

TREATMENT PLANT FOR PURIFICATION OF DOMESTIC SEWAGE

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Introduction

"Nature abhors inaccuracies and does not forgive mistakes" / R.Emerson/

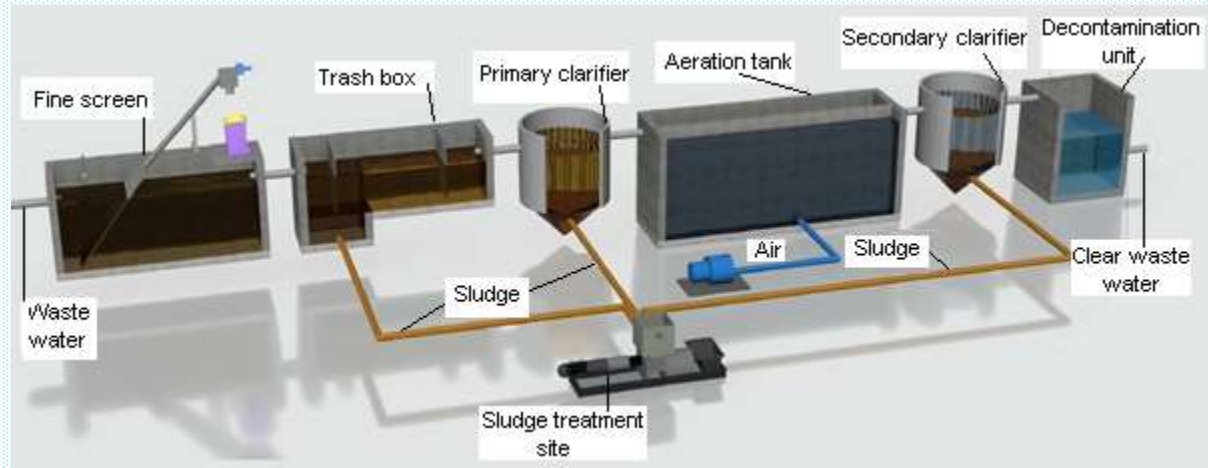
Protection of natural resources in the world is getting worse every year and caused the problem is increasingly global. Experts have long warned about the threat of ecological disaster and the need to introduce special plans to protect water bodies.

To ensure high quality of treated wastewater is produced:

- construction or modernization of local treatment facilities and treatment of Subscriber using local wastewater treatment plant;***
- creating water recycling systems;***
- production technologies, services, works, reducing pollutants concentration in wastewater.***



Wastewater treatment plant for MBR - technology

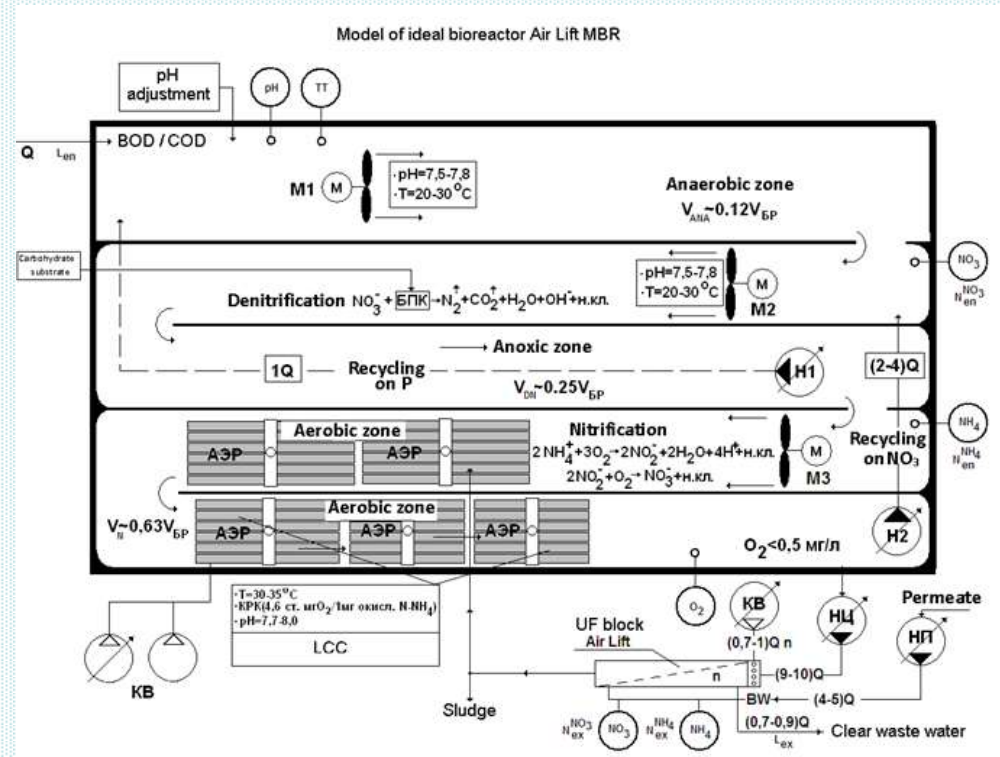


Biological treatment of wastewater in aeration tanks designed to remove oxidizable substances.

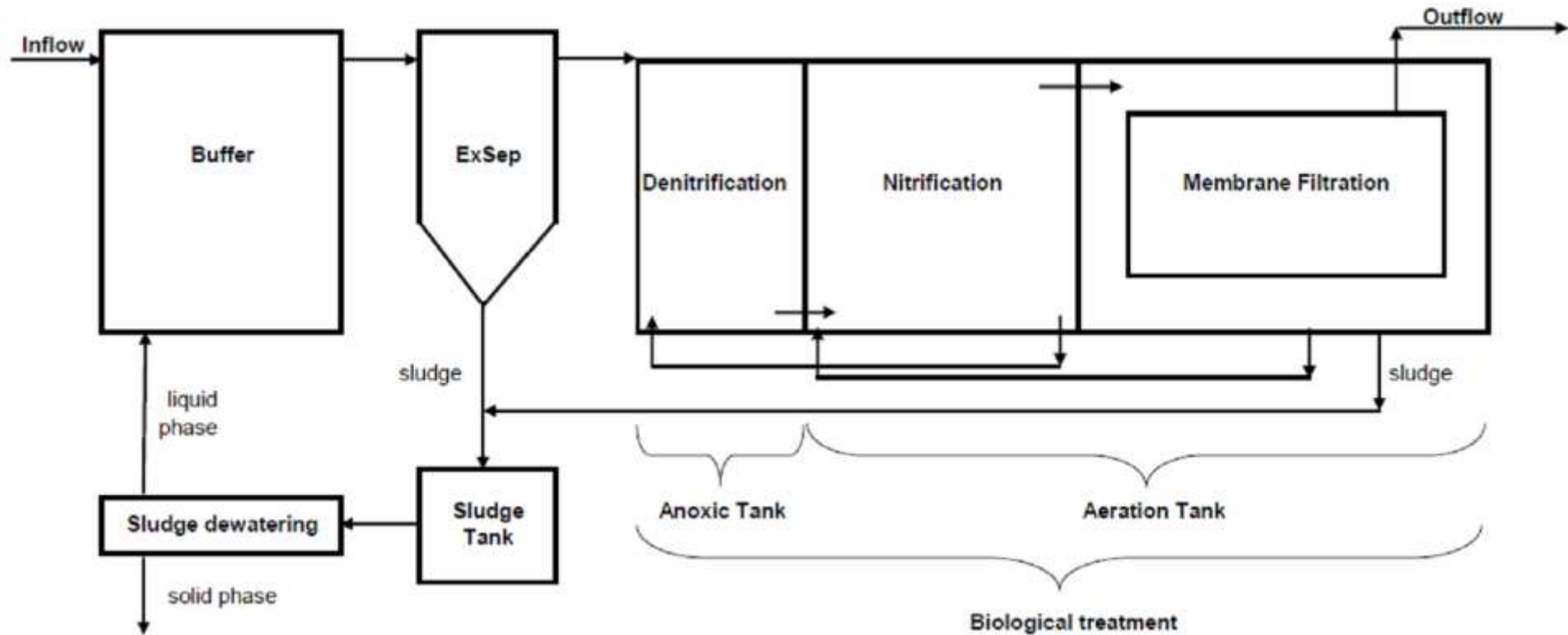
Efficiency of nutrient substances removal is low. The technology is extremely unstable when changing indicators source of waste water. For separating water from sludge typically used secondary sedimentation tanks. Often purified waste water does not comply with sanitation in water.

Replacing the sedimentation tanks by membrane ultrafiltration module helps prevent the removal of active sludge from bioreactor, reduce the built-up area, which is essential for construction of wastewater treatment plants in conditions of dense buildings and in remote areas. The quality of treated wastewater is at a high level, in strict compliance with the standards of the dumping into water bodies.

Nitrification-denitrification zones of MBR-plants ensures reduction of nutrient pollutants to normalized values of ammonia nitrogen, nitrates, phosphorus, petroleum, heavy metals in clear waste water.



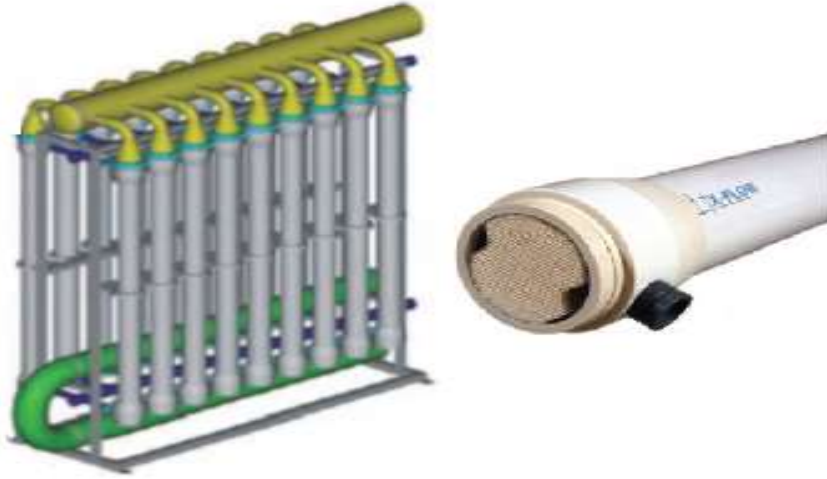
Box4Water installation scheme



Comparative characteristics of mobile MBR installations

	Epuramat Box4Water (Slovakia)	EEC MBBR-MBR (United States)	Veolia Aquamove MOFI-MBR (France)	FilterBoxx C-Series WWTP (Canada)	Mann+Humme Mem-Bio (Germany)	ASIO AS-ISO MBR (Czech Republic)	ItN Nanovation MBCR Filtration Container (Germany)
							
Productivity	12,5 – 120 м³/day 60 - 600 inh.	30 - 300 м³/day	7 - 48 м³/day	38 - 300 м³/day 150 - 1,200 inh.	50 - 100 м³/day	18 - 79 м³/day 80 - 350 inh.	55 - 110 м³/day 550 - 1,000 inh.
Size and number of containers	1 x 20' or 2 x 40' cotainer	container	1 x 40' container	50' or 60' container	20' or 40' container	20' or 40' container	20' or 40' container
Mechanized grille	Yes	No	Yes	Yes	No	No	No
Tank-device	Yes	No	Yes	No	Option	No	No
Pre-cleaning	Separator ExSep®	No	No	No	No	Mechanical (> 1mm)	No
Bioreactor	MBBR + MBR	MBBR + MBR	MBR	MBR	MBR	MBR	MBBR + MBR
Nitrificator	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Denitrificator	Yes	Yes	Yes	No	No	No	No
Sludge dewatering	Yes	No	No	Option	No	No	No
LCC	Yes	No	Yes	Option	No	No	Yes
Achieved parameters	COD: 50 mg/l BOD₅: 5 mg/l SS: 1 mg/l N: 2 mg/l P: 2 mg/l	COD: 50 mg/l BOD₅: 5 mg/l SS: 1 mg/l N: 5 mg/l		BOD₅: 10 mg/l SS: 10 mg/l			COD: 50 mg/l BOD₅: 5 mg/l SS: 5 mg/l N: 10 mg/l P: 2 mg/l

Technological grade of the project



Ultrafiltration Air-Lift membranes module remote type



Submerged membrane module is located inside the bioreactor.

Filtration of active sludge occurs under little vacuum.

Submersible type ultrafiltration membranes module

Remote MBR implies circulation of active sludge, which is served by pump on membrane module. Sludge mixture is separated into permeate and concentrate containing activated sludge. The surplus active sludge is continuously withdrawn from bioreactor for dehydration.



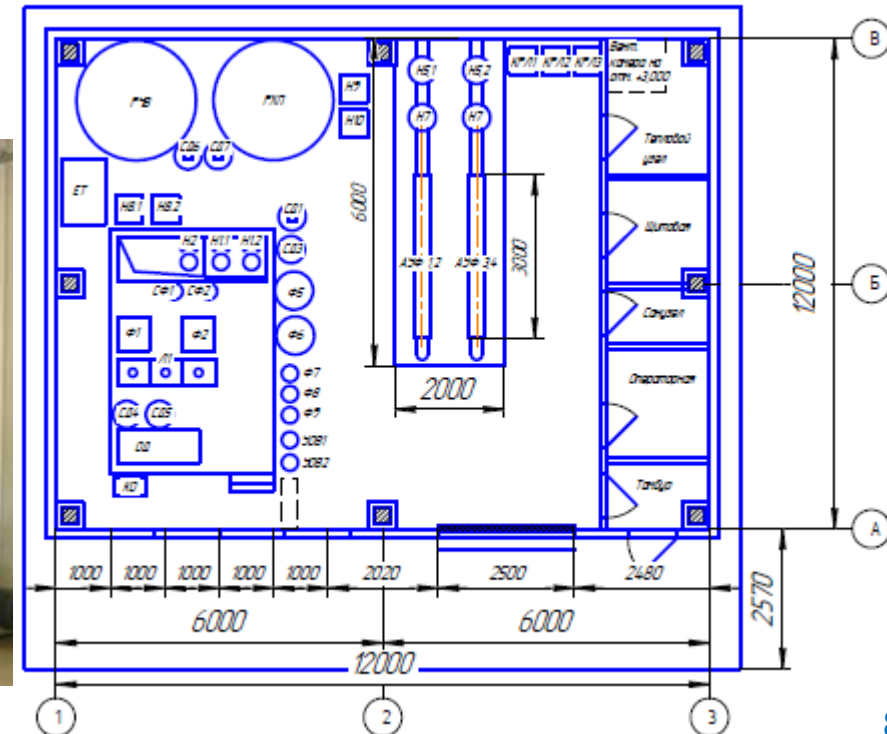
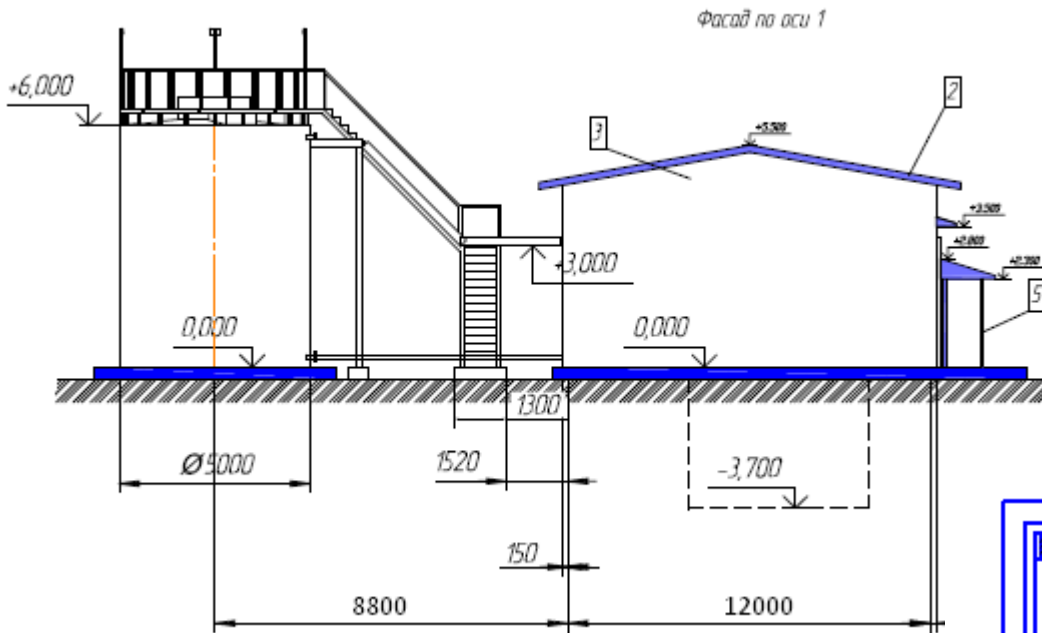
Ultrafiltration Cross-Flow membranes module remote type



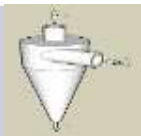
ExSep separator for wastewater pre-treatment before membrane modules



General view of installation Box4Water-200-WW

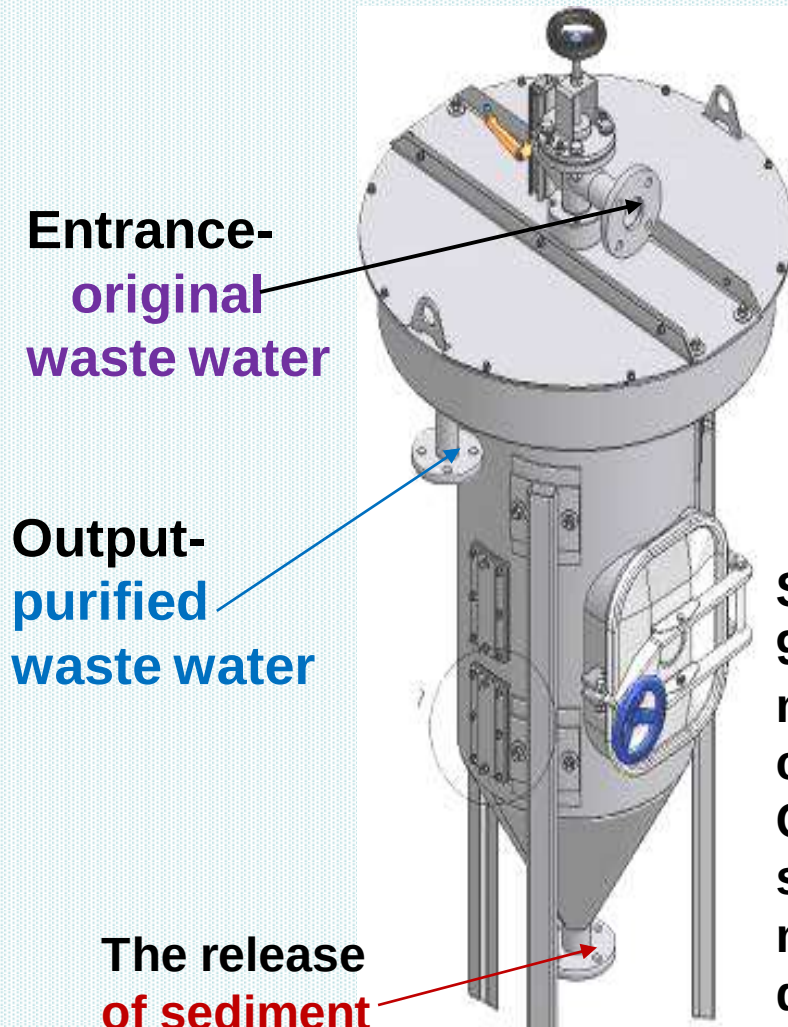


Equipment for pre-treatment of wastewater

Equipment and its parameters	Separator ExSep	Sand traps	Sedimentation tanks	Hydrocyclone	Flotation	Lamella separator
						
Cost	Medium	High			Medium	
Separation degrees of organic and inorganic particles, %	96-99	~ 80	Up to 97	Up to 90 and only inorganic	Up to 99	Up to 97
Adaptation to the quality and quantity of waste water	Yes	No			Yes	No
	Medium	Yes	Medium	No	Medium	
Particle size, MKM	> 15	>>25	>10	>25	>5	>25
Mounting size	Very low	Very high	Medium	Small	Medium	
Chemical reagents	If you need to handle subtle variances				Required	
Power optimization	Low	Medium		High		Medium
Operating costs	Very low	Medium	Low			
Production time	Short	Long		Medium		
Term of service	Long	Medium	Long	Medium		Long
Maintenance and service	According to the regulations			Mandatory and periodic		According to the regulations

ExSep® Technology

Pre-treatment of wastewater from mechanical impurities =
efficient biological wastewater treatment in MBR



Separator ExSep allows you to remove 90-99% of undissolved fractions larger than 15 microns in size, which significantly reduces contamination of original wastewater. Compared to the settling tanks ExSep-separator provides effective cleaning of mechanical particles, grease and oil with different process performance (from 1 till 250 m³/h).

ExSep-compact high-tech system with high requirements on environmental protection



Advantages of ExSep[®] separators:

- ☐ **Pre-treatment efficiency is up to 99% for mechanical impurities with a particle size of at least 15 microns.**
- ☐ **Small occupied space without the need for deepening of a design.**
- ☐ **High energy efficiency.**
- ☐ **Low capital and operating costs, space saving.**
- ☐ **Remote control and automatic alert system operator.**
- ☐ **The modularity of system allows to smoothly increase the capacity.**
- ☐ **Short delivery times, quick commissioning, low design risks.**
- ☐ **Service.**

A comparative analysis of technology on wastewater treatment plant (performance example 200 m³/d)

Technology	Conventional (aerotank)	MBR
Space of plant, m ²	200-220	140-150
Bioreactor volume, m ³	110	80
Primary sedimentation tank volume, m ³	20	20
Secondary sedimentation tank volume, m ³	2 * 24	No
Total electrical power, kW	85	85
Probability of active sludge loss	Possible takeaway from secondary clarifier	Loss of active sludge is not possible
Main equipment of process	Aerotanks, secondary clarifiers, purification unit	Ultrafiltration membranes
Efficiency of cleaning process	No more 80%	Not less than 98 %
Resistance to wastewater supply peaks	Degradation cleaning by rows of indicators	High process stability when salvo emissions
Period of starting-up and adjustment works	40 - 60 days	40 days
Climatic conditions	When the temperature is lowered the growth rate of active sludge particles reduced. In order to ensure conditions of nitrification-denitrification requires aeration tank thermoinsulation	Nitrification year round even in cold climates
Reliable operation	Constant presence of staff and in-depth control of waste water	Fully automated process, remote access and management



Field of application

Construction of local municipal wastewater treatment facilities in areas with a population of 50 to 15,000 inhabitants and more



Solutions for various industries:

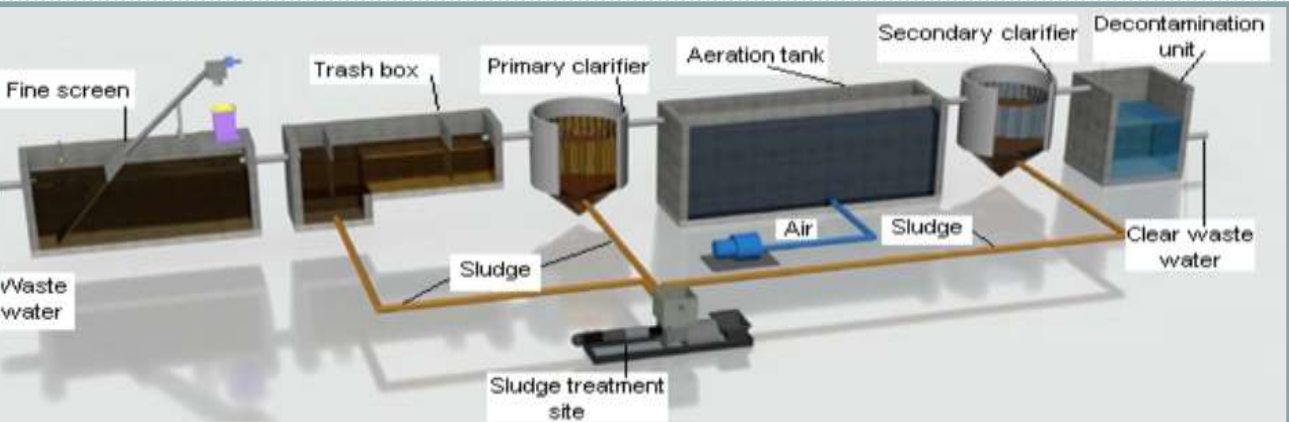
- **construction and upgrading of local treatment waste water facilities;**
- **construction, upgrading and operation of water treatment facilities;**
- **waste processing industry;**
- **food, paper, pharmaceutical industry;**
- **mining;**
- **wastewater treatment biogas plants.**

Techno-economic feasibility

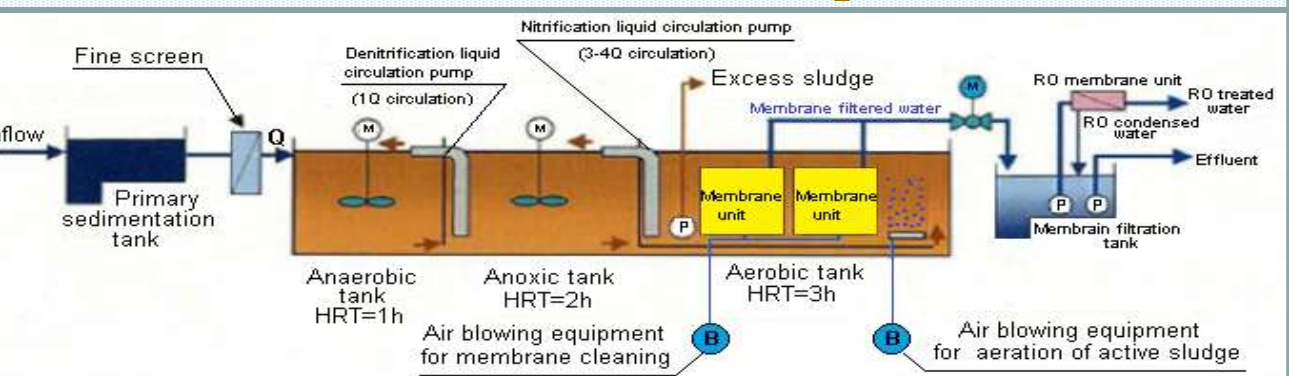
Wastewater treatment by MBR technology eliminates the problems inherent in the classic treatment plants:

- 1. A high degree of mechanical, biological and microbiological treatment of household wastewater is provided. This allows you to divert the treated water not only into reservoirs of fisheries value, but also to restore wastewater for purposes of technical water supply and melioration.**
- 2. To reconstruct the existing treatment facilities to ensure the required degree of treatment with increasing load on the treatment plant up to 3-5 times without increasing the occupied space.**
- 3. To place treatment facilities at construction sites in conditions of a shortage of space with a significant reduction in construction time.**
- 4. During the whole period of membrane elements operation high quality treated wastewater is provided.**
- 5.Excluded harm nature and ecology.**
- 6.In place of effluent water dumping eutrophication is missing.**

Costs comparison of sewage treatment plants production



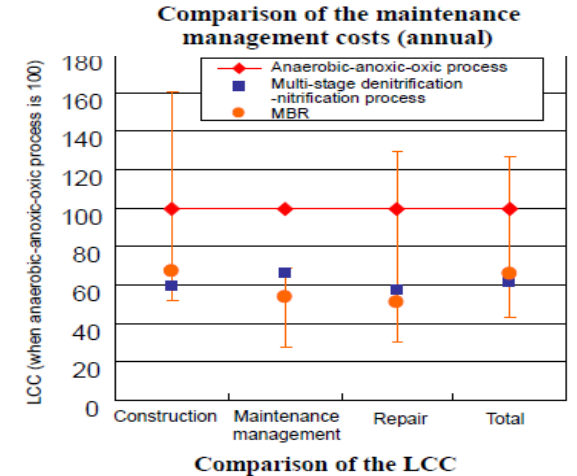
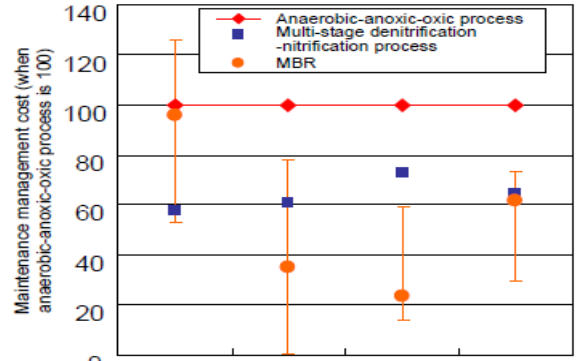
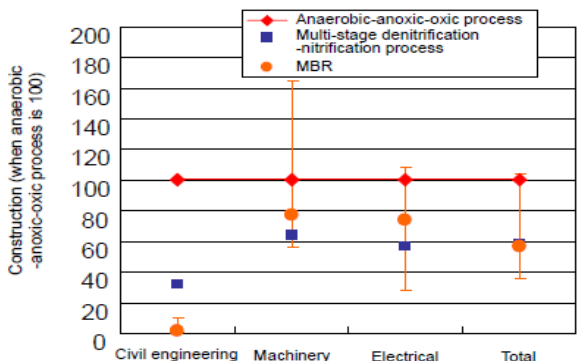
Classic treatment plant (A₂O process)



MBR - treatment plant

Comparison of water treatment capacities and necessary space

	Anaerobic-anoxic-oxic process (A ₂ O process)	Multi-stage denitrification-nitrification process	MBR process	
			Min to Max	Median
The number of lines required	23 (13)	14 (4)	7 to 9	8
Treatment capacity (m ³ /day)	50600	50400	53600 to 56000	55350
Treatment capacity per line (m ³ /day)	2200	3600	6000 to 8000	6700
Required space (A ₂ O=100%)	100	59,5	20,6 to 34,8	20,7



Competitive advantages

Classic aeration tank

Low concentrations of suspended solids in sludge (3-5 g/l).

Small lifetime of active sludge.

Only bacteria-flocculates and fast-growing bacteria.

Do not develop a component-specific bacteria.

Takeaway of a sludge.

Quality purified water, unstable installation when equipment fails, it is possible to reset the volley of impurities.

Membrane bioreactor

High concentrations of suspended solids in sludge (10-20 g/l).

Prolonged lifetime of active sludge.

Survive all kinds of bacteria.

Good conditions for the development of component-specific bacteria.

No takeaway of activated sludge.

Stable high quality of treated wastewater.

Advantages of MBR – technology:



- small built-up area;
- small footprint-less structures;
- cleaning efficiency;
- non-failure operation even in extreme north;
- independence from sludge values index;
- operation is fully automated;
- physical disinfection of treated wastewater;
- surplus sludge volume reduction;
- short time construction of treatment plant.

References



**Box 4 Water-WW container type
in terms of Canada**



Box4Water-WW in Luxembourg



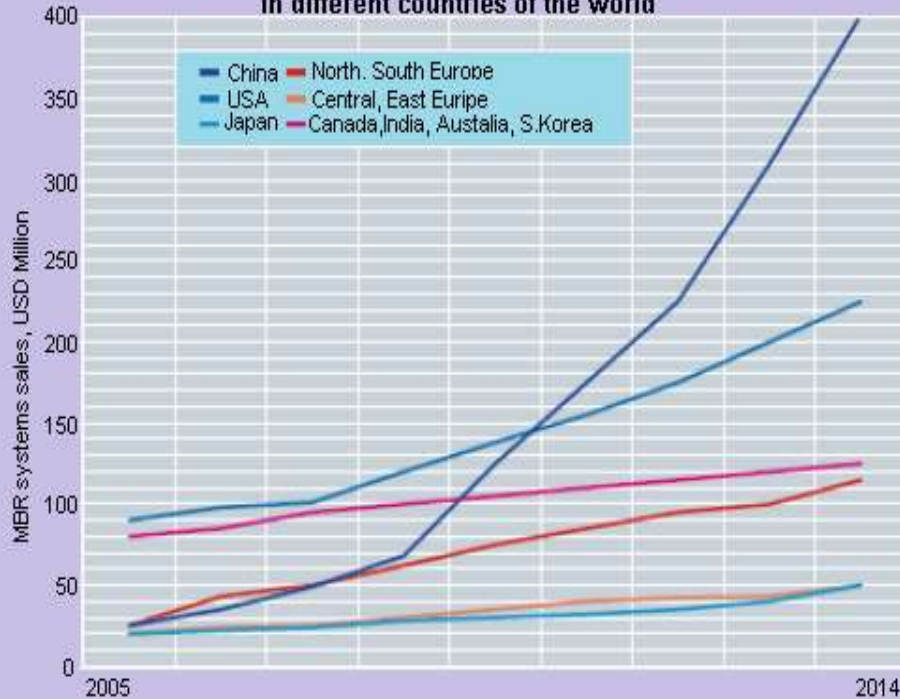
Box4Water-WW in production environments



Separators ExSep in production environment (Germany)

Commercial potential

Dynamics of MBR-technology for wastewater treatment in different countries of the world



Application of MBR-technology leads to improved wastewater quality indicators. Effectively removes suspended solids, bacteria and viruses. Biological treatment intensive at high concentration of activated sludge and small amount of excess sludge. Stages of secondary purification, sedimentation, decontamination by chemical agents are excluded. Significantly reduced area occupied by buildings. MBR technology is forefront of twenty-first century research direction that implement socially important and available technology, providing innovative development of global industry.

In 2011 global MBR - market was valued at 838.2 million USD and its growth was 22.4 % per annum. The market sales of MBR-systems was estimated at 3.44 billion USD in 2018 year. The most important part is China, MBR-market which in 2011 was 308.1 million USD and in 2017 rose to a level of 1.35 billion USD. A growing number of companies offering their services on dynamic MBR-market where the dominant position occupied by firms Kubota, Pentair and Zenon. In today's world there is no alternative to MBR-technology.

Prizes and awards

Company Epuramat won many awards



In 2017 by the decision of Scientific Council of Baikal International Ecological Forum the sewage treatment plant Box4Water and ExSep-separator were recognized as the best equipment for Lake Baikal and Epuramat was awarded the diploma of Irkutsk Region Governor, Russia.

In 2018 at the exhibition Zlata Aqua (Slovakia, Trencin) Epuramat a.s. awarded a diploma of 3 degrees for water treatment equipment - ExSep-separator.

Conclusions

The modern facility for biological wastewater treatment using the membrane bioreactor technology (MBR) has the following advantages:

- fewer facilities in the processing line - MBR replaces aerotanks, secondary clarifiers and sand filters;
- compactness - the concentration of activated sludge in MBR is several times higher than in traditional structures, respectively - less volume of facilities;
- cleaning efficiency in MBR is significantly higher than in the aeration tank - sedimentation system;
- the possibility of year-round nitrification;
- reliable operation of facilities does not depend on the value of sludge index;
- the operation process is fully automated;
- physical disinfection of biologically treated wastewater;
- reducing mass and frequency of spent sludge export.

An analysis of the market for modern sewage treatment plants has shown that from an economic and environmental standpoint the technology of biological wastewater treatment in a membrane bioreactor is optimal. At the output of MBR plant it is guaranteed and stably obtained purified waste water with parameters corresponding to the fishery objects. It is also possible to produce recovered wastewater for reuse in production cycle of an enterprise as process water.



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THANK YOU FOR YOUR ATTENTION!