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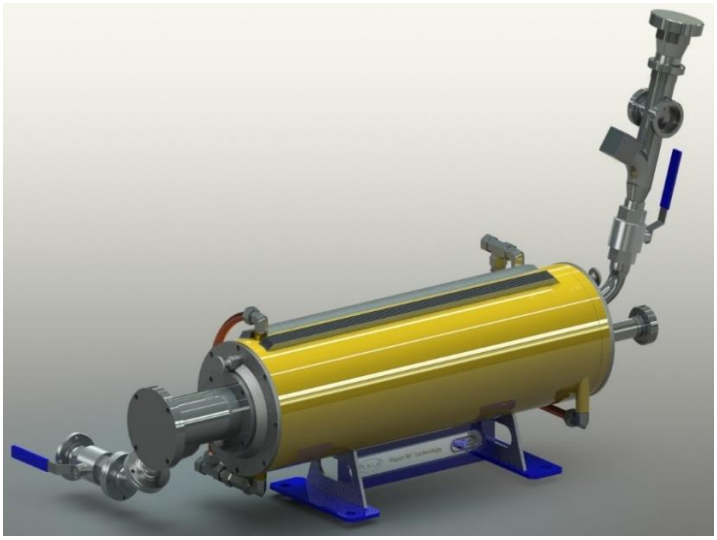
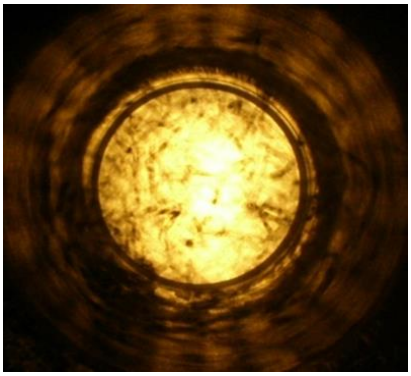
PRESENTS

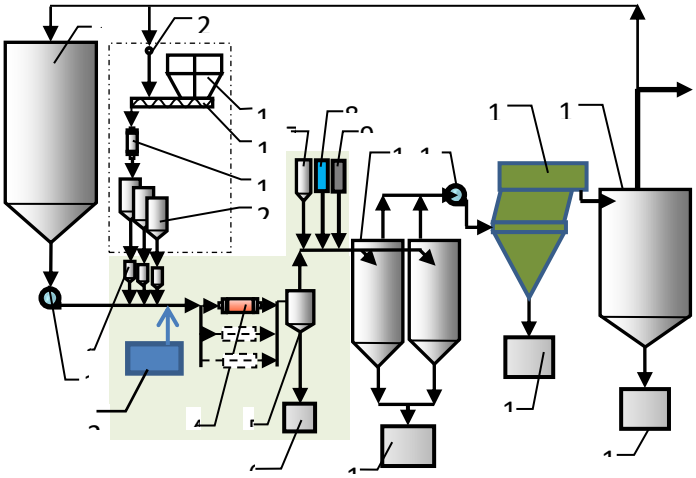
APPENDIX 1
to the Technical and Commercial proposals from September 29, 2020
to establish the demonstration and processing module
for wastewater treatment

DESCRIPTION, TECHNICAL AND ECONOMIC EFFICIENCY OF THE TECHNOLOGY FOR DOMESTIC AND INDUSTRIAL WASTEWATER TREATMENT USING DEVICES FOR MICROARC PROCESSING IN ROTATING MAGNETIC FIELDS

US PATENT (pending)







CONTENTS

1. APPLICATION FIELD

Technological equipment based on the innovative technology of microarc processing in rotating magnetic fields is designed for high-efficiency purification of urban domestic and industrial wastewater and sewage sludge with minimum energy consumption. It can also be the basis for the construction of wastewater treatment systems in communities with local and centralized (sanatoriums, hospitals, schools, hotels, offices, and shopping complexes), as well as treatment facilities of any type industrial enterprises, including food and consumer goods industry, processing of agricultural products, industrial livestock farms, poultry farms, etc.

2. TECHNICAL DETAILS

2.1. Description of the innovative technology of microarc processing in rotating magnetic fields

The innovative energy-saving technology of microarc processing in rotating magnetic fields is based on using the device, which essentially is a flow reactor, generating rotating magnetic field (Fig 2.1). In the operating zone of the reactor ferromagnetic elements (working bodies) are placed. Working elements oscillate relative to the magnetic field strength vector, reaching several thousand periods per second. For a short time, the electric circuits are formed, with arising strong currents. At the breaking of such circuits, a large amount of micro-arcs is formed, which compose the "cloud."

During its movement, the working bodies continuously emit force pulses, which practically no materials can withstand in direct contact. The materials to be processed in the operating zone are intensively mixed and experience a high-power shock impulse effect (about 150 tn / mm^2). In a liquid medium, the distance of action of these impulses increases several times.

In the operating zone of the apparatus, the processed media (substances, materials) are affected by the following:

- effect of micro-arcs and electromagnetic fields;
- mechanical effect (intensive mixing and impacts of working bodies);
- destructuring flows generated by the inductor of the reactor, weakening the intramolecular and interatomic bonds of the processed media;
- hydrodynamic impact, which expressed in big shearing stress in liquid, developed turbulence, pressure pulsation, and fluid flow rate;
- hydroacoustic effect on liquid media due to small-scale pressure pulsation, intense cavity, shock waves, and secondary nonlinear acoustical effects;
- hydrolysis reactions;
- thermal effect.

The simultaneous effect of all factors on any particles of a substance provides deep structural and energy changes in them creating a very high level of activation of all components of a substance participating in the process, allowing to change the diffusion type of transfer of matter, inherent in all traditional technologies, to kinetic. This circumstance allows hundreds and thousands of times to increase the productivity of production processes, reduce material and energy consumption, and implement processes that were previously considered unattainable and nonprofitable.

Fig. 2.1. The apparatus for microarc materials processing in the rotating electromagnetic field of the Plazer-RF

Such features of the microarc treatment in rotating magnetic fields determine its versatility and possibilities of practical applications for different processes. Below we provide some examples of highly efficient applications of the given process:

- Purification for different types of sewage (incl. galvanic) from heavy metals and other harmful impurities, liquidation of sludge with the possibility of simultaneous production of organic fertilizers.
- Oxidation of phenol, alcohol in sewage.
- Neutralization of formation water during oil and gas production with simultaneous extraction of valued components.
- Neutralization and utilization of bilge water on ships and in ports (including wastewater from washing tankers and containers with oil products).
- Processing of petcoke, incl. water-encroached with rising of quality indexes, production of resistant combustible black oil fuel suspensions with water.
- High-efficiency recycling of bitumen into fluxing oil.
- Preparation of emulsions water-oil and coolant-lubricants.
- Production of biodiesel fuel.

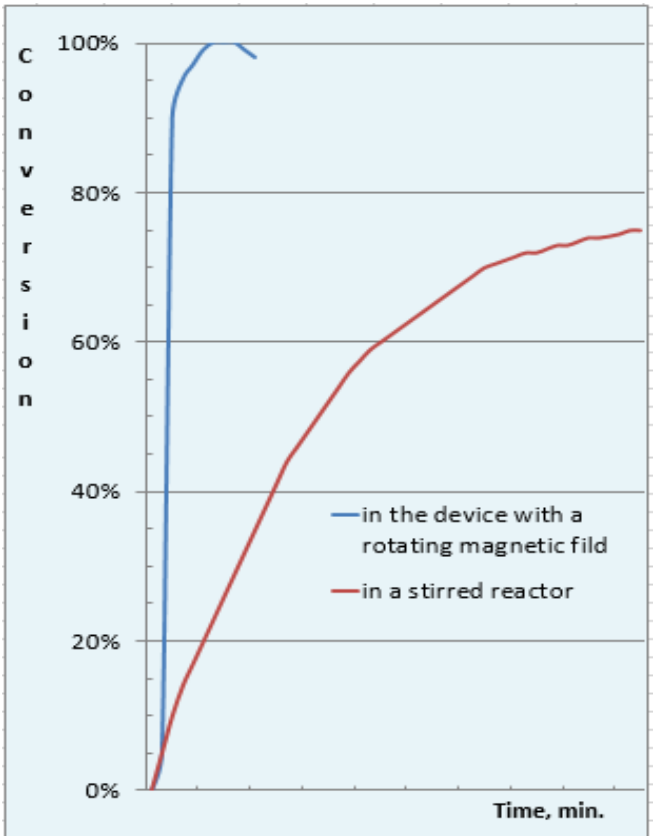
- Extraction of valued components from rocks with their low content (depleted ores), as well as the processing of dumps (for example tungsten, gold, molybdenum, nickel, copper, rare earth metals, etc.).
- Powder metallurgy (grinding, mixing, agglomeration, production of nanomaterials, various composite materials, including metal-filled plastics).
- Production of water-proof sand for waterproofing (hydrophobic material).

2.2. New scope and advantages of the innovative technology of microarc processing in rotating magnetic fields as applied to the wastewater purification

Widely used nowadays in the urban economy and in the industrial enterprise, the technologies and equipment for the neutralization of sewage use multistage purification methods: chemical treatment, coagulation, aeration, sedimentation, filtration, neutralization and dewatering of sludge, etc., providing of which demands buildings, the ponds septic tanks system -, biological final purification, filtration, etc. These processes are slow, while and the dimensions of the equipment are very large, material- and energy-intensive. But most importantly, they do not provide the required level of purification and maximum permissible concentrations of hazardous elements and compounds (MPC) and not being able to capture and dispose of, for example, heavy metals.

An important factor worsening the technical and economic indicators of neutralization is the low specific energy intensity of operating zones of the sewage equipment of all types. Lack of energy determines the low rate of physical and chemical reactions. This means that the method of diffusion transfer of material and energy is being developed. Intensifying the diffusion in conventional type appatatuses is difficult. Essentially, only the thermal activation and mechanical agitation are known. But their capabilities are limited.

Consequently, the intensification of production processes using conventional technologies and equipment is difficult to carry out. Volume increase of processed sewage is only possible by increasing the quantity of the equipment. On the other hand, you have to spend a lot of energy and resources for deep cleaning. Moreover, their number is such that it is quite comparable with the costs of the main production.



In the apparatus with rotating magnetic field, the oxidation reaction occurs in seconds. Its kinetics appears as a straight line, almost coinciding with the axis of ordinates. The process ends in 1-2 min. At the same time, in the reactor with a mixer, the oxidation is much slower and its running is displayed on a smooth curve diagram, at that the reaction does not reach to the end, as the formation of the new product already slows the supply of components into reaction point.

Fig.2.3. The kinetics of chemical reactions in the heterogeneous system

Due to the high mixing efficiency **in Plazer-RF devices** the system components supply is provided into the reaction point along the entire volume of the operating zone simultaneously, since the working bodies are distributed along the entire volume of the operating zone. Under the effect of shock waves generated by the working bodies due to the mechanism of magnetostrictive, the solid parts are ground very quickly (cleaned from surface films). The grinding process runs continuously and with increasing speed along the entire volume. This phenomenon has very important effects. Each solid particle has an oxide film, dirt, etc. at the surface and, in addition, when reacting components interact, a solid or liquid film of reaction products forms on the particle surface, which slows down this reaction. As a result of the continuous destruction of large and small particles, a new cleavage surface is continuously formed, not protected by any films, which significantly increases the chemical activity of the solid component. Simultaneously, the shock waves from working bodies churning these films.

The energy radiated by the working bodies is large enough to change the medium structure, e.g. water. This appears in the formation of ions H + and OH-, which also participate in the reactions. In the presence of a continuous supply of activated components to the points of interaction, reactions occur throughout the volume simultaneously. Kinetics of the process (Figure 2.3) is represented as a straight, almost parallel to the axis of coordinates, and cut off, reaching a maximum when the free components run out.

Technological and operational advantages of the equipment for wastewater treatment based on the Plazer-RF devices are determined by the high intensity of processes. In the operating zone of Plazer-RF devices simultaneously take place:

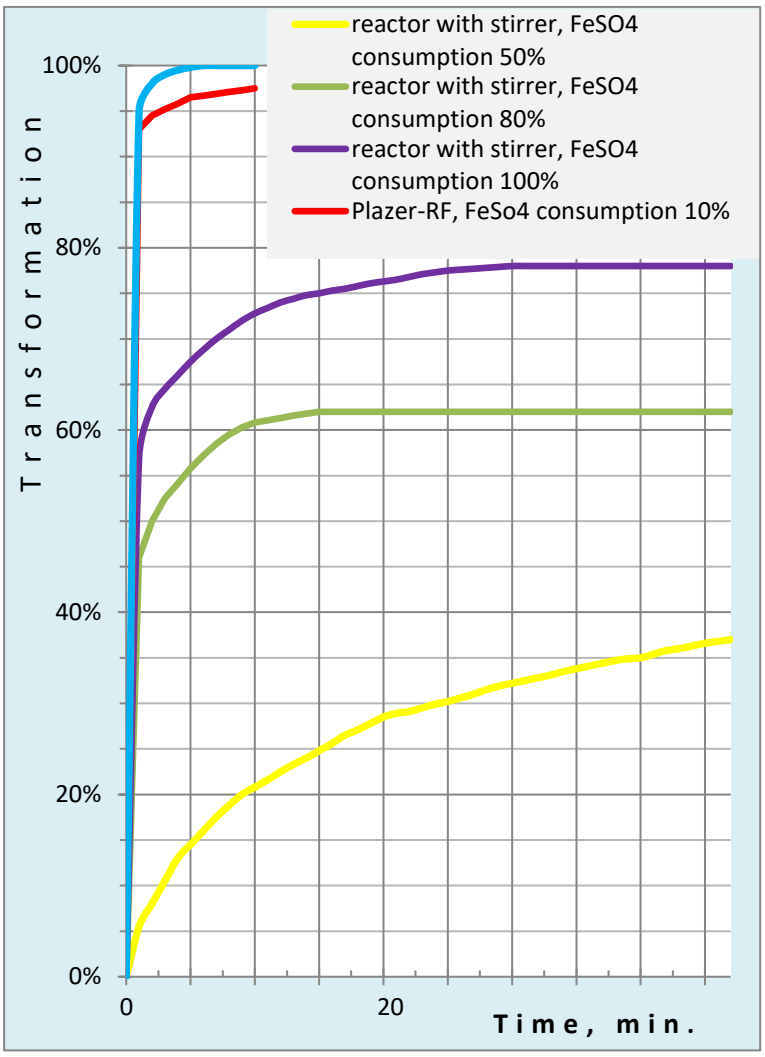
- intensive dispersion of particles and components;
- water ionization with separation of ions H^+ and OH^-;
- weakening intermolecular and interatomic bonds by destructuring flows as a result of the action of the inductor`s electromagnetic lens;
- oxidation and reduction of several compounds;
- elimination of pathogenic flora and microorganisms

This means that other things being equal, a noticeable acceleration in the course of chemical reactions, and, accordingly, production processes, as well as a reduction in the consumption of additives can be expected. The substances at the exit from the operating zone of the apparatus acquire new properties - they settle several times faster, and the precipitate and the solution above it have a clear interface, i.e. there is no transition layer (the effect of solvatization is eliminated). When treating wastewater with Plazer-RF devices, there is an accelerated separation and deposition of the mineral component and heavy metals in wastewater and other types of liquid waste in the form of non-hazardous hydroxides. Water disinfection takes place - pathogenic microflora and microorganisms are destroyed in a complex way, due to a highly ionized medium, magnetohydrodynamic shocks, and intensive rotation of the liquid phase flow.

This means that, under otherwise equal conditions, a significant acceleration of chemical reactions and production processes, respectively, and reduction of the consumption of the additive can be expected. The substances at the apparatus operating zone output acquire new properties - they settle several times faster, at that the precipitate and the solution above it have a clear boundary, i.e. there is no transition layer (the effect of solvatization is eliminated). When treating wastewater with Plazer-RF devices, there is an accelerated separation and deposition of the mineral component and heavy metals in wastewater and other types of liquid waste in the form of non-hazardous hydroxides. Water disinfection takes place - pathogenic microflora and microorganisms are destroyed in a complex way, due to a highly ionized medium, magnetohydrodynamic shocks, and intensive rotation of the liquid phase flow.

As the result, the decrease of volume and the number of clarification tanks, mixers, filters, containers, etc can be reached. Finally, it provides a sharp decrease of metal intensity, sizes of the auxiliary equipment, initial capital expenditures, and investments for

wastewater treatment plants. A very important factor is the significant reduction in operating costs (energy consumption, reagents, labor costs).



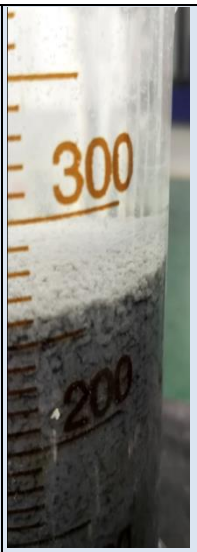
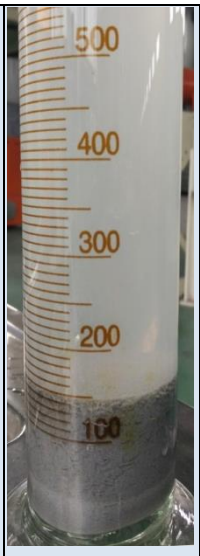
The peculiarities of the conditions arising in the operating zone of the Plazer-RF reactors make it possible to drastically reduce the consumption of reagents when treating wastewater from hexavalent chromium and other heavy metals (galvanic effluents), achieve a more complete purification, and transfer these procedures to a continuous process.

Ferromagnetic working bodies under the influence of an electromagnetic field perform intensive mixing of the reagents entering the reaction zone, the grinding reaches a colloidal degree of dispersion, the formed colloidal metal is a good reducing agent. At the same time, hydrogen is formed due to the electrolysis of water. Both factors significantly affect the reduction reaction of hexavalent chromium and other metals in wastewater. This feature can significantly reduce the consumption of iron sulfate.

As can be seen from the diagram, in Plazer-RF devices, almost complete recovery is achieved even when the consumption of iron sulfate does not exceed 10% of the stoichiometric one. The recovery process takes a fraction of a second, which makes it possible to run the process continuously and at high speed.

Tests for cleaning sewage from fish processing plants using microimpulse microarc processing in Plazer-RF rotating electromagnetic fields

(In the experiments the reagents and operating modes of the installation were selected. The work was carried out on the test site in a cyclic mode in a manual container V = 1.5 liters).

					
Drain	**1'**	**3'**	**4'**	**Sludge Sediment**	**Filtered**

The devices are easily integrated into almost any technological lines and do not require significant rework and capital costs, always increase production efficiency. The efficient use of the unique properties of the installations allows quickly to improve the environmental situation in any place. According to the design of production lines, equipment, and technologies, all processes are isolated from the atmosphere. This provides ecological cleanliness and the safety of staff.

2.3. Processing equipment for the purification of domestic and industrial sewage using devices for microarc processing in rotating magnetic fields

2.3.1. Description of the technological module for wastewater purification

The main unit of the technological equipment complexes for purification of wastewater on the technology of microarc processing in rotating magnetic fields are the Plazer-RF devices (fig. 2.1). The configuration of the equipment depends on the specific types of sewage, their composition, purification (performance) volume, requirements to the final products, existing infrastructure, other factors. Although the volumes and compositions of wastewater are extremely diverse, the devices themselves practically do not differ from each other. This circumstance makes it possible to create a generalized technological line, in which the same units with the same purposes are almost always present and repeated.

The general technological scheme for the treatment of domestic and industrial wastewater using Plazer-RF devices is shown in Fig.2.3. The line is equipped only with active sedimentation tanks and sludge collectors. No special buildings or strong foundations are required. Constructive elements of the line, including the number of Plazer-RF units, the number of sedimentation tanks at one site can vary depending on the specified capacity.

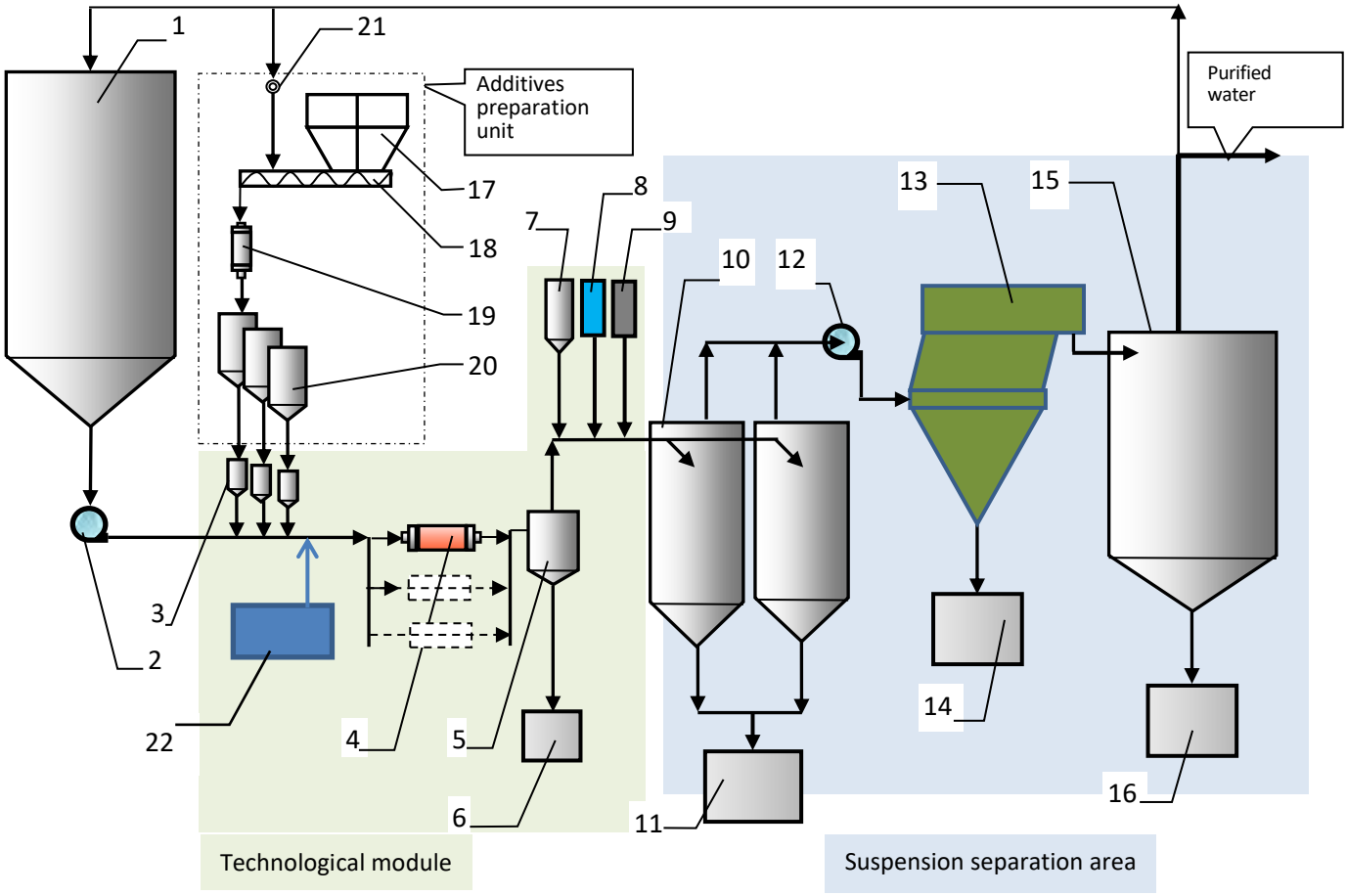


Fig 2.3. Fundamental PFD and PID of the domestic sewage water treatment using the apparatus of microarc processing in rotating magnetic fields:

1. Collecting-balancing tank; 2,12. Pumps; 3,7. Containers for additives; 4,19. Plazer-RF devices;
5. Intermediate container; 6,11,14,16. Sludge tanks; 8. Ozone generator; 9. CO_2 source;
10. Round sludge collector; 13. Sludge collector with thin layer block; 15. Neutralized water collecting tanks;
17. Tank for granular reagents; 18. Screw; 20. Additives holding tanks; 21. Water source; 22. Compressor.

The block structure of the technological scheme allows to single out a technological module, the basis of which is a Plazer-RF apparatus with a cooling and control system, as well as a system for dosing additives and reagents. The equipment of the technological module can be mounted in a 20-foot container and, if necessary, can be easily moved to the required place. The container can accommodate 1-3 Plazer-RF devices (Fig. 2.4-2.5).

In addition to constructing a technological scheme for specific tasks, such solutions allow conducting pilot demonstration works at existing treatment facilities for various purposes (city, enterprises). In this case, the connection of the technological module is provided according to the bypass scheme to the existing structures. The technological module accepts liquid effluents for processing after preliminary cleaning from large objects on grids and sand traps.

After processing at the outlet of the technological module and separation of the suspension, water purified to the required local standards is obtained, suitable for discharge into the environment, or sent for additional processing to obtain the required quality for the intended use. After studying the composition of the solid sediment, recommendations can be given on its use (reclamation, building materials, fertilizers, etc.).

The technological module can run periodically in a test mode, as well as in continuous mode. Before Plazer-RF devices, the necessary reagents are supplied to the drains with dosing pumps. Large particles slipped trough are held in the container 5, and the bulk of the solid phase settles in containers 10, with that up to 95% of the sediment falls out in the first 10-15 minutes. Further, the suspension settles in a collector with thin-layer blocks 13. For deep water purification from turbidity, a filter with a floating load can be additionally installed.

In the operating zone of devices, all sterilization reactions run very fast and are brought to completion. The solid phase is separated from solutions, at this, the particles acquire new properties, their deposition rate increases becoming much greater than could be expected. The size of particles is not determinative, it is mainly explained by the elimination of the solvating phenomenon. Therefore, the size of the sludge tanks is significantly less than traditional. There appears the opportunity to refuse ponds and perform sludge tanks ass hydrocyclons of continuous or semi-continuous action. The work schedule of sludge tanks is determined during commissioning works.

Fig. 2.4. Plazer-RF Devices for microarc materials processing in rotating magnetic fields.

Fig. 2.5. A version of the design for the technological container with three Plazer-RF devices.

Table 2.1

2.3.2. Main technical characteristics of the technological module for wastewater purification

Parameters	Values
Types of wastewater to be treated	Wastewater formed by the objects of domestic purposes in the urban economy, as well as enterprises engaged in the processing of agricultural products and livestock
Teatment performance, m^3 / hour:	5 – 30 m^3 / hour (3 devices)
Mains supply, V / Hz	3-phase: 400 / 50 or 60
Input power, kVA	25 – 30
Main parameters of the **Plazer-RF** device:	
Power supply: voltage / frequency	3-phase: 400V -15%+10% / 45…66Hz
Mains supply current, A	8-20
Rated input (active), kWt	4-9
Operating zone diameter, mm	95
Magnetic field density in the operating zone, T	0,11 – 0,18
Operating frequency range, Hz	40 – 100
Operating voltage range, V	250 – 390
Cooling liquid	Circuit-breaker oil
Performance capacity (water), m^3 / hour	2-10 (1 device)
Inductor dimensions (diameter, length), m	0,3/0,8
Weight (including inverter, without cooling system), kg	Up to 180
Total rated input of the technological module, kWt	8 - 35
Dimensions of the technological module, max m	6 x 2,5 x 2,8

The given technological module is the basis for purification complexes of different types not only domestic wastewater but also for the highly efficient purification of various types of industrial wastewater, including those containing toxic components.

3. TECHNICAL AND ECONOMIC EFFICIENCY

3.1. Efficiency of microarc processing in rotating magnetic fields for toxic waste treatment and sewage purification

3.1.1. Domestic sewage purification with simultaneous utilization of sewage sludge and liquidation of sludge drying bed

The efficiency of the technology of microarc processing in rotating magnetic fields in comparison with currently commonly used technologies of wastewater purification (primarily with biological treatment) lies in the possibility of complete disposal of all constituent waste, namely:

- obtaining purified water that meets sanitary standards for discharge into natural water bodies, for irrigation or technical purposes;

- processing of solid sediment to obtain commercially attractive products (organic fertilizers, metal concentrate, refined fine sand).

An important advantage of this technology is the ability to eliminate old sludge beds where sewage sludge has been stored for many years.

An inevitable waste of traditional systems of biological treatment of industrial and domestic wastewater is excess activated sludge. Currently, heavy sludge formed after wastewater treatment has become a threat to the existence of the entire civilization. There is so much of it that it changes the landscape of the area and poisons it to the depth of the drinking water horizons, occupying large areas of land. This sludge contains the number of heavy metals comparable to their content in natural ores (Table 3.1).

This problem is one of the most serious in the urban economy.

Methods for the treatment and disposal of excess sludge together with solid sediment, which typical projects of urban sewage treatment plants provide, are dewatering with chemicals and accumulation in reservoirs. These methods are characterized by a high consumption of chemicals (up to 30% of weight) and harm the environment. Currently, there are practically no technologies capable of extracting heavy metals (HM) from sewage sludge and use other components in industry and agriculture.

The technological line for sludge utilization operates in continuous mode (Fig.3.1.). The first stage of sludge processing includes wastewater treatment under the process flow diagram shown in Fig. 2.3.

Further, from the map (reservoir), the sludge is fed by a conveyor (homogenizer) into hopper 1, from which it is delivered to the Plazer-RF apparatus by a screw. Recycled water is

used to dilute the sludge. The resulting slurry, consisting of organic sludge and a solution of metals, is sent through an intermediate tank 4 with a pump 5 to sludge tanks 6 (work alternately), where the sludge is separated from the solution, collected in a 7,8 collector with a replaceable container (Fig. 3.1). Next, the sludge is sent to the bunker 9, from which it is captured by the auger. Dry lime and mineral fertilizers from containers 10 are added to the screw. The components are mixed in the screw 10. A significant part of the water goes to the formation of $Ca(OH)_2$. The resulting mass is pressed through the outlet nozzle of the auger with the formation of cylindrical pieces, which fall on the conveyor passing through the dryer 11. The dryer and the firebox are optional since the mass hardens after a while due to the heat of chemical reactions. The granules are dropped into hopper 12 and packaged.

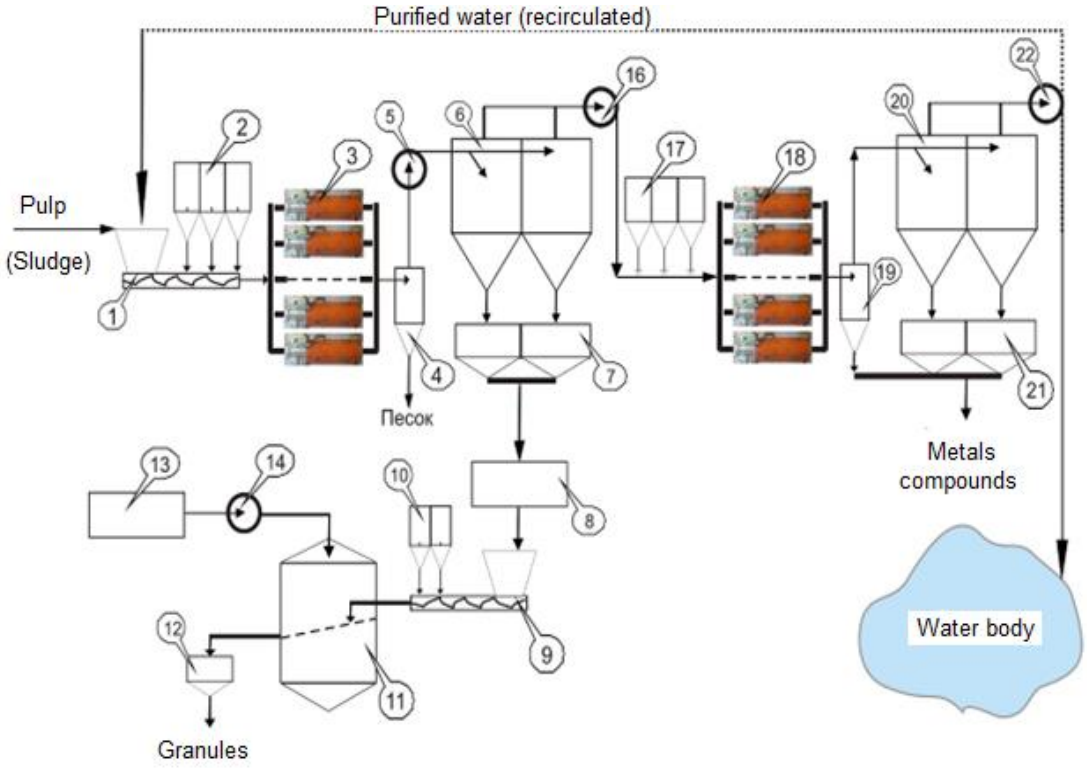


Fig. 3.1. PFD and PID of the sludge processing line using devices for micro-arc processing in rotating magnetic fields

1. Bulk container with screw-feed; 2. Containers for additives; 3,18. Plazer-RF; 5,16,22. Pumps; 4,19. Intermediate container; 6,20. Sludge tanks; 7,8. Organics collecting tanks; 17. Containers for additives; 21. Compounds collecting tanks HM; 9. Container with extrusion screw; 10. Containers for additives; 11. Chamber (drying stove); 12. Granules collecting tanks; 13. Air heater; 14. Ventilator.

Results of sludge processing are shown in Tables 3.1., 3.2.

Table 3.1.

Example content of sludge drying beds, formed after purification of sewage in municipal treatment facilities.

Humi-dity %	pH	Organ. Subst. %	Sand %	N, total %	P, %	K, %	Metals mg/kg								
							Sb	Hq	Pь	Cd	Ni	Cr	Mn	Zn	Cu
82,6	7,4	35,6	30	2	3,7	0,03	38,5	5,0	224	118	164	3635	462	5840	1306

Table 3.2.

Initial sludge content by metals and products after its processing.

Products	Units of meas.	Elements								
		Sb	Hg	Pb	Cd	Ni	Cr	Mn	Zn	Cu
Sewage sludge (initial sludge)	mg/kg	38,5	5	224	118	164	3635	432	5840	1306
Sewage sludge processing products:										
Organic sediment (organic ertilizers)	mg/kg	-	-	0,06	0,004	0,03	0,1	0,2	0,08	0,6
Metallic concentrate (metal hydroxide sediment)	mg/kg	120	-	2900	330	4400	5100	7600	3400	3100
Вода оборотная	mg/l	-	-	0,05	-	0,25	0,01	-	-	0,40

***Note:** one of the products is not specified in the table – purified fine ground sand*

In the considered case, no special requirements were imposed on the treated water, since almost all of it is used to dilute the sludge. There are practically no metal losses.

It should be noted that the urban sludge fields, especially in large cities, occupy vast areas and sharply worsen the ecological situation in the whole region. Therefore, it is advisable to redistribute sludge from sedimentation tanks directly on the field using mobile installations.

Sludge processing products: sand, organic component and a mixture of metal hydroxides are the raw material for the production of granular fertilizers, also the mixture can be sold to metallurgical plants as a valuable concentrate. Thus, the processing of sludge and wastewater becomes profitable, and an important environmental effect is revealed. But the most important achievement is the return to operation of significant areas of the city, the cost of which is very high.

These provisions also apply to the neutralization of domestic and industrial wastewater. It is obvious that the overwhelming majority of traditional neutralization technologies, including biotechnologies, are costly and not focused on utilization.

The given innovative technology allows:

- process wastewater environmentally friendly, completely safe for the environment, working in a closed cycle, sludge, as a product, is completely processed;

- improve the environment, avoid the formation of sludge beds and dispose of the existing ones (complete neutralization, removal of heavy metals), reclaim large areas of land plots, return them for economic land use or natural objects;

- transform the wastewater treatment from a costly process into profitable, obtain financially rewarding production:

A) organic fertilizers;

B) building material – purified fine particle fractions sand;

C) metal hydroxide concentrate (raw material for metallurgy);

D) water for irrigation - active or in natural pools.

3.1.2. Livestock complexes waste utilization

Complexes for utilization of industrial waste from livestock (including manure) are very complicated heterogeneous systems, consisting of organic and inorganic components, living organisms, plant seeds, a solution with changing composition and concentration, solid particles - plant residues from litter and undigested animals, sand, etc.

Traditional methods of processing such waste are unprofitable and environmentally hazardous, despite the many modifications of these structures and technologies, there are no reliable industrial methods for separating the solid phase of manure from the liquid. This is due to the large material costs for the construction of composting sites, sedimentation tanks with waterproof coverings, huge transport costs, the loss of large areas for structures, including ponds for biological treatment, and long holdings of manure for biothermal treatment.

Existing methods do not provide reliable disinfection of manure. It is known that biothermally treated manure contains dangerous microorganisms such as salmonella. After 1.5-year exposure, 30-80% of eggs of helminths of trichocephalus, trichostrongylids, etc., as well as 1-17% of weed seeds, which can significantly reduce the yield of cultivated plants, remain viable. Besides, fresh bird droppings, in turn, have a detrimental effect on animals and plants, and it is extremely undesirable to dump it into water bodies without biological treatment in ponds, sedimentation tanks, or heaps. Diluting the droppings several times with water only formally makes discharges permitted, preserving their harmfulness to nature.

Therefore, there is a need for reliable and cheap methods for disinfecting manure, moreover, specially designed for poultry manure.

This problem is successfully solved with the waste-free technology of micro-arc treatment in rotating magnetic fields, which ensures the elimination of harmful components and the production of effective organomineral fertilizers.

When using this technology in the operating zone of the devices, several factors act simultaneously:

Mixing. It was found that after processing, semi-liquid manure does not stratify at all within 2-3 weeks, and the nature of the separation itself has acquired a new order. The gases absorbed by the particles are released immediately after leaving the apparatus, there is no upper crust of floating particles, almost the entire mass of solid particles sank to the bottom, forming a precipitate. The liquid acquires transparency, however, after a relatively long exposure, which is usually not observed during aging in manure storage facilities.

Grinding of the solid phase simultaneously with mixing occurs with high intensity in a flow-through mode (Table 3.3)

Table 3.3.

Change of the fractional composition in the solid phase of industrial waste of breeding complexes after microarc processing in rotating magnetic fields. Processing time 3-10 sec.

Processing	Humidity %	Fracional composition %						Note
		3 mm	2 mm	1 mm	0,5 mm	0,25 mm	Less than 0,25 мм	
Initial	93,27	7,38	5,78	18,59	4,76	4,89	58,6	
After processing	95,03	0,29	0,21	12,59	5,94	6,06	76,91	Production capacity 4,5 m^3/hour

Disinfection, destruction of weed seeds. For the disinfection of such waste, storages of liquid and semi-liquid manure with a width of 12, 18 and 24, and a depth of up to 6 m are used. Biochemical reactions take place and lead to the temperature rise inside. As a result, the content of pathogenic microflora and helminths in the manure sharply decreases. However, there is still a risk of infectious diseases, pathogens, and epidemics. Liquid or semi-liquid manure, manure runoff, or sediments are disinfected by treatment with liquid ammonia, which is introduced into the volume of the manure storage using a needle lowered to the bottom. Disinfection is carried out up to 5 days at an ammonia consumption of 30 kg/m^3 of manure.

Disinfection is also carried out with formalin (the consumption is 7.5 l / m3 of manure), containing 38% formaldehyde. The procedure requires mixing for 6 hours and holding for 72 hours.

Solid manure, contaminated with pathogens, is subjected to heat treatment in the steam jet apparatus.

For the implementation of the chemical method for disinfecting manure, the structures should additionally provide for special containers equipped with pumps and collapsible pipes.

In the case of micro-arc treatment in rotating magnetic fields, the destruction of microflora takes place already in the operating zone of the apparatus (Table 3.4).

Noteworthy is the fact of a significant reduction in the consumption of ammonia and formaldehyde. The consumption of the latter according to the instructions of the ONTP 17-86 standard (RF) is about 30% of the mass of manure (in the form of a 40% solution). The use of safe potassium hydroxide greatly simplifies the disinfection of manure on any farm. Its efficiency is higher than that of formaldehyde.

Simultaneously with the destruction of microflora, helminths, and their eggs are destroyed.

Table 3.4.

The effect of additives and micro-arc processing in rotating magnetic fields on the microflora content in livestock industrial waste and cultures (E-*coli and St-aureus*). Processing time 3-10 sec

No	Material	Additive		E-coli	St-aureus	Control in (days)
		Type	Quantity			
1	Initial	–	–	10^6	10^6	1
2	After processing	Potassium hydrate	1 l/t	10^2	10^2	1
3	After processing	Potassium hydrate	3 l/t	10°	10°	1
4	After processing	Potassium hydrate	5 l/t	0	0	1
5	After processing	Ammonia	30 l/t	0	0	3
6	After processing	Ammonia	5 l/t	0	0	3
7	After processing	Formaldehyde	10 l/t	10	10	1
8	After processing	Formaldehyde	25 l/t	0	0	1

Such a degree and very high rate of manure neutralization and, accordingly, other similar types of waste, cannot be obtained by biological treatment and biofiltration, as well as by any known method of disinfection.

Ultimately, after micro-arc treatment in rotating magnetic fields of these types of industrial waste from livestock complexes, an intermediate product is received, uniform in composition, completely disinfected, and having the necessary consistency.

From this semi-finished product, it is possible to obtain two main types of industrial products: granular organic fertilizers or compound feed. The technologies for their production practically do not differ - only the introduced additives change.

Processing of industrial waste from poultry farms (droppings) using innovative technology in Plazer-RF devices to obtain organic and organomineral fertilizers

Original and homogenized droppings.

Granular organic fertilizers (from droppings) **Homogenized organic matter (litter)** **Homogenized organic-mineral mixture with peat** **Granulated organic-mineral fertilizer with peat**

3.2. Comparative technical and economic indicators of innovative technology with traditional wastewater treatment systems.

3.2.1. Advantages of innovative technology over biological treatment technology

Biological treatment technologies are currently most widely used in various wastewater treatment systems, especially in urban areas.

The principle of biological wastewater treatment is that under certain conditions microbes can break down organic matter into simple substances such as water, carbon dioxide, etc. The classical scheme of biological treatment is shown in Fig. 3.2a. Wastewater treatment in biological filters simulates the treatment of soil wastewater by microorganisms. Wastewater treatment in aerotanks is similar to treatment in reservoirs. The aeration tank is a complex multistage structure, equipped with very energy-intensive aeration systems, pumps, mixing systems, etc. (Fig. 3.2b-3.2d) Biofilters and sedimentation tanks are also complex material-intensive structures. All units are large and are often located in a dedicated production building. Colonies of microorganisms live inside the aeration tank - on silt flakes. These colonies process wastewater organics. The course of the technological process requires constant monitoring and regulation, which provides fairly significant maintenance personnel. Automatization is challenging.

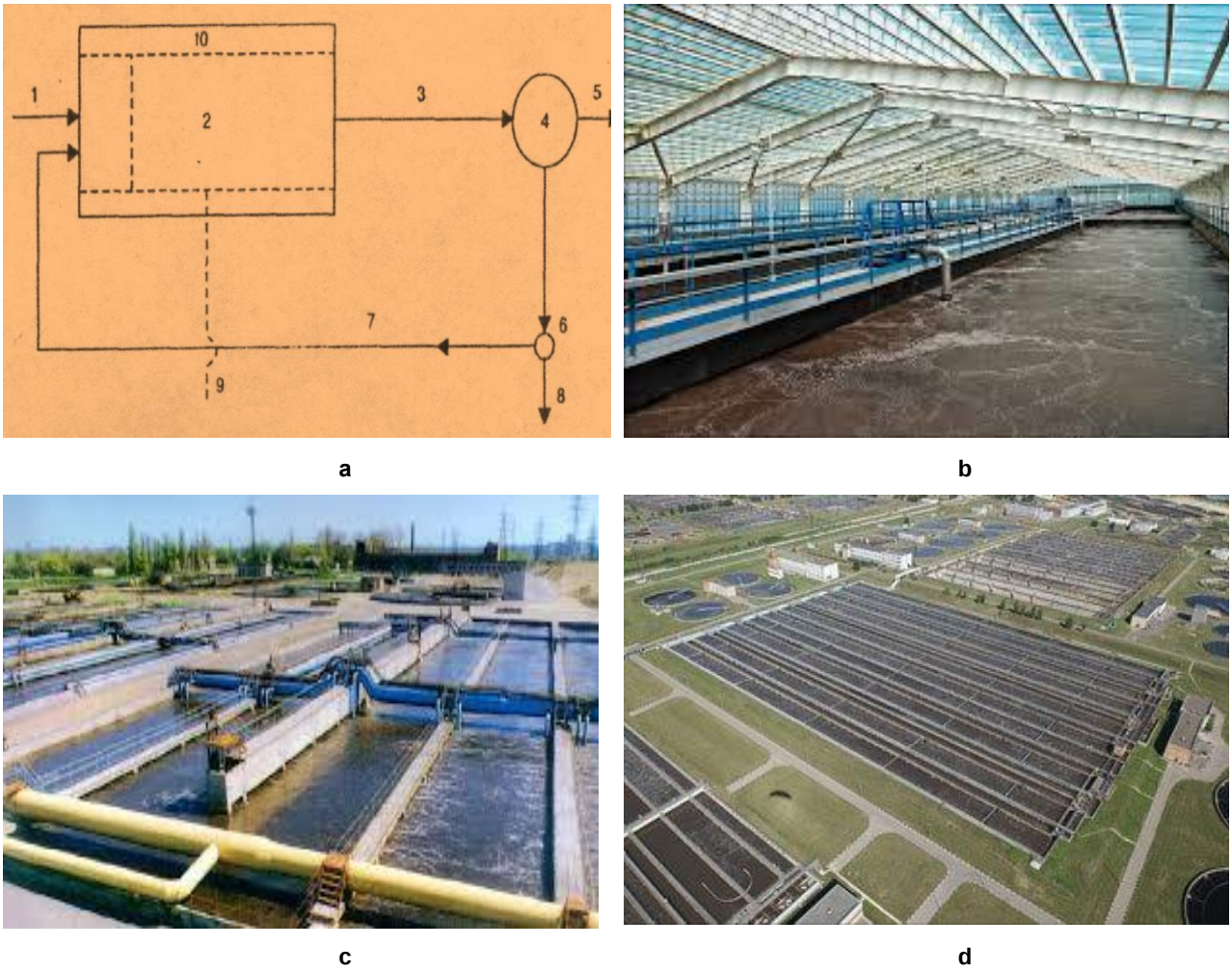
After the aeration tanks, clean water is supplied to the sedimentation tanks, where the activated sludge settles down with its subsequent partial return back to the tank.

In bioremediation, the processes of destruction of harmful components effectively proceed in the presence of certain temperature, atmospheric conditions, as well as the composition of wastewater, etc. The mechanism of separation of products from wastewater produced by the biosphere is very complex, has many steps, and requires very specific conditions.

In aeration tanks, the microbial mass that carries out cleaning remains in suspension in the form of separate flakes. It is the process of separating these flakes that is the most time consuming and laborious step. Most often, this operation is carried out by settling. But even after settling, the sludge contains a large amount of water. It takes 2-4 weeks to bring the aeration tank into the design mode.

Since the flow of wastewater cannot be stopped, therefore, for the treatment to proceed continuously, a block consisting of a large number of these units is required. The process can be accelerated due to the initiation of "foreign" activated sludge. Instead of an aeration tank, a biofilter can be built, the principle of which is the same. A secondary clarifier is required in the circuit.

There are a large number of biofilters modifications: drum, drum submersible, submersible disc, and others. Biofilters have layers loading height of 2, 3 and 4 m Loading weight for large biofilters is dozens of tons. It should be noted that the loading requires periodic cleaning.



a **b**

c **d**

Fig.3.2. The traditional scheme of sewage water biological treatment (a) and external view of various biological treatment complexes (b, c):

1 – sewage water after preliminary septic tanks; 2 - aeration tank; 3 – sludge mixture from aeration tanks; 4 – secondary sedimentation tank; 5 – purified water; 6 – sludge chamber; 7,8 – circulating and surplus activated sludge; 9 – air from blast blower; 10 – aeration system for air supply and distribution inside aeration tank.

The main disadvantage of biological treatment systems is the instability of the operation of biological treatment facilities. It is determined by the complexity of structures, multistage processes, difficulties in regulating the composition of activated sludge. The course of biochemical reactions largely depends on the chemical composition of wastewater, the particle size of suspensions in wastewater, as well as external factors: temperature, pressure, etc. This determines the instability of the degree of purification. In general, the treated water does not meet the requirements of the sanitary and epidemiological service.

One of the significant problems in this technology is the disposal of excess sludge (sewage sludge) and the need to allocate fields for its accumulation and storage. Without additional purification of sludge from heavy metals and toxic chemical compounds, it is not suitable for use as organic fertilizers. To solve this problem, biotechnology is helpless.

Comparison of technological lines of biological treatment with technological complexes for wastewater treatment using devices for micro-arc treatment in rotating magnetic fields (Table 3.3) shows many advantages and high competitiveness of the innovative technology using Plazer-RF installations in almost all main technical and economic indicators.

Among the benefits and advantages of the innovative technology, first of all, it should be noted the possibility of complete utilization of wastewater with the possibility of obtaining commercial products - purified water, organic fertilizers, purified fine sand, metal concentrate.

And in biological treatment systems, the full cycle of wastewater disposal is not achieved, since there is a need for additional disposal of sludge (sludge), including its disinfection and dehydration. At the same time, there is still the problem of cleaning this sludge from heavy metals, which in most cases cannot be solved.

A very important advantage of the innovative technology is the absence of the need for sludge beds, which in biological treatment complexes occupy tens and hundreds of acres and cause great harm to the ecology of the environment.

In addition, equipment for micro-arc treatment in rotating magnetic fields has a significantly lower material consumption and lower energy consumption of the cleaning process.

Table 3.3.

3.2.2. Comparison of some technical and economic indicators of biological treatment process lines of technological complexes for sewage treatment using devices for microarc processing in rotating magnetic fields (or installations of processes activation - IPA)

No	Names of indicators	**Traditional technology:** biological treatment complexes	**Innovative technology:** complexes for sewage treatment with microarc processing in rotating magnetic fields
1	Performance (by the number of treated effluents)		
	- minimum	Up to 0,05-1 m^3 / hour	Up to 4-5 m^3 / hour in continuous operation Unlimited - for periodic work
	- maximum	Limited to the area required for accommodation of aeration tanks, sedimentation tanks, filters, etc.	Without limitation, determined by the number of used Plazer-RF devices
3	Sludge pads area to ensure continuous operation of wastewater treatment equipment - for performance:	Sludge beds are required. (the size of one map of sludge areas is usually at least 25 x 24 x 1.3 m)	Not required
	- 24 m^3 / day	Not less than 3 hectares	
	- 280 m^3 / day	Not less than 50 hectares	
6	Restrictions on wastewater treatment by the limiting content of impurities in them mg / l	200-800	Up to 10 000 and more
9	Temperature limitations of incoming wastewater	Not less than 8-10 °C	Not less than 0-5 °C

10	Energy consumption (excluding electricity consumption for mechanical dewatering and thermal treatment of sludge), kWh / m^3	More than 1.3-3.5 - does not include electricity consumption for mechanical dewatering and thermal treatment of sludge	Less than 1.5-2.5 - includes dewatering and sludge treatment
11	The need for additional purification of water to sanitary requirements for discharge into natural reservoirs	Additional post-treatment department is required	Not required
12	The need to dehydrate the sludge after cleaning	In most cases, it is necessary to apply additional dewatering processes with additional energy costs. ... For example, the specific power consumption for dewatering per 1m^3 of dry sludge is: - centrifugation 1.5-40 kW / hour / m^3; - vacuum filtration 2-50 kW • h / m^3 - thermal drying in dryers with counter streams 20-180 kW • h / m^3	Not required
13	Disinfection of sediment (sludge) from microorganisms	A special department (site) for disinfection is required. Electricity costs for disinfecting sediment in deworming chambers are usually: - up to 160-650 kW / h per 1 ton of sediment	No special department (section) for disinfection is required, this is included in the cleaning process
14	Possibility to remove heavy metals	No, requires the use of other technologies	Achieved removal of heavy metals below the requirements of maximum permissible concentrations (MPC) according to sanitary standards
15	Restrictions on wastewater treatment in terms of the content of alcohol, surfactants, chemical compounds, etc.	The possibility of purification depends on the content of these components in the wastewater	No
16	Sedimentation rate	Very low - the settling process takes several days	High - sedimentation takes place in time from several minutes to several tens of minutes

17	Purification level	Does not always meet the sanitary and epidemiological standards. services	Complies with the standards of sanitary and epidemiological services
18	Limits on the size of solid particles present in the sewage	Less than 0,1 mm	Less than 1,0 mm
19	Disposal of wastewater products	Complete utilization is not achieved through biotechnology. It is necessary to use other methods of sewage sludge	Utilization of wastewater products is carried out to obtain cost-effective products
20	Products obtained after wastewater treatment	Purified water following sanitary standards for discharge into natural reservoirs	➢ Water purified following sanitary standards for discharge into natural water bodies, for irrigation or technical purposes; ➢ Organic fertilizers, ➢ Building material - refined fine sand; ➢ Concentrate of metal hydroxides (raw materials for metallurgy)
121	New positive properties of purified water	No	Purified water acquires biologically active properties, has a positive effect on plant growth during watering, has fungicidal, antibacterial, and anthelmintic properties

3.2.3. Comparative technical and economic indicators of innovative technology with other traditional wastewater treatment and disinfection systems.

Excess of specific indicators of processing devices in rotating magnetic fields over similar indicators of the replaced equipment

Process	Previously used equipment	Exceeding specific indicators (number of times)		
		Increase in specific productivity	Decrease in specific metal consumption	Decrease in specific energy consumption
Oxidation of phenol in wastewater	Reactors with a capacity of 18 m^3	21 400	1 500	960
Purification of wastewater from heavy metals by precipitation in the form of hydroxides	Reactors with a capacity of 12 m^3	15 100	40	3

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