The Development of New Technologies for Processing and Disposal of the Oil Containing Wastes Enterprises of Railway Infrastructure

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Summary. In article traditional methods of utilization and renewal of the fulfilled cooling lubricants and waste compressor oils of separate brands are considered. In developing the scheme of recovery of operating quality of the oil containing wastes for the purpose of forming and calculating the process flow diagram suggested, the process optimization, namely temperature, reagent amount, and time of its contact with oil was conducted. The new technologies with use of surface-active substances are offered.
Key words: waste compressor oils, cooling lubricants (coolants), surface-active substances, environmental safety, utilization.

INTRODUCTION

The creation and development of high-efficient technologies subject to demands on resource and energy conservation as well as environmental safety are prerequisites for the production development at the present stage.

The railway infrastructure is one of the largest consumers of valuable material resources such as petroleum, because the environmental safety of the railways is one of the priorities [25, 26].

MATERIALS AND METHODS

To reduce the negative impact of railway transport in all parts of the biosphere during regular operation, the degree of its impact should be constantly monitored and regulated. Analysis of the annual activities of the railway under-takings suggests that more than 40% of water consumed is discharged into surface water reservoirs in the form of wastewater contaminated with oil products, salts of heavy metals, synthetic surface active substances, etc.; over 50 tons of harmful substances are emitted into the atmosphere from stationary sources, only about 30% of them are recaptured and detoxified; more than 65 tons of waste are formed as a result of industrial activity; railway facilities in Ukraine occupy approximately 263 hectares withdrawn from agricultural sector [24].

Large part of emissions (about 85%) is produced by fuel combustion during operation of diesel mainline and shunting rolling stock, refrigerated trains.

The quality of wastewater of the railway undertakings varies widely. Water pollution by industrial wastewaters creates a potential threat to public health, restricts the use of water reservoirs for household, drinking, cultural and domestic purposes, causes great damage to fisheries and agriculture [25, 26].

The sources of wastes in railway transport are all its subdivisions. Major transport companies, which include, in particular, locomotive, railcar depots, railway stations, railway machinery repair plants and bases supporting them, tend to form and accumulate processing wastes, oil-contaminated ones being the most common of them (Table 1).

Table 1. Processing wastes of railway undertakings

Type of waste	Technological process that forms wastes	Waste volume per annum
Oil sludge	Purification of wastewaters	up to 200 thous. t
Washing machinery sludge	Washing of bearings, bearing boxes, four-wheel trucks and carriage bodies of rolling stock, various details before repair works	up to 2000 m³
Galvanic sludge	Purification of washing waters of galvanic sections	up to 20 t
Dry-cleaning machinery subsidence	Work wear cleaning	500-1600 m³
Scavenge oils	Cleaning of bearing boxes before repair, scavenge oil change	5-7 thous. T
Scavenge diesel oils	Scavenge diesel oils change during rolling stock maintenance and repair	Over 1 thous. T

Type of waste	Technological process that forms wastes	Waste volume per annum
Contaminated soil	Cleaning of industrial sites, midpoint pump station, sleeper impregnation plant, railside territories of depots, plants etc.	up to 1 mln. T
Cross-sleepers	Replacement of used cross-sleepers during repair works	1-1,2 mln. pcs.
Fluorescent lamps	Replacement of defective lamps in administrative premises and workshops of the undertakings	up to 40-50 thous. pcs.
Mechani-cal-rubber wastes	Replacement of brake shoes during repair works, of battery jars and other rubber pieces	500-700 t

Amount of managed waste of all grades is negligible, due to the general economic trend of decline in production, which in turn is a condition for reducing the volume of financing environmental measures aimed at increasing the level of waste utilization not only in railway transport, but also in all industries in Ukraine.

Storage and disposal of waste in railway transport, as in other industries, do not often meet sanitary requirements, leading to contamination of groundwater, soil and atmosphere.

The most effective approach to minimizing the negative environmental impact is to develop eco-protection technologies based on the monitoring data, which allows for taking into account the peculiarities of the objects.

At the railway undertakings oil-contaminated and oily waste (waste oils, cooling lubricants, contaminated soils, grease, technology sludge (petroleum slime), etc.) constitute a significant part of the total volume of all wastes. This follows, for example, from the analysis of the dynamics of the formation of different types of waste that were formed at the undertakings of different railway departments.

In particular, the major contributors to the formation of such waste are the undertakings of locomotive department, so, Fig. 1 presents the data on the formation of all types of waste at the undertakings of that department of the Prydniprovska railway in 2010 [6].

Fig. 1 clearly shows that in general for the undertakings of the railway locomotive department it is scavenge oils that constitute the main group of waste; process sludge comes third after accumulator batteries.

According to the public management policy in the field of waste treatment, all processing waste for which the methods for recycling and rational use in the national economy are developed, are to be used as secondary raw material and should not be transported to landfills.

Disposal of exhausted petroleum and oil-containing wastes is an important scientific-and-technical challenge because they are classified as hazardous waste, which adversely affect all objects of the environment – air, soil and water. For instance, water pollution by petroleum products is 20% of the total man-made contamination [20].

In most developed countries the relevant laws, environmental standards and economic conditions regulate the collection and disposal of exhausted oils. Increased attention to meeting these laws is stipulated by large amounts of waste oils, high environmental risk they lead to and also the valuable properties of oils as hydrocarbon-containing raw [9]. A well-adjusted mechanism of recycling waste oils provides the return them to production or consumption sector as secondary products or intermediates, which provides real saving the resources in oil importing countries [15].

For example, in Germany more than 0.5 million tons of the exhausted oils is collected annually, while in the U.S.A. – ca. 5 million tons. Despite the stabilization of production and use of lubricants at the level of 40-43 million tons per year, in the coming years, according to experts' forecasts, the steady amount growth in the collection of waste oils is expected. This is due to the improvement of the legal and economic mechanisms of managing the turnover of commodity and waste oils, the development of technologies for collecting and recycling the latter, strengthening the state and public control over the handling of hazardous wastes and other factors [7].

Experts estimate that today the global production volume of lubricating oils of different brands is about 38.5 mln. tons per year. An insignificant part thereof (10-20%) is irrevocably lost in the course of use due to evaporation, spills, burn-out and leak-offs. Their bigger part (80-90%) is gradually contaminated by various metal, mineral and organic impurities, is thermally decomposed through interaction

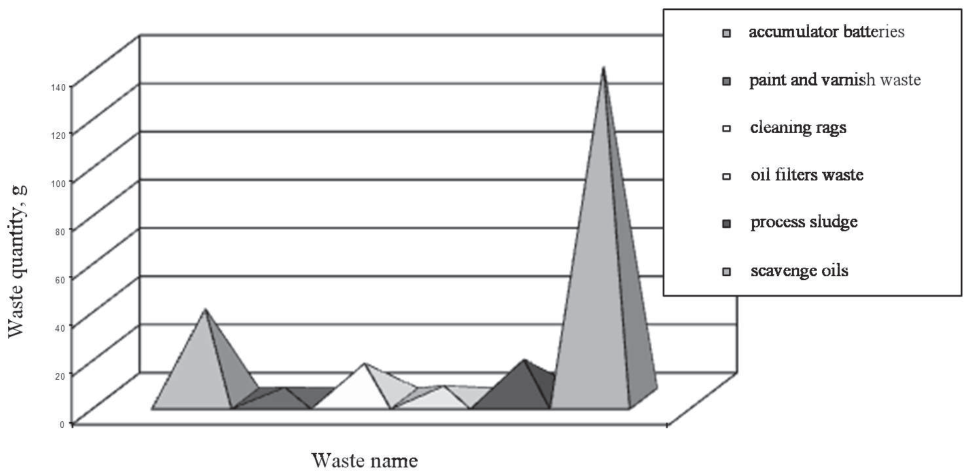

Fig. 1. Formation of waste at the undertakings of locomotive department of the Prydniprovska railway in 2010, t/year

with hot parts of the equipment, oxidized by atmospheric oxygen, exposed to such environmental factors as pressure, electric field and natural lighting. As a result, scavenge oil completely changes its properties and turns into very thick, ooze-like black or dark-brown substance, thick mixture of various kinds of liquids with addition of solids – metal oxides, wear debris.

Regeneration of waste oils for railway companies is virtually non-existent, except for certain physical methods (settling and centrifugation), which do not ensure the full effect [5].

At present, waste oils are often used without regeneration as heating and boiler fuel directly at railway enterprises or transferred for further use or regeneration to other businesses that leads to significant repeated economic expenses [24]. E.g., the regeneration of waste oils is often conducted in petroleum refineries by a full technological scheme. It is a well-known fact that with proper organization of process the cost of recovered oils is less by 40-70% than the cost of the fresh oil at almost the same quality [18].

In the operation, physical and chemical properties of oils vary but experiments have shown that in the main the group chemical composition of the oil varies slightly [19]. Products of physicochemical transformations of oils as well as harmful impurities, which get from outside and make the oil unfit for further work, are only a small part of their total mass and by means of using special processing methods they can be removed. After removal of contaminants, the original properties of oils are recovered therefore they can be re-used in a mixture with fresh oils [3].

A joint processing in a mixture with petroleum at oil refineries and their target processing with obtaining the grease components (regeneration) are the main areas of processing the exhausted oils.

Generally, regeneration methods are divided into: physical, chemical, physical and chemical, biological and complex. Here is a schematic diagram of a comparative analysis of scavenge oil disposal/recycling technologies (Fig. 2) [18].

To physical belong such methods that provide for removal of only mechanical impurities, i.e, dust, sand, metal particles, water, tarry, asphaltum-like substances and carbon blacks, as well as fuel, without affecting the chemical base of oils to be refined. These include sedimentation, filtration, separation, flushing with water; also, if necessary, light fractions recovery is carried out.

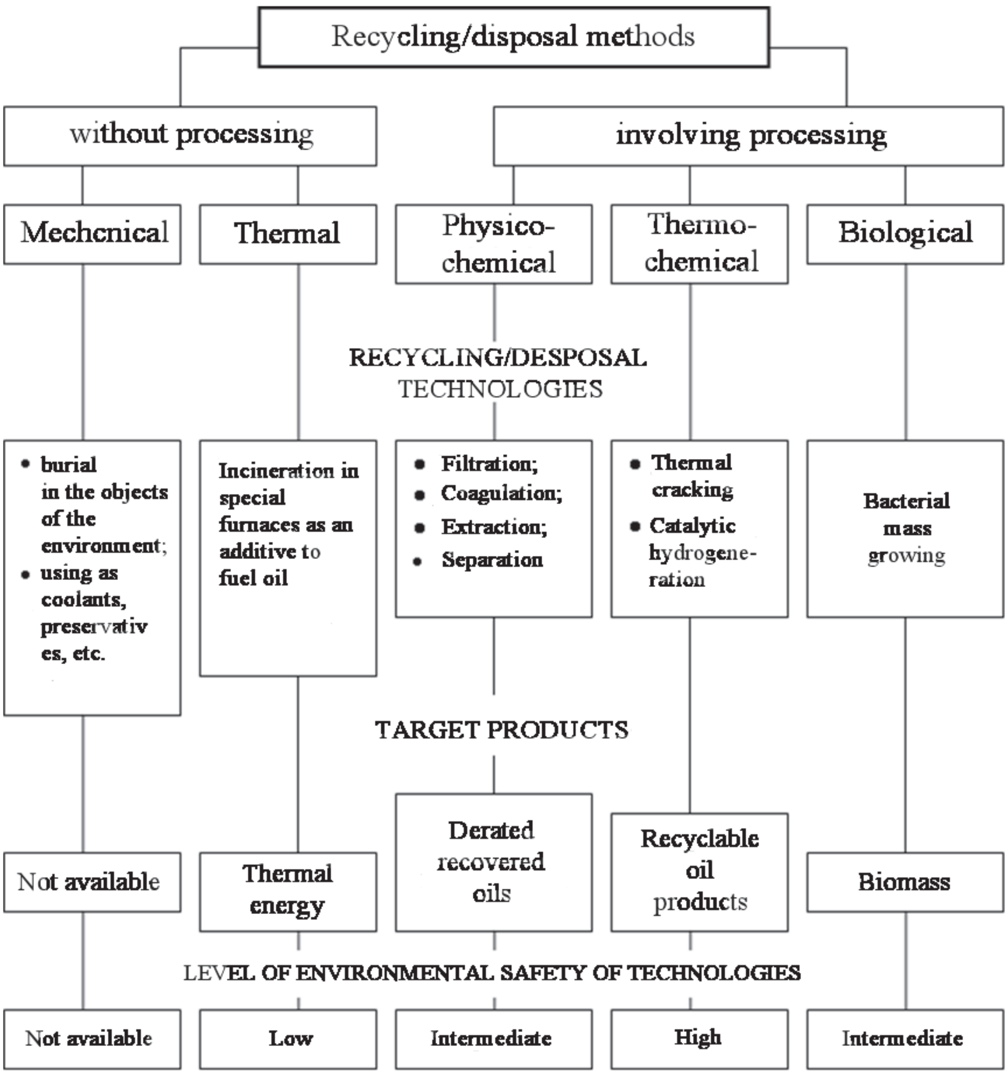

Fig. 2. Diagram of scavenge oil disposal/recycling technologies

Sedimentation is the first and mandatory operation of the regeneration process. Mechanical impurities and water, suspended in the oil, sediment at the oil still standby for 2-18 hours depending on the heating temperature and the height of the liquid column. Sedimentation is based on the principle of particle settling by gravity. The greater the particles' sedimentation rate (from Stokes equation), the bigger their size and specific gravity, and the lower the fluid viscosity [2, 9].

Separation allows for deeper purification of scavenged oil. This is a centrifugation process when products, affected by centrifugal effort, are separated according to their density: the heaviest contaminating impurities are pushed to the walls of the container, forming an annular layer of sediments; the next annular layer is made up of water that is released, and the third one located near the axis of rotation is refined oil.

Filtration is a process of separation of heterogeneous systems through porous walls that block some phases of these systems and let through others. These processes include separation of suspensions into pure liquid and wet sediment, such as separation of mechanical impurities or bleaching clay from oil. Filtering is one of the most efficient methods of regeneration, because it can be used directly in the operation, when the lubrication systems of engines and tools include tailor-made filters.

The disadvantage of this method is low cleaning efficiency due to the fact that contaminant particulates as small as 1 micron pass through the pores of the filters. Additionally, filtration only removes mechanical impurities and has no effect on the processes that lead to changes in the physical and chemical properties of the oil, and therefore requires further processing with chemical reagents [19, 15].

In addition to the above-mentioned methods, which refer to the list of physical ones, one should also note thermal methods that allow for getting the heat, but constitute additional challenges due to the installation of expensive equipment and auxiliary machinery for cleaning the combustion products [8].

Physical and chemical methods include coagulation and adsorption. During the coagulation the particles of colloidal system coalesce and grow to form loose aggregates, thereby exacerbating sedimentation of contaminants. Adsorbents take in and retain on its surface a significant amount of asphalt pitch, acidic compounds, ethers and other products of aging.

For recovery of oils that are not filtered different detergents and surfactants are used as coagulants [2, 19].

The disadvantages of the method are the difficulties in finding coagulants and conditions under which the coagulation process is successful (temperature, necessity and intensity of mixing).

An important condition for adsorption purification is the intensity and time of contact of oil with an adsorbent which is usually achieved by two methods. In the first method an adsorbent is fed into the oil with vigorous stirring of 1000...1400 rpm, which lasts for at least half an hour; then the used adsorbent is separated by sedimentation. The second method is a filtration through a layer of coarse adsorbent [18].

A common disadvantage of the adsorption method is the need for removal of waste adsorbents and sludge, which will no longer be recycled, but simply thrown away, which leads to contamination of the environment. In addition, some adsorbents due to insufficiently high mechanical properties (strength, resistance to abrasion) degrade filter performance, generally complicating the cleaning process.

Quite often chemical methods of regeneration are used. Sulfuric acid, alkaline sodium silicate solutions are used more often than others, but there is a more effective method of chemical treatment , which provides for the use of different selective solvents and their mixtures (phenol, propane, mixtures of phenol with propane) used for treatment of residual oil that belonged to irreversibly lost ones.

The disadvantage of the use of sulfuric acid is the presence of residual acid and sulpha compounds that adversely affect the physical and chemical properties of oil and increase its corrosion activity. Also formed is acidic sludge, which is difficult to dispose. Removal of acidic compounds requires a significant investment of time and money and is accompanied by a loss of up to 50% of oil. Also to get a neutral reaction, alkaline agents should be added to the oil.

Insufficient degree of scavenge oil purification by alkaline treatment method is associated with the presence in many oils of different types of additives that significantly impair coagulation and flocculation functions of alkaline agents. Therefore, for successful regeneration one should choose specific conditions for each type of oil [3, 13].

In practice, for better effect the combined methods best suited to provide high-quality cleaning and recovery of waste oils are applied.

RESULTS, DISCUSSION

At the railway businesses the personnel applies compressor oil of mark CS-19 as all-seasonal lubricant for friction units of compressors of diesels and diesel trains [23].

In the operation, chemical engineering laboratories at each depot investigate oil on suitability for further use, comparing the results of analyzes with scrap indices [2, 23] (numeric values of quality parameters when the lubricants lose their functional properties). When sampling for rejection on the results of laboratory analysis, the full replacement of oils in compressors is conducted.

The analysis of current technologies and schemes of regeneration of waste oils led to drawing the conclusion that the physical-and-chemical methods are the most promising [4, 12], in particular the use of different types of advanced surface-active substances (surfactants).

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We conducted the laboratory studies to recover the properties of waste compressor oils with a wide range of surface-active substances (surfactants). Specifically, some quantity of surfactants tested, among which ethyl oxide sodium lauryl sulfate (Emal 270d) gave the best result.

In developing the scheme of recovery of operating quality of waste compressor oils for the purpose of forming and calculating the process flow diagram suggested, the process optimization, namely temperature, reagent amount, and time of its contact with oil was conducted.

In Fig. 3, the result is presented as the quality recovery scheme for a waste compressor oil CS-19, developed and proposed for railway usage.

The obtained results of verification of key operational indices of waste compressor oil and comparison of them to the indices of refined oil and rejection parameters are given in Table 2.

Table 2. Comparison of key parameters of the fulfilled and cleared oil with rejection indicators

Physico-chemical properties	Rejection index	Rejected oil	Parameter value after cleaning
Contamination, τ cm^{-1}	1300	181	27.24
Flash point in open crucible, °C	Below 180	179	191
Viscosity at 100 °C, mm²/s	Below 15	14.50	15.30
Alkaline number, mg KOH/g	≤ 0.35	0.72	0.75
Water percentage, %	≥ 0.03	Traces (<0.03)	Traces (<0.02)

As the above table shows, the main operating indices of purified oil exceeded the rejection indices, i.e. it is possible to draw the conclusion that the use of this technology gives a positive result.

Yield of purified product with using this scheme is about 91.3%, while for treatment it was 86.7%.

The analysis of the dynamics of formation (Table 3) of the oil-contaminated waste at the Prydneprovska railway shows that 6–9 tons of the process sludge are annually formed at the undertakings of various departments. If you look at percentages, you can see that they take up a significant share (about 40%) of the total volume of the passenger department waste [5, 16].

In appearance processing waste represented by process sludge are brown mass, having crumby structure. Often process sludge refers to the third class of hazard and are moderately hazardous.

Oil sludge of the operating units of the railways are accumulated in wastewater of the undertakings after washing of cars, locomotives and their parts, that is why most of them are formed in the railcar and passenger car de-pots of the railways, as it is here where washing of the rolling stock during repair works is made.

One of the most common ways of disposing oil sludge is a thermal method, such as incineration. However, process sludges are limited combustible substances, for this reason their incineration can be performed only by using additional quantities of fuel. For example, for railway undertakings it is offered to incinerate them when mixed with solid fuel in the furnaces of stationary steam engines located in the territory of the depot. The ash that remains after burning is recommended to check for the presence of heavy metals [5, 6].

Table 3. Analysis of the formation of oil-contaminated waste at the Prydniprovska rail-way, t/year

No.	Type of waste	Department or division								
		locomotive	car service	public facilities	Railway tracks	electrification	water supply	freight commercial	passenger	Total
1	Used oil filters	68,55	0,08	-	5,16	0,19	-	0,08	-	73,64
2	Scavenge engine oils	223,46	7,60	-	35,38	3,01	1,99	0,90	56,92	329,26
3	Oil sludge	76,63	-	-	-	-	-	-	-	76,63
4	Oily rags	25,45	13,04	-	2,23	1,51	-	2,05	0,11	44,40
5	Wastewater residual oils	191,61	-	-	-	-	-	-	-	191,61
6	Oil-contaminated soil	1,30	-	-	5786,5					5787,8

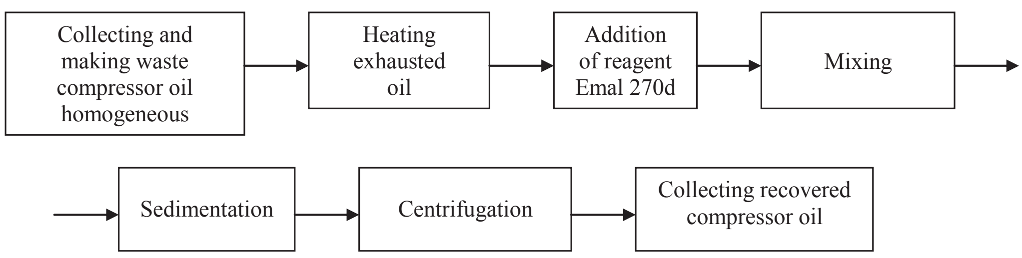

Fig. 3. Recovery scheme for waste compressor oil

However, these technologies are low-production, energy and financially costly because of the high price of boilers, besides, one has to install additional expensive equipment to purify atmospheric emissions; they do not allow the complete recycling and disposal of oil sludge and do not ensure the environmental safety.

When choosing a technology of process sludge disposal, one should take into account the frequency of formation of these wastes, their limited amount, significant consumption of additional fuel to support the combustion process. Therefore, to account for these characteristics of the railway sludge, we offer to apply much cheaper mechanical methods. For example, to install in the depots decanters of different design depending on the overall composition of the sludge and composition of each of its major components: hydrocarbon-bearing particles, water and mechanical impurities [15, 16].

Decanters provide for oil product incineration in standard containers, the possibility of waste disposal directly at the place of their formation at a special site of any depot. Singled out should be a better quality of incineration compared to open burning, high explosive hazard rate as a result of combustion chamber blow-down.

As railway oil sludges are sufficiently watered, being the wastes of rolling stock washing, they do not need to be further diluted with water to reduce the percentage of mechanical impurities. It is recommended to use decanters with a screw that is covered with special protection, such as ceramics or tungsten carbide.

Such measures are caused by the presence in process sludges of so-called "hard" mechanical impurities (sand, forge slag, metal chips and so on), which can cause premature wear of the working parts of the equipment. Additionally, to prevent ingress of large mechanical impurities into decanter, it is advisable to in-stall strainer screens of various fineness of treatment or vibratory separators.

The effectiveness of the decanter depends on the parameters of raw materials, such as their homogeneity and temperature. The first parameter will allow the decanter to run in continuous operation and eliminate the constant human control over the parameters of its operation; indeed, it takes minimum 15 minutes for the employee who services the decanter to set it for the necessary parameters. Another parameter provides the necessary viscosity of the material and is usually 80-90ºC; higher temperatures can lead to overheating of the device. Typically, this heating is carried out directly in the repository for the oil sludge (by heating intermediate containers) or "on the go" with special heat exchangers, when oil sludge is heated while passing through them.

Below in Fig. 4 shown is the general scheme of sludge processing using a centrifuge-decanter and heat exchanger.

Practical research shows that for optimum separation of three phases of process sludges required are different types of flocculants for each case. Depending on the type of the equipment used for the treatment of oil sludge (centrifuges, filter presses, vacuum filters) selected is the most appropriate type of reagent to be used in further processing.

From the experience of using cationic flocculants, most effectively they influence organic compounds, while anionic ones are more suitable for inorganic substances. Due to the diversity of the structure and properties of sludges, the selection of effective flocculants in each case should be made with prior laboratory and industrial tests.

For example, widely known are such flocculants as FT-410, PT-506, Zetag-89 flocculants, industrial polyacrylamide (PAA) and others. Thus, water-based cationic flocculant Zetag-89 manufactured by Swiss company Ciba Specialty Chemicals is used in the oil-refinery industry in the process of oil sludge dehydration at the consumption rate of 2 kg per ton of dry residue.

Known are the results of studies into the opportunity of sludge treatment in the presence of Zetag-89 and Praestol 853 flocculants and polyacrylamide at the consumption rate of 10 grams per one ton of sludge. The results showed that at low consumption of the flocculant one can clearly separate mechanical impurities from oil products. The content of oil products in the lower layer-sediment, when using Zetag-89 and Praestol 853 flocculants, was 6-10%, and in the sediment without flocculants – 18% [16].

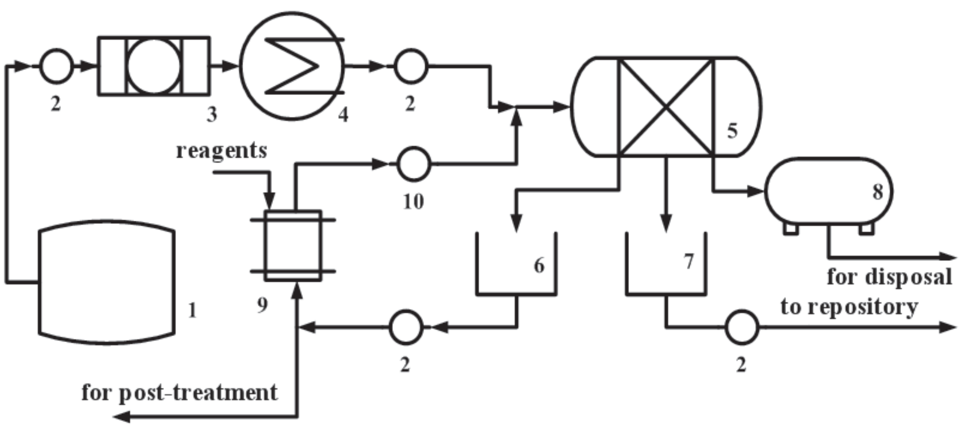

Fig. 4. Schematic diagram of the reagent sludge processing using a decanter and a heat exchanger: 1 – the oil sludge storage tank; 2 – the pumps; 3 – the coarse filter; 4 – the heat exchanger; 5 – the decanter-centrifuge; 6 – the container for collecting water; 7 – the container for collecting centrate (hydrocarbons); 8 – the container for collecting sediment; 9 – the container for preparation of rea-gents; 10 – the dosing pump for feeding reagents

To get rid of wasted mechanical impurities, several options are usually offered: their disposal at the landfill; burning; gradual decomposition using biologically active sorbents at the specially prepared sites.

Under the conditions of the depot it would be reasonable to make gradual accumulation and exportation of wastes to the landfill for disposal.

The water that remains after oil sludge treatment is fed for the post-treatment and subsequently can be used, as already mentioned above, for preparing solution of reagents and included in the production cycle of the enterprise as technical water or the discharged into water bodies.

As reagents recommended for use as flocculants are surfactants (Synthanol and Neonol).

Significant contribution to the human pressure on the environment make metalworking shop of numerous companies, such as machine-building and rail companies (wagon, locomotive depots etc.) [1].

Intensification of processes of metal mechanical treatment, implementing high-performance equipment, automated processes, extensive use of structural materials lead to the fact that metal cutting becomes impossible without the use of efficient cooling lubricants (coolants).

Coolants are a water emulsion of mineral oil stabilized by surfactants and various organic additives aimed at preventing the premature emulsion aging. In the process of use, the coolant loses its technological properties and needs to be replaced with fresh one. An exhausted cooling lubricant (coolant) refers to hazard class 3 [10, 21].

During the use of coolants, they are prone to contamination with:

- smallest mechanical particles (impurities) emitted from the oxidized metal layer, sludge after pickling and products of metal wear during pickling and cold rolling;
- free (non-emulsified) oils extracted from the emulsion as a result of separation;
- oils falling into an emulsion system as a result of leakage from the mechanical and hydraulic components and other metal treatment equipment and so on [14].

The waste coolant (emulsion) is a special type of sewage water that is very dangerous for the environment, since it contains a large number of stable emulsified petroleum products and heavy metals. In this regard, a complex of measures for neutralization of waste coolant is necessary [11, 17].

The spent coolant is subject to obligatory rendering safe from the most toxic components. Existing methods of neutralizing the emulsions of the kind of coolant-containing sewage water can be divided into three main groups:

- thermal;
- physicochemical;
- biological.

However, none of these groups alone can meet the modern requirements concerning the quality of water after its purification and the amount of waste materials generated. The use of common chemical and physicochemical methods leads to secondary contamination due to the formation of various wastes. Most methods of neutralization of coolant-containing wastewater are either economically inefficient or environmentally unacceptable [21]. Therefore, the problem of neutralization of coolants remains urgent.

Local cleaning the wastewater of various compositions, eliminating or reducing the total quantity of discharges of exhausted process liquids due to their regeneration, and reuse of purified sewage waters in closed systems of water turnover and technical water supply in companies can be considered as the most appropriate ways to reduce the harmful effects of contaminated sewage waters of metalworking shops of various industries on the aquatic environment. Repeated use of waste water does not require their deep purification, it is even enough to remove only those substances, which have a negative impact on the quality of products to be manufactured, and to set their MPC values in the water under usage [11, 22].

We conducted research in the field of rendering safe and neutralization of exhausted cooling lubricants, including "Emulsol SVK" using different types of surface-active substances (surfactants). E.g., surfactants such as asparal F, cocamidopropylbetain, oxyethylated monoalkylphenylic acid (neonol AF 9-12), ethoxylated sodium lauryl sulfate (Emal 270d), cocamidopropylaminoxide SAO (Yevroksid SRO), stearox, Syntanol ALM-10, sulphonol (pasta of mark "technical") were first tested. To intensify the process of sediment loss, the possibility of using an acidic agent such as alkyl benzene sulfuric acids (ABSA) was investigated. As a research result, the combination of neonol AF 9-12 and ABSA led to the best result.

In Fig. 5, the result is presented as scheme for neutralization of waste cooling lubricants developed and proposed for railway usage.

The use of the technology suggested provides the following indices: the degree of purification is 71.4%, the yield of purified water is 95.3%, the yield of oil and petroleum products is 1.7%.

The oil and petroleum products obtained can be offered as commodities to various petroleum refineries, and companies producing concrete constructions, asphalt.

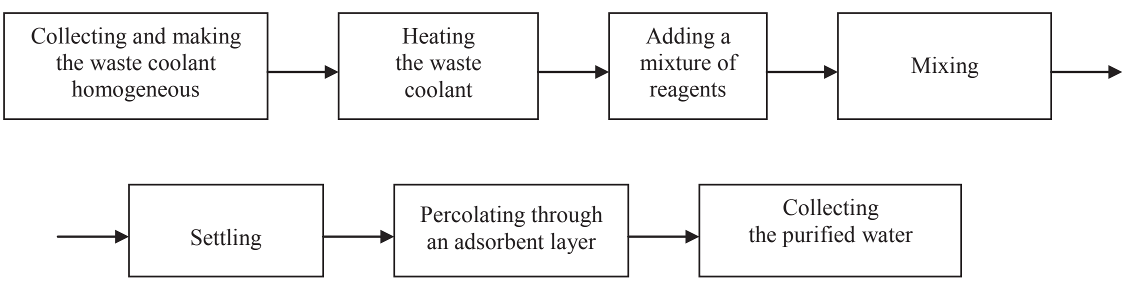

Fig. 5. Neutralization scheme for waste cooling lubricant (coolant)

The water purified can be used in industrial turnover for internal consumption or for the preparation of new cooling lubricant or while maintaining the sanitary requirements it can be dropped into urban sewer network and even into the water basins.

The water after regeneration of the adsorbent can be used for washing a railway rolling stock.

The given technology can be applied in metalworking shops of railway enterprises, machine-building, metallurgical and other industries, where coolant-containing drainage is a part of wastewater complex generated. One of the most promising examples of using this technology for recycling a waste coolant is its introduction at local purification stations of locomotive and wagon depots, as well as railway stations of complex neutralization.

CONCLUTIONS

1. The scheme for a waste compressor oil CS-19 developed and proposed for railway usage. Yield of purified product with using this scheme is about 91.3%, while for treatment it was 86.7%.
2. The proposed scheme sludge processing using centrifuge-decanter and heat exchanger.
3. The scheme for neutralization of waste cooling lubricants that proposed for introduction at local treatment plants and locomotive depots, as well as comprehensive utilization railway stations.
4. The technology for neutralization of waste cooling lubricants ensures a double effect: the environmental effect (owing to minimizing the amount of waste belonging to the IIIrd class of danger, and rational use of water resources) and the economic impact (due to reusing the water in the circulating system of water supply as well as oil and petroleum products).

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РАЗРАБОТКА НОВЕЙШИХ ТЕХНОЛОГИЙ ПЕРЕРАБОТКИ И УТИЛИЗАЦИИ НЕФТЕСОДЕРЖАЩИХ ОТХОДОВ ПРЕДПРИЯТИЙ ЖЕЛЕЗНОДОРОЖНОЙ ИНФРАСТРУКТУРЫ

Аннотация. В статье рассмотрены традиционные методы утилизации и регенерации отработанных смазочно-охлаждающих жидкостей и компрессорных масел. При разработке схем регенерации нефтесодержащих отходов с целью формирования и расчета предложенных технологических схем была проведена оптимизация технологического процесса, а именно температуры, количества реагента и времени контакта. Предложены новые технологии с использованием поверхностно-активных веществ.

Ключевые слова: отработанные компрессорные масла, смазочно-охлаждающие жидкости, поверхностно-активные вещества, экологическая безопасность, утилизация.