

UDC 504.064.47:621.357.7

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INVENTORY OF GALVANIC SLUDGE AND DEPOSITS OF THE TREATMENT FACILITIES FORMED AT THE ENTERPRISES OF THE REPUBLIC OF BELARUS

The article presents the results of inventory of galvanic sludge and deposits of the treatment facilities, formed at the enterprises of The Republic of Belarus. The analysis of the presented information has revealed that, despite an existing system of the account of wastes, formed at the enterprises, there is a discrepancy of the declared kind of waste and the actually stored one at the industrial object's territory. It is connected, first of all, with the long period of accumulation and storage of wastes of galvanic manufacture, during which there occurred a work reprofiling at the enterprise, a change of technological processes of galvanic manufacture, a change of the proprietor, a loss of documents and etc. Besides, while storing of sludge and deposits of galvanic manufacture sewage, there often occurs their predrying that changes mass of a waste. Such state of affairs causes the necessity of detailed inventory of the accumulated wastes, more precise definition of its structure and quantity.

Introduction. The largest enterprises in machinery, instrumentation, metallurgy of Belarus use processes of metal plating and surface treatment to give it all the necessary properties. Electrochemical (galvanic) coating method is the most widespread, and it is used for metal plating as well as for oxide films at the time of anodic treatment of products.

Comparing with others, this way is the most perfect. Its main advantage is the ability to receive coatings with the desired thickness – from a few to tens and even hundreds of micrometers.

In the processes of surface treatment various reagents, containing heavy metals are used to make it corrosion resistant and to add it decorative properties. They are the components of the by-products of this production, namely solid and liquid wastes, sewage, air emissions.

As a result, companies consisting of functioning galvanic parts are the main sources of entry of toxic heavy metals in the environment. Set standards of permissible concentrations of heavy metal ions for sewage, led into sewerage system, often are not performed, making work of city treatment facilities more difficult. During treatment sewage at the local treatment facilities, there form sediments that represent wastes of the third and fourth classes of risk.

In the process of using of technological solutions sludge are formed which are not used and stored at the sites of enterprise. For exceeding of the established standards of permissible concentrations and storage of sludge at their sites enterprises spend sizeable means on charges which are transferred to the cost price of production.

In Belarus, the assessment of galvanic production from the position of its impact on the envi-

ronment wasn't undertaken. Betterment works of the technology and equipment of sewage treatment of galvanic manufacture are not coordinated at republic level that leads to the using in practice of outdated technologies and equipment, unreasonable waste of means.

Main part. The basis for task-oriented work on solution to the problem of galvanic production waste at republic level is reliable information on their quantitative and qualitative composition, so we have made inventory work of galvanic sludge and sludge of treatment facilities, stored at sites of enterprises of the Republic of Belarus.

When working we have used information contained in the accounts of enterprises, scientific and technical information. Carried-out data analysis of statistical reports of industrial enterprises [1, 2] has shown that in 2010 6.8 thousand tons of galvanic wastes were formed at the 142 enterprises (in comparison with 5.9 thousand tons per 145 enterprises in 2009). Over the last year due to changes in production activity at the 45 Belarusian enterprises wastes of galvanic production were not formed. 42 enterprises are still storing wastes, accumulated earlier. Thus, despite the fact that the quantity of enterprises where galvanic wastes were formed, had decreased, the total amount of wastes increased by 15% due to an increase of production capacity. The dynamics of the generation, use and disposal of wastes at the enterprises of the Republic of Belarus in 2009 and 2010 is presented in Table 1.

According to data for 2010 the largest number of galvanic wastes (74.98%) was formed in the Gomel region. Significant amount of wastes was formed in the city of Minsk (20.48%). The least amount of waste was generated in Grodno (0.40%) and Mogilev regions (0.99%).

Table 1

**The dynamics of the formation, using and disposal of wastes
at the enterprises of the Republic of Belarus in 2009 and 2010 years, t [1, 2]**

Region	Quantity of forming wastes		Used, transferred, realized wastes		Quantity of removed wastes		Presence of wastes at the end of the year	
	2009 y.	2010 y.	2009 y.	2010 y.	2009 y.	2010 y.	2009 y.	2010 y.
Brest region	94.33	83.27	38.40	21.30	67.73	64.73	402.22	401.34
Vitebsk region	39.17	38.62	0.00	0.18	39.17	71.84	485.20	505.52
Grodno region	21.84	27.23	8.42	16.99	13.84	14.04	286.58	316.64
Gomel region	4,401.23	5,070.26	3,421.13	3,401.40	1,116.50	1,885.36	1,361.35	2,772.54
Minsk region	103.76	90.18	45.70	76.18	59.05	46.44	604.43	606.03
Minsk	1,218.56	1,385.03	300.58	385.99	927.70	1,109.31	1,787.54	1,064.98
Mogilev region	45.83	67.26	15.80	15.00	55.74	55.76	72.22	79.14
The Republic of Belarus	5,924.71	6,761.85	3,830.04	3,917.04	2,279.73	3,247.48	4,999.53	5,746.19

The number of used, transferred, realized wastes of galvanic production increased by 2% in 2010 in comparison with 2009. Meanwhile 87% of all used, transferred and realized wastes in 2010 falls on Gomel region. In Brest, Mogilev and Gomel regions there was a decrease of using of wastes in 2010 in comparison with 2009. The number of used, transferred, realized wastes of galvanic manufacture for Brest region in 2010 in comparison with 2009 decreased by 45%, for the Mogilev region – by 5% for the Gomel region – by 1%. The essential increase in the number of using wastes in 2010 in comparison with the previous year took place in Grodno (in 2 times), in Minsk region (in 1.7 times), in Minsk (in 1.3 times).

Amount of waste, disposed from the territories of enterprises to waste storing place in 2010, increased by 42% as compared with 2009. According to the data of 2010 year the largest number of removed wastes falls on the Gomel region (58% of total wastes) and the city Minsk (34%). For the rest regions of the Republic of Belarus quantity of removed wastes amounts 1–2%.

The amount of waste, storing at the territories of enterprises, at the beginning of 2010 year is by 17% more than at the beginning of 2009, while at the end of 2010 year it is more by 15% than at the end of 2009 year.

It is established that in the Gomel region this figure on 2010.01.01 increased in 2.5 times as compared to 2009.01.01, and it decreased in 1.5 times in Minsk. For 2010.12.31 as compared to 2009.12.31 these figures were 2 and 1.7 times accordingly. In general, there is a steady growth of galvanic manufacture wastes, storing at the enterprise area. In the period from 2009.01.01 to 2010.12.31 (2 years) the overall increase of galvanic wastes, storing at the industrial sites, amounted 1,440.91 t.

According to “The Classifier of wastes produced in the Republic of Belarus” all wastes of the galvanic production can be divided into galvanic sludge and sewage deposits [3]. As shown in figure, there are only 22 items of sludge and 7 names of sediments.

Table 2 presents information about the accumulated and generated waste at the enterprises in Belarus.

The data in the Table 2 show that a large part of waste refers to galvanic sludge – 19 names, while only 5 refer to sediments. Most often at the enterprises the following wastes were formed:

- in 2009 – a mixture of galvanic sludge (at 19 enterprises, 0.37% of the total amount of galvanic production waste) and deposits of the treatment facilities (at 73 enterprises, 75% of total number of waste);

- in 2010 – zinc-containing sludge (at 21 enterprises, 0.03% of the total amount of all waste of galvanic production) and deposits of the treatment facilities of galvanic production (at 78 enterprises, 33% of total amount of waste).

Quantitative characteristics of sewage wastes of galvanic industry, formed in the Republic of Belarus, according to data in 2009 and 2010 years, is presented in Table 3.

From the Table 3 we can see that in 2010 the largest amount of sediments of treatment facilities of galvanic industry – 2,213.65 t (48% of total amount of sewage sludge) was formed. There is also a significant proportion of the dewatered sediment of the treatment facilities of galvanic production (1,010.31 t, or 22%). The quantity of formed sediments in sedimentations after reagent treatment and those of sediments from sedimentations of electro-coagulation treatment is approximately 13% of the total amount of sewage sludge and was respectively 578.64 and 571.01 t.

Table 2

**Classification of galvanic production wastes, accumulated
and produced in the Republic of Belarus in 2009 and 2010 years**

Code of waste	Name of waste	Class of risk	Number of enterprises, where waste is formed or stored	
			2009 y.	2010 y.
Galvanic sludge				
5110700	Nickel-containing	1	17	16
5110100	Cyanide-containing	1	1	3
5110600	Cadmium- containing	1	1	1
5110400	Copper-containing	2	6	5
5110500	Zinc-containing	3	18	21
5111702	Oxidation	3	8	11
5110200	Containing hexavalent chromium	3	13	11
5110300	Containing trivalent chromium	3	7	8
5110900	Containing salts of heavy metals	3	10	7
5111300	Containing metal hydroxides	3	9	7
5111600	Iron-containing	3	6	5
5110501	Zinc-containing from the process of zinc plating in ammine electrolyte	3	2	4
5111200	Containing tin and copper	3	4	4
5111500	Containing aluminum hydroxide	3	3	4
5112300	A mixture of galvanic sludge	Undefined	19	17
5111703	Degreasing baths	Undefined	3	5
5112900	Other galvanic sludges	Undefined	6	5
5111400	Containing hydroxides of lead, nickel and cadmium	Undefined	2	1
5111100	Containing lead and tin	Undefined	1	1
Deposits of galvanic production sewage				
5112000	Treatment facilities of galvanic production	3	73	78
5112100	Dewatered deposit of treatment facilities of galvanic production	3	22	25
5111900	From sedimentation after reagent treatment	3	18	15
5111800	From sedimentation of electro-coagulation treatment	3	11	11
5112101	Dewatered sediment of treatment facilities of galvanic production, mixed with sawdust	Undefined	4	5

Table 4 shows the characteristics of galvanic sludge, formed in the Republic of Belarus. Galvanic sludge is seen to have a wide range of quantity of generated wastes. A sludge mixture (2,135.06 t, or 97% of the total amount of galvanic sludge) was generated in the largest quantities.

Sludge, containing lead and tin were formed in the least quantity (0.01 t, or less than 1%). It should be also noted that in 2010 cadmium-containing sludge was not formed at the industrial enterprises (only one enterprise in the Republic of Belarus) accumulated 0.35 t of such sludge).

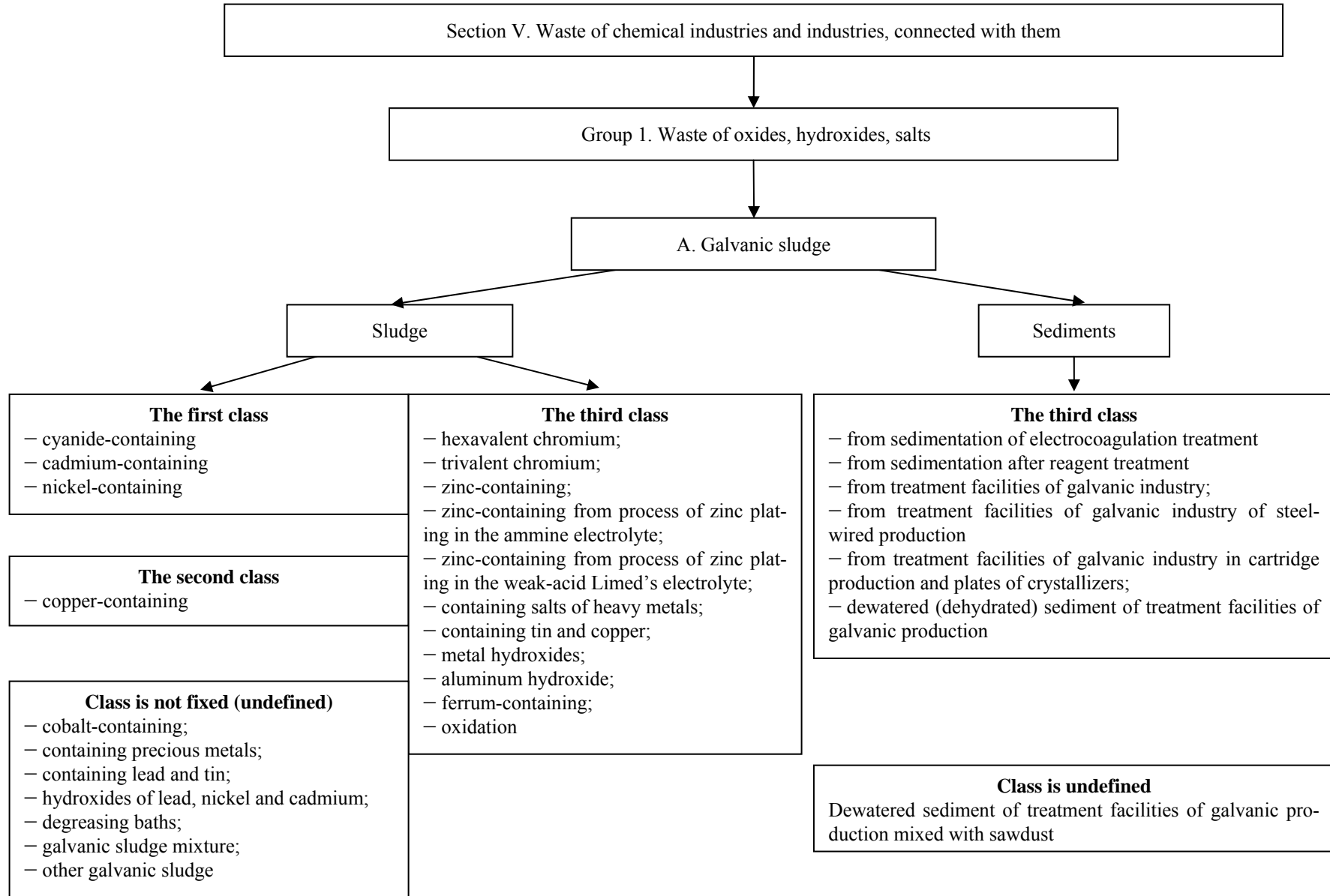


Fig. 1. Classification of waste formed in the Republic of Belarus

Table 3
Amount of sewage wastes of galvanic industry,
formed in the Republic of Belarus

Name of waste	2009 y.	2010 y.
Sediment from sedimentation after reagent treatment	427.65	578.64
Dewatered sediment of treatment facilities of galvanic production	187.71	1,010.31
Sediment of treatment facilities of galvanic production	4,448.07	2,213.65
Sediment from sedimentation of electrocoagulation treatment	531.28	571.01
Dewatered sediment of treatment facilities of galvanic production, mixed with sawdust	43.0	184.47

Table 4
Amount of galvanic sludge, which is generated
in the Republic of Belarus

Name of waste	2009 y.	2010 y.
Degreasing baths	0.67	1,18
oxidation	16.12	3.04
The mixture of sludge	22.12	2,135.06
Containing lead and tin	0.02	0.01
Nickel-containing	1.31	1.9
Zinc-containing	159.27	2.35
Containing hexavalent chromium	0.89	2.37
Chromium trivalent chromium	5.8	3.79
Containing salts of heavy metals	4.44	1.1
Containing metal hydroxides	9.88	8.06
Containing tin and copper	0.44	0.11
Containing hydroxides of lead, nickel and cadmium	2.1	0.66
Ferrum (Iron)-containing	25.13	26.21
Zinc-containing (ammine electrolyte)	0.03	0.56
Containing aluminum hydroxide	0.79	1.67
Other sludge	36.26	16.01
Copper-containing	1.79	0.28
Cyanide-containing	0	1.42

In 2010 wastes of the third class of danger, in the total number of formed wastes, amounted 65.4%. Significant proportion was composed by wastes of undefined (not fixed) danger class. The share of first-class danger wastes (nickel- and zinc-containing sludge) is 3.32 t, or 0.05% of the total waste mass. Only copper-containing sludge is the second class of danger wastes which was generated in the amount of 0.28 t, accounting 0.004% of the total number. Wastes of the third class of danger (14 items in number of 4,423 t) are sediments, formed at the local treatment facilities, and sludge, containing heavy metals. In the group of wastes with undefined class of danger one may include 6 items. These wastes contain lead, nickel, cadmium, tin, etc. Their number amounted 2,338 t (34.6%) according to data for 2010.

The level of using of galvanic production wastes is low, and their main mass is stored at the enterprises sites in metal containers, airtight vessels, sedimentations, sludge accumulators or at least – at the locations out of the enterprises. Although the volume of formed galvanic industry wastes at many enterprises doesn't exceed 10 t/year these enterprises have to keep them in their territory for many years due to the absence of systems for their neutralization.

The enterprises of Brest region have 4 objects (tank, vessel, container or the ground) for storage and disposal of their own wastes. Gomel region has 2 objects, Minsk region has 5 objects, Mogilev region has 1 and there is 1 object in the city of Minsk:

- 1) Brest region: storage of
 - the reservoir for galvanic production wastes – PLC “Hydroselmash”;
 - container for storage of wastes of galvanic production – UE “Baranovichi Branch of the Belarusian Railways”, locomotive depot Baranovichi;
 - an area for storing of galvanic wastes – RPUE “Agropromstroy mash”;
 - storage of galvanic sludge and sediments after treatment – RPUE “Torg mash”;
- 2) Gomel region:
 - an area for storing of galvanic sludge – RUE “Gomel car-repair plant, named after M. I. Kalinin”;
 - an area for storing of sediments of galvanic liquid-waste drains – RUE “Gomel Plant of trade machine-building”;
- 3) Minsk region:
 - the reservoir for storage of sediments of galvanic production – PLC “Loshnitsky plant “Agromash”;
 - the reservoir with a solution of trivalent chromium – PLC “Loshnitsky plant “Agromash”;
 - a platform for storing of treated galvanic solutions – PLC “Borisov plant of medicines”;
 - galvanic wastes repository – RUE “140 Repair Plant”;
 - an area for storing sludge of degreasing baths – LLC “BELHOL”;
- 4) Minsk:
 - an area for storing of sludge of galvanic production – RUE “MTW”;
- 5) Mogilev region:
 - sludge collector for storing of galvanic sludge, containing trivalent chromium – “Mogilevkhimvolokno” [4].

In 2010 57.9% of total number of formed galvanic wastes were used, transferred or sold (in 2009 – 64.7%). Table 5 illustrates that in 2010 the sediment of treatment facilities of galvanic production and sludge, containing tin and copper, were used, transferred and sold in the amount exceeding their annual formation. It means that some part of wastes accumulated over the last years was reused. Sludge containing lead and tin was fully used, transferred and realized [4].

Table 5

The amount of used wastes

Name of waste	Was used, transferred, realized			
	2009 y.		2010 y.	
	t	% of generated amount	t	% of generated amount
Sediment from sedimentation after reagent treatment	–	–	4	0.7
Dewatered sediment of treatment facilities of galvanic production	125.7	67.0	154.26	15.3
Sediment of treatment facilities of galvanic production	3,655.36	82.2	2,271.49	102.6
Sediment from sedimentation of electrocoagulation treatment	40.9	7.7	13.3	2.3
Mixture of galvanic sludge	2.6	11.8	1,452.41	68.0
Sludge containing lead and tin	0	0	0.01	100.0
Zinc-containing sludge	0	0	0.16	6.8
Sludge containing tin and copper	0	0	0.18	163.6
Sludge containing hydroxides of lead, nickel and cadmium	2.1	100	0.54	81.8
Dewatered sediment of treatment facilities of galvanic production, mixed with sawdust	–	–	20.5	11.1
Copper-containing sludge	–	–	0.19	67.9
Sludge, containing salt of heavy metals	3.15	70.9	–	–
Sludge of hydroxides of metal	0.2	2.0	–	–

Table 6

The list of objects using galvanic industry wastes

Code of waste	Name of waste	Name of facility
5111800	Sediment from sedimentation of electrocoagulation treatment	Manufacture plot of mineral supplements (additives), PPC “Katpromstroy”, Kokhanovo, Vitebsk region
5111900	Sediment from sedimentation after reagent treatment	
5112000	Sediment of treatment facilities of galvanic production	Claydite shop, Petrikov expanded clay plant PC “Gomel DSK”, Gomel [5]
		Recycling of sewage wastes of treatment facilities of galvanic production, RUE “Minsk Tractor Works”, Minsk
		Manufacture plot of mineral supplements (additives), PPC “Katpromstroy” Kokhanovo, Vitebsk
		PPC “Silicate Plant”, Bobruisk, Mogilev
5112100	Dewatered sediment of treatment facilities of galvanic production	Manufacture plot of mineral supplements, PPC “Katpromstroy”, Kokhanovo, Vitebsk region

Table 7

List of facilities of galvanic wastes neutralization

Code of waste	Name of waste	Name of facility
5110200	Galvanic sludge, containing hexavalent chromium	JV PLC “Brestgasapparat”, Brest
5110400	Copper-containing galvanic sludge	Cleaning facilities of electrodeposit and lightning engineering shop, CLC “Cascade”, Lida, Grodno region
5112000	Sediments of treatment facilities of galvanic production	Local treatment facilities, PLC “Brest Electromechanical Plant”, Brest

The list of facilities of using of galvanic industry wastes is in Table 6 [4]. Galvanic wastes are processed for the production of mineral additives, expanded clay aggregate, etc at these facilities.

List of facilities of galvanic wastes neutralization is presented in Table 7 [4].

From the data of Tables 6 and 7 we can see that only a few enterprises use and neutralize wastes of galvanic industry. The problem of using galvanic sludge, sewage deposits is worth solving on a country scale since the amount of newly formed and already accumulated wastes is increasing all the time.

Conclusion. The carried-out analysis of galvanic sludge and treatment facilities deposits, formed and/or stored at the sites of the metalcutting, radio engineering, machine- and instrument-making enterprises in the Republic of Belarus has shown that despite an existing system of the account of wastes, formed at the enterprises, there is a discrepancy of the declared kind of waste and the actually stored one at the industrial object's territory. It is connected, first of all, with the long period of accumulation and storage of wastes of galvanic manufacture, during which there occurred a work reprofiling at the enterprise, a change of technological processes of galvanic manufacture, a change of the proprietor, a loss of documents and etc. Besides, while storing of sludge and deposits of galvanic manufacture sewage, there often occurs their predrying, that changes mass of a waste. Such state of affairs causes the necessity of detailed in-

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Received 03.03.2012