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### ИМПОРТОЗАМЕЩЕНИЕ В СЕКТОРЕ ВОДОПРОВОДНО-КАНАЛИЗАЦИОННОГО ХОЗЯЙСТВА

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#### О СТАТЬЕ

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#### Ключевые слова:

импортзамещение, водопроводно-канализационное хозяйство, станции водоподготовки, оборудование для станций водоподготовки, мешалка с регулированием скорости вращения, скребок для удаления осадка из отстойника.

#### АННОТАЦИЯ

Импортзамещение в секторе водопроводно-канализационного хозяйства (ВКХ) в условиях современного экономического кризиса является достаточно актуальным направлением. Проблема импортзамещения в отрасли ВКХ сложна, характеризуется такими особенностями, как условия производства, наличие научных разработок, интенсивность отношений с зарубежными коллегами. Для многих участников сектора ВКХ реализация мероприятий по снижению зависимости от иностранных поставщиков с ориентацией на отечественных производителей в рамках импортзамещения становится приоритетной.

Целью настоящей статьи является оценка целесообразности импортзамещения в отрасли ВКХ России и выбор оборудования в области водоподготовки, которое можно производить в России с целью создания конкурентоспособной на мировом рынке продукции.

В данной статье представлен обзор и анализ номенклатуры основного и вспомогательного оборудования сектора ВКХ. В статье предложен обзор патентов на полезные модели в области водоподготовки, которые с экономической точки зрения целесообразно производить на отечественном рынке промышленности, однако в настоящее время они ввозятся из-за границы. Статья посвящена вопросам: насколько процессы импортзамещения востребованы отраслью водопроводно-канализационного хозяйства России и какое оборудование целесообразно производить в России, а не закупать за рубежом.

Структура настоящей статьи следующая:

- история развития отрасли водоснабжения и водоотведения;
- анализ текущего состояния отрасли водоснабжения и водоотведения России и обзор основного технологического оборудования для станций очистки природных вод и очистки сточных вод;
- обзор патентов на полезные модели в области очистки воды;
- заключение.

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## **IMPORT SUBSTITUTION IN THE INDUSTRY OF WATER SUPPLY AND SANITATION**

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import substitution, the industry of water supply and sanitation, water treatment plants, water treatment equipment, variable speed stirrer, sludge scraper.

### ABSTRACT

Import substitution in the industry of water supply and sanitation (WSS) in the context of the current economic crisis is a rather attractive operation. The problem of import substitution in the water supply and sanitation industry is complex being characterized by features such as production conditions, the availability of scientific and technical developments, the intensity of relations with foreign colleagues. Many WSS sector participants focus on implementing measures to reduce their dependence on foreign suppliers and shifting to products of domestic manufacturers within the framework of import substitution.

The overall goal of this paper is to assess the feasibility of import substitution in the sector of water supply and sanitation in Russia. In addition, the article offers a choice of equipment in the field of water treatment, which can be produced in Russia in order to create products that are competitive on the world market.

This article provides a review and analysis of the nomenclature of the main and auxiliary equipment for the water supply sector. The article offers an overview of patents for useful models in the field of water treatment which are feasible to produce in the domestic industrial market, however, they are currently imported from abroad. The review investigates the extent of import substitution demanded by the industry of water supply and sanitation in Russia. It also describes types of water treatment equipment to be produced in Russia.

The structure of the paper is as follows:

- the history of the development of water supply and sanitation industry;
- the analysis of the current status of water supply and sanitation industry of Russia and review of basic technological equipment for natural water treatment plants and for wastewater treatment;
- the review of utility model patents in the field of water treatment;
- the conclusion.

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## **Introduction**

Import substitution has been very relevant since 2014. The need to shift to domestic materials and equipment has become particularly acute for almost all the sectors of the Russian economy in the current economic and political situation. Import substitution is reflected in regulations [1]. This fact has an impact on the sector of water supply and sanitation (WSS). The problem of import substitution in the WSS sector is complex. It is characterized by features such as production conditions, scientific and technical developments, relations with foreign colleagues. Implementation of measures to reduce dependence on foreign suppliers with a focus on domestic producers within the framework of import substitution is becoming a priority for many participants in the industry of water supply and sanitation. Thus, the study and elaboration of this problem is very relevant taking into account the constant changes both in the Russian and the world economy [2, 3].

The overall goal of this paper is to assess the feasibility of import substitution in the sector of water supply and sanitation in Russia. In addition, the article offers a choice of equipment in the field of water treatment, which can be produced in Russia in order to create products that are competitive on the world market.

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- the conclusion.

## **Methods**

### **The history of the water supply and sanitation industry**

Relevant processes of import substitution are to be taken into account in order to get an understanding of the history of the water supply and sanitation industry and long-standing practices for designing and operating water and sanitation facilities.

Chairman of the Expert and Technological Council of the Russian Association for Water Supply and Sanitation E.I. Pupyrev, Head of the Center for Technical Policy and Modernization in Housing and Public Utilities D.A. Danilovich emphasize in the article “Import Substitution in WSS: What is Needed and Possible” that the initial stage of development of centralized water supply facilities in Russia was inextricably linked with the use of imported pumping equipment [4].

Options to purchase imported equipment were limited in the first 10-15 years of the post-revolutionary period. At the same time, there was a strong engineering school in the WSS sector, which ensured the further development of the industry. For example, the Lublin aeration station was built in Moscow in the 1930s [4].

Foreign relations were again strengthened after the collapse of the stock exchange in the United States in 1929 [4, 5]. At that time, many Western qualified specialists came to work in the USSR, bringing their knowledge of modern high-tech equipment.

Relations with foreign colleagues changed dramatically with the beginning of the Cold War (1946-1989), which was a prerequisite for the formation of a large self-sufficient domestic market. This led to the development of water supply and sanitation industry, but the growth and development trends depended on the economic policy within the existing planning system. Russia produced dry installed pumps, blowers, grates, sludge scrapers and suckers in this period. According to [4], equipment for sludge dewatering came to the industry from the pulp and paper, coal and mining industries. There was a shortage of mineral reagents.

However, foreign equipment for treatment facilities in Moscow and Leningrad was only partially available. For example, it was decided to purchase centrifuges and imported flocculant for the Central aeration station in Leningrad [4, 6]. An ozonation shop was procured for the Eastern water supply station in Moscow. In addition, a German complete unit for thermal conditioning and sludge dewatering was bought for the Lyubertsy treatment facilities in Moscow [4].

The share of imported equipment that is part of treatment facilities in Russia has increased significantly after the 90ies of the twentieth century. During the same period, there was a tendency to switch to more efficient and more technologically sophisticated of natural and wastewater treatment in many large cities of the country.

Today, treatment facilities are a complex combination of specialized high-tech engineering equipment that provides preparation or treatment of natural water or wastewater to the established standards in line with local requirements.

## Analysis of the current status of the Russian water supply and sanitation industry

The article analyzes the current state of the water supply and sewerage industry. It summarizes and systematizes the range of equipment for water supply stations and treatment facilities. The article identifies and describes 6 types of equipment which have no domestic analogues.

For 17 items of basic equipment, domestic samples do not provide the necessary quality (efficiency) (Table 1). It is necessary to use 20-25 % of imported components to ensure the efficient operation of natural water purification plants, and 35 % components are needed to operate complex sewage treatment plants (Table 2).

Table 1

Specification of basic technological equipment for natural water treatment plants

<b>Water abstraction, pumping stations 1, 2 lifts</b>	<b>Membrane ultrafiltration</b>
Dry installed pump/submersible pumps with frequency-controlled drive	Membrane
<b>Mixer and flocculation chamber</b>	Flushing pump of membrane
Variable speed stirrer	Membrane washing water treatment facilities
<b>Sedimentation tanks</b>	<b>Chemical plant</b>
Thin layer module	Coal pulp metering pumps
Metering pump of flocculent	Metering pump of coagulant
Sludge scraper	Metering pump of flocculent
Flocculant preparation unit	Apparatus for the preparation of flocculent
<b>Sand filter</b>	Metering pump of sodium hypochlorite
Drainage	Metering pump of acid/lye
<b>Ozone treatment</b>	Silos for Coal (PAK)
Compressor	<b>Facilities for the circulation of filter washing water</b>
Desiccant	Booster pump
<b>Sorption of powdered activated carbons</b>	<b>Facilities for the sludge treatment</b>
	Metering pump of flocculent
Stirrer in carbon contact pool	Apparatus for the preparation of flocculent
	Flushing pump of membrane

The symbols:

There are no domestic analogues

The sub-optimal domestic analogues

Table 2

Specification of basic technological equipment for wastewater treatment

<b>Decontamination facility</b>	<b>Filters block</b>
Pump	Packaged quartz sand filter
Compressor	Pneumatic control panel
Mini wash of module	<b>Pumping station of compressed sludge</b>
<b>Chemical plant</b>	Submersible pump
Reagent dissolving pump	<b>Workshop for dewatering and drying of sludge</b>
Metering pump	Stirrer of recipient reservoirs
<b>Pumping stations of return flows</b>	Macerator
Submersible pump	Sludge feed pump for decanters
<b>Compressor shop for filters block</b>	Decanters
Compressor	Screw discharge transporter

Receiver	Flocculant preparation station
<b>Workshop of grates</b>	Metering pump of flocculent
Automated pump assembly	Dewatered sludge feed pump to the dryer
Submersible drainage pump	Dryer
Screw transporter	Dry sludge discharge conveyor
<b>Sand traps</b>	Circulating air fan
Submersible sand pump	Exhaust air fan
<b>Units block</b>	Scrubber for air cooling
Scraper mechanism	Biofilter for air purification
Turning pipe	<b>Pumping station for drainage water from emergency silt sites</b>
Submersible stirrer	Submersible pump

The symbols:

There are no domestic analogues

The sub-optimal domestic analogues

Based on the above, this paper reviews patents for useful water treatment models in order to analyze the inventions of Russian and foreign colleagues and to find a solution for upgrading the water treatment equipment.

Upon analyzing the nomenclature of the main technological water treatment equipment, the following devices will be considered:

1. Variable speed stirrer for mixer and flocculation chamber.
2. Scraper for removing sludge from the sump.

The decision to consider these two types of water treatment equipment is related to the fact that to ensure optimal water treatment it is necessary to import, first of all, scrapers for removing sludge from the sump, various stirrers, all membrane equipment, starting with membranes, dispensers, flocculant preparation units, etc. Despite the fact that the domestic industry produces this equipment, its reliability, which is understood as the number of hours between failures, is several times inferior to equipment of Western European production [7, 8].

The idea of import substitution is not feasible for the entire range of equipment in the water supply and sanitation sector. The degree of production localization and creating competitive products on the world market are factors that influence the implementation of import substitution in the Russian sector of water supply and sanitation. For a number of positions, the purchase of imported equipment will always be more appropriate. Therefore, this paper focuses on the above-mentioned items of water treatment equipment.

The patent RU 2 578 156 C1 [9] shows and describes the stirrer with coaxial placement of confusers fixed at the ends of the radial spokes of the rotor (Fig. 1). The design of confusers is considered with inlet flared openings facing in the direction of rotation. Confusers are interconnected by longitudinal ribs. The confusers pick up the liquid when the stirrer rotor rotates. The speed of movement of fluid flows increases significantly at the exit from them. The flows hit one another and the liquids located outside are mixed together inside the working body of the rotor. The totality of these effects on the fluid such as stroke, cavitation leads to intensive dispersion and mixing of the components resulting in a homogeneous structure.

The patent RU 2 680 503 C1 [10] outlines the mixer containing a driven vertical shaft and a rotor with radial spokes (Fig. 2). Confusers at the ends of the spokes are fixed in pairs coaxially to each other using longitudinal ribs. Confusers are made in the form of straight round hollow truncated cones. Cones large bases are turned towards the rotation [11]. On the lower base of the

outer confusers mounted coaxially to them hollow cones made in the form of a Laval nozzle. It has been experimentally established that the efficiency of a mixer with a Laval nozzle for mixing liquid-solid systems is 30-45 % higher than a mixer made according to the prototype scheme (RU 2 578 156 C1 [9]) with equal hydraulic resistance.

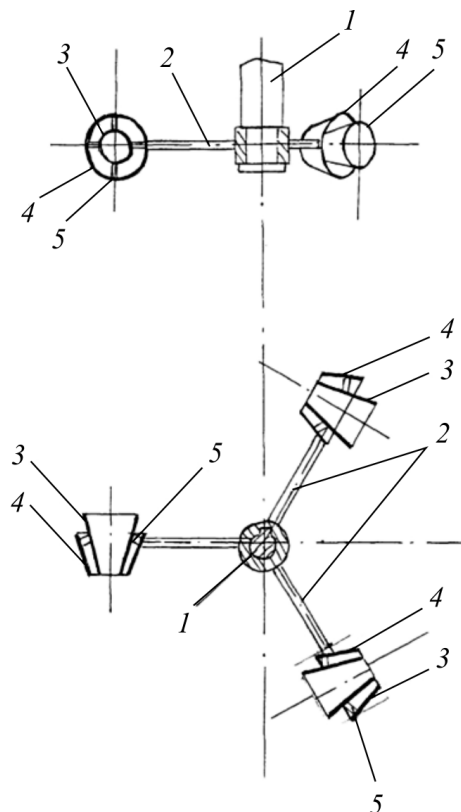


Fig. 1. Stirrer with coaxial placement of confusers fixed at the ends of the rotor radial spokes

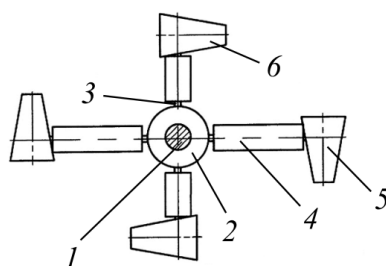


Fig. 2. Stirrer with a Laval nozzle

The patent RU 2 277 964 C2 [12] shows the stirrer and its vertical shaft on which a horizontal rotor with spokes and blades is mounted (Fig. 3). Confusers are installed at the ends of the blades, facing the expanding sides in the direction of the rotor rotation. Inside each confuser, hyperbolic turbulators are installed, their top facing the rotation of the confuser. When the rotor rotates, the confusers pick up the liquid. Getting into the confusers, the liquid changes its direction of movement when it meets the turbulator. The liquid is pressed against the confuser wall and then exits through the slit space. Cavitation of the mixture occurs in the liquid behind the turbulator. Cavitation disperses the liquid. In addition, when the flow leaves the confuser, the speed of its movement increases manyfold.

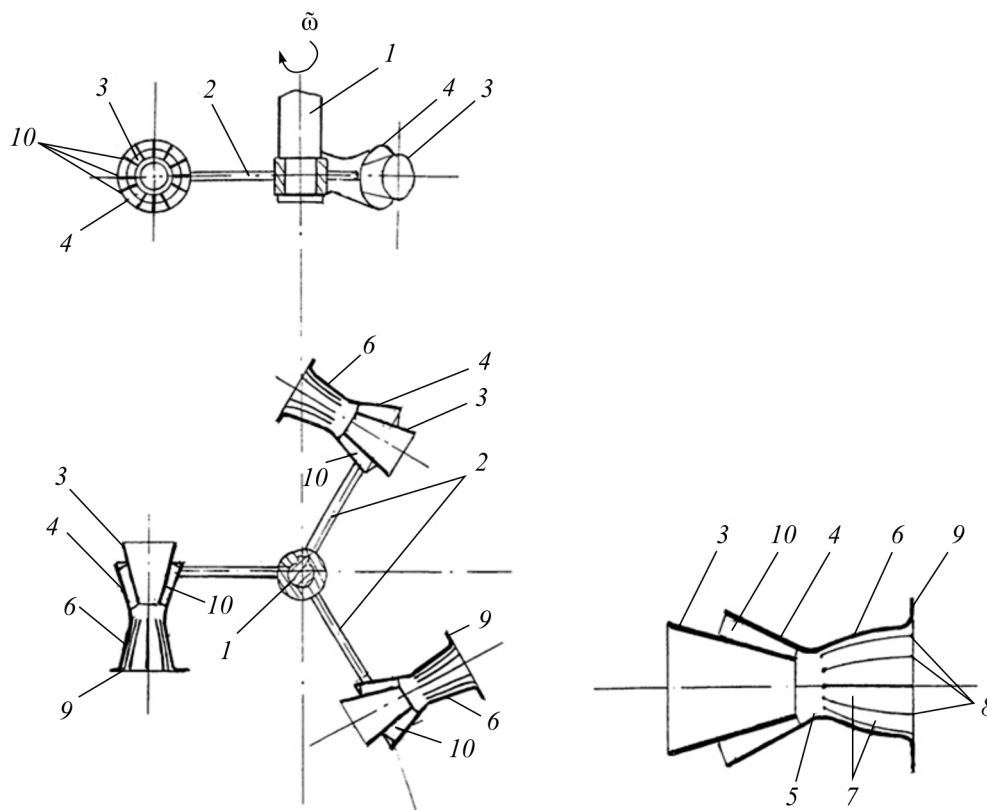


Fig. 3. Stirrer with hyperbolic turbulators installed inside the confusers

The patent RU 2 716 679 C1 [13] shows a stirrer with a spherical kneading body (Fig. 4). The spherical shape causes excessive pressure in the direction of movement in front of the kneading organ, acceleration of the liquid from the outside around the kneading organ and low pressure in the liquid in the direction of movement behind the kneading organ [14, 15]. These processes ensure very gentle mixing of the material without introducing significant tangential forces.

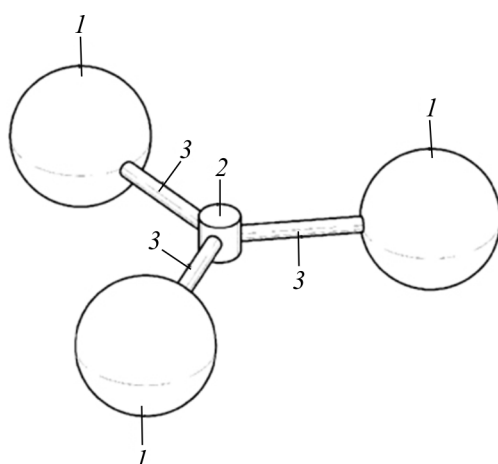


Fig. 4. Stirrer with a spherical kneading body

The patent RU 2 348 461 C2 [16] reveals an auxiliary mixer for a flotation device for use in the separation of minerals (Fig. 5). The auxiliary stirrer includes an auxiliary mixing paddle located above the main rotor to create axial fluid flow. The device has a connecting means for

connecting the auxiliary mixing blade to the drive shaft for simultaneous rotation with the main rotor [17]. An auxiliary stirrer is used in a mixing device that has a main mixer including a rotor, a drive means, and a drive shaft. The mixer is used in a flotation device that includes a tank feeding an inlet, a sludge aeration device [18]. The technical result is an increase in the flotation efficiency [19].

The patent RU 154 397 U1 [20] describes a device for mechanical removal of sludge from the sump. The device contains a bearing girder and a group of scrapers, which have a kinematic connection both with the bearing girder and among themselves. The group of scrapers together forms one dump at the bottom of the sump. The kinematic connection of each scraper to the carrier girder is formed of four bearing rods. The rods are combined into a rectangular structure, in which one end is pivotally connected to the supporting frame, and the other is pivotally connected to the corresponding supporting frame. The scraper, in turn, is rigidly connected to the said supporting frame and a gap is formed between its lower edge and the bottom of the sump. The gap changes as the scraper moves over the bottom under the influence of the sediment dump formed in front of it. This new technical solution allows for creating a device for mechanical removal of sediment from the sump, which ensures the achievement of the following technical result. The technical result consists in increasing the durability of the device while maintaining the bottom surface of the sump and promptly removing the precipitated sediment from the wastewater from it. This is achieved due to the fact that the kinematic connection between the scraper and the active carrier is formed by a rectangular structure. One of the ends is pivotally connected to the active carrier and to the frame, under which the scraper is located.

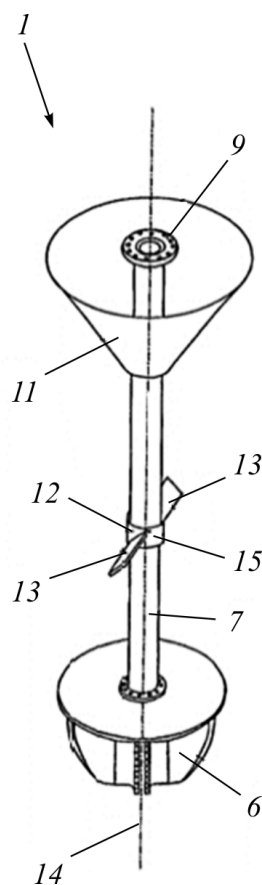


Fig. 5. Auxiliary mixer  
for a flotation device



The patent RU 2 442 635 C2 [21] describes the invention which is related to the technology of wastewater treatment in radial sumps. Purification is carried out by removing suspended particles of insoluble substances from the effluent which fall to the bottom of the sump in the form of sediment. The device contains an active carrier and a group of main scrapers which have a kinematic connection both with the active carrier and with one another (Fig. 6). So a dump is formed at the bottom of the radial settling tank. The device is equipped with a group of additional scrapers distributed along the dump and kinematically connected to the active carrier. Each of the scrapers is installed in front of the blade at a distance not less than the height of the main scraper. The technical result of the invention is to provide effective cleaning of the bottom of the radial sump while the energy consumption remains minimal.

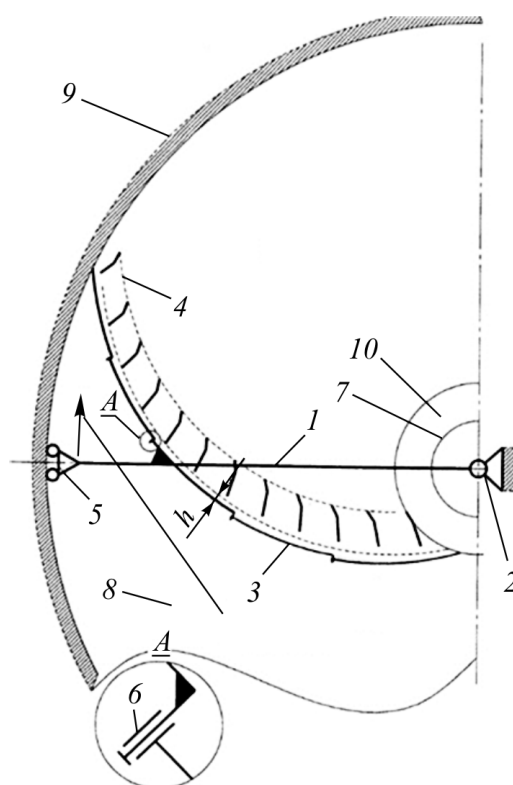


Fig. 6. Device for wastewater treatment  
in radial sumps

## Results and future work. Conclusion

This review has outlined the nomenclature of the main equipment for water treatment plants and sewage treatment plants. Russian and foreign patents in the field of water treatment for a variable speed stirrer and a sludge scraper have been considered. This could be helpful in upgrading the existing equipment and manufacturing competitive products in the Russian and the global market.

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