the phenol adsorption rate is high and further decreases as time of their contact with effluents increases. The highest ini-

Table 8

Moisture Resistance of the Sample Obtained Using Magnesium Cement (sludge:cement = 1:4) and Trypillia TPP Fly Ash (sludge:ash = 1:4)

Holding period		Specific electric conductivity, Ohm • sm^{-1} (10^{-6})	
Magnesium cement	Fly ash	Magnesium cement	Fly ash
1 week	1 week	3.47	17.35
2 weeks	2 weeks	14.82	17.98
1 month	1 month	13.70	18.22
2 months	2 months	14.70	22.80
3 months	3 months	35.46	23.19
Distilled water		1.46	
Municipal water		38.00	

Table 9

Industrial Wastewater Purification from Phenol Using Various Sorbents

Contact time, min	Residual phenol content, mg/l		
	BAC	Sample 4	Sample 3
	Phenol content 1 mg/l		
10	0.11	0.24	0.36
20	0.05	0.19	0.28
30	0.03	0.17	0.23
40	0.03	0.15	0.19
50	0.03	0.15	0.16
60	0.03	0.15	0.16
70	0.03	0.15	0.16
Phenol removal, %	97	85	84

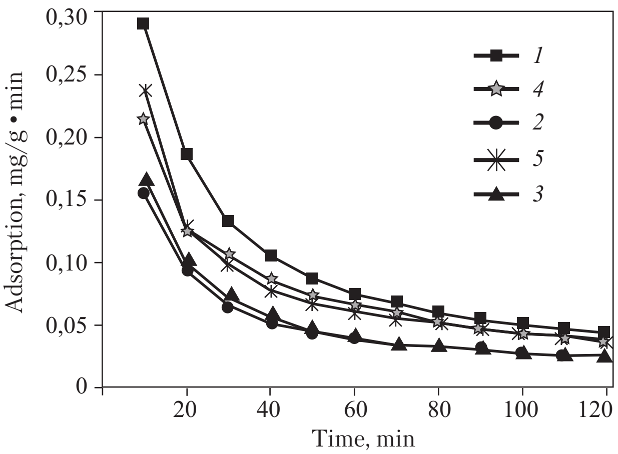

Fig. 1. Kinetics of phenol adsorption by various adsorbents: 1 — BAC GOST 6217—74; 2 — Trypillia TPP ash after electric filters (hereinafter — the ash), 3 — Trypillia TPP ash slag, 4 — mechanical mix: BAC-type activated charcoal (50%) + Trypillia TPP ash slag (50%), 5 — mechanical mix: BAC-type activated charcoal (50%) + ash (50%)

tial adsorption rate is reported for birch activated charcoal (BAC); it is slightly lower for the samples 4 and 5 and much lower for the samples 2 and 3. Further, this difference is leveled and, for example, for two-hour contact, the phenol adsorption rate is almost the same for all samples.

In the case of industrial wastewater containing 1 mg/l phenol, the best purification is also reported for activated charcoal (Table 9), although for the samples 4 and 5 a rather high phenol removal of 84 and 85%, respectively is reached. It should be noted that the purification intensity on the sample 4 is slightly higher. In general, it can be stated that the mixed samples (4 and 5) are slightly inferior to the BAC type activated charcoal. However, given the fact that 50% of their composition is industrial waste, such materials have significant price advantages and can be used for industrial wastewater dephenolization.

The problem of wastewater purification from heavy metals is of great importance. The main methods used for solving this problem are mainly: sedimentation, extraction, distillation, and ion exchange. These methods are usually multi-stage, costly and require bulky equipment.

The sorption-based purification methods could take a prominent position if cheap and effective adsorbents based on available minerals and renewable organic raw materials of plant origin are used. Given their significant efficiency, it would mean a near prospect of creating high-performance technologies for wastewater purification from heavy metals. This is especially true for enterprises of ferrous and non-ferrous metallurgy, mining and chemical industry, which are main generators of environment pollutants.

The efficiency of Trypillya TPP fly ash for the removal of heavy metals has been pre-estimated. Wastewater of *Azot* Association (Severodonetsk), decomposition product of the organic part of solid municipal waste i.e. filtrate (landfill 5, Kyiv), as well as model solutions were used as research objects.

Sorption ability of fly ash was estimated by the static method: 10 g sorbent was put in 100 ml of a corresponding solution with known metal content. Having been slightly uninterruptedly stirred up for 1 hour, the solution was separated from fly ash and the equilibrium concentration of each metal was measured.

The results in Table 10 show a high efficiency of fly ash for waste purification from heavy metals.

OBTAINING OF AMORPHOUS HIGH-PURITY SILICON DIOXIDE FROM TPP ASH WASTE

For the separation of silicon dioxide from waste, fluoride technology is used. It enables returning the initial reactants to the process cycle, which makes it environmentally friendly and efficient. NH_4F a waste of fluoride production, including that of aluminum and plastics is taken as fluoridating agent. Under normal conditions, ammonium fluoride is a non-aggressive, solid, crystalline substance. Molten ammonia fluoride is a more energetic fluorine reagent as compared with gaseous fluoride.

As a result of the interaction of ammonium fluoride with silicon oxide, ammonium hexafluorosilicate is formed. When dissolved in ammonia, it forms silicon dioxide:

$$SiO_2 + 6NH_4F \rightarrow (NH_4)_2SiF_6 + 4NH_3 + 2H_2O,$$

$$(NH_4)_2SiF_6 + 4NH_4OH \rightarrow SiO_2 + 6NH_4F + 2H_2O.$$

There is quite a lot of data on the use of fluoride technology for the production of silicon dioxide from silicon-containing raw materials. Having analyzed them in detail, some contradictions and false or misleading information (for example, regarding the stability of equipment's nickel coating in ammonium fluoride) have been identified. To understand the real situation, systematic studies have been carried out. They have finally outlined the following main stages of the optimized process: milling of initial siliceous material, drying and magnetic separation (if necessary); preparation of fluoride ammonium-siliceous material mix and its feed to the fluoridation stage; fluoridation; pyrohydrolysis; sublimation; obtaining of amorphous silica; centrifugation of the mix formed at the previous stage; ultrasonic washing of centrifuged mass; repeated centrifugation; drying of the final product; packing of the final product or its feed to the polycrystalline silicon production line. The optimal conditions for each of the identified stages have been selected. This has enabled to arrive at a sound technical solution, to obtain amorphous silicon dioxide with a purity of 99.995—99.999%, to work out the input data for the design and design documentation, and to start the construction of a pilot plant for the production of high-purity amorphous silica with a capacity of 15 kg /h.

PURIFICATION OF RETURN SUPERNATANT WATER (BAS CASE STUDY)

One of the BAS unresolved problems is the problem of so-called supernatant water that returns from sludge beds to the initial stages of purification. Wastewater sludge is supplied to the sludge beds, where it is partially dehydrated forming a supernatant water that enters the special canal through the drainage system and is pumped to the station. However, the sludge beds being extremely overflowed, the drainage system practically does not work and, as a result, very contaminated supernatant water returns to the technological process with a COD of 10—20 × 10^3 mg O_2/dm^3, whereas the input wastewater has a COD less than 1000 O_2/dm^3. Of course, this has a very negative effect on the biological wastewater treatment and leads to the fact that a considerable part of the station's potential is used to remedy the situation. One of the proposed options that can be an effective technological solution to the problem of supernatant water is to place with the territory of sludge bed pumping station an analogue of a filtration unit tested at BAS under various weather conditions (its operation has been described in detail in [10, 11]). The supernatant water entering the pumping station passes through the filtration plant and, having been purified, is fed to the BAS initial stages of the technological process. The pretests on the purification of supernatant water at the pilot plant have showed the following results: COD is 300—350 mg O_2/dm^3,

Table 10

Model Solution and Wastewater Purification from Heavy Metals Using Trypillia TPP Fly Ash

Metals	Metal content in solution before purification, mg/l	Metal content in solution after purification, mg/l	Purification factor, %
Model solutions			
Iron	10	0.24	97.6
Chromium (III)	10	0.13	98.7
Copper	10	0.17	98.3
Lead	10	0.37	96.3
Manganese	10	0.28	97.2
Zinc	10	0.76	92.4
Azot Association (Severodonetsk) wastwater			
Copper	17.5	0.47	97.3
Iron	0.25	0.009	96.4
Vanadium	1.2	n/a	—
Filtrate, landfill 5			
Iron	136.0	1.1	99.2
Chromium (III)	0.2	0.003	98.5
Copper	1.42	0.004	99.7
Lead	0.29	0.283	97.6
Manganese	4.83	0.05	99.0
Zinc	12.1	0.17	98.6

suspended matter is 70—100 mg/dm^3, and dry residue is 500—1000 mg/dm^3.

Another possible option is to place supernatant water purification plant in the BAS territory at the point of its arrival from the sludge beds.

The proposed filtration method has several advantages: it is financially rewarding; the filtration effectiveness is determined by the properties of geotextile that is the plant working body; the system operates in a round-the-clock mode and is serviced by one operator.

The other technological solution is based on unique property of TPP fly ash and ash slag as adsorption barrier. In addition to the adsorption of heavy metals, this ash-slag barrier has been found to effectively hold back organic contamination and suspended mechanical particles. The supernatant water (COD 16570 mg O_2/dm^3 and suspended particles 9,500 mg/dm^3) having passed through a layer of ash slag with 1—2 mm aggregates, COD and the suspended particles decrease down to 920 mg O_2/dm^3 and 156 mg/dm^3, respectively. It should be noted that 200 dm^3 supernatant water was treated using 10 dm^3 sorbent without apparent loss of effectiveness.

CONCLUSIONS

Thus, the above results have showed the following. Ash waste of coal TPPs should not be classified as man-made waste, since they have strong binding, sorption and plastic properties and can be used as good raw material for obtaining various materials and, in particular, amorphous silica. The TPP fly ash contributes to the additional dehydration of fresh and fermented sludge, as well as of residual activated sludge. A significant increase in dehydration of formed sludge is reported also for reagent wastewater purification, provided fly ash is added in the course of purification.

By the example of model systems and real industrial effluents, fly ash has been showed to be effective for purification from heavy metals. The ability of ash-slag barrier to effectively prevent organic pollution and hold back mechanical suspended particles has been established, which opens the way for the creation of technology for deep purification of supernatant water at BAS. To solve this problem, one more method, filtering through geotextile, has been proposed. The proposed filtration method has several advantages: it is financially rewarding; the filtration effectiveness is determined by the properties of geotextile that is the plant working body; the system operates in a round-the-clock mode and is serviced by one operator.

A technical solution for obtaining amorphous silicon dioxide from the TPP ash residues has been developed and the product with a purity of 99.995—99.999% has been obtained. The input data for the design and design documentation has been worked out and the construction of a pilot plant for the production of high-purity amorphous silica with a capacity of 15 kg/h has started. The proposed approaches are exclusive, and the obtained results enable to solve specific practical tasks.

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Recieved 20.12.16

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ЗОЛЬНІ ТА ЗОЛОШЛАКОВІ ВІДХОДИ ЯК БАГАТОФУНКЦІОНАЛЬНА СИРОВИНА

Роботу присвячено розробці способів ефективного використання потенціалу зольних і золошлакових відходів, зокрема для фіксації комунальних осадів (сирі та зброджені осади, надлишкові мули, депоновані осади), для одержання аморфного високочистого діоксиду кремнію та для очищення зворотної надмулової води станцій аерації.

Ключові слова: зола, золошлак, водовіддача, фіксація, сорбція, аморфний кремнезем.

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ЗОЛОВЫЕ И ЗОЛОШЛАКОВЫЕ ОТХОДЫ КАК МНОГОФУНКЦИОНАЛЬНОЕ СЫРЬЕ

Работа посвящена разработке способов эффективного использования потенциала золовых и золошлаковых отходов, в частности для фиксации коммунальных осадков (сырые и сброженные осадки, избыточный ил, депонированные осадки), для получения аморфного высокочистого диоксида кремния и для очистки оборотной надиловой воды станций аэрации.

Ключевые слова: зола, золошлак, водоотдача, фиксация, сорбция, аморфный кремнезем.