



TOGETHER
for a sustainable future

OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.



TOGETHER
for a sustainable future

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as “developed”, “industrialized” and “developing” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

RECP Experiences at St.Petersburg Vodokanal

The efficient and environmentally sound use of materials, energy and water - coupled with the minimization of waste and emissions - makes good business sense. Resource Efficient and Cleaner Production (RECP) is a way to achieve this in a holistic and systematic manner. RECP covers the application of preventive management strategies that increase the productive use of natural resources, minimize generation of waste and emissions, and foster safe and responsible production. Benefits are eminent in many enterprises, regardless of sector, location or size, as demonstrated by the experiences of State Unitary Enterprise St.Petersburg Vodokanal, Russia.

Achievements at a Glance

To meet the HELCOM Baltic Sea Action Plan (2007) and HELCOM recommendations, St.Petersburg Vodokanal responsible for water supply and sewage treatment in the city of Saint-Petersburg, Russia, implemented an advanced process for sewage purification providing a significantly improved efficiency of phosphorous and nitrogen significantly below the level recommended by HELCOM according to the Recommendation 28E/5 «Municipal wastewater purification», particularly phosphorous content in the purified wastewater is reduced to 0.34 mg/L and can be further decreased to about 0.3 mg/L compared with the recommended threshold value (< 0.5 mg/L). The method is based on the innovative approach involving the replacement of a relatively toxic and corrosive reactant iron (III) sulfate (“Ferix-3”) by a non-hazardous aluminum sulfate in combination with the technology optimization. In addition to a significant contribution to the prevention of Baltic Sea eutrophication caused by excessive phosphorous and nitrogen discharge, the implementation affords a reduction of the consumption, cost and hazard of the reagents used for wastewater treatment. Furthermore, the relations between St.Petersburg Vodokanal and innovative reagent supplier are arranged on the basis of Chemical Leasing business model as a service with the payment to supplier for the purified water volume instead of the amount of the supplies chemicals that promotes a further increase of the reagent application efficiency due to the enhanced responsibility of the supplier.



Overview

To meet the HELCOM Baltic Sea Action Plan (2007) and HELCOM recommendations, SUE St.Petersburg Vodokanal implemented specific processes for high degree removal of phosphorous and nitrogen at all 13 sewage purification facilities, particularly involving special chemical reagents for the increase of purification efficiency. The overall daily amount of purified wastewater in over 5-millionth St.Petersburg is about 2.2 mln m³. Presently 98.4% of wastewater incoming to all 13 sewage purification facilities of St.Petersburg Vodokanal undergo an efficient treatment, whereas in 1985 this figure was only 85% and before 1978 wastewaters were directly discharged into the Gulf of Finland without any purification.

Also very importantly, St. Petersburg is the first large city in the world where the problem of wastewater sludge precipitate utilization is completely solved.

Three sludge incineration facilities operate in the city including Central, Northern and South-West wastewater treatment plants. The sludge is incinerated in the fluidized-bed furnaces at the temperature of 900°C. The heat produced by sludge incineration is used for process needs, heat supply and power generation for Vodokanal to save energy resources. Flue gases are treated in three stages.

Phosphorous and nitrogen impose one of the main threats to the Baltic Sea ecosystem since upon entering the sea these elements facilitate the growth of cyano-bacteria (so called blue-green algae) resulting in eutrophication. Furthermore, blue-green algae consume large amounts of oxygen from the water thus causing a mortal threat for all other marine organisms. Unless special measures are taken to retard this process the Baltic Sea can become an almost lifeless body of water unusable for fishing and convenient shore life.

The implementation of Chemical Leasing business model at SUE St.Petersburg Vodokanal based on the optimization of the use of reagents at the existing sewage purification facilities at SUE Vodokanal's facilities provides a significant increase in the environmental and economic efficiency of wastewater purification.

The analyses performed at all the purification stations of SUE St.Petersburg Vodokanal indicate that the amount of aluminum sulfate (supplier: *Research & Manufacturing Enterprise Chemical Reactants Plant, St.Petersburg region*) required for efficient wastewater processing is lower compared with the amount of «Ferix» reagent earlier applied (until autumn of 2011) for the same purpose by about 19%. The application of aluminum sulfate affords the effective removal of phosphates to the level below 0.5 mg/L (really – 0.34 mg/L) in the purified effluents that meets the HELCOM Recommendation 28E/5. The project is organized in accordance with the Chemical Leasing concept with the payment for aluminum sulfate as a water purification reagent based on the amount of purified water (US\$ 2.3 per 1`000 m³ of purified water).

Benefits

Economic benefits:

The overall consumption of «Ferix» reagent (supplier: *KEMIRA-ECO company*) earlier used for the chemical precipitation of phosphorous was 23`262 tons per year or 30.88 kg per 1`000 m³ of the purified wastewater. Presently aluminum sulfate is used in the amount about 18`865 tons per year or 24.14 kg per 1`000 m³ of the purified wastewater. The overall amount of purified wastewater in 2013 was 781`516 thousand m³. The cost of 1 ton of aluminum sulfate is 2`670 roubles (US\$ 81.65) Although in 2014 it increased up to 3`095 roubles (US\$ 94.7) versus 3`352 roubles (US\$ 102.5) for «Ferix» reagent. Therefore, the replacement of «Ferix» by aluminum sulfate provided the annual savings of about 36 million roubles (approximately US\$ 1.1 mln).

The application of aluminum sulfate as a reagent for wastewater purification instead of earlier applied reagent «Ferix» provides:

- Reduction of the consumed reagent amount by the average 19%
- Cost reduction for the purchase of 1 ton of the required reagent by the average 20%

Environmental benefits:

In accordance with the main goals of the Helsinki Convention involving the protection of the Baltic Sea marine environment, recovery and preservation of the environmental balance in the Baltic Sea region and providing the efficient and environment

friendly exploration of the regional natural resources Russian Federation adopted a National Action Plan as a component of the general HELCOM Action Plan on the Baltic Sea.

According to the Russian Federation Government Decree «On the approval of the Convention on the marine environment protection in the Baltic Sea region» (No. 1202 from 15.10.1998) the responsibility and control over the performance of commitments relating to the Helsinki Convention was appointed to the Russian State Committee on Ecology, other federal authorities responsible for the relating issues and regional executive authorities within the frames of their power.

The control of the Helsinki Convention compliance is performed on the basis of national reports submitted to the HELCOM once in three years. The national reports are prepared by the national representatives in HELCOM working groups and submitted to the HELCOM Secretariat upon the coordination with the respective governmental authorities.

Since 2007 the Government of St.Petersburg adopted a set of programs on the development of municipal wastewater sewage and purification meeting the HELCOM requirements and aiming at the achievements of the goals set forth in HELCOM Action Plan on the Baltic Sea.

Particularly, an advance process for effective removal of biogenic species is implemented at all the wastewater purification facilities in St.Petersburg affording the decrease in nitrogen and phosphorous discharge by 56.8% and 83% correspondingly.

The implementation of these processes provided an early compliance of the HELCOM Recommendation 28E/5 «Municipal wastewater purification». The year average total phosphor and nitrogen concentrations in St.Petersburg wastewater is below 0.5 mg/L and 10 mg/L correspondingly.

Absolute Indicator	Change (%) Year 1	Change (%) Year 2	Relative Indicator	Change (%) Year 1	Change (%) Year 2
Resource Use			Resource Productivity		
Energy Use			Energy Productivity		
Materials Use	-19	- 22	Materials Productivity		
Water Use	-15	-29	Water Productivity		
Pollution Generated			Pollution Intensity		
Air emissions (global warming, CO ₂ equivalent)			Treated waste water pollution: with phosphorous with nitrogen	83 56.8	86 67
Waste-water					
Waste					
Production Output			Cost reduction	20	24

RECP Profile

Resource Efficient and Cleaner Production (RECP)

Resource Efficient and Cleaner Production (RECP) entails the continuous application of preventive environmental strategies to processes, products and services to increase efficiency and reduce risks to humans and the environment.

RECP addresses three sustainability dimensions individually and synergistically:

- *Production efficiency*

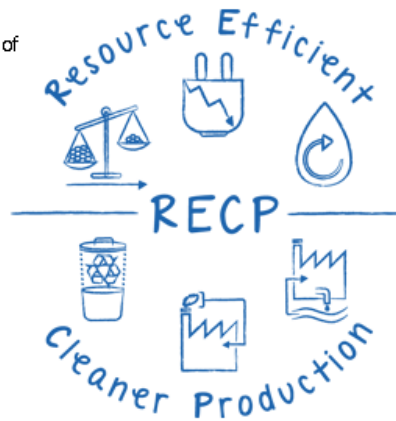
> Through improved productive use of natural resources by enterprises

- *Environmental management*

> Through minimization of the impact on nature by enterprises

- *Human development*

> Through reduction of risks to people and communities from enterprises and supporting their development



Success Areas

The implemented advanced process for effective removal of biogenic species is implemented at all the wastewater purification facilities in St.Petersburg affording the decrease in nitrogen and phosphorous discharge by 56.8% and 83% correspondingly. In addition to a significant contribution to the prevention of Baltic Sea eutrophication caused by excessive phosphorous and nitrogen discharge, the implementation affords a reduction of the consumption, cost and hazard of the reagents used for wastewater treatment.

Principal Options Implemented	Benefits			
	Economic		Resource Use	Pollution generated
	Investment [USD]	Cost Saving [USD/yr]	Reductions in energy use, water use and/or materials use (per annum)	Reductions in waste water, air emissions and/or waste generation (per annum)
Implementation of an advanced wastewater purification process based on the innovative approach involving the replacement of a relatively toxic and corrosive reactant iron (III) sulfate ("Ferix-3") by a non-hazardous aluminum sulfate in combination with the technology optimization.		Appr 1.1 mln		Decrease in nitrogen and phosphorous discharge in sewage effluents by 56.8% and 83% correspondingly.

Approach taken

Chemical processing of effluents is based on reactions involving the added reagent. Consequently, aluminum forms insoluble compounds with phosphates that can be removed from the system with the overall precipitate. The reagent feeding is carried out using stationary installations in an automatic mode depending on the amount of phosphates weight in the wastewater undergoing the purification. The transition of wastewater treatment processes to the use of aluminum sulfate and the resulting general decrease in the reagent amount provides a significant reduction in the discharge of hazardous chemicals into the Gulf of Finland international waters.

Before the adoption of the decision on the launch of the new reagent application in 2012, pilot tests on aluminum sulfate application for chemical removal of phosphate phosphorous from wastewater were performed at all the sewage purification facilities. The testing results were analysed in respect of the main control parameters to make a complex assessment of aluminium sulphate effect on each step of effluent purification and subsequent precipitate processing in comparison with the application of "Ferix" reagent. The following conclusions were made on the basis of analysis performed at all the sewage purification facilities:

- The amount of aluminum sulfate required for the effective removal of phosphates is lower compared by the corresponding amount of «Ferix» by about 19%.
- No inhibition effect upon the activated sludge biocenosis is observed.
- Like earlier applied «Ferix» reagent, aluminum sulfate feeding does not lead to any changes in the sludge index.
- The level of phosphate phosphorous in the purified effluents is about 0.1 mg/L.
- Aluminum sulfate feeding does not result in any increase in the residual aluminum content (remaining below the maximum allowable concentration for the effluents) compared with «Ferix» application.
- Aluminum sulfate feeding provides a significant reduction in the residual iron content and achievement of its permanent reduction much below the maximum allowable concentration) compared with «Ferix» application .
- The application of aluminum sulfate does not affect the resulting mixed precipitate humidity.
- The application of aluminum sulfate does not require any changes in the amount of the used flocculant.
- The resulting cake quality meets all the requirements for the precipitates incineration.

Thus, the application of aluminum sulfate as a reagent for chemical removal of phosphorous was found to cause no adverse effects upon both the technological processes and the quality performances. The main positive effects of aluminum sulfate application include a stable and efficient wastewater purification from phosphorous and savings in respect of the applied reactants amount.

Business case

The project is organized in accordance with the Chemical Leasing concept with the payment made by Vodokanal of St.Petersburg for aluminum sulfate as a water purification reagent to its supplier (Research & Manufacturing Enterprise Chemical Reactants Plant, St.Petersburg region) based on the amount of purified water (US\$ 2.3 per 1000 m³ of purified water).

Testimony Box
National Cleaner Production Centre (NCPC)
North-Western International Cleaner Production Centre (NWICPC, St.Petersburg, Russia) performs a coordinative role at all the phases of the process implementation
Contact Details
NWICPC: Nevsky prospect, 110 St.Petersburg, Russian Federation; E-mail: admin@nwicpc.ru (for letters: P.O.Box 157, St.Petersburg 191119)
St.Petersburg Vodokanal affiliation «Engineering Innovative Centre», Kavalergardskaya str.42, St.Petersburg 191015 Russian Federation, E-mail: office@vodokanal.spb.ru
English Abstract (where applicable)



RECP Experiences



ABOUT RECP EXPERIENCES

Through the joint Resource Efficient and Cleaner Production (RECP) Programme, the United Nations Industrial Development Organization (UNIDO) and the United Nations Environment Programme (UNEP) cooperate to improve the resource productivity and environmental performance of businesses and other organizations in developing and transition countries. The Programme is implemented in partnership with the Global Network for Resource Efficient and Cleaner Production (RECPnet). This series of enterprise success stories documents the resource productivity, environmental and other benefits achieved by enterprises in developing and transition countries through the implementation of RECP methods and practices.

These successes were achieved with the assistance of the National Cleaner Production Centres, which are part of RECPnet established with support of the UNIDO and UNEP. The success stories employ the indicator set described in *Enterprise Level Indicators for Resource Productivity and Pollution Intensity*, UNIDO/UNEP, 2010. The primer with accompanying calculator tool and further case studies are available at www.recpnet.org, as well as on www.unido.org/cp and www.unep.fr/scp/cp.