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Monitoring of Innovative Technologies and Projects in the Sector of Essential Water Resource Management Aimed at Sustainable Development of Northern (Arctic) Regions of Russia

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Abstract

Objective: The study is aimed at identifying and analyzing technologies and projects in the sector of essential water resource management and wastewater treatment focused on industrial introduction in the Northern (Arctic) Regions of Russia and promoting their sustainable development. **Methods:** An expert study is a key method of research. The concept and methodology have been developed for monitoring and two-level expert evaluation of projects and technologies, the selection criteria have been determined. While forming the research methodology, the experience of Western countries in the two-level expert evaluation was taken into account. Nine experts in water resource management and wastewater treatment were invited. Mathematical processing of expert data was carried out by an averaged evaluation of the expert committee members' opinions and by determining the resulting expert opinion. Statistical and economic research method was used to analyze the markets for application of the selected technologies. **Findings:** The theoretical and methodological framework has been developed to select the most promising projects. An array of information about the world and Russian markets of water treatment and wastewater treatment has been formed. The problems have been identified that hinder the development of this industry in Russia and in the world, an electronic catalog of existing and emerging projects and technologies has been created. With a view to the urgency and importance of the Arctic Russia the priority was given to projects with a high stage of development. Recommendations have been developed to improve the effectiveness of cooperation between Russian educational and scientific institutions conducting research in the field of water resource management and wastewater treatment and industrial enterprises operating in the northern regions of Russia. To determine the key scientific leaders in the given subject area we assessed the degree of readiness of Russian scientific institutions to participate in the innovative development of the northern regions and to introduce advanced technologies of water resource management and wastewater treatment. The obtained results serve as a basis for decision making in the implementation of an effective policy for the development of the Russian Arctic regions, which since 2016 will complement the range of activities, developed in 2014 within the Russian government decree. **Applications:** A suite of selected technologies will enable enterprises to organize environmentally safe activities for sustainable development of the Arctic regions of Russia. At the same time, it can be used regardless of the climatic conditions and can serve for effective environmental development of industrial enterprises in all climatic zones.

Keywords: Biological Treatment, Innovative Project, Inter-university Cooperation, Membrane Technologies, New Industrial Technologies, The Arctic Region, Wastewater, Water Resource Management

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1. Introduction

To date, research in the field of water conditioning and purification and wastewater treatment is one of the key areas of research and development focused on Russia's Arctic zone. The relevance of this research area is determined by the intensive exploration of the northern territories of Russia in oil and gas, as well as in other industries. The relevance of this research issue is also conditioned by the specific character of water resource management in the Extreme North context[1], when most of the water intake is made from surface sources, which requires further water purification. For comparison, in the southern regions of the bulk of the water intake is formed by ground water, requiring virtually no deep processing. In addition, the presence of permafrost creates problems for the wastewater disposal.

In the development of new technologies for water conditioning and purification and wastewater treatment research activities are carried out by more than 1,000 organizations, however, today there are no scientific papers in Russia aimed at systematizing the whole scientific experience of the recent years in the sector of essential water resource management. As part of the research work carried out with the support of the Ministry of Education and Science of the Russian Federation, the aim was pursued to carry out monitoring of scientific activity in the field of developing responsible water resource management technologies, and to identify the most promising among them, which are able to have the greatest impact on the development of industrial regions of the Extreme North of Russia.

The RF Government Regulation dated 21.04.2014. No. 366 "On the Approval of the Russian Federation State Program "Social and Economic Development of the Arctic Zone of the Russian Federation for the period until 2020"[2] determined a special status of the Arctic Regions and established benchmarks and targets for the development of the Extreme North of Russia. In this context, the problem of the modernization of existing technologies and development of new ones in the sector of essential water resource management takes on added urgency, especially for the Northern regions of Russia. Moreover, in the last decade in Russia the wastewater treatment infrastructure depreciation rate amounted to more than 80%, and the depreciation rate continues to increase by 2-3% per year[3].

This research is relevant not only for the Russian Arctic area and the Extreme North Regions, but for the entire Russia as well. This is explained by the fact that today more than 70% (13.7 cubic km) sewage being subject to wastewater treatment are discharged inadequately treated, and almost 20% (3.7 cubic km) are discharged contaminated without any treatment, and only 10% (1.9 cu. km) are treated[4].

2. Research Methodology

In the first phase of the research work on the monitoring of the projects and technologies in the sector of essential water resource management in the world practice no concepts were found that would be fully consistent with the objectives of our scientific work. In this regard, the authors have developed own concept of monitoring and two-level expert assessment that includes the following key steps: applying for a dedicated resource on the Internet, a preliminary evaluation, the first stage of expert evaluation, the second stage of the expert evaluation, projects ranking and completion activities. Monitoring stages and the selection process are presented in Figure 1 in more detail[5].

To form a general concept, we used the EU and Euratom practice for the two-level expert evaluation of promising projects[6,7].

After developing the monitoring concept using Science Citation databases monitoring of Russian scientific organizations with regard to their scientific work (or innovative projects and technologies ready for the introduction of) was carried out in the field of water conditioning and purification and wastewater treatment.

To evaluate the research activities in these areas, identify key players, and assess the changes in the value of the annual scientific contribution from the 20th to 21st century

Offer
Preliminary evaluation
Individual evaluation
Consensus panel
Sifting according to debarring criteria
Expert panel
Project ranking
Negative decision on the project
Positive decision on the project
Project hearings (optional)
The applicant is informed about the evaluation results
The applicant is informed about the final decision

Figure 1. Stages of the process of monitoring and selecting technologies and projects in the sector of essential water resource management.

we analyzed scientific works published in more than 240 universally recognized Russian scientific journals on the subject. The analysis of the research activities was carried out over the past 5 years (2010 - 2014) using the Russian Science Citation Index (RSCI)[8].

The next stage of research work referred to interacting with the scientific institutions that have made the greatest contribution to the development of essential water resource management technologies over the past 5 years, resulting in the formation of the registry of the most promising technologies in this domain, which also includes the registry of key developers.

The compiled detailed list of the most promising projects in the sector of essential water resource management allowed holding a two-level expert evaluation, for which 9 independent experts specializing in water resource management and wastewater treatment were invited.

At the final stage of work, we developed the recommendations for improving the effectiveness of cooperation between Russian higher educational institutions with industrial enterprises, operating in the sector of essential water resource management and wastewater treatment in the territory of the Northern (Arctic) Regions of Russia.

In addition, the proposals were formulated to introduce the best of the selected projects, and the readiness of Russian research organizations conducting scientific activity in the field of water conditioning and purification and wastewater treatment (selected within the study) to participate in the implementation of innovative programs and environmentally sound development of enterprises for sustainable performance of the Arctic Regions of Russia.

3. Results

3.1 The Results of the Analysis of the Research Activities of Russian Research Institutions in the Sector of Essential Water Resource Management

The analysis of the research activities of Russian research institutions in the sector of essential water resource management over the past 5 years has allowed achieving three key outcomes:

1) A list of organizations was drawn up, which made the greatest contribution to the scientific development of water conditioning and purification and wastewater treatment in the period from 2010 to 2015;
2) The water resource management technologies were determined, which currently get the most attention on the part of Russian scientists and developers;
3) Sectors of the economy with the highest scientific potential for the introduction of new technologies relating to water resource management were identified.

Table 1 gives the list of 30 scientific institutions in Russia which have made the greatest contribution to this scientific area in the period from 2010 to 2015. Projects and technologies in the sector of essential water resource management, developed by these organizations, were selected for the two-level expert evaluation.

It is important to note that the main driving forces of scientific development in these areas are the Universities and research organizations. The share of industrial companies is much lower.

As for the most popular technologies of essential water resource management, the research found that the most studied technologies in water conditioning and purification are: membrane technologies, which include microfiltration, ultrafiltration, nanofiltration and reverse osmosis; reagent cleaning and electromagnetic treatment. In total between 2010 and 2015these technologies accounted for 48% of published scientific papers in the field of water conditioning and purification. In the area of water treatment, most scientific papers are devoted to biological treatment, and the interest of scientists in to the membrane technologies (including in the wastewater treatment sector) increases annually. This conclusion has also received confirmation during the two-level expert evaluation.

In the course of research, it was also revealed that the various sectors of the economy have different potential for the introduction of new technologies. The following sectors have been recognized as the most promising: water management, housing and utilities, and household water supply, power engineering, chemical industry, architecture ab civil engineering, machine building, food industry, mining, agriculture and forestry, metallurgy, biology and ecology.

3.2 Determination of Target Regions within the Framework of Research Work

It is important to note that the ongoing monitoring is focused on the selection of essential water conditioning and purification technologies for industrial implementation

Table 1. Thirty institutions with the largest contribution into the scientific development of water conditioning and purification and wastewater treatment

#	Scientific Research Institution	Works
1	Kazan National Research Technological University	170
2	D. Mendeleyev University of Chemical Technology of Russia	137
3	Moscow State University of Civil Engineering (National Research University)	127
4	Kazan State Power Engineering University	118
5	Ufa State Petroleum Technological University	72
6	Irkutsk State Technical University	67
7	Bauman Moscow State Technical University	62
8	Perm National Research Polytechnic University	56
9	Volgograd State Technical University	51
10	Samara State University of Architecture and Civil Engineering	49
11	National Research Tomsk Polytechnic University	48
12	Rostov State University of Civil Engineering	44
13	Penza State University of Architecture and Civil Engineering	39
14	South Ural State University (National Research University)	37
15	Yuri Gagarin State Technical University of Saratov	36
16	Moscow State University of Mechanical Engineering (MAMI)	35
17	Kazan State University of Architecture and Civil Engineering	26
18	National Mineral Resources University (Mining University)	25
19	Belgorod State Technological University named after V. G. Shoukhov	25
20	Kuban State Technological University	24
21	Tomsk State University of Architecture and Civil Engineering	23
22	Far Eastern Federal University	21
23	Petersburg State Transport University	21
24	Kazan (Volga Region) Federal University	20
25	Ural Federal University named after the first President of Russia B.N. Yeltsin	19
26	Ivanovo State Power Engineering University named after V.I. Lenin	17
27	Moscow State University of food production	16
28	National Research University Moscow Power Engineering Institute	13
29	Nizhny Novgorod State University of Architecture and Civil Engineering	8
30	Moscow State University of Technologies and Management named after K.G. Razumovsky	7

in in the Northern Regions of Russia (Figure 2). These regions have been defined by law as far back as in the USSR[9]. Nevertheless, most selected technologies are no specifically bound in the terms of climate, therefore, they may be implemented anywhere in Russia. Thus, virtually any technology of water conditioning and purification or wastewater treatment enables to accommodate the required equipment in purpose-built modular structures.

Within the research framework all the selected technologies of water conditioning and purification and wastewater treatment can be applied in the Arctic climatic conditions (conditions of the Extreme North, i.e. in the presence of melting or solid ice ranging from 60 to 100% during the year and at a temperature below 40°C for more than 10 % of the time per year[11,12].

3.3 Market Research Results

Following the research results the total volume of the Russian market of water conditioning and purification and wastewater treatment is estimated at RUB 107 billion,

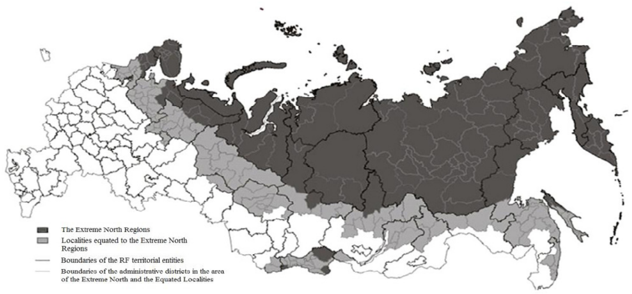

Figure 2. Statutorily established borders of the Extreme North Regions and Equated Localities (geographic demarcation of the Institute of Economic Problems, Kola Science Center, Russian Academy of Sciences)[10].

with 48.6% of the total amount accounting for cleaning reagents. This segment is still dominant in the structure of the Russian market as chemical reagents (coagulants, flocculants, etc.) are used not only in the chemical or reagent wastewater treatment, but even in mechanical processing, for example, in the wastewater sludge dewatering with centrifuges at the municipal sewage stations.

According to Frost & Sullivan, the Russian market of equipment for water conditioning and purification and wastewater treatment was estimated around USD 1,200 million in 2013 [13]. Given that, according to Global Industry Analysts, Inc., the global equipment market is estimated in terms of USD 40,000 million, the Russian market makes about 3% of the world level. For comparison, the US share of the equipment market for water conditioning and purification and water treatment is about 22.5%. With the weighted average dollar exchange rate being RUB 31.84 in 2013, the volume of the Russian market of equipment for water conditioning and purification and water purification is estimated at RUB 38 billion (RUB 46 billion in 2014, with the weighted average dollar exchange rate of RUB 38.4 in 2014).

At the same time according to customs statistics, the market consists of about 30% imported equipment, which annually amounts to over RUB 12 billion in money terms[14]. Today adsorption filters are mainly imported (about 48% of the entire market), and the proportion of multi-technology mainline filters, ion exchange units and membrane plants is also high.

When determining the most promising niches for the introduction of new technologies in the sector of essential water resource management it is required primarily to find out the market prospects for water resource management in Russia.

In opinion of the Frost & Sullivan analysts in the long term up to 2020 the following trends are expected in the Russian market of water conditioning and purification and water treatment[13]:

1) Introduction of new technologies for nitrogen and phosphorus removal from wastewater;
2) Introduction and spread of UV disinfection technology;
3) Development of biological wastewater treatment technologies (namely, incineration of sludge formed during the biological purification);
4) Development of membrane technologies.

In this context particular potential of the market development is forecast in the area of membrane technologies. The main driving force behind the realization of this potential will be the need to reduce significantly the existing backlog of Russia from Western countries. At the same time, it is predicted that by 2020 the share of new technologies (UV treatment, ozone treatment, the widespread use of membrane technologies (although they are used worldwide since the 1960s)) will have amounted to almost 80% in the structure of water resource management in Russia, while today it is only 17%.

3.4 Projects Selected for Two-Level Expert Evaluation

It is worth noting that to date there has been a significant increase in the attention of scientists to the membrane technologies, applied for liquid phase processes. Of 30 projects, participating in two-level expert evaluation within the framework of research, more than 30% were based on improving the application of membrane technologies for liquid phase processes (Table 2). The evaluation covered the projects of organizations that have made the greatest scientific contribution to the development of the essential water resource management technologies in the period from 2010 to 2015.

The largest number of projects, participating in two-level expert evaluation, are dedicated to the development and study of the following: membrane technologies (9 projects), biological treatment (8 projects), development of new reagents for wastewater treatment (4 projects). Another 2 projects are devoted to the study of magnetic water treatment. Some organizations specialize in the development of new narrow but promising areas, such as thermal vacuum pulsed technologies.

The total amount of funding that may be required for the implementation of all the represented projects is estimated at about RUB 850 mln.

Table 2. List of projects participating in two-level expert evaluation

#	University	Issue-related developed technologies
1	Kazan National Research Technological University	Membrane technologies
2	Kazan National Research Technological University	Biological wastewater control
3	D. Mendeleyev University of Chemical Technology of Russia	Electroflotation membrane water treatment
4	Bauman Moscow State Technical University	Biological treatment (1st project)
5	Kazan State Power Engineering University	Membrane technologies in wastewater treatment
6	Irkutsk State Technical University	Electric coagulation
7	Ufa State Petroleum Technological University	Electrochemical and biological wastewater treatment wastewater
8	Perm National Research Polytechnic University	Biological wastewater treatment
9	Volgograd State Technical University	Sorption wastewater treatment
10	Samara State University of Architecture and Civil Engineering	Biological treatment and membrane technologies
11	National Research Tomsk Polytechnic University	Electrophysical water disinfection
12	Rostov State University of Civil Engineering	Biological and physical-chemical wastewater treatment
13	Penza State University of Architecture and Civil Engineering	Reagent wastewater treatment
14	South Ural State University	Fibrous nanostructured materials for wastewater treatment
15	Kazan State University of Architecture and Civil Engineering	Hydrodynamic treatment
16	Yuri Gagarin State Technical University of Saratov	Membrane technologies
17	Kuban State Technological University	Sorption treatment
18	Tomsk State University of Architecture and Civil Engineering	Biological treatment и membrane technologies
19	Belgorod State Technological University named after V. G. Shoukhov	Wastewater sludge processing technologies (thermal vacuum pulsed technologies)
20	Tomsk State University of Architecture and Civil Engineering	Groundwater treatment technologies (Biological treatment и membrane technologies)
21	Far Eastern Federal University	Reagent and sorption water conditioning and processing
22	Petersburg State Transport University	Sorption wastewater treatment
23	Kazan (Volga Region) Federal University	Magnetic water treatment
24	Ural Federal University named after the first President of Russia B. N. Yeltsin	Sorption wastewater treatment
25	Ivanovo State Power Engineering University named after V.I.Lenin	Ion exchange water treatment and membrane technologies
26	Moscow State University of food production	Magnetic water treatment
27	Moscow Power Engineering Institute	Membrane technologies wastewater treatment
28	Nizhny Novgorod State University of Architecture and Civil Engineering	Membrane technologies wastewater treatment
29	Moscow State University of Technologies and Management named after K.G. Razumovsky	Sonchemical wastewater treatment

3.5 Description of the Selection Criteria and the Results of Two-Level Expert Evaluation

In the course of two-level expert evaluation, the projects were selected based on three groups of criteria developed within the framework of the study[6]:

1. S/T-quotient (scientific and technical quotient) comprising the validity of the submitted proposal, its perspective potential, as well as the scientific and applied novelty of the technology;
2. Implementation. This group of criteria implies the evaluation of quality and efficiency of implementation and management;
3. Impact. This group of criteria deals with the potential effect on Russian market of water resource management and on the development of Russian industry produced by developing, promoting and applying the project results.

As a result of the undertaken two-level expert evaluation engaging nine independent experts in water conditioning and treatment and wastewater purification sector, 8 out of 30 projects under consideration have been recognized, based on the abovementioned criteria, as those having the best potential for implementation and capable of producing maximum economic effect on developing Russian society and industry (Table 3).

3.6 Description of the Project Recognized as the Best One in the Course of Selection

Thus, based on the results of two-level expert evaluation, the project of Yuri Gagarin State Technical University of Saratov (Saratov) named "Developing technologies based on fibrous nanostructured materials (sorbents) and membranes for wastewater purification", in which this scientific organization develops technology in partnership with LISSKON Research and Production Company, LLC, was recognized as the most promising one.

The project is developed within the framework of a call for proposals named "Developing technologies for complex treatment of surface and subsurface waters to ensure potable water supply to population in troubled regions of the Russian Federation and creating the plants for communal and individual use under emergency conditions". The major targets set within the project are as follows:

1) Developing technological bases and a pilot plant for cleaning the water contaminated in natural and industry-related emergencies.
2) Intensifying and improving the efficiency of water treatment processes by applying nanostructured

Table 3. The list of the most promising projects in the sector of wastewater treatment and essential water resource management.

Project rank	Institution	Process	Amount (max=15)
1	Yuri Gagarin State Technical University of Saratov	Nanostructured sorbents and membranes	14.7
2	Rostov State University of Civil Engineering	Biological and physicochemical wastewater treatment	14.3
3	Irkutsk State Technical University	Electric coagulation	14.2
4	Kuban State Technological University	Sorption purification	14.2
5	Kazan National Research Technological University	Membrane technologies	14.0
6	D. Mendeleyev University of Chemical Technology of Russia	Electroflotation membrane treatment	13.2
7	Bauman Moscow State Technical University	Biological treatment	12.7
8	Moscow State University of Technologies and Management named after K.G. Razumovskiy	Sonochemical wastewater treatment	12.0

materials, process activation means, as well as through combining the modern water treatment techniques and equipment in most effective way.

3) Developing environmentally-friendly energy saving technologies for surface and subsurface water treatment applying the multi-purpose filtering systems based on nanostructured sorbents and polymeric membranes and creating the model range of the plants to solve the issue of potable water supply to communal objects in troubled regions of the Russian Federation, including the Autonomous Republic of Crimea, and also to individual consumers in field conditions and under the emergencies associated with natural and industry-related disasters.

The maximum investment amount in the project is estimated at RUB 65.625 mln, of which RUB 52.5 mln are the funds from Federal Budget, and RUB 13.125 mln are extra-budgetary funds[15].

The novelty of the project lies in developing the technology for complex treatment of surface water applying the innovative sorbents. The developed sorbents have been created based on natural biologically active and nanostructured materials, efficient for various chemical contaminations, and based on the innovative nanobiopolymeric composite with antibacterial properties. The complex technology will make it possible not only to clean the water from chemical and mechanical impurities, but also to sterilize it simultaneously.

The advantage of the developed technique is its low production cost at high sorptive capacity. Contaminations of chemical and biological origin are steadily fixed in the pores of the sorbent in the course of the water filtration process and do not come back to water again. The costs for cleaning one liter of water make 1.95-2.15 kopeks.

The novelty of the presented technology has been proved by the submitted application for a patent: “Bactericidal composition” and “Bactericidal charge for sterilizing surface water”, as well as by the available know-how for the technology of obtaining the nanostructured sorbent.

Among the qualitative advantages of membrane techniques, as compared to conventional wastewater treatment technologies, the research associates of Yuri Gagarin State Technical University of Saratov identify the following[15]:

- absolute barrier for viruses and bacteria;
- the costs for cleaning one liter of water is 3-4 times lower as compared to, for example, sorption purification;
- total absence of suspended matters;
- effective removal of iron and manganese with high concentration values (higher than 10 mg/l);
- high degree of organic matters removal;
- filtrate quality stabilization of more than 2-3 times;
- 5 times decrease in the costs of treated water;
- 3–10 times decrease in the occupied area;
- more than 10 times lower amount of utilized chemicals;
- 1,5-2 times lower water consumption;
- 1,5-2 times lower energy consumption;
- considerable decrease in labor for operation and maintenance.

Major application area for the developed technology is potable water production by purifying surface and subsurface water. It is planned that initially a pilot plant should be created based on applying the nanostructured materials and employing the most efficient technology of reverse osmosis treatment. In future, the application of nano- and ultrafiltration membranes will make it possible to widen the range of applications for the developed technology. Thus, in many cases, for example, in industrial water treatment no reverse osmosis purification is required. Table 4 shows the potential range of applications for the developed pilot plant.

As of 2015, the total number of the membrane-based wastewater treatment equipment installed by Yuri Gagarin State Technical University of Saratov and LISSKON Research and Production Company, LLC in Saratov region amounted to 613 units, which makes 30% of the required number[16].

The developed technology and the equipment employing this technology possess considerable technical and economic advantages. In the first place, the costs for cleaning one liter of water are estimated to be 3-4 times lower as compared, for example, to different processes of sorption or ion change purification.

As of 2014, the capacity of Russian market for membrane-based wastewater treatment systems was estimated at RUB 7-8 bln. Thereat, the market capacity for membranes (source material) was estimated at the level of RUB 9 - 10 bln in 2014 (the figure is higher due to the fact that membrane application in wastewater treatment

Table 4. Potential range of applications of the pilot plant, developed within the framework of the project

Type of the applied nanostructured membranes	Range of the plant applications
Reverse osmosis membranes	1) Obtaining demineralized water for: — biotechnological industry; — medical industry; — food-processing; — chemical; — electronics; — liquor industry; 2) Water treatment in potable water fine purification process 3) Wastewater treatment: — electroplating, — acryl emulsion production
Nanofiltration membranes	1) Water softening, partial demineralization of water, removing low molecular organic matters from surface water. 2) Concentrating and treatment of saline solutions in biotechnology, water treatment in dairy, food and chemical industry. 3) Obtaining physiologically valid potable water. 4) Wastewater treatment in food and textile industry (lactose recovery from whey, protein-lactose concentration in whey, waste treatment in silk-and-cotton production, ion acetates, tannides recovery).
Ultrafiltration membranes	1) Concentration and treatment of milk products, proteins, curd and cheese whey, skim milk; biologically active products (viruses, blood products), enzyme solutions.

is only a part of the world market of membrane-based technologies).

The world market of membrane-based separation systems was estimated in 2011 at USD 16.5 bln (USD 25.7 bln in 2017), in this case the share of membrane-based equipment, employed for wastewater treatment and purification roughly amounts to USD 5 - 6 bln[17]. Moreover, this forecast is also up-to-date in 2015-2016. Thus, according to the data from Markets and Markets analytical company, the world market capacity for membrane-based separation technologies in 2015 is estimated at USD 20.445 bln, and there is a forecast for the market growth up to USD 32.14 bln until 2020 at CAGR = 9.47%[18].

Based on the given data, today the market capacity for membrane-based water treatment systems in Russia accounts for not more than 3% of the world market.

4. Conclusion

Within the framework of the undertaken research and development study, a monitoring of both existing and prospective projects in the sector of essential water resource management was carried out (water treatment and wastewater purification) to ensure sustainable development of the Far North regions. The research and development study enabled achieving the scientific results as follows:

1) A concept for monitoring and expert evaluation of projects and technologies in the sector of essential water resource management has been developed (the concept is universal and can be applied in other research areas).
2) The criteria and mechanisms for evaluating and selecting the projects or technologies in the sector of essential water resource management have been established.
3) A sampling has been made of 30 Russian educational organizations that made the largest contribution to developing the water resource management technologies in Russia over the last 5 years.
4) Two-level expert activity has been undertaken to evaluate innovative projects and technologies in the sector of essential water resource management.
5) The proposals have been formulated for implementing the best project.
6) The classified register has been created for the projects and developers in the sphere of essential water resource management.
7) The evaluation activity has been carried out to determine how Russian scientific organizations are prepared

to take part in implementing the programs for innovative and ecologically friendly business extension to ensure sustainable development of the North (Arctic) regions of Russia.
8) The level of accomplishment has been estimated for the projects or technologies in the sector of essential water resource management in Russia.
9) The degree of cooperation between Russian scientific organizations and the industrial enterprises in the sector of essential water resource management has been evaluated; the recommendations on improving the effectiveness of such interaction have been formulated.

The results of the study will be used by the Ministry of Education and Science of the Russian Federation to solve the issues associated with implementing the technologies for essential water resource management and wastewater treatment, developed by Russian scientific centers and higher educational institutions, in industrial sector of the North (Arctic) Regions of Russia.

In the long run, developing the technologies for water resource management and wastewater treatment in Russia should ensure sustainable development of businesses, located in northern (Arctic) regions of Russia, which, in its turn, will improve the financial stability and investment prospects of the owner organizations.

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