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Summary of C.7.3 deliverable „Handbook of wastewater treatment“

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Editor: Aleksander Maastik

Authors (in alphabetical order): Aare Kuusik, Aimar Kivirüüt, Alar Noorvee, Aleksander Maastik, Andra Villers, Anne Menert, Argo Kuusik, Aser Sikk, Daisy Rist, Egge Haiba, Egle Saaremäe, Enn Tõnisberg, Erki Lember, Jaak Jaaku, Jaak Truu, Kaja Orupõld, Kristjan Karabelnik, Maarja-Liis Salumäe, Mailis Laht, Mait Kriipsalu, Mait Põldemaa, Margit Kõiv-Vainik, Mart Taklai, Mihkel Gross, Olev Sokk, Pille Kängsepp, Priit Tamm, Raili Kärmas, Taavo Tenno, Toomas Tamm, Vahur Värk, Vallo Lemmiksoo ja Vallo Kõrgmaa

Graphic design of drawings: Ottar Tamm

Reviewers: Aare Kuusik, Aimar Kivirüüt, Anni Mandel, Andra Villers, Argo Kuusik, Egge Haiba, Egle Saaremäe, Enn Tõnisberg, Erki Lember, Jaak Truu, Karin Pachel, Katri Kartau, Mait Kriipsalu, Mart Taklai, Mihkel Gross, Sergei Zub, Taavo Tenno, Tatjana Rein, Vahur Värk, Vallo Lemmiksoo ja Vallo Kõrgmaa

Cover photo: Morten Poolakese

Aruanne on valminud LIFE IP CleanEST projekti raames, mida rahastavad Euroopa Komisjoni LIFE programm ja Eesti riik. LIFE programmi rahastusleping nr LIFE17 IPE/EE/000007. Aruanne kajastab autori seisukohti ja Euroopa Komisjon ei vastuta sisu kasutamise eest.

Summary

All living organisms on our planet need water for life, including humans. In Estonia, both surface and groundwater are used in everyday life and in the industry. Most of this water ends up in sewers and must be cleaned before being returned to nature or reused. This is done in a wastewater treatment plant, which requires a variety of equipment and trained engineers and workers to implement the complex processes that take place.

Over the years, many manuals and some textbooks on sewage networks and water protection have been published in Estonia, but not all aspects related to wastewater treatment have been covered before. However, we have a number of specialists who continuously supplement and pass on the professional knowledge they received from the legendary scholars and engineers of the older generation.

Wastewater treatment is expensive, and its development got a big boost in Estonia at the beginning of this century, when it became possible to use grants from the *Environmental Investment Center* (SA KIK) and the support programs of the *European Union*. Although the major water supply and sewerage projects have been completed to date, and a rapid increase in water supply and sewerage works is not foreseen, these systems still need to be maintained, expanded and optimized. For many years, the Ministry of Climate has been organizing tenders for the training of sewage treatment plant operators. Since 2017, it is possible to acquire the water treatment operator's qualification at the Järvamaa Vocational Education Center. Wastewater treatment engineers and technologists are trained at the Tallinn University of Technology, the Estonian University of Life Sciences and the University of Tartu. Although it is possible to learn the specialty of wastewater treatment according to curricula of different levels (in the form of vocational or higher education), there is a lack of educational literature at the modern level, because the last more comprehensive textbooks in Estonian date from the first half of the 1980s.

According to the *LIFE IP CleanEST* Grant Agreement one of the deliverables of action C.7.3 had to be „Guidelines for urban wastewater management and wastewater treatment in sparsely populated areas“, but as there are several guidelines already available for wastewater treatment in sparsely populated areas [1–4], it was decided during the Phase I that a „Handbook for wastewater treatment“ would be published instead (see memos 12.03.2020, 07.09.2020 and Interim Report Covering the project activities from 01/January/2019 to 31/December/2020 page 42).

This handbook has been completed within the *LIFE IP CleanEST* project, which is financed by the LIFE program of the European Commission and the Ministry of Climate. When compiling the book, authors tried to be so thorough that it could be used for teaching in vocational and in higher education schools, but it would also be understandable to those people in the field of water management, whose job duties do not include wastewater treatment. Because wastewater treatment is a very broad and rapidly developing field, the book may not cover all treatment technologies and methods, but authors did their best to cover the main ones. Although the writing of the book was largely based on professional standards (mainly German standards) and foreign university textbooks, the results of scientific research were also considered, in which previous knowledge has been significantly specified or even reshaped.

The handbook is written in Estonian and contains 22 chapters and four annexes, in total 748 pages:

1. The water cycle, human and water management – the chapter introduces the water cycle, emphasizes the anthropogenic impact to the water quality and introduces main principles of water management.
2. How to describe wastewater – the chapter gives an overview of analytical methods for wastewater characterization, but also gives guidelines for data that is needed for process design and control.
3. Sewage disposal – the chapter gives an overview of main components of the sewer system, including design principles.
4. General principles of wastewater treatment – the chapter gives a short introduction to the stages of wastewater treatment, gives an overview of other aspects that are relevant while selecting the best method (e.g., social-economic aspects) and emphasizes the role of critical triangle (wastewater characteristics, technology and operation) in achieving best results.
5. Pretreatment – a description and working principle of different wastewater pretreatment facilities is given with design guidelines.
6. Fundamentals of biological processes – this is an introductory chapter that describes micro-organisms that are used for wastewater treatment, explains how different (environmental) conditions can affect the biological treatment process and introduces basic principles of reaction stoichiometry and kinetics.
7. Activated sludge treatment – describes activated sludge treatment in general and gives guidelines for calculating and controlling the process either in flow through or in the sequencing batch reactor (SBR).

8. Nitrogen removal – describes principles of nitrogen removal with guidelines for design and process control.
9. Phosphorous removal – describes principles of both chemical and biological phosphorous removal with guidelines for design and process control.
10. Biofilm process – describes biofilm process in general and gives guidelines for calculating and controlling different biofilm solutions.
11. Constructed wetlands – describes different solutions for wastewater treatment with artificially created nature-based wetland systems among with guidelines for calculating and controlling different these solutions.
12. Anaerobic wastewater treatment – describes anaerobic process in general and gives guidelines for calculating and controlling different solutions.
13. Membrane bioreactors – general working principles with design and process guidelines are given for solutions, where biological treatment is combined with membrane filtration.
14. Blowers, mixers and pumps – a short overview of equipment needed for mixing, pumping and aerating is given.
15. Clarification – principles of solids removal are described among with guidelines for design and process control.
16. Effluent polishing – a description and working principle of different wastewater post-treatment facilities (e.g., filtration, adsorption, disinfection) is given with design and maintenance guidelines.
17. Sewage sludge treatment – this chapter describes different opportunities to reduce the water content in sewage sludge among with processes needed for stabilization.
18. Air treatment – strong odours from wastewater treatment have been a problematic issue in Estonia for long period. This chapter introduces principles of odour removal among with guidelines for design and process control.
19. Designing a wastewater treatment plant – gives a short overview of design process, including parties involved and data that is needed. Additional focus has been given to the industrial wastewater treatment, as these waters might need an extra attention.
20. Operation of the wastewater treatment plant – a special focus was put on the maintenance and process control practices. Factors limiting the performance of the wastewater treatment plant were described. Management practices were introduced among with possibilities for process optimization.
21. Safety and healthcare – main principles of risk assessment and management were introduced. Work in wastewater treatment facilities can be quite dangerous and operators have to be able to either prevent different occupational hazards or minimise their impact.

22. History of wastewater treatment – an overview of history of wastewater treatment was given for the general level but also for Estonia.

Annex I – special emphasis has been placed on Estonian vocabulary to help standardize the language of people from different professions. Estonian terms were mainly associated with English, which has become the *lingua franca* of the world's scientific language, but also with Russian, because a considerable part of wastewater treatment plant operators are Russian speakers. The vocabulary selection was compiled by Aleksander Maastik, Raili Kärmas, Karin Pachel, Vallo Kõrgmaa, Mait Kriipsalu and Vjačeslav Mutavči, based mainly on the EVS-EN 16323 standard.

Annex II – Guidelines for microscopic examination of activated sludge.

Annex III – Guidelines for sampling in wastewater treatment facilities.

Annex IV – Description of selected analytical methods for wastewater treatment.

The handbook was prepared by leading Estonian scientists and specialists whose main workplace is an Estonian educational institution or a design and consulting company. The book was completed thanks to the long-term and good cooperation of these people. Authors tried to choose the illustrative photos from the personal archives and the majority of the diagrams were drawn up by the authors. Drawings by other authors have been represented or adapted if necessary.

References

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