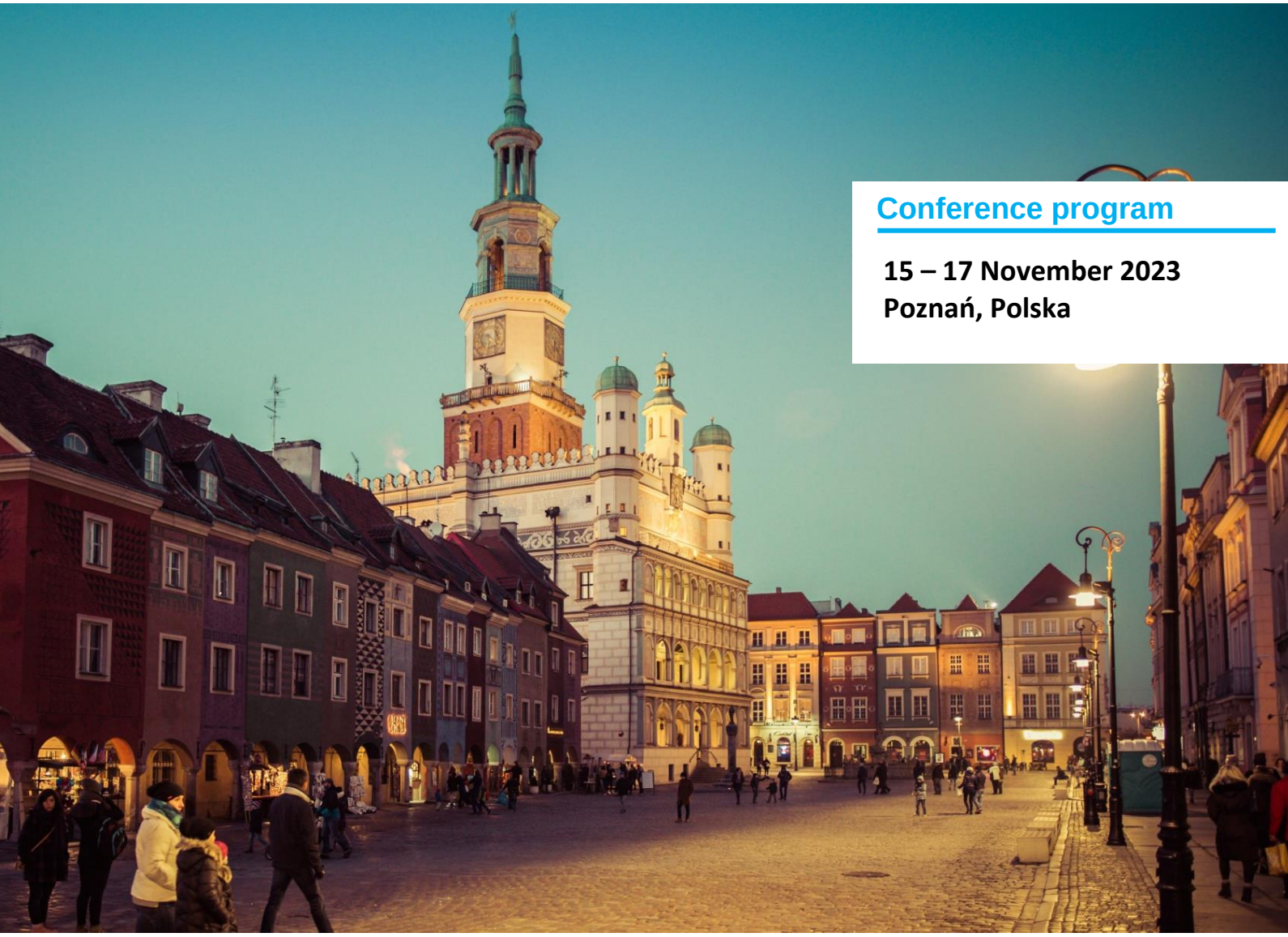
Water - Excellent Science and Industrial Development

3’rd Polish YWP Conference



Conference program

15 – 17 November 2023
Poznań, Polska

https://ywp.put.poznan.pl/

ORGANIZER

the international water association

POLAND
YOUNG WATER PROFESSIONALS PROGRAMME

POZNAN UNIVERSITY OF TECHNOLOGY

CO- ORGANIZER

Politechnika Warszawska – Warsaw University of Technology

Politechnika Gdańska

Mineral and Energy Economy Research Institute
Polish Academy of Sciences

Cracow University of Technology

Fundacja na Rzecz Rozwoju Politechniki Poznańskiej

GOLDEN PARTNER

3W • WODA • WODÓR • WĘGIEL

BGK
Bank Gospodarstwa Krajowego

SILVER PARTNER

HYDRO MARKO

izostal sa
Grupa kapitałowa Stalprofil S.A.

PATRONAGE

Izba Gospodarcza
WODOCIĄGI POLSKIE

GDAŃSKA FUNDACJA WODY

Gaz, Woda i Technika Sanitarna
100 lat czasopisma

FORUM
EKSPLOATATORA

INSTAL

technologia wody

DAY 1

Wednesday, November 15

13:30 - 17:00
Workshops (with Lunch break)

- Modelling Wastewater treatment plant [305*]
- Modeling Water Distribution Systems [UCK*] (in Polish)

17:10 - 18:40
Industrial development track (in Polish) [051*]

Chair: Jacek Mąkinia, Agnieszka Szuster-Janiaczyk

- Monika Ochmańska (Cracow University of Technology)
  Związki PFAS w wodzie przeznaczonej do spożycia dla ludzi w aspekcie zagadnień Dyrektywy (UE) 2020/2184

- Justyna Michalska (Silesian University of Technology)
  Ocena możliwości zastosowania wybranych materiałów naturalnych i odpadowych do usuwania substancji humusowych z cieczy osadowej i przywrócenia materii organicznej do gleby

- Dominika Poproch (Cracow University of Technology)
  Oczyszczalnia ścieków Kraków-Płaszów w kontekście zrównoważonej gospodarki obiegu zamkniętego

- Mateusz Muszyński Huhajło, Stanisław Miodoński (Wroclaw University of Science and Technology)
  Produkcja wolnego kwasu azotowego (III) ze strumienia odcieków z odwadniania osadu przefermentowanego w komunalnej oczyszczalni ścieków

- Stanisław Miodoński, Mateusz Muszyński Huhajło (Wroclaw University of Science and Technology)
  Analiza możliwości eliminacja bakterii nitryfikacyjnych II fazy z osadu czynnego z wykorzystaniem selektora opartego o FNA.

DISCUSION

18:45 WELCOME RECEPTION AND INFORMAL ACTIVITIES

DAY 2

Thursday, November 16

8:00 - 9:00
Conference Registration
[UCK*]

9:00 - 10:30
OPENING SESSION
[UCK*]

Chair: Zbysław Dymaczewski, Jacek Mąkinia, Jakub Drewnowski, Jędrzej Bylka

Welcome speech

- Mahesh Ganesapillai (Vellore Institute of Technology)
  Establishing a Bioeconomy based on Human Excrete: Nutrient Recovery from Human Urine and Feces
- Francisco Jesus Fernandez Morales
  (University Castilla-La Mancha)
  An effective HCT doping strategy of carbon felt anode for metal recovery in microbial fuel cells
- Marta Saracyn (BGK - Bank Gospodarstwa Krajowego)
  Co hydrolog robi w banku? O wodzie w instytucji finansowej i nie tylko

10:30 - 10:45 COFFE BREAK

10:45 - 12:15
Water and Wastewater
[UCK*]

Chair: Joanna Jeż-Walkowiak, Małgorzata Komorowska-Kaufman

- Edyta Kiedrzyńska
  (European Regional Centre for Ecohydrology of the Polish Academy of Sciences)
  Ecohydrological analysis of emerging pollutants in water and wastewater: from the Pilica River to the Baltic Sea basin
- Katarzyna Jaszczyszyn
  (European Regional Centre for Ecohydrology of the Polish Academy of Sciences)
  Analysis of microplastics using FTIR imaging microscopy: preliminary results for Pilica River catchment
- Dominika Piwowarska (University of Lodz)
  Analysis of PAHs and heavy metals in industrial and municipal wastewater
- Paulina Otto (Poznan University of Technology)
  Implementation of the IWA Water-Wise Cities principles in Polish urban planning
- Natalia Kolwicz (Poznan University of Technology)
  Comparison of struvite recovery from sludge liquids using two different sources of magnesium

12:15 - 13:15 LUNCH & POSTER

13:15 - 14:45

Wastewater and Resources Recovery 1

[UCK*]

Chair: Małgorzata Cimochowicz-Rybicka, Katarzyna Jaszczyszyn

- Sajid Hussain (University of Trento)
  Start-up of granulation in aerobic granular sludge sequencing batch reactor for treating industrial wastewater using cationic polymer
- Aleksander Czapla (Gdansk University of Technology)
  The strategy of using composite as a material for Water and Wastewater Systems
- Bogna Śniatała (Gdansk University of Technology)
  Membrane distillation for N recovery from wastewater – operational parameters optimization
- Wiktor Gielniak (Poznan University of Technology)
  Food industry wastewater as an external carbon source for the denitrification process in a municipal wastewater treatment plant
- Maciej Floczyk (University of Warmia and Mazury)
  Characterization of extracellular polymers extracted from activated sludge

DISCUSION

14:45 - 15:00 COFFE BREAK

15:00 - 16:00

Wastewater and Resources Recovery 2

[UCK*]

Chair: Jakub Drewnowski, Mahesh Ganesapillai

- Hubert Byliński (Gdansk University of Technology)
  Effects of low-thermal pretreatment combined with enzymatic hydrolysis on solubilisation of food waste
- Kishore Kumar Kadimpati (Silesian University of Technology)
  In situ bio-methanation of sewage sludge biogas using a mesophilic CSTR system
- Emilia Bączkowska (Gdansk University of Technology)
  The influence of UV disinfection method on the concentration of micropollutants in treated wastewater – Case study o Jastrzębia Góra (Baltic Sea Region)
- Aisha Khan Khanzad (Gdansk University of Technology)
  Comparative Analysis of Lactic Acid Fermentation Using Rice and Potato Substrates, and Profiling of Volatile Fatty Acids

DISCUSION

16:00 - 16:30

CLOSING SESSION

Zbysław Dymaczewski, Jacek Mąkinia, Jędrzej Bylka

18:30 DINNER

DAY 3

Friday, November 17

10:00 - 13:00

Technical trip

Aquanet S.A. Centralna Oczyszczalnia Ścieków
Meeting at Gdyńska 1, 62-028 Koziegłowy:

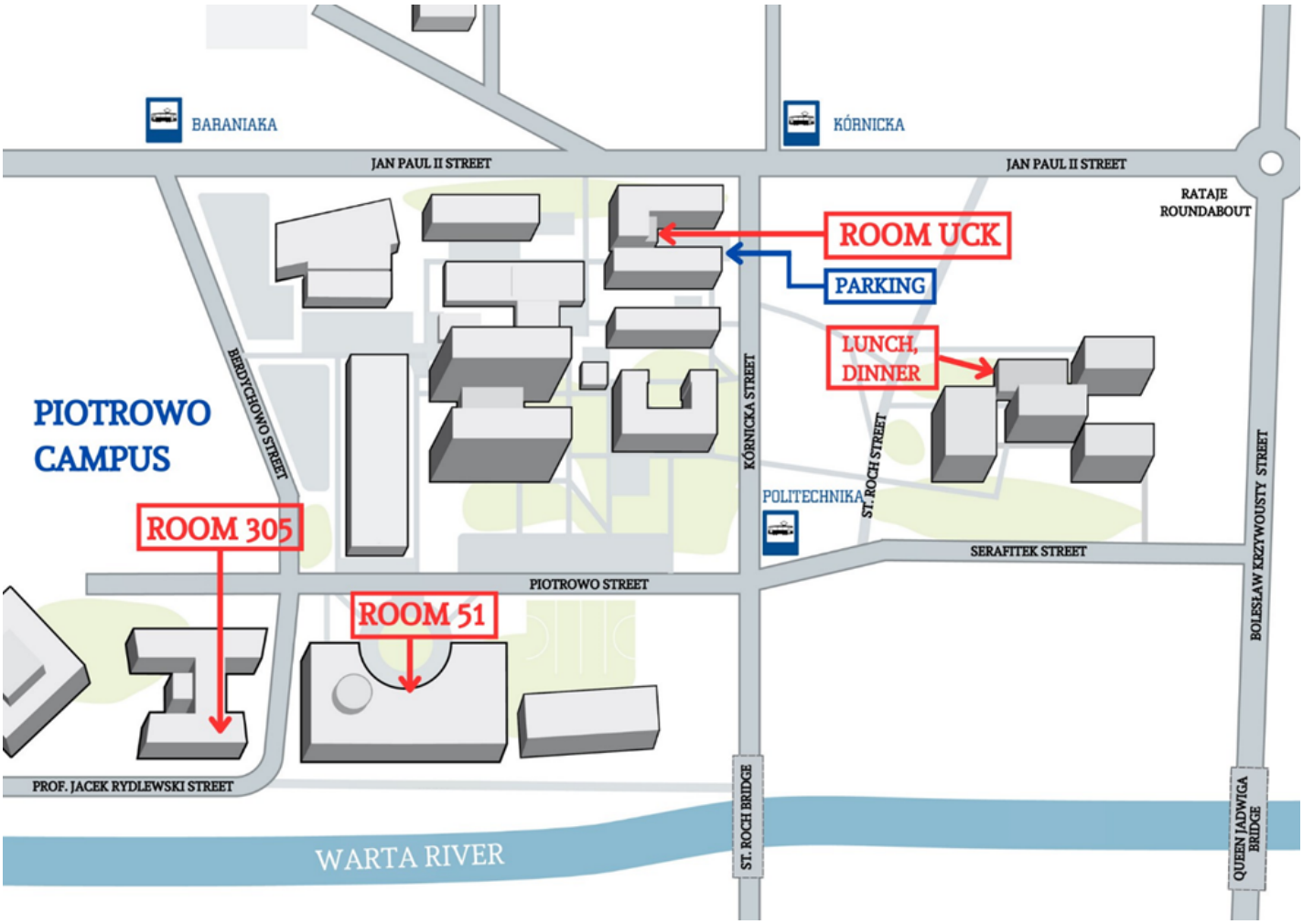
Access by public transport
From: Rondo Śródka
To: Koziegłowy/Piaskowa COŚ
BUS numbers: 312 or 341

*Location of meeting rooms

305 - Wydział Technologii Chemicznej PP
ul. Berdychowo 4
3 rd. floor

UCK - Uczelniane Centrum Kultury PP
ul. Jana Pawła II 28

051 - Centrum Wykładowe PP
ul. Piotrowo 2



POSTERS

- **Anna Wilińska-Lisowska**
  Gdansk University of Technology
  Biodegradation of the dissolved fraction of organic nitrogen in leachate from biogas plants located at wastewater treatment plants

- **Zahra Askarniya**
  Gdansk University of Technology
  The application of advanced reduction processes for the removal of halogenated compounds

- **Hameed Ul Haq1**
  Gdansk University of Technology
  Novel method for methyl violet dye determination in contaminated river water – a natural deep eutectic solvent based ultrasound assisted liquid-liquid micro-extraction approach

- **Łukasz Cichocki**
  Gdansk University of Technology
  Advanced reduction processes (ARPs) in degradation of pesticides in wastewater by CO2 reducing radicals generated in the HCOOH/UV system

- **Mohanad Awad**
  Gdansk University of Technology
  Model-Based Evaluation of Strategies for Mitigating N2O emissions in Activated Sludge Systems: Insights from Poznan's Wastewater Treatment Plant

- **Francisco Jesus Fernandez Morales**
  University Castilla-La Mancha
  Energy and material valorisation of corn-syrup by uncontrolled pH fermentation

- **Małgorzata Iwanek**
  Lublin University of Technology
  Efficiency Analysis of Selected Methods for Sustainable Management of Rainwater

- **Dominika Łomińska-Płatek**
  Cracow University of Technology
  Humic acids and their influence on the environment and climate changes

POSTERS

- **Paulina Ormaniec**
  Cracow University of Technology
  Characteristics of microplastics in municipal wastewater treatment plants

- **Krzysztof Kwiatkowski**
  Cracow University of Technology
  Ocena skuteczności usuwania wybranych zanieczyszczeń ze ścieków przy wykorzystaniu osadów z klarowania wody.

- **Weronika Borowska**
  Warsaw University of Technology
  Effect of short-term oxygen concentration variations on nitrification process and microbial community structure

- **Alicja Jeżewska**
  Gdansk University of Technology
  Application of low-thermal pretreatment of waste activated sludge with/without addition of cow dung in technological scale

- **Paweł Suchorab**
  Lublin University of Technology
  Classification of the nodal demands in 3 case study water supply networks

- **Rafał Ciepłuch**
  West Pomeranian University of Technology
  Analiza błędu oszacowania retencji powierzchniowej wód płytkich w oparciu o dane pochodzące z lotniczego skaningu laserowego

- **Joanna Majtacz**
  Gdansk University of Technology
  The role of the combined nitrogen-sulfur-carbon cycles for efficient performance of anammox-based systems

- **Marianna Piosik**
  Poznan University of Technology
  Universal method for the determination of estrogens in water, wastewater and soil

- **Agnieszka Rybarczyk**
  Poznan University of Technology
  Konwersja zanieczyszczeń farmaceutycznych z wykorzystaniem immobilizowanej lakazy

POSTERS

- **Joanna Antos**
  Poznan University of Technology
  Effect of artificial infiltration process on non-steroidal anti-inflammatory drugs and antibiotics concentrations
- **Michał Narojczyk**
  Poznan University of Technology
  Technologia wody basenowej w Polsce i USA – doświadczenia z badań
- **Urszula Derkacz**
  Poznan University of Technology
  Budownictwo zrównoważone – woda jako ważny element certyfikacji BREEM i LEED
- **Anna Januchta-Szostak**
  Poznan University of Technology
  Concept of development of the Wierzbak valley in Poznań using surface runoff modeling tools
- **Justyna Michalska**
  Silesian University of Technology
  Validity of recovering humic substances from reject water using opoka and concrete
- **Farooque Janjhi9**
  Gdansk University of Technology
  MXene as emerging sustainable materials for wastewater treatment – a review
- **Aleksander Czapla**
  Gdansk University of Technology
  Strategizing for Sustainability: A Deep Dive into Optimizing Energy Efficiency in Wastewater Treatment Plants
- **Jakub Żywiec**
  Rzeszow University of Technology
  The concept of estimating the risk of water losses in the water supply network
- **Karolina Klobukowska**
  University of Warmia and Mazury
  Wpływ gęstości prądu stałego na efektywność oczyszczania ścieków szklarniowych

POSTERS

- **Paulina Szulc-Kłosińska**
  Poznan University of Technology
  Introduction to the algorithm of carbon footprint calculation for municipal wastewater treatment plants according to EU legislation

- **Sechout Arouna N.M**
  Poznan University of Technology
  Wastewater management in Cameroon

- **Ewelina Nowak**
  Poznan University of Technology
  The use of Raman spectroscopy in the identification of plastic particles in water intended for human consumption

- **Fasilate Uwimpaye, Julia Jakubowska, Beata Konopczyńska, Karolina Mazurkiewicz , Joanna Jeż-Walkowiak**
  Poznan University of Technology
  Preliminary research on membrane filtration for surface water treatment

Związki PFAS w wodzie przeznaczonej do spożycia dla ludzi w aspekcie zagadnień Dyrektywy (UE) 2020/2184

Monika Ochmańska*, Małgorzata Cimochowicz-Rybicka**

* Wodociągi Miasta Krakowa, Szkoła Doktorska Politechniki Krakowskiej, ul. Warszawska 24, 31-155 Kraków (e-mail: monika.ochmanska@wodociagi.krakow.pl)
** Politechnika Krakowska, Wydział Inżynierii Środowiska i Energetyki, Katedra Technologii Środowiskowych (e-mail: mcrybicka@pk.edu.pl)

Słowa kluczowe: uzdatnianie wody, związki per i polifluoroalkilowe (PFAS), Dyrektywa (UE) 2020/2184

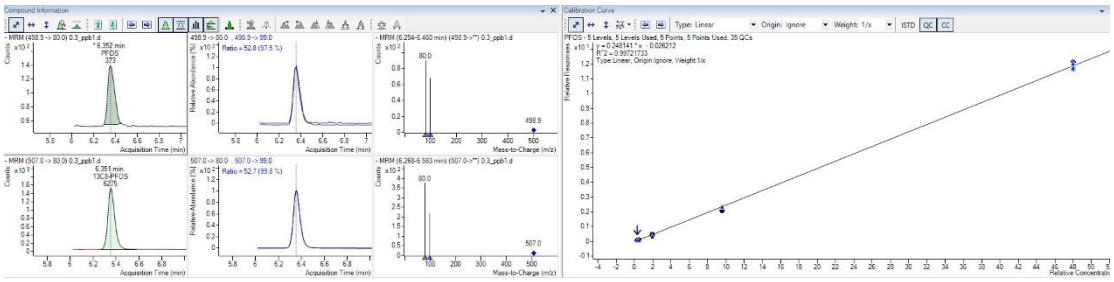
Streszczenie

W artykule przedstawione zostały badania laboratoryjne wykonane pod kątem wykrywania syntetycznych związków per- i polifluoroalkilowych (PFAS) w wodzie wraz z opracowaną metodyką badawczą.
Związki PFAS są wykorzystywane w licznych dziedzinach przemysłu (spożywczy, odzieżowy, motoryzacyjny, budowlany, elektroniczny). Ich powszechne stosowanie, wraz z ich trwałością w środowisku, powoduje rosnące zanieczyszczenie środowiska. Mają zdolność do kumulowania się w wodzie, a nawet powietrzu. Wpływają na układ odpornościowy, metabolizm człowieka, jego płodność, mogą przyczynić się do chorób nowotworowych, mogą mieć niekorzystny wpływ na poziom cholesterolu w surowicy, wątrobę oraz masę urodzeniową. PFAS-y zostały wymienione w nowej Dyrektywie (UE) 2020/2184 jako substancje podlegające kontroli i przygotowywane są polskie regulacje prawne narzucające dopuszczalne stężenia tych substancji. Przedsiębiorstwa wodociągowe zobligowane są do wprowadzenia modernizacji procesów technologicznych umożliwiających usuwanie tych substancji z wody.
W badaniach przeanalizowano wodę przeznaczoną do spożycia na terenie Krakowa. Badania laboratoryjne prowadzone były w kolejnych etapach:
- pobór próbek, utrwalanie, transport i przechowywanie;
- przygotowanie próbek: technika ekstrakcji ciecz-ciało stałe, z wykorzystaniem automatycznej stacji ekstrakcji i zatężania SPE-03 firmy Promochrom;
- analiza próbek: technika chromatografii cieczowej z detekcją przy użyciu spektrometrii mas - Chromatograf UHPLC Agilent 1290 Infinity II z tandemowym detektorem mas MS/MS 6470B (Rys.1);
- optymalizacja metody, wybór odpowiednich wzorców wewnętrznych (Tabela 1)
- elementy walidacji metody analitycznej (Tabela 2, Tabela 3)
Podsumowanie: stężenie wszystkich analizowanych związków fluoroalkilowych mieściło się poniżej wartości parametrycznej określonej Dyrektywą (Tabela 4). Wykonano szereg analiz potwierdzających wystarczającą czułość metody oraz odzyski na poziomie pomiędzy 64 a 91 % (Tabela 5) dla dolnego zakresu badawczego.

Bibliografia

Dyrektywa Parlamentu Europejskiego i Rady (UE) 2020/2184 z dnia 16 grudnia 2020 r. *w sprawie jakości wody przeznaczonej do spożycia przez ludzi*.
Snyder S., Anumol T., (2022) *Application Note, Automated Online SPE for LC/MS/MS Analysis of Trace Organic Contaminants in Water Using the Agilent 1290Infinity Flexible Cube Module*.
Rosenblum L., Wendelken S.C., (2019) *Determination of Per- and Polyfluoroalkyl Substances in Drinking Water by Isotope Dilution Anion Exchange Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry*, Method 533.

Rysunki i tabele



Rysunek 1 Odpowiedź detektora oraz krzywa kalibracyjna dla PFOS.

Tabela 1 Dobór odpowiedniego wzorca wewnętrznego dla badanych związków fluoroalkilowych.

↓ Name	RT→	2,783		3,821		3,902		4,222		4,768		4,816		5,515		6,461		6,500		7,525		8,586		9,488	
	ISTD →	13C4-PFBA		13C5-PFPeA		13C3-PFBS		13C5-PFHxA		13C4-PFHpA		13C3-PFHxS		13C8-PFOA		13C9-PFNA		13C8-PFOS		13C6-PFDA		13C7-PFUnDA		13C2-PFDoDA	
	↓RT	Final Conc.	Accuracy	Final Conc.	Accuracy	Final Conc.	Accuracy	Final Conc.	Accuracy	Final Conc.	Accuracy	Final Conc.	Accuracy	Final Conc.	Accuracy	Final Conc.	Accuracy	Final Conc.	Accuracy	Final Conc	Accuracy	Final Conc.	Accuracy	Final Conc.	Accuracy
PFBA	2,780	0,04518	90,4	0,04358	87,2	0,04160	83,2	0,04261	85,2	0,04423	88,5	0,04176	83,5	0,04495	89,9	0,04602	92,0	0,04069	81,4	0,04264	85,3	0,04307	86,1	0,03841	76,8
PFPeA	3,814	0,04752	95,0	0,04585	91,7	0,04377	87,5	0,04483	89,7	0,04652	93,0	0,04392	87,8	0,04728	94,6	0,04840	96,8	0,04281	85,6	0,04485	89,7	0,04533	90,7	0,04039	80,8
PFBS	3,903	0,05039	100,8	0,04863	97,3	0,04642	92,8	0,04755	95,1	0,04934	98,7	0,04658	93,2	0,05014	100,3	0,05132	102,6	0,04542	90,8	0,04756	95,1	0,04808	96,2	0,04285	85,7
PFHxA	4,223	0,04830	96,6	0,04661	93,2	0,04449	89,0	0,04557	91,1	0,04728	94,6	0,04464	89,3	0,04805	96,1	0,04920	98,4	0,04352	87,0	0,04559	91,2	0,04607	92,1	0,04106	82,1
PFPeS	4,280	0,05067	101,3	0,04889	97,8	0,04667	93,3	0,04780	95,6	0,04961	99,2	0,04684	93,7	0,05042	100,8	0,05161	103,2	0,04566	91,3	0,04783	95,7	0,04834	96,7	0,04309	86,2
PFHpA	4,762	0,04617	92,3	0,04454	89,1	0,04251	85,0	0,04355	87,1	0,04520	90,4	0,04268	85,4	0,04594	91,9	0,04703	94,1	0,04159	83,2	0,04357	87,1	0,04403	88,1	0,03926	78,5
PFHxS	4,810	0,04841	96,8	0,04670	93,4	0,04457	89,1	0,04566	91,3	0,04739	94,8	0,04475	89,5	0,04817	96,3	0,04931	98,6	0,04361	87,2	0,04569	91,4	0,04616	92,3	0,04118	82,4
PFOA	5,508	0,04742	94,8	0,04574	91,5	0,04366	87,3	0,04472	89,4	0,04643	92,9	0,04384	87,7	0,04719	94,4	0,04831	96,6	0,04271	85,4	0,04476	89,5	0,04521	90,4	0,04034	80,7
PFHpS	5,554	0,04866	97,3	0,04694	93,9	0,04480	89,6	0,04589	91,8	0,04763	95,3	0,04498	90,0	0,04842	96,8	0,04956	99,1	0,04383	87,7	0,04592	91,8	0,04640	92,8	0,04138	82,8
PFNA	6,455	0,04634	92,7	0,04469	89,4	0,04266	85,3	0,04370	87,4	0,04536	90,7	0,04284	85,7	0,04611	92,2	0,04720	94,4	0,04174	83,5	0,04374	87,5	0,04418	88,4	0,03942	78,8
PFOS	6,485	0,05064	101,3	0,04886	97,7	0,04664	93,3	0,04777	95,5	0,04958	99,2	0,04681	93,6	0,05038	100,8	0,05158	103,2	0,04562	91,2	0,04779	95,6	0,04830	96,6	0,04304	86,1
PFDA	7,509	0,04778	95,6	0,04610	92,2	0,04400	88,0	0,04507	90,1	0,04678	93,6	0,04417	88,3	0,04754	95,1	0,04867	97,3	0,04305	86,1	0,04510	90,2	0,04557	91,1	0,04064	81,3
PFNS	7,531	0,05184	103,7	0,05002	100,0	0,04775	95,5	0,04890	97,8	0,05075	101,5	0,04792	95,8	0,05158	103,2	0,05280	105,6	0,04671	93,4	0,04893	97,9	0,04944	98,9	0,04408	88,2
PFDS	8,567	0,04975	99,5	0,04800	96,0	0,04582	91,6	0,04693	93,9	0,04870	97,4	0,04596	92,0	0,04950	99,0	0,05068	101,4	0,04482	89,6	0,04695	93,9	0,04745	94,9	0,04229	84,6
PFUnDA	8,571	0,04794	95,9	0,04625	92,5	0,04415	88,3	0,04522	90,4	0,04693	93,9	0,04432	88,6	0,04770	95,4	0,04893	97,7	0,04319	86,4	0,04525	90,5	0,04572	91,4	0,04077	81,5
PFUdS	9,454	0,05267	105,3	0,05081	101,6	0,04850	97,0	0,04968	99,4	0,05156	103,1	0,04869	97,4	0,05240	104,8	0,05365	107,3	0,04745	94,9	0,04971	99,4	0,05023	100,5	0,04478	89,6
PFDoDA	9,473	0,05466	109,3	0,05273	105,5	0,05033	100,7	0,05156	103,1	0,05351	107,0	0,05053	101,1	0,05439	108,8	0,05568	111,4	0,04924	98,5	0,05159	103,2	0,05213	104,3	0,04648	93,0
PFDoS	10,035	0,04990	99,8	0,04815	96,3	0,04596	91,9	0,04707	94,1	0,04885	97,7	0,04613	92,3	0,04965	99,3	0,05082	101,6	0,04496	89,9	0,04710	94,2	0,04759	95,2	0,04243	84,9
PFTrDA	10,069	0,05109	102,2	0,04929	98,6	0,04705	94,1	0,04819	96,4	0,05001	100,0	0,04722	94,4	0,05083	101,7	0,05204	104,1	0,04603	92,1	0,04822	96,4	0,04873	97,5	0,04343	86,9
PFTrDS	10,471	0,04791	95,8	0,04622	92,4	0,04411	88,2	0,04519	90,4	0,04690	93,8	0,04428	88,6	0,04766	95,3	0,04880	97,6	0,04315	86,3	0,04521	90,4	0,04568	91,4	0,04072	81,4

Tabela 2 Granica oznaczalności dla PFAS

	PFBA	PFPeA	PFBS	PFHxA	PFPeS	PFHpA	PFHxS	PFOA	PFHpS	PFNA	PFOS	PFDA	PFNS	PFUnDA	PFDS	Kwas perfl	PFDoDA	Kwas perfl	PFTrDA	Kwas perfl
Name	Final Conc.																			
0.1_ppb_1.d	0,1635	0,1308	0,103	0,104	0,0994	0,098	0,1129	0,1036	0,0877	0,1168	0,0779	0,0961	0,0415	0,1206	0,1086	0,1077	0,1052	0,1329	0,1373	0,1151
0.1_ppb_2.d	0,1487	0,1172	0,1025	0,0996	0,092	0,1028	0,0943	0,1133	0,0816	0,1034	0,0759	0,0704	0,0717	0,1106	0,0951	0,097	0,0956	0,098	0,113	0,1181
0.1_ppb_3.d	0,1372	0,1165	0,0953	0,1079	0,0975	0,0908	0,1002	0,099	0,081	0,1103	0,0744	0,0996	0,0707	0,1105	0,1009	0,1105	0,1101	0,1395	0,1333	0,1386
0.1_ppb_4.d	0,1546	0,1309	0,1066	0,115	0,095	0,0958	0,0917	0,0978	0,0753	0,1062	0,0692	0,074	0,0654	0,1279	0,1161	0,1183	0,1067	0,1204	0,0942	0,1241
0.1_ppb_5.d	0,1612	0,1374	0,1089	0,0932	0,1115	0,0848	0,1039	0,106	0,079	0,1027	0,0732	0,084	0,0783	0,1123	0,0889	0,1037	0,1079	0,1031	0,0963	0,1174
0.1_ppb_6.d	0,1258	0,1212	0,1018	0,1005	0,1086	0,1012	0,0835	0,1401	0,0934	0,1007	0,0996	0,081	0,0568	0,1211	0,0977	0,0806	0,1024	0,1066	0,1098	0,1184
0.1_ppb_7.d	0,1443	0,1311	0,1074	0,0989	0,102	0,099	0,1046	0,1035	0,0691	0,1005	0,0734	0,0821	0,0375	0,1041	0,0941	0,108	0,0997	0,129	0,1084	0,1559
0.1_ppb_8.d	0,1522	0,1166	0,1007	0,1121	0,1001	0,1042	0,0952	0,1121	0,0788	0,1008	0,0755	0,0716	0,0689	0,1101	0,1064	0,0981	0,0985	0,1104	0,1062	0,1329
0.1_ppb_9.d	0,151	0,1481	0,1164	0,1023	0,122	0,0961	0,0976	0,1209	0,075	0,0971	0,0882	0,0796	0,0535	0,1161	0,0885	0,0907	0,1346	0,1146	0,1193	0,1328
0.1_ppb_10.d	0,1372	0,1295	0,0996	0,1112	0,0966	0,0951	0,1071	0,1272	0,0708	0,1089	0,0726	0,0918	0,0715	0,1235	0,0917	0,1151	0,1029	0,1124	0,1164	0,1016

Tabela 3 Potwierdzenie dolnego zakresu na matrycy wody pitnej dla PFAS

	PFBA	PFPeA	PFBS	PFHxA	PFPeS	PFHpA	PFHxS	PFOA	PFHpS	PFNA	PFOS	PFDA	PFNS	PFUnDA	PFDS	PFUnDS	PFDoDA	PFDoDS	PFTrDA	PFTrDS
1831_0	0,2921	0,1379	0,1124	0,1281	0,0808	0,0872	0,0381	0,1068	0,0184	0,0549	0,0545	0,0334	0,0139	0,0326	0,0156	0,0171	0,0352	0,0000	0,0456	0,0130
1831_1	0,5788	0,3655	0,3006	0,3600	0,3048	0,2912	0,2893	0,3278	0,2541	0,2862	0,2977	0,2718	0,2515	0,2813	0,2546	0,1937	0,2854	0,2067	0,1986	0,1368
1831_2	0,5736	0,3847	0,3233	0,3450	0,3470	0,2967	0,2890	0,3596	0,2995	0,3207	0,3213	0,2788	0,2831	0,2921	0,2729	0,2121	0,3064	0,1963	0,2546	0,1882
1831_3	0,5448	0,3723	0,3500	0,3616	0,3424	0,3178	0,2709	0,3148	0,2591	0,3057	0,3405	0,3225	0,2849	0,3129	0,3057	0,2488	0,2937	0,2462	0,2924	0,2445
1831_4	0,4923	0,3294	0,3233	0,3282	0,3137	0,2840	0,2890	0,3367	0,2844	0,2829	0,2805	0,2707	0,3149	0,2812	0,2462	0,2204	0,2526	0,2045	0,2462	0,2237
1831_5	0,5025	0,3561	0,3430	0,3477	0,3133	0,3079	0,2986	0,3317	0,2555	0,2692	0,3076	0,2777	0,2925	0,2917	0,2584	0,2652	0,2637	0,1945	0,3119	0,2459
1831_6	0,5240	0,3396	0,3095	0,3392	0,3167	0,2864	0,2759	0,3481	0,2404	0,2668	0,2967	0,3106	0,2857	0,2780	0,2477	0,2254	0,2660	0,2621	0,2806	0,2313
1831_7	0,5348	0,3537	0,3444	0,3535	0,3264	0,3083	0,2786	0,3490	0,2722	0,2843	0,3366	0,2990	0,2846	0,3054	0,2974	0,2739	0,2923	0,2782	0,2752	0,2415
1831_8	0,5511	0,3579	0,3159	0,3696	0,3569	0,3421	0,3015	0,3531	0,3580	0,3111	0,3316	0,3174	0,3230	0,3258	0,2767	0,2613	0,2955	0,2913	0,3164	0,2655
1831_9	0,5395	0,3586	0,3171	0,3621	0,3271	0,3140	0,2965	0,3337	0,2981	0,2992	0,3065	0,2663	0,2701	0,2769	0,3172	0,2566	0,2731	0,2516	0,2562	0,2016
1831_10	0,5496	0,3398	0,2885	0,3623	0,3237	0,3055	0,2979	0,3267	0,2780	0,3017	0,3165	0,2796	0,2705	0,2753	0,2665	0,2076	0,2723	0,2100	0,2378	0,0771

Tabela 4 Analiza wody w Zakładach Uzdatnia na terenie Krakowa, pod katem oznaczenia PFAS.

	PFBA Results	PFPeA Result	PFBS Results	PFHxA Result	PFPeS Result	PFHpA Result	PFHxS Result	PFOA Results	PFHpS Result	PFNA Results	PFOS Results	PFDA Results	PFNS Results	PFDS Results	PFUnDA Res	Kwas perfluorounde kanosulfonowy	PFDoDA Res	Kwas perfluorododе kanosulfonowy	PFTrDA Resu	Kwas perfluorotridek anosulfonowy
Name	Final Conc.	Final Conc.	Final Conc.	Final Conc.	Final Conc.	Final Conc.	Final Conc.	Final Conc.	Final Conc.	Final Conc.	Final Conc.	Final Conc.	Final Conc.	Final Conc.	Final Conc.	Final Conc.	Final Conc.	Final Conc.	Final Conc.	Final Conc.
Rudawa	0,296460937	0,147841224	0,130782837	0,112760671	0,066695349	0,077328772	0,134640482	0,621011822	0,04178695	0,087498679	0,073732836	0,056087928	0,033407076	0,034198914	0,059669259	0,042567227	0,061131546	0,064515139	0,049558094	0,03105914
Raba	0,449840651	0,261446219	0,205621736	0,470258927	0,062633116	0,199604599	0,081432302	0,489846915	0,038756615	0,136453035	0,052355946	0,061372047	0,03387284	0,030031032	0,059697704	0,04007333	0,054102211	0,054211425	0,048696568	0,029476424
Bielany	0,50130871	0,31285741	0,368998916	0,389532287	0,20982855	0,176447266	0,815607647	0,380233833	0,043978668	0,101709142	0,117705573	0,050119966	0,032806953	0,031084466	0,05162938	0,039933287	0,053808253	0,052460931	0,051482498	0,031139256
Dłubnia	0,075013384	0,063362249	0,098549711	0,092813175	0,061433	0,056370362	0,066580208	0,304013041	0,039676255	0,074841258	0,0298546	0,059167331	0,032858211	0,029598539	0,059161727	0,041044509	0,066422483	0,053065017	0,051191955	0,028554076

Tabela 5 Odzysk uzyskany dla analizowanych PFAS, po przeprowadzeniu całej procedury analitycznej.

	PFBA	PFPeA	PFBS	PFHxA	PFPeS	PFHpA	PFHxS	PFOA	PFHpS	PFNA	PFOS	PFDA	PFNS	PFUnDA	PFDS	PFUnDS	PFDoDA	PFDoDS	PFTrDA	PFTrDS
1831_0	0,2921	0,1379	0,1124	0,1281	0,0808	0,0872	0,0381	0,1068	0,0184	0,0549	0,0545	0,0334	0,0139	0,0326	0,0156	0,0171	0,0352	0,0000	0,0456	0,0130
1831_1	0,5788	0,3655	0,3006	0,3600	0,3048	0,2912	0,2893	0,3278	0,2541	0,2862	0,2977	0,2718	0,2515	0,2813	0,2546	0,1937	0,2854	0,2067	0,1986	0,1368
1831_2	0,5736	0,3847	0,3233	0,3450	0,3470	0,2967	0,2890	0,3596	0,2995	0,3207	0,3213	0,2788	0,2831	0,2921	0,2729	0,2121	0,3064	0,1963	0,2546	0,1882
1831_3	0,5448	0,3723	0,3500	0,3616	0,3424	0,3178	0,2709	0,3148	0,2591	0,3057	0,3405	0,3225	0,2849	0,3129	0,3057	0,2488	0,2937	0,2462	0,2924	0,2445
1831_4	0,4923	0,3294	0,3233	0,3282	0,3137	0,2840	0,2890	0,3367	0,2844	0,2829	0,2805	0,2707	0,3149	0,2812	0,2462	0,2204	0,2526	0,2045	0,2462	0,2237
1831_5	0,5025	0,3561	0,3430	0,3477	0,3133	0,3079	0,2986	0,3317	0,2555	0,2692	0,3076	0,2777	0,2925	0,2917	0,2584	0,2652	0,2637	0,1945	0,3119	0,2459
1831_6	0,5240	0,3396	0,3095	0,3392	0,3167	0,2864	0,2759	0,3481	0,2404	0,2668	0,2967	0,3106	0,2857	0,2780	0,2477	0,2254	0,2660	0,2621	0,2806	0,2313
1831_7	0,5348	0,3537	0,3444	0,3535	0,3264	0,3083	0,2786	0,3490	0,2722	0,2843	0,3366	0,2990	0,2846	0,3054	0,2974	0,2739	0,2923	0,2782	0,2752	0,2415
1831_8	0,5511	0,3579	0,3159	0,3696	0,3569	0,3421	0,3015	0,3531	0,3580	0,3111	0,3316	0,3174	0,3230	0,3258	0,2767	0,2613	0,2955	0,2913	0,3164	0,2655
1831_9	0,5395	0,3586	0,3171	0,3621	0,3271	0,3140	0,2965	0,3337	0,2981	0,2992	0,3065	0,2663	0,2701	0,2769	0,3172	0,2566	0,2731	0,2516	0,2562	0,2016
1831_10	0,5496	0,3398	0,2885	0,3623	0,3237	0,3055	0,2979	0,3267	0,2780	0,3017	0,3165	0,2796	0,2705	0,2753	0,2665	0,2076	0,2723	0,2100	0,2378	0,0771
średnia	0,5391	0,3558	0,3216	0,3529	0,3272	0,3054	0,2887	0,3381	0,2799	0,2928	0,3136	0,2894	0,2861	0,2921	0,2743	0,2365	0,2801	0,2341	0,2670	0,2056
stężenie dodatku	0,2470	0,2179	0,2092	0,2248	0,2464	0,2182	0,2506	0,2313	0,2615	0,2379	0,2591	0,2560	0,2722	0,2595	0,2587	0,2194	0,2449	0,2341	0,2214	0,1926
odzysk	82	73	70	75	82	73	84	77	87	79	86	85	91	86	86	73	82	78	74	64

Ocena możliwości zastosowania wybranych materiałów naturalnych i odpadowych do usuwania substancji humusowych z cieczy osadowej i przywrócenia materii organicznej do gleby

Joanna Surmacz-Górska[1], Jolanta Turek-Szytow[1, 2], Justyna Michalska[1], Agnieszka Dudło[1]

[1]Katedra Biotechnologii Środowiskowej, Wydział Ochrony Środowiska i Energetyki, Politechnika Śląska, Akademicka 2A, 44-100, Gliwice, Poland

[2]Centrum Biotechnologii, Politechnika Śląska, Krzywoustego 8, 44-100 Gliwice, Poland

Intensyfikacja urbanizacji, przemysłu i gospodarki towarzysząca postępującemu wzrostowi liczby ludności na świecie pochłania nie tylko ogromnie ilości wody, ale także stanowi bezpośrednią przyczynę obniżania się jakości gleb. Szacuje się, że do tej pory na całym świecie blisko 25% gleb utraciło swoją naturalną produktywność, a dodatkowe 8% jest zdegradowanych w stopniu umiarkowanym. Jeżeli nie zostaną podjęte odpowiednie działania naprawcze, skala tego zjawiska może w najbliższej przyszłości dotknąć ponad 90% gleb występujących na Ziemi. Jednym z głównych zagrożeń gleby jest utrata materii organicznej, która stanowi jedną z przyczyn degradacji środowiska glebowego. Ze względu na pozytywny wpływ substancji humusowych na glebę i żyjące w niej organizmy, stabilizowanie i zwiększanie puli tych związków w środowisku glebowym wydaje się być obiecującym podejściem zmierzającym do poprawy jego jakości. Ponieważ nadmierne wykorzystywanie nieodnawialnych surowców naturalnych jako źródeł substancji humusowych stanowi duże obciążenie dla środowiska naturalnego, konieczne jest poszukiwanie innych, odnawialnych źródeł tych związków. Obecnie prowadzone badania dowodzą, że substancje humusowe mogą być z pozyskiwane z wody nadosadowej, stanowiącej produkt uboczny procesu fermentacji metanowej. Proces ten może być przeprowadzony metodą adsorpcji z użyciem szerokiej gamy materiałów jako sorbentów substancji humusowych. Wielokrotne zasilanie gleby małymi dawkami substancji humusowych wydaje się mniej ekonomiczne niż jednokrotne bądź kilkukrotne wprowadzenie do tego środowiska większego stężenia tych związków skoncentrowanych na odpowiednich nośnikach. Materiały rozważane pod kątem adsorpcji substancji humusowych w celu ich dostarczenia do gleby powinny być nietoksyczne i odznaczać się wysoką porowatością oraz dużym udziałem mezoporów i makroporów w swojej budowie. Ponadto powinny wykazywać zdolność nie tylko do zatrzymywania związków humusowych, ale także do ich powolnego uwalniania do gleby, po zaaplikowaniu do tego środowiska. Pożądanym jest także, aby wyselekcjonowane sorbenty były łatwo dostępne i tanie, a także same w sobie posiadały wartość agronomiczną. Najbardziej obiecującym wydaje się zatem taki dobór sorbentów związków humusowych, które pozwoliłyby na stworzenie systemów o charakterze dualnym, pozwalających na regulację materii organicznej w glebie i jednocześnie poprawiających jej właściwości. W ostatnich latach coraz większą uwagę zwraca się na potencjalne wykorzystanie do adsorpcji substancji humusowych naturalnych i mineralnych materiałów odpadowych, których zagospodarowanie jest często problematyczne. Strategia ta może być obiecującym rozwiązaniem problemu związanego z ich utylizacją. Co więcej, zastosowanie materiałów odpadowych jako adsorbentów może być opłacalne ekonomicznie, ponieważ są to materiały łatwo dostępne i tanie, a wiele z nich wykazuje pozytywne właściwości adsorpcyjne oraz może być cennych z agronomicznego punktu widzenia.

Oczyszczalnia ścieków Kraków-Płaszów w kontekście zrównoważonej gospodarki obiegu zamkniętego

D. Poproch*, J. Górka, M. Cimochowicz-Rybicka**, B. Łuszczek*****

*Doctoral School, Department of Environmental Technologies, Faculty of Environmental Engineering and Energy, Cracow University of Technology, 24 Warszawska Street, 31-155 Cracow, Poland (E-mail: *dominika.poproch@doktorant.pk.edu.pl*)
**Department of Environmental Technologies, Faculty of Environmental Engineering and Energy, Cracow University of Technology, 24 Warszawska Street, 31-155 Cracow, Poland (E-mail: *justyna.gorka@pk.edu.pl; mcrybicka@pk.edu.pl*)
***Krakow Water, 1 Senatorska Street, 30-106 Cracow, Poland (E-mail: *bartosz.luszczek@wodociagi.krakow.pl*)

Keywords: oczyszczalnia ścieków, gospodarka obiegu zamkniętego, odpady, osady, energia odnawialna

Streszczenie:

W ostatnich latach zauważono rosnące zainteresowanie tematyką zarządzania odpadami i energią w oczyszczalniach ścieków. Obserwowany jest dynamiczny rozwój technologii, które pozwalają na minimalizację ilości generowanych odpadów, jak również tych, które umożliwiają skuteczne unieszkodliwianie i ich ekonomiczne wykorzystanie. Oczyszczalnie ścieków mogą stać się cennymi elementami wdrażania koncepcji gospodarki o obiegu zamkniętym (GOZ) poprzez wdrożenie zasad 3R (z j. ang.: reduce, reuse, recycle). Transformacja tradycyjnej gospodarki liniowej w gospodarkę o obiegu zamkniętym wynika z konieczności zmiany podejścia do zasobów naturalnych, wtórnych oraz odpadów. Oczyszczalnie ścieków i stacje uzdatniania wody są bardzo dobrym przykładem obiektów, w których założenia modelu GOZ mogą być efektywnie wdrażane - przede wszystkim poprzez odzysk energii, surowców wtórnych, a także naturalnych. Podczas procesów oczyszczania ścieków, wciąż generowane są odpady, które stanowią wyzwanie dla naszej gospodarki. Jednakże, odzyskiwanie i właściwe zarządzanie tymi odpadami stanowi kluczowy element modelu gospodarki o obiegu zamkniętym, co sprzyja zrównoważonemu rozwojowi, zachowaniu naturalnych zasobów, oraz ma pozytywny wpływ na naszą ekonomię.

W artykule zaprezentowano przykłady wdrażania zasad GOZ w miejskiej oczyszczalni ścieków Kraków-Płaszów. Analizy dokonano w dwóch kluczowych aspektach – energetycznym i odpadowym. W związku z rosnącymi cenami energii elektrycznej, aspekt energetyczny nabrał znaczenia priorytetowego. W oczyszczalni ścieków odzyskiwana jest energia w procesie kogeneracji wykorzystując biogaz pozyskany w wyniku prowadzenia procesu stabilizacji beztlenowej osadów ściekowych. Ponadto wykorzystywana jest zielona energia pochodząca z paneli fotowoltaicznych oraz turbiny wodnej. Ponadto, dużym wyzwaniem dla branży wod-kan jest sposób zagospodarowania odpadów. W pracy zbadano potencjał odpadów technologicznych pochodzących z procesów oczyszczania ścieków oraz wskazano kierunki wykorzystania odpadów w różnych ścieżkach postępowania.

Bibliografia

Smol M., Adam C., Preisner M. 2020. Circular economy model framework in the European water and wastewater sector. *J. Mater. Cycles Waste Manag.*, 2020, 22, str. 682-697.

Smol M., Szodrowska D. 2021. Model gospodarki o obiegu zamkniętym (GOZ) w gospodarce wodno-ściekowej w Polsce. *Materiały konferencyjne w książce Międzynarodowa Konferencja Strategie Wdrażania Zielonego Ładu: Woda i Surowce*, 2021, str. 6-19.

Produkcja wolnego kwasu azotowego (III) ze strumienia odcieków z odwadniania osadu przefermentowanego w komunalnej oczyszczalni ścieków

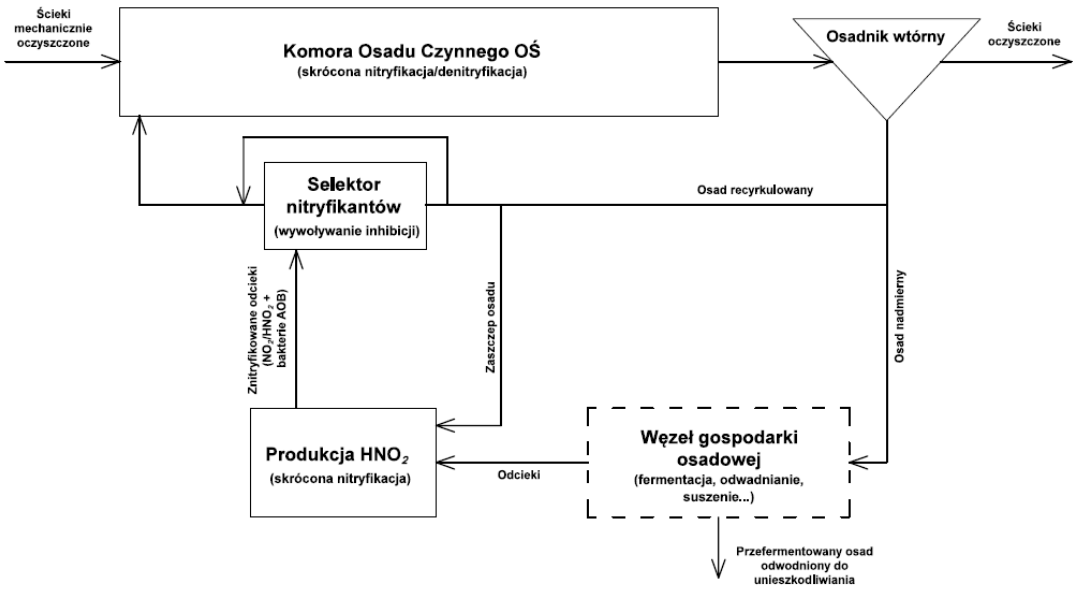
Mateusz Muszyński-Huhajło*, Stanisław Miodoński, Bartosz Zięba*****

* Politechnika Wrocławska (Wydział Inżynierii Środowiska, mateusz.muszynski-huhajlo@pwr.edu.pl)
** Politechnika Wrocławska (Wydział Inżynierii Środowiska, stanislaw.miodonski@pwr.edu.pl)
*** Politechnika Wrocławska (Wydział Inżynierii Środowiska, bartosz.zieba@pwr.edu.pl)

Słowa kluczowe: nitrytacja, usuwanie azotu, skrócona nitryfikacja, wolny kwas azotowy(III)

Streszczenie

Możliwości wykorzystania wolnego kwasu azotowego (III) (HNO_2, ang. Free Nitrous Acid, FNA) w obszarze technologii oczyszczania ścieków są ciągle badane. Pośród najbardziej interesujących jego zastosowań należy wymienić chociażby dezintegrację osadów ściekowych czy inhibicję różnych grup bakterii obecnych w osadzie czynnym. Ostatnie z wymienionych zastosowań FNA odnosi się przede wszystkim do hamowania rozwoju nitryfikantów II fazy (ang. Nitrite Oxidizing Bacteria, NOB), co wielokrotnie potwierdzono w badaniach nad procesami oczyszczania odcieków z odwadniania osadów. Istnieją doniesienia o możliwości powtórzenia tego sukcesu w osadzie czynnym ciągu głównego oczyszczalni ścieków, gdzie przy udziale FNA możliwe jest wywołanie selektywnej inhibicji NOB (Rysunek 1). Osiągnięta w ten sposób skrócona droga nitryfikacji-denitryfikacji pozwoli na istotne ograniczenie kosztów (mniejsze zapotrzebowanie na tlen) i poprawę efektywności procesu oczyszczania ścieków (skuteczniejsza denitryfikacja).



Rysunek 1 Schemat technologii skróconej nitryfikacji-denitryfikacji z wykorzystaniem FNA produkowanego ze strumienia odcieków jako czynnika inhibitującego bakterie NOB w wydzielonym selektorze.

W pracy przedstawiono analizę możliwości produkcji FNA z rzeczywistego strumienia odcieków z odwadniania osadu przefermentowanego dużej oczyszczalni ścieków. Na bazie danych z rozruchu i wielomiesięcznej eksploatacji reaktora

badawczego do nitrytacji odcieków (SBR o pojemności 150dm^3) określono wydajność procesu produkcji N-NO_2 w warunkach niskiego pH (< 6.0), celem maksymalizacji stężenia FNA. Maksymalne stężenie FNA w odciekach oczyszczonych sięgało 1.5 gHNO_2-N/m^3 przy obciążeniu reaktora na poziomie 0.24 kg NH_4-N/(m^3·d). Nawet w tak wysokich stężeniach kwasu azotowego (III) możliwe było efektywne utlenianie azotu amonowego, co dowodzi dużych zdolności adaptacyjnych biomasy nitryfikacyjnej I fazy, przy całkowitym zahamowaniu aktywności NOB (99% akumulacji NO_2-N w odciekach oczyszczonych).

Wyniki eksperymentu wykorzystano w techniczno-ekonomicznej ocenie możliwości zastosowania FNA produkowanego z odcieków jako czynnika selekcyjnego dla bakterii NOB w osadzie czynnym ciągu głównego oczyszczalni. Jednym z głównych założeń proponowanego rozwiązania jest zastosowanie selektora, w którym fragment strumienia osadu recyrkulowanego wystawiony jest na działanie FNA zgodnie z przedstawionym schematem (Rysunek 1). Przeprowadzona analiza miała na celu określenie możliwych do osiągnięcia stężeń FNA oraz NO_2-N w selektorze projektowanym dla dużej oczyszczalni ścieków wraz z oceną ekonomiczną wariantów maksymalizacji stężenia FNA w selektorze (stosowanie korekty odczynu, modyfikacje sposobu prowadzenia procesu nitrytacji odcieków).

Efekty przedstawionych prac, jak i sama koncepcja technologii skróconej nitryfikacji-denitryfikacji wywoływanej z pomocą FNA stanowią przedmiot badań w ramach projektu SNIT (NOR/POLNOR/SNIT/0033/2019) realizowanego w ramach programu POLNOR19, finansowanego przez Narodowe Centrum Badań i Rozwoju.

Bibliografia

Szypulska, D., Miodoński, S., Janiak, K., Muszyński-Huhajło, M., Zięba, B., & Cema, G. (2021). Waste activated sludge disintegration with free nitrous acid–comprehensive analysis of the process parameters. *Renewable Energy*, 172, 112-120.

Zhou, Y., Oehmen, A., Lim, M., Vadivelu, V., & Ng, W. J. (2011). The role of nitrite and free nitrous acid (FNA) in wastewater treatment plants. *Water research*, 45(15), 4672-4682.

Muszyński-Huhajło, M., Zięba, B., Janiak, K., Miodoński, S., Jurga, A., & Szetela, R. (2021). Can nitrifiers from the sidestream deammonification process be a remedy for the N-overload of the mainstream reactor?. *Science of The Total Environment*, 790, 148066.

Wang, Z., Zheng, M., Meng, J., Hu, Z., Ni, G., Guerrero Calderon, A., ... & Yuan, Z. (2021). Robust nitritation sustained by acid-tolerant ammonia-oxidizing bacteria. *Environmental science & technology*, 55(3), 2048-2056.

Wang, Z., Zheng, M., Duan, H., Ni, G., Yu, W., Liu, Y., ... & Hu, S. (2021). Acidic aerobic digestion of anaerobically-digested sludge enabled by a novel ammonia-oxidizing bacterium. *Water research*, 194, 116962.

Wang, D., Fu, Q., Xu, Q., Liu, Y., Ngo, H. H., Yang, Q., ... & Ni, B. J. (2017). Free nitrous acid-based nitrifying sludge treatment in a two-sludge system enhances nutrient removal from low-carbon wastewater. *Bioresource Technology*, 244, 920-928.

Duan, H., Watts, S., Zheng, M., Wang, Z., Zhao, J., Li, H., ... & Hu, S. (2022). Achieving robust mainstream nitrite shunt at pilot-scale with integrated sidestream sludge treatment and step-feed. *Water Research*, 223, 119034.

Analiza możliwości eliminacji bakterii nitryfikacyjnych II fazy z osadu czynnego z wykorzystaniem selektora opartego o FNA

Bartosz Zięba Mateusz* Stanisław Miodoński, Muszyński-Huhajło***,**

* Politechnika Wrocławska (Wydział Inżynierii Środowiska, bartosz.zieba@pwr.edu.pl)
** Politechnika Wrocławska (Wydział Inżynierii Środowiska, stanislaw.miodonski@pwr.edu.pl)
*** Politechnika Wrocławska (Wydział Inżynierii Środowiska, mateusz.muszynski-huhajlo@pwr.edu.pl)

Słowa kluczowe: skrócona nitryfikacja, wolny kwas azotowy (III), selektor, ciąg główny

Streszczenie

Toczące się prace nad alternatywnymi metodami biologicznego usuwania azotu ze ścieków w procesach takich jak skrócona nitryfikacja-denitryfikacja czy też deamonifikacja, skupiają się na zahamowaniu rozwoju bakterii nitryfikacyjnych II fazy (ang. Nitrite Oxidizing Bacteria, NOB), przy jednoczesnym ograniczonym wpływie na pozostałe procesy oczyszczania. Przyjęte rozwiązania mające do tego doprowadzić podzielić można na dwie grupy – te dążące do wytworzenia niesprzyjających dla NOB warunków pod kątem walki o substraty i tym samym ograniczenia ich możliwości przyrostu oraz te skupiające się na selektywnej inhibicji tej grupy bakterii. Rozwiązania z pierwszej kategorii w znacznej części skupiają się na alternatywnych strategiach napowietrzania, podczas gdy te z drugiej forsują koncepcję selektora zlokalizowanego poza głównym ciągiem oczyszczania. W przeprowadzonych dotychczas badaniach, do głównych czynników inhibitujących stosowanych w selektorach należy zaliczyć wolny amoniak (NH_3, ang. Free Ammonia, FA) oraz wolny kwas azotowy (III) (HNO_2, ang. Free Nitrous Acid, FNA), mimo tego, iż poszukuję się również innych związków, wśród których wymienić można chociażby kwas borowy. Z uwagi na silnie inhibitujący wpływ na NOB, potwierdzony w instalacjach do oczyszczania odcieków pofermentacyjnych, jak również możliwość produkcji go bezpośrednio na oczyszczalni ścieków szczególną popularność w obrębie selektorów zyskał FNA. Jednakże po analizie dostępnych badań zaznaczyć należy, iż przyjęte parametry pracy selektorów są często nieuzasadnione ekonomicznie lub zwyczajnie nierealistyczne, co wraz z wsadową koncepcją ich funkcjonowania podważa sens ich stosowania w rzeczywistych układach pełnoskalowych. W pracy przedstawiono analizę opłacalności wdrożenia procesu skróconej nitryfikacji w osadzie czynnym przy wykorzystaniu selektora FNA na modelowej oczyszczalni o 500 000 RLM, stosując graniczne wartości obecne w literaturze (Tabela 1).

Tabela 1 Graniczne wartości parametrów opisujących selektory FNA obecne w literaturze

	Wartość minimalna	Wartość maksymalna
Ilość osadu kierowana do selektora [%]	6,3%	30%
Czas przetrzymania [h]	12	24

W kalkulacjach wzięto pod uwagę zmniejszone zapotrzebowanie na tlen w procesach oczyszczania, zwiększoną produkcję biogazu z tytułu możliwości strącania związków organicznych w osadniku wstępnym jak również koszty inwestycyjne związane z budową selektora. Przeprowadzona analiza miała na celu określenie jaki przedział wartości, niezależnie od osiąganych efektów, może w przyszłości stanowić podstawę do pełnoskalowego wdrożenia.

Efekty przedstawionych prac, jak i sama koncepcja technologii skróconej nitryfikacji-denitryfikacji wywoływanej z pomocą FNA stanowią przedmiot badań w ramach projektu SNIT (NOR/POLNOR/SNIT/0033/2019) realizowanego w ramach programu POLNOR19, finansowanego przez Narodowe Centrum Badań i Rozwoju.

Bibliografia

Miao, Y., Zhang, L., Yu, D., Zhang, J., Zhang, W., Ma, G., ... & Peng, Y. (2022). Application of intermittent aeration in nitrogen removal process: development, advantages and mechanisms. Chemical Engineering Journal, 430, 133184.

Zhou, Y., Oehmen, A., Lim, M., Vadivelu, V., & Ng, W. J. (2011). The role of nitrite and free nitrous acid (FNA) in wastewater treatment plants. *Water research*, 45(15), 4672-4682.

Wang, D., Fu, Q., Xu, Q., Liu, Y., Ngo, H. H., Yang, Q., ... & Ni, B. J. (2017). Free nitrous acid-based nitrifying sludge treatment in a two-sludge system enhances nutrient removal from low-carbon wastewater. Bioresource Technology, 244, 920-928.

Qiu, S., Wang, L., Chen, Z., Yang, M., Yu, Z., & Ge, S. (2021). An integrated mainstream and sidestream strategy for overcoming nitrite oxidizing bacteria adaptation in a continuous plug-flow nutrient removal process. Bioresource Technology, 319, 124133.

Jiang, C., Xu, S., Wang, R., Feng, S., Zhou, S., Wu, S., ... & Zhuang, X. (2019). Achieving efficient nitrogen removal from real sewage via nitrite pathway in a continuous nitrogen removal process by combining free nitrous acid sludge treatment and DO control. Water research, 161, 590-600.

An effective HTC doping strategy of carbon felt anode for metal recovery in microbial fuel cells

Yelitza Delgado[1], Álvaro Ramirez[1], Ester López[1], Martín Muñoz[1], Jakub Drewnowski[2], Javier Llanos[1], Francisco Jesús Fernández-Morales[1]*

[1] University of Castilla-La Mancha, ITQUIMA, Chemical Engineering Dept., Avda. Camilo José Cela S/N 13071, Ciudad Real, Spain. E-mail: fcojesus.fmorales@uclm.es
[2] Faculty of Civil and Environmental Engineering, Gdansk University of Technology, 80-233 Gdansk, Poland. E-mail: jdrewnow@pg.edu.pl

Keywords: Hydrochar; microbial fuel cell; metal recovery

Abstract:

In this study, the doping microbial fuel cell (MFC) carbon felt anodes with hydrochar was studied. The raw material used for hydrochar synthesis was metal-polluted plant biomass taken from an abandoned mining site. The hydrochar obtained was studied in two forms: activated and deactivated. The activation was carried out at 500 °C under an N_2 atmosphere (Ramirez et al., 2023). Under steady-state, the applied current, as well as the cyclic voltammetry and polarization curves, indicated that the activated hydrochar-doped anodes exhibited the best electrochemical performance: 0.06 W/cm^2 and 0.2 mA/cm^2. These values were about 25% higher than those achieved with non-doped or non-activated hydrochar-doped anodes. Once reached a steady operation of the MFC, a synthetic acid mine drainage (AMD) was fed to the cathode and the cathodic metal reduction was studied. The synthetic AMD was composed of 500 mg·L^{-1} of Cu^{+2} and Fe^{+3}, and 50 mg·L^{-1} of Ni^{+2} and Sn^{+2}. The MFC was for material and energy recovery from the spontaneous processes occurring at the MFC. During MFC operation, Fe^{3+} was reduced to Fe^{2+} and Cu^{2+} was reduced to Cu^0.

Based on these results, it can be concluded that, from the electrical perspective, hydrochar-doped electrodes exhibited superior electrochemical performance, achieving the maximum energy recovery, current density of 0.21 mA·cm^{-2}, and copper was recovered. These results lead to the conclusion that the electrochemical processes are significantly enhanced when doping the carbon felt anodes with activated hydrochar. Additionally, considering that hydrochar was derived from waste biomass, its use facilitates the material and energy valorisation but also is as an environmentally friendly remediation method that could be applied in the frame of the circular economy.

References

Ramírez Á., Muñoz-Morales M., Fernández-Morales F.J., Llanos J. (2023). Valorization of polluted biomass waste for manufacturing sustainable cathode materials for the production of hydrogen peroxide. *Electrochimica Acta*, 456, 142383.

Ecohydrological analysis of emerging pollutants in water and wastewater: from the Pilica River to the Baltic Sea basin

Kiedrzyńska E.*, Kiedrzyński M. **, Harnisz M. *, Jaszczyszyn K. ****, Piwowarska D.*****

* European Regional Centre for Ecohydrology of the Polish Academy of Sciences, Tylna 3, 90-364 Łódź; UNESCO Chair Ecohydrology and Applied Ecology University of Lodz, Poland
e.kiedrzynska@erce.unesco.lodz.pl
** Department of Biogeography, Paleoecology and Nature Conservation, University of Lodz, Banacha 12/16, 90-237 Lodz, Poland, marcin.kiedrzynski@biol.uni.lodz.pl
*** Department of Water Protection Engineering and Environmental Microbiology, Faculty of Geoengineering, University of Warmia and Mazury in Olsztyn, Prawocheńskiego 1, 10-720 Olsztyn, Poland
**** European Regional Centre for Ecohydrology of the Polish Academy of Sciences, Tylna 3, 90-364 Lodz, Poland, k.jaszczyszyn@erce.unesco.lodz.pl
***** Doctoral School of Extract and Natural Sciences, University of Lodz, Lodz;
UNESCO Chair on Ecohydrology and Applied Ecology, University of Lodz; Banacha 12/16, 90-237 Lodz Poland;
European Regional Centre for Ecohydrology of the Polish Academy of Sciences, Lodz, Poland
dominika.piwowarska@edu.uni.lodz.pl

Keywords: Pharmaceuticals and chemical pollution, antibiotic resistant bacteria, microplastic

Emerging pollutants such as pharmaceuticals, antibiotic-resistant bacteria, and microplastics are newly recognized environmental threats whose source is wastewater discharged from municipal treatment plants. Due to the limited knowledge of their toxicity and impact on aquatic organisms and biodiversity, they're labelled 'emerging'. This research aims to discuss the issue of emerging pollutants and wastewater and will focus on case studies, projects, as well as specific pollutants that constitute a threat to the environment and also nature-based solutions for their elimination.

The aim of the study was to assess the role of the wastewater treatment plants (WWTPs) in the contamination of Pilica River with emerging pollutants. Ecohydrological studies were conducted in the 9,258 km2 Pilica River catchment (the largest left tributary of the Vistula) where the research was performed on 17 WWTPs, divided into three size categories, viz. small, medium-sized and large. Ecohydrological analyses of anthropogenic sources of pollution were also conducted and the Baltic Sea basin. The research findings revealed the presence of various pharmaceutical substances, including antibiotics, and microplastic particles in both untreated sewage and treated sewage released into the environment. River water samples also contained these pollutants, albeit at lower concentrations. Furthermore, antibiotic-resistant bacteria were detected in both treated sewage and river water samples (Harnisz, Kiedrzyńska et al. 2020). These research outcomes are crucial for enhancing our understanding of water ecosystems' condition and the extent of pollution they face.

Badania współfinansowane w ramach projektów Narodowego Centrum Nauki, Polska:
- Nr. 2021/43/B/ST10/01076, kierownik projektu: dr hab. Edyta Kiedrzyńska, prof. ERCE PAN.
- Nr. 2015/19/B/ST10/02167, kierownik projektu: dr hab. Edyta Kiedrzyńska, prof. ERCE PAN.
- Narodowego Centrum Badań i Rozwoju, Polska Nr. TANGO2/339929/NCBR/2017, kierownik Prof. dr hab. Maciej Zalewski

References

Harnisz M., Kiedrzyńska E., Kiedrzyński M., Korzeniewska E., Czatzkowska M., Koniuszewska I., Jóźwik A., Szklarek S., Niestępski S., Zalewski M., (2020). The impact of WWTP size and sampling season on the prevalence of antibiotic resistance genes in wastewater and the river system. *Science of the Total Environment*. 741: 140466.

Analysis of microplastics using FTIR imaging microscopy: preliminary results for Pilica River catchment

K. Jaszczyszyn*, E. Kiedrzyńska, M. Kiedrzyński*****

* European Regional Centre for Ecohydrology of the Polish Academy of Sciences, 3 Tylna Str., 90-364 Lodz, Poland; Poznan University of Technology, Faculty of Environmental Engineering and Energy, 5 Piotrowo Str. 60-965 Poznan, Poland; k.jaszczyszyn@erce.unesco.lodz.pl
** European Regional Centre for Ecohydrology of the Polish Academy of Sciences, 3 Tylna Str., 90-364 Lodz, Poland; University of Lodz, Faculty of Biology and Environmental Protection, UNESCO Chair on Ecohydrology and Applied Ecology, Banacha 12/16, 90-237 Lodz, Poland; e.kiedrzynska@erce.unesco.lodz.pl
*** University of Lodz, Faculty of Biology and Environmental Protection, Department of Biogeography, Paleoecology and Nature Conservation, Banacha 1/3, 90-237 Lodz, Poland; marcin.kiedrzynski@biol.uni.lodz.pl

Keywords: Microplastics; FTIR imagining microscope analysis; environmental samples

Abstract:

Over the past decades, with the advancement of technology, industrialization and increased consumption, the diversity of environmental pollutants has also increased. Many types of anthropogenic micropollutants including microplastic (plastic fragments smaller than 5mm), due to their persistent chemical structure and ineffective wastewater treatment methods can lead to contamination of surface waters. The lack of legal regulations and wastewater treatment standards allow microplastic particles to get into marine and freshwater ecosystems. Within these ecosystems, they can circulate in the water-sediment-aquatic organisms cycle and also may occur in water for industrial purposes and drinking water. Microplastics are ubiquitous in the aquatic environment, but also in food. They can bioaccumulate in the tissues and human organs causing toxic effects (Jenner et al., 2022; Kögel et al., 2023).

Due to the limited number of environmental studies focusing on the transfer of microplastics from wastewater to the river system, the study was conducted in the Pilica River catchment (central Poland). Samples were taken seasonally from selected wastewater treatment plants (raw and treated wastewater) and measurement-control points on the river. Fourier transform infrared spectroscopy (FTIR) was used to identify the types, numbers and sizes of the polymer particles. The presented preliminary results show that microplastic particles are present in all tested samples (in various forms, e.g. fibers or fragments, of various sizes). The results of the research will contribute to the quantification of the transfer of microplastics from wastewater treatment plants to surface waters. This data will be crucial in developing strategies to limit the release of microplastics into the environment.

The research was funded by the National Science Centre, Poland (Project No. 2021/43/B/ST10/01076) project manager: prof. Edyta Kiedrzyńska, ERCE PAS

References

Jenner, L. C., Rotchell, J. M., Bennett, R. T., Cowen, M., Tentzeris, V. and Sadofsky, L. R. (2022). Detection of microplastics in human lung tissue using μFTIR spectroscopy. *Science of The Total Environment*, **831**, 154907.
Kögel, T., Hamilton, B. M., Granberg, M. E., Provencher, J., Hammer, S., Gomiero, A., Magnusson, K. and & Lusher, A. L. (2023). Current efforts on microplastic monitoring in Arctic fish and how to proceed. *Arctic Science*, **9**(2), 266–283.

Analysis of PAHs and heavy metals in industrial and municipal wastewater

Piwowarska D.*, Kiedrzyńska E., Kiedrzyński M. *****

* 1/ Doctoral School of Exact and Natural Sciences, University of Lodz, Jana Matejki 21/23, 90-237 Lodz; 2/ UNESCO Chair on Ecohydrology and Applied Ecology, Faculty of Biology and Environmental Protection, University of Lodz; , Banacha 12/16, 90-237 Lodz; 3/ European Regional Centre for Ecohydrology of the Polish Academy of Sciences, Tylna 3, 90-364, Lodz (dominika.piwowarska@edu.uni.lodz.pl)

** 1/European Regional Centre for Ecohydrology of the Polish Academy of Sciences, Tylna 3 Lodz; 2/ UNESCO Chair on Ecohydrology and Applied Ecology, University of Lodz, Banacha 12/16, 90-237 Lodz (e.kiedrzynska@erce.unesco.lodz.pl)

*** 1/ Department of Biogeography, Paleoecology and Nature Conservation, Faculty of Biology and Environmental Protection, University of Lodz, Banacha12/16, 90-237 Lodz (marcin.kiedrzynski@biol.uni.lodz.pl)

Key words: Pilica River catchment, heavy metals and PAHs, water contamination

Abstract

Xenobiotics and heavy metals are currently one of the greatest threats to the environment. Their increased concentration in ecosystems is caused by urbanization, dynamic development of industry and agriculture, as well as ineffective wastewater treatment (Piwowarska & Kiedrzyńska, 2022; Rodríguez et al. 2015). In the face of previously reported pollution of the aquatic ecosystems, it is extremely important to analyze the causes and sources of these pollution.

The aim of the research was: 1/ to determine the share of industrial and municipal wastewater treatment plants located in the Pilica River catchment area in the release of selected compounds from the group of polycyclic aromatic hydrocarbons (PAHs) and heavy metals with wastewater; 2/ determining the impact of the treatment plants on the quality of water in Pilica. Seasonal research conducted in 2022/2023 showed the presence of PAHs and heavy metals in almost all among 28 tested samples. Phenanthrene was the most frequently detected compound from the PAHs with average concentration 0.029 µg/L for treated wastewater from municipal treatment plants, 0.019 µg/L for treated wastewater from industrial plants and 0.015 µg/L for riverine water. Among the heavy metals, the most frequently identified were barium, zinc, copper, nickel, lead and chromium.

The results indicate the problem of contamination of the Pilica waters with toxic substances. This requires the development and implementation of activities in the field of ecohydrological biotechnologies and nature-based solutions for their biodegradation and self-purification of the river. Research conducted in the Pilica River catchment offers valuable insights into the influence of industrial and municipal facilities on anthropogenic pollution.

The research was funded by the National Science Centre, Poland (Project No. 2021/43/B/ST10/01076) project manager: prof. Edyta Kiedrzyńska, ERCE PAS

References

Piwowarska, D., Kiedrzyńska, E. (2022). *Xenobiotics as a contemporary threat to surface waters.* Ecohydrology & Hydrobiology., Vol. 22, Is., pp. 337-354.

Rodríguez Martín, J. A., et al. (2015). *Impact of 70 years urban growth associated with heavy metal pollution*. Environmental Pollution, 196, 156–163.

Implementation of the IWA Water-Wise Cities principles in Polish urban planning

Paulina Otto*, Anna Januchta-Szostak,**

* Poznan University of Technology, Faculty of Architecture (paulina.a.otto@gmail.com)
** Poznan University of Technology, Faculty of Architecture (anna.januchta-szostak@put.poznan.pl)

Keywords: rainwater management; urban catchment; water policy

Abstract:

In Polish cities, over 70% of rainwater is wasted through rapid drainage, and simultaneously urban areas suffer from water shortages and heatwaves. Adaptation to climate change requires changing urban water policies and sustainable management of rainwater, surface and groundwater resources. In 2016, the International Water Association (IWA) prepared a list of 17 Water-Wise Cities (WWC) principles. The aim of the article is to analyse successes and barriers in the implementation of these principles on the example of Polish cities of Gdańsk and Poznań.

The analysis was carried out using the measures and results of the Water City Index - the only ranking of cities in Poland in terms of the efficiency of water resources management. The analysis showed that the range of measures used in this ranking is not sufficient to address the goals set out in the WWC principles. And one of the key barriers identified in the research is the lack of data for Polish cities enabling a comprehensive assessment in all 4 categories of WWC principles. It was also noted that environmental aspects in urban catchment management are often ignored.

Nevertheless, the authors focused on the "water sensitive urban design" category and indicated good practices in the water policy of Gdańsk, which is the leader of the Water City Index ranking, and Poznań, which has the ambition to be a city in the blue-green grid.

To address the goals of sustainable water management in cities, it is necessary to look for synergistic solutions that integrate effective water retention, ecosystem productivity as well as high quality of urban space and social involvement.

References

Biuro Rozwoju Gdańska, (2022). Gdańska Polityka Wodna. Available online: https://www.brg.gda.pl/planowanie-przestrzenne/inne-opracowania-urbanistyczne/1501-gdanska-polityka-wodna (accessed on 8 August 2023).

IWA (n.d) *The 17 IWA Principles for Water-Wise Cities*. Available online: https://iwa-network.org/projects/water-wise-cities/#the_17_iwa_principles_for_water-wise_cities (accessed on 8 September 2023)

Januchta-Szostak, A. (2020). Błękitno-zielona infrastruktura jako narzędzie adaptacji miast do zmian klimatu i zagospodarowania wód opadowych. *Zeszyty Naukowe Politechniki Poznańskiej. Architektura, Urbanistyka, Architektura Wnętrz*. nr 3, s. 37-74

Januchta-Szostak, A. (2021) Eco-Hydrological Consequences of Urbanization and the Development of Riparian Areas. In *Climate Change and Creative Solutions for Cities*; Ressano Garcia, P., Nyka, L., Borucka, J., Szczepański, J., Eds.; Gdańsk University of Technology: Gdańsk, Poland, Chapter 3; pp. 53–60. Available online: http://sosclimatewaterfront.eu/sos/results (accessed on 8 August 2023).

Kundzewicz, Z. W., Januchta-Szostak, A., Nachlik, E., Pińskwar, I., & Zaleski, J. (2023). Challenges for Flood Risk Reduction in Poland's Changing Climate. *Water*, *15*(16), 2912. MDPI AG. Retrieved from http://dx.doi.org/10.3390/w15162912

Ministry of Development Funds and Regional Policy (2022). *National Urban Policy 2030* (KPM 2030); Warsaw, Poland.
Ptak-Wojciechowska, A., Januchta-Szostak, A., Gawlak, A., & Matuszewska, M. (2021). The Importance of Water and Climate-Related Aspects in the Quality of Urban Life Assessment. *Sustainability*, *13*(12), 6573. MDPI AG. Retrieved from http://dx.doi.org/10.3390/su13126573
Water City Index. Available online: https://oees.pl/water-city-index-2022/?doing_wp_cron=1694722794.1579799652099609375000 (accessed on 8 September 2023)

Figures and Tables

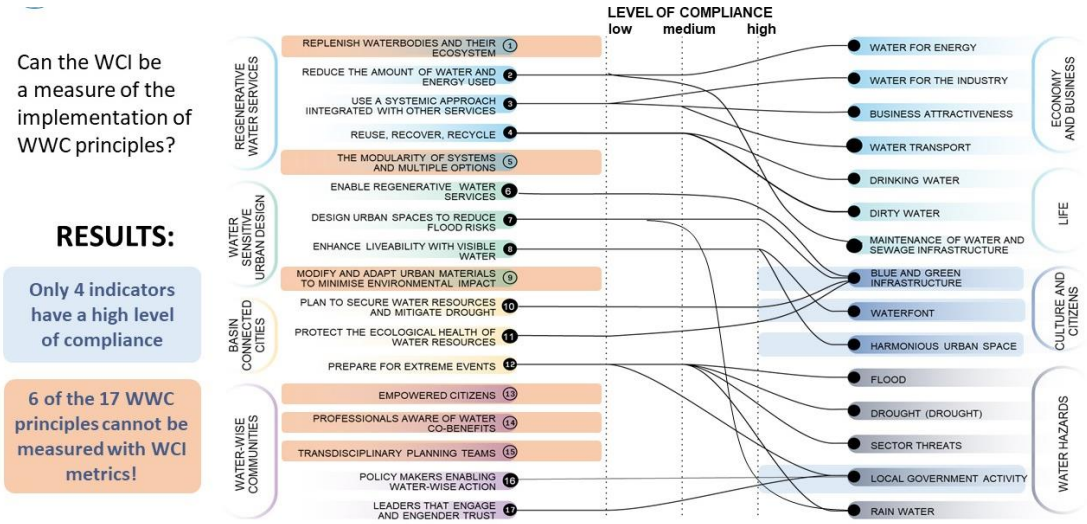


Figure 1 The compliance of Water-Wise Cities goals and Water City Index indicators

Start-up of granulation in aerobic granular sludge sequencing batch reactor for treating industrial wastewater using cationic polymer.

Sajid Hussain*, Roberta Ferrentino, Gianni Andreottola *****

* University of Trento, 38123, via Mesiano77, Trento, Italy. Email: sajid.hussain@unitn.it
** University of Trento, 38123, via Mesiano77, Trento, Italy. Email: roberta.ferrentino@unitn.it
***University of Trento, 38123, via Mesiano77, Trento, Italy. Email: gianni.andreottola@unitn.it

Keywords: Aerobic Granular Sludge; Startup; Cationic Polymer

Abstract:

In recent years, Aerobic Granular Sludge (AGS) has gained attention and popularity due to its compactness, efficiency, and sustainability. This technology has introduced a better settling sludge which has allowed higher biomass concentration in the reactor. The purpose of this research is to convert conventional SBR to an AGS. For this method, a strategy to speed up the startup process of granulation, and the effect of cationic polymer on aerobic granulation in SBR was investigated using industrial wastewater. To identify whether the cationic polymer can enhance granule formation, a Laboratory scale 2 L cylindrical column-type SBR reactor with a 9 cm diameter, and 35.5 cm height was used. The optimum dose of cationic polymer was used as 150 mg/L during the reactor operation. The reactor was operated at a 38% volumetric exchange ratio. This study examined the possible formation of aerobic granules and other organic substances removal. The AGS system achieved high organic substances removal efficiencies. After 55 days of operation, the SVI_5, SVI_{15}, and average MLSS were observed at 60 ml/g, 40 ml/g, and 12.8g/L. Effluent ammonium, total nitrogen, total phosphorus, total chemical oxygen demand, and soluble chemical oxygen demand of the system were 0.3 mg/L, 16.8 mg/L, 3.8 mg/L, 82.5 mg/L, 94 mg/L, and their removal rates were 96%, 67%, 56%, 91%, and 75% respectively. The study results reveal that AGS can be a better option than conventional SBR for the treatment of industrial wastewater which requires less energy and is eco-friendly for full-scale implementation.

References

Tanavarotai, K., Anuar, A. N., Aris, A. M., Lei, Z., & Ab Halim, M. H. (2022). Rapid method of aerobic granular sludge bioreactor start-up for domestic wastewater treatment. *IOP Conference Series: Earth and Environmental Science*, *1091*(1), 012049. https://doi.org/10.1088/1755-1315/1091/1/012049

Zou, J., Yu, F., Pan, J., Pan, B., Wu, S., Qian, M., & Li, J. (2021). Rapid start-up of an aerobic granular sludge system for nitrogen and phosphorus removal through seeding chitosan-based sludge aggregates. *Science of The Total Environment*, *762*, 144171. https://doi.org/10.1016/j.scitotenv.2020.144171

Mohammad, T. A., Mohd Noor, M. J. M., & Ghazali, A. H. (2016). Assessment of using synthetic polymers in dewatering of sewage sludge. *Desalination and Water Treatment*, *57*(48–49), 23308–23317. https://doi.org/10.1080/19443994.2016.1154708

Jalali, S., Shayegan, J., & Rezasoltani, S. (2015). Rapid start-up and improvement of granulation in SBR. *Journal of Environmental Health Science and Engineering*, *13*(1), 36. https://doi.org/10.1186/s40201-015-0188-9

Lochmatter, S., & Holliger, C. (2014). Optimization of operation conditions for the startup of aerobic granular sludge reactors biologically removing carbon, nitrogen, and phosphorous. *Water Research*, *59*, 58–70. https://doi.org/10.1016/j.watres.2014.04.011

Yang, G., Li, X., & Yang, Q. (2011). Reducing the startup time of aerobic granular sludge reactors through magnesium and PAC augmentation. *2011 International Conference on Electronics, Communications and Control (ICECC)*, 2766–2769. https://doi.org/10.1109/ICECC.2011.6067966

Table 1 Operating condition of AGS SBR reactor

Process Parameter	Condition
Feed medium	Industrial Wastewater
Reactor Volume	2 L
Height of reactor	35.5 cm
Diameter	9 cm
Settling time	15 min
Volumetric exchange ratio	38%
Total cycle time	6 h
Temperature	22-27 °C
pH	7.3-7.8
Total number of operating days	55 days

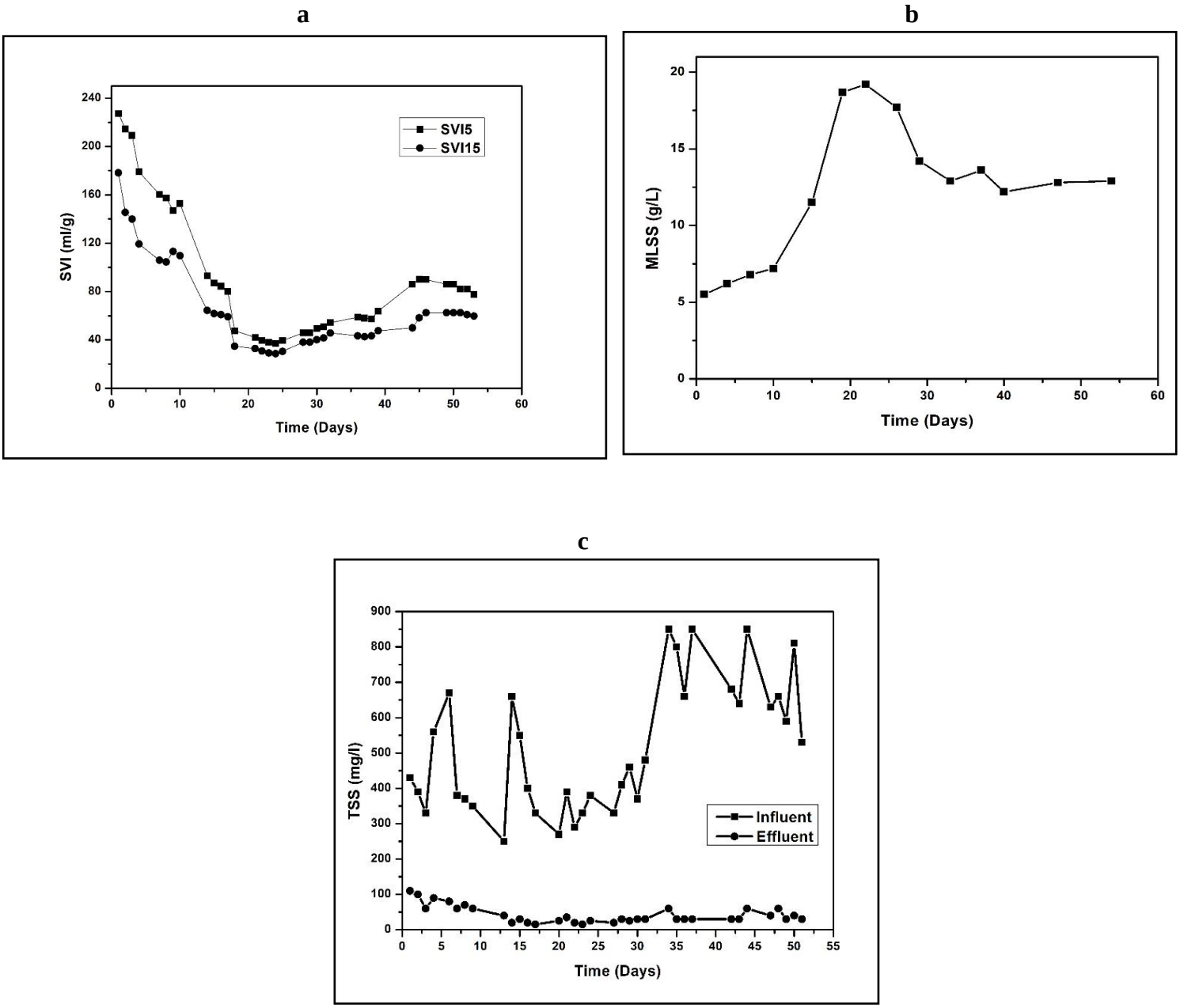


Figure 1 Sludge volume index (a), biomass concentration (b) and TSS of influent and effluent of AGS reactor

Strategizing for Sustainability: A Deep Dive into Optimizing Energy Efficiency in Wastewater Treatment Plants

A. Czapla*, G. Mannina, M. Ganesapillai***, J. Drewnowski***

* Faculty of Civil and Environmental Engineering, Gdansk University of Technology, Narutowicza 11/12, 80-233 Gdańsk, Poland, a.czapla.1993@gmail.com, jdrewnow@pg.edu.pl
** Department of Civil, Environmental, Aerospace, Materials Engineering, University of Palermo, Piazza Marina 61, 90133 – Palermo, Italy, giorgio.mannina@unipa.it
*** Mass Transfer Group, School of Chemical Engineering, Vellore Institute of Technology, Vellore 632014, India, maheshgpillai@vit.ac.in

Keywords: WWTP; energy neutrality; sustainability; modelling and computer simulations

Abstract:

The pursuit of energy neutrality in Wastewater Treatment Plants (WWTPs) is paramount in the current environmental context, and this study underscores a multitude of strategies and innovative technologies aimed at augmenting energy efficiency and mitigating energy consumption within these facilities. By analysing extensive research and real-world applications it outlines transformative and sustainable strategies, emphasizing minimizing ecological impacts and refining operational processes in WWTPs worldwide.

The study provides an overview of various techniques and practices, emphasizing their potential to improve energy conservation and reduce environmental impacts. By addressing key challenges and presenting potential solutions, the study illuminates the pathways toward implementing sustainable operations and achieving energy neutrality in wastewater treatment settings. This involves the integration of renewable energy resources, innovations in biogas utilization, and the advancement of anaerobic digestion processes. By evaluating these elements, the study aims to contribute to a broader understanding and application of energy-efficient practices and sustainable strategies in wastewater treatment management.

Reviewing successful WWTPs in terms of energy self-sufficiency proved the point that the existing inefficient WWTPs should take a series of actions reviewed in this publication. The priorities of the actions should be analysed separately for each case study depending on several parameters, such as the operational cost and the environmental impact to predict performance of WWTPs and analyse detailed information in terms of the influent and effluent quality as well as energy consumption. The advanced and complex analysis procedures, techniques and simulation tools (plant-wide models) can support decision-making to meet the paradigm of sustainable WWTPs combining dynamic process model including GHG, detailed energy models, operational cost and LCA was also proposed. Simulation tools (such as GPS-X, WEST, AQUASIM, DESASS, SIMBA,) and modelling also allows comparison of different strategies to achieve energy neutrality. These tools have been developed and widely applied worldwide, however the lack of data, poor knowledge of newly developed processes, uncertainty in prediction GHG emissions and over parameterization are still a challenge.

References:

Maktabifard M., Zaborowska E., Mąkinia J. (2018). *Achieving energy neutrality in wastewater treatment plants through energy savings and enhancing renewable energy production. Springer*.

Seco A., Ruano M. V., Ruiz-Martinez A., Robles A., Barat R., Serralta J., Ferrer J. (2020). *Plant-wide modelling in wastewater treatment: showcasing experiences using the Biological Nutrient Removal Model. Water Science & Technology.*

WERF (2015). *Demonstrated energy nuetrality leadership: a study of five champions of change. Water Envvironment Reseearch Foundatioon. 635 Slaters Lane, Suite GG-110 Alexandriaa.*

Yang Z., Pei H., Hou Q. et al. (2018). *Algal biofilm-assisted microbial fuel cell to enhance domestic wastewater treatment: nutrient, organics removal and bioenergy production. Chemical Engineering Journal.*

Zaborowska E., Czerwionka K., Makinia J. (2017). *Strategies for achieving energy neutrality in biological nutrient removal systems—a case study of the Słupsk WWTP (northern Poland). Water Science & Technology.*

Membrane distillation for N recovery from wastewater – operational parameters optimization

B. Śniatała[a]*, D. Sobotka[a], J. Mąkinia[a]*****

[a] Faculty of Civil and Environmental Engineering, Gdansk Tech, Narutowicza 11/12, Gdańsk, PL
* bogna.sniatala@pg.edu.pl
** domsobot@pg.edu.pl
*** jmakinia@pg.edu.pl

Keywords: gas-permeable membrane; membrane distillation; nitrogen recovery

Abstract:

A novel integrated technology for nitrogen (N) and phosphorus (P) removal and recovery (INPORR) was proposed as a solution to close the N and P cycles at wastewater treatment plants and produce the wastewater-derived fertilizers (Figure 1a). In membrane distillation (MD) process gaseous ammonia (NH_3) is absorbed from the waste stream into sulfuric acid (H_2SO_4) circulating inside of a gas-permeable membrane (submerged in the feed solution) (Figure 1b). The research aimed to investigate the impact of acid flux, operating pH and effective membrane area on the process efficiency.

The experiments were conducted in a batch reactor presented on Figure 2. Firstly, the impact of wastewater pH in the range of 11-13 (controlled by adding 1N NaOH) was analysed. Then, the impact of the acid circulation rate (0.6-2.4 $dm^3\ h^{-1}$) was examined. Finally, the effect of membrane effective area (0.0035 vs 0.0070 m^2) was tested under the previously concluded most efficient conditions. The N removal efficiency was estimated via the mass balance calculations, and the mass of N recovered in acid was analysed according to EN 12260 and ISO 20236.

N-recovery was the most efficient at pH of 11. The increasing pH led to NH_3 stripping, lowering the possibility to produce fertilizer. In contrast, increasing the acid flux and membrane area affected the process positively. The average rates of N removal and recovery were 23.0±0.8 g N m d and 4.8±0.7 g N $m^2\ d^{-1}$ respectively. The N-recovery can be compared to 1.9÷4.5 g N $m^2\ d^{-1}$ obtained by Soto-Herranz et al. (2019) (2015) treating swine manure. Nevertheless, it is around three times lower compared to the efficiency reported by Daguerre-Martini et al. (2018).

The process proofed to be able to recover N in the form of potential fertilizer. However, the technique is not yet fully mature and requires further optimization. In order ro increase nutrient recovery rate, pH should be decreased, the membrane area increased and the operation time prolonged. The in-depth statistical data analysis and process modelling are needed.

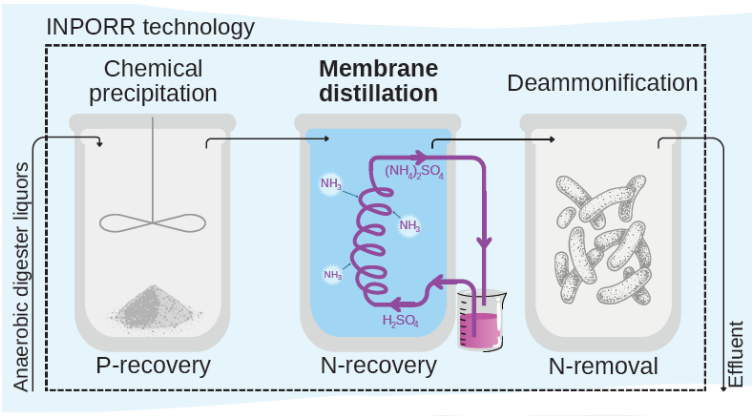
References

S. Daguerre-Martini, M.B. Vanotti, M. Rodriguez-Pastor, A. Rosal, R. Moral, Nitrogen recovery from wastewater using gas-permeable membranes: Impact of inorganic carbon content and natural organic matter, *Water Research*, Volume 137, 2018, Pages 201-210, ISSN 0043-1354, https://doi.org/10.1016/j.watres.2018.03.013

Soto-Herranz, M., Sánchez-Báscones, M., Antolín-Rodríguez, J.M., Conde-Cid, D., & Vanotti, M.B. (2019). Effect of the type of gas-permeable membrane in ammonia recovery from air. Environments - MDPI, 6(6). https://doi.org/10.3390/environments6060070.

Figures and Tables

a



b

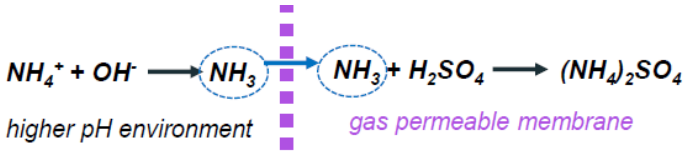


Figure 1 The INPORR technology (a) and the MD process.

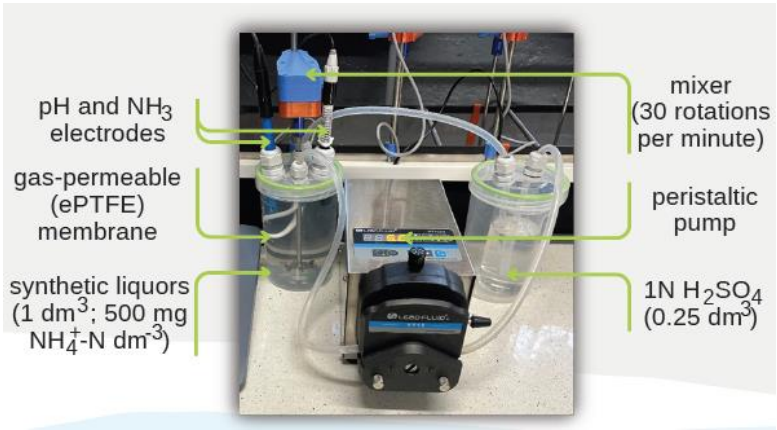


Figure 2 Experimental setup.

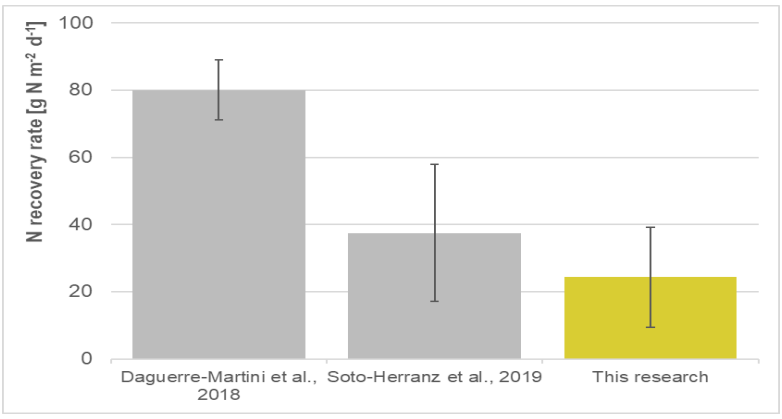


Figure 3 Average N recovery rate.

Food industry wastewater as an external carbon source for the denitrification process in a municipal wastewater treatment plant

Wiktor Gielniak*, Paulina Szulc*, Zbysław Dymaczewski*

*Poznan University of Technology, Faculty of Environmental Engineering and Energy, Institute of Environmental Engineering and Building Installations, Berdychowo 4, 60-965 Poznan
wiktor.gielniak@put.poznan.pl
paulina.ma.szulc@doctorate.put.poznan.pl
zbyslaw.dymaczewski@put.poznan.pl

Keywords: wastewater treatment, denitrification, carbon source

Abstract

The work describes research on intensifying the denitrification process in the wastewater treatment process in a municipal wastewater treatment plant by adding sewage from food industry plants. As part of the work, an analysis of sewage delivered to the wastewater treatment plants in the city and surroundings of Poznań was carried out, and then, based on those analysis and the current situation four factories were selected, samples from which were further analysed to determine the change in the concentration of sewage parameters during the simulation of the denitrification chamber's operation. Four 3-hour test series were performed on sewage and activated sludge from the wastewater treatment plant in Koziegłowy.

Each series corresponded to wastewater from a different industrial factory. The industrial factories from which wastewater samples were collected were: fish processing; production of food creams and icings; production of alcohol and preparation and delivery of food (catering company). In each series, the nitrate removal rates in the reactor with the addition of industrial sewage were compared with the nitrate removal rates in the reactor with the addition of a commercial carbon source, i.e. a concentrated substance rich in nutrients that can easily be used by denitrifying bacteria. A proposal for a strategy for delivering wastewater as an external source of carbon from industrial factories as well as storing and distributing this wastewater at the treatment plant was also prepared.

The research has shown that wastewater from the food industry effectively accelerates the denitrification process. In each series, the maximum denitrification rate was the highest in the reactor with the addition of an industrial carbon source, similarly, the time needed to achieve the maximum level of nitrate reduction was also the shortest in each time in the reactors with the addition of an industrial carbon source. The level of nitrate removal by bacteria in the reactor with the addition of industrial sewage was more than satisfactory. After 3 hours of reaction, the nitrate concentration was as follows: 0.1 mg/l for sewage from fish factory; 0.1 mg/l for wastewater from icing and cream factory; 0.17mg/l for wastewater from alcohol factory and 1.7mg/l for wastewater from a catering company, which corresponds to the degree of nitrate removal from the initial concentration to the final concentration, respectively: 98.3% for wastewater from fish factory; 98.7% for wastewater from icing and cream factory; 98% for wastewater from alcohol factory and 83.5% for wastewater from a catering company. An additional advantage is that industrial wastewater is recirculated and it closes the circulation of this wastewater. Industrial sewage can be transformed from useless waste into a very useful ingredient that can

be used to improve the efficiency of one of the municipal wastewater treatment processes, i.e. denitrification.

References

Dymaczewski Z., Sozański M., „Poradnik Eksploatatora Oczyszczalni Ścieków", PZITS, Poznań, 2011.

Kaszubowska M., „Ocena badań kinetycznych procesu denitryfikacji w komorach osadu czynnego z dozowaniem zewnętrznego źródła węgla," Gdańsk, 2015.

Kopeć Ł., „Ilościowe i jakościowe aspekty procesu denitryfikacji w reaktorze ze złożem ruchomym", rozprawa doktorska, Politechnika Gdańska, 2014.

Mąkinia J. i Czerwionka K., „Wytyczne oceny alternatywnych źródeł węgla," Gdańsk, 2013.

Mielcarek A., Rodziewicz J., Kupczyk K. i Rokicka M., „Wpływ rodzaju zewnętrznego źródła węgla organicznego na szybkość denitryfikacji.," Olsztyn, 2014.

Milferstedt K., Hamelin J., Park C., Jung J., Hwang Y., Cho S.-K., Jung K.-W. i Kim D.-H., „Biogranules applied in environmental engineering," International Journal of Hydrogen Energy, 9 (9), p. 27801-27811, 2017.

Figures tables

Table 1 Comparison of $N\text{-}NO_3$ values after simulations with wastewater from each food industry factory

Time	Factories			
	Fish factory	Icing and cream factory	Alcohol factory	Catering company
	$N\text{-}NO_3$ concentration [mg/l]			
0h	5,94	7,7	8,61	10,3
0.5h	0,68	1,66	0,42	7,58
1h	0,1	0,1	0,15	6,23
1.5h	0,1	0,1	0,1	4,92
2h	0,1	0,1	0,1	3,65
2.5h	0,1	0,1	0,1	2,49
3h	0,1	0,1	0,17	1,7

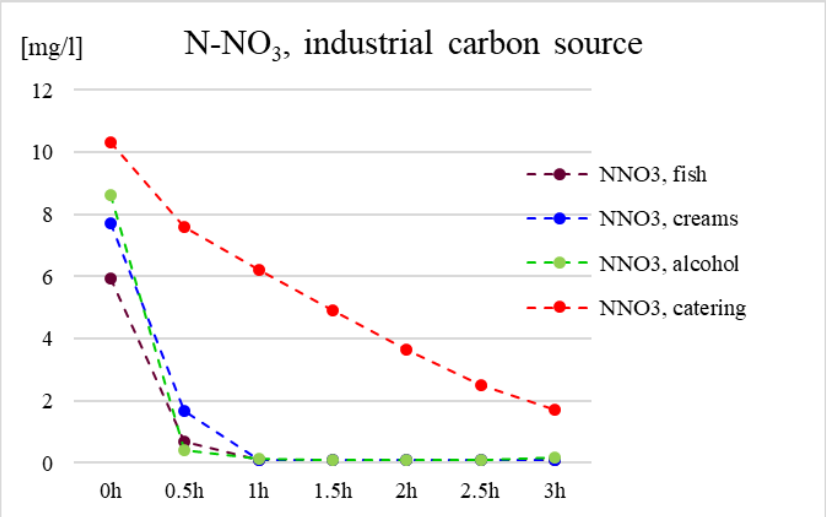


Figure 1 Changes in nitrate nitrogen concentration during simulations with sewage from each food industry factory

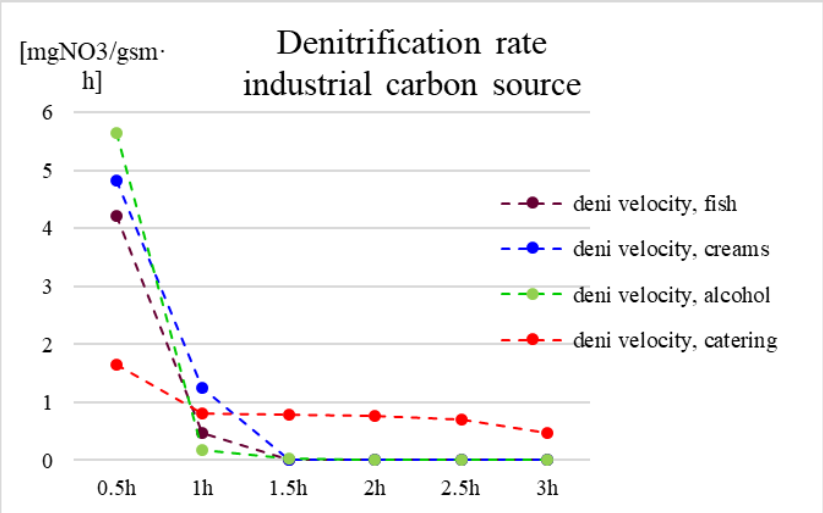


Figure 2 Changes in denitrification rate during simulations with sewage from each food industry factory

Characterization of extracellular polymers extracted from activated sludge

A. Cydzik-Kwiatkowska[a], **M. Florczyk**[a], **S. Pasieczna-Patkowska**[b], **M. Komorowska-Kaufmann**[c], **W. Pomian**[d], **K. Jóźwiak**[d], **P. Oleśkowicz-Popiel**[c], **S. Ciesielski**[a]

a Department of Environmental Biotechnology, University of Warmia and Mazury in Olsztyn, Olsztyn, 10-709, Poland. **b** Department of Chemical Technology, Faculty of Chemistry, Maria Curie Skłodowska University, Pl. Marii Curie-Skłodowskiej 3, 20-031 Lublin, Poland. **c** Institute of Environmental Engineering and Building Installations, Poznan University of Technology, Poznań, 60-965. **d** AQUANET S.A., Dolna Wilda 126, 61-492 Poznań, Poland

Keywords: extracellular polymeric substances; alginate; biomaterials

Abstract:

The sustainability and economics of wastewater treatment could be substantially increased if biomaterials could be recovered from the waste activated sludge (WAS). For example, proteins (PNs), polysaccharides (PSs), glycoproteins, humic acids, lipids, and nucleic acids which are part of extracellular polymeric substances (EPS). Thanks to EPS, microorganisms responsible for aerobic wastewater treatment tend to aggregate. Moreover, isolated PSs with theirs gel-forming abilities appear like an alginate (ALE) isolated from algae, which is widely used in industry.

We characterized extracellular polymers extracted from WAS in four calendar seasons: winter, spring, summer and autumn. In addition to PNs and PSs content in EPS fractions, we also measured the physical properties of EPS (viscosity) and analyzed their visual images using scanning electron microscope (SEM). In order to characterize recovered ALE we used FT-IR spectra, SEM and block fractionation analysis. We also conducted analysis based on 16S rRNA amplicon sequence variants (ASVs) in order to identify relationship between microbial communities and production of biomaterials.

Analysis of viscosity of EPS fractions revealed that there were no significant differences. SEM images showed crystal-like structures present in all three EPS fractions. SEM analysis of ALE indicated that it has rough, unporous structure and that ALE could be useful as a potential encapsulation material. FT-IR spectra for ALE may suggest that there were no significant changes in the chemical composition of ALE samples depending on the season, however slight difference between the glucoronic and mannuronic acids residues proportions was observed, which was also reflected in the analysis of block fractionation. Microbiological analysis at the phylum level revealed that the most common bacteria belonged to *Proteobacteria*, *Bacteroidota*, *Actinobacteriota* and *Chloroflexi*. We also identified 16S rRNA ASVs potentially responsible for ALE production (*Nitrospira* sp. and NS9 marine group). Our results extends knowledge needed to utilize waste as a source of bioproducts which could be the basis of the modern bioeconomy.

References

Cydzik-Kwiatkowska A. (2021). Biopolymers in Aerobic Granular Sludge—Their Role in Wastewater Treatment and Possibilities of Re-Use in Line with Circular Economy. *Energies* **14**, 7219.

Schambeck, C.M. et al. (2020). Chemical and physical properties of alginate-like exopolymers of aerobic granules and flocs produced from different wastewaters. *Bioresource Technology* **312**, 123632.

Effects of low-thermal pretreatment combined with enzymatic hydrolysis on solubilisation of food waste

Hubert Byliński*, Antoni Taraszkiewicz, Vijayalakshmi Shankar***, Małgorzata Szopińska*, Aneta Łuczkiewicz*, Sylwia Fudala-Książek***

* University of Technology, Faculty of Civil and Environmental Engineering, 11/12 Narutowicza St., Gdansk 80-233, Poland (hubert.bylinski@pg.edu.pl).
** University of Technology, Faculty of Chemistry, 11/12 Narutowicza St., Gdansk 80-233, Poland.
*** CO2 Research and Green Technologies Centre, Vellore Institute of Technology, Vellore - 14, India

Keywords: enzymatic hydrolysis; food-waste; low-thermal pretreatment

Abstract:

Food waste (FW) is one of the common type of waste, which is produced all over the world. FW is characterized by a high content of organic substances such as: soluble sugars, proteins, starches and other compounds that make it a source of potential fermentative substrates. However, the hydrolysis of FW still serves as a rate-limiting step in an application of many biological processes, such as anaerobic digestion. In some cases, to render the FW susceptibility to digestion and increase its solubilisation, the various types modifications of substrate are performed [1]. In this study, the efficiency of low-thermal pretreatment combined with enzymatic hydrolysis (EH) was evaluated.

The experiments were performed in laboratory scale; around 50g of artificial FW (containing mainly fruits, vegetables, bread, waste paper, tea and coffee grounds) with TS=5% was feed into the reactors. The EH was performed using two enzymes: α-amylase (Sigma Aldrich, St. Louis, USA) and NS-50012 commercial enzyme (Novozyme, Frederiksbergwith, Denmark). Enzyme loading were 0,05% and 0,5% of TS amount of food waste. Efficiency of presented methodology has been evaluated based on the determination of soluble chemical oxygen demand (sCOD), volatile organic compounds (VFAs) using XION 500 spectrophotometer Dr. Lange (GmbH, Germany), and also reducing sugars using 3,5-dinitrosalicylic acid (according to procedure describe in literature) [2].

LT-PT combined with EH resulted in the increase of reducing sugars (Figure 1) and VFAs concentrations (Figure 2). The highest values of VFAs were noted after 24h pretreatment with addition of 0.5% α-amylase. However, even after 4h LT-PT combined with EH, increasing of reducing sugars and VFAs concentrations are significantly in comparison to untreated sample. Data analysis obtained in this study, showed significantly different properties of FW subjected to LT-PT combined with both tested enzymes if compared to untreated FW.

Acknowledgements

This study was supported by the project “WasteValue - Anaerobic biorefinery for resource recovery from waste feedstock”, funded by The National Centre for Research and Development, EEA and Norway grants – Applied Research Programme, NOR/POLNOR/WasteValue/0002/2019-00.

References

Xu F. et al. (2018). Anaerobic digestion of food waste – Challenges and opportunities. *Bioresource Technology*, **247**, 1047-1058.
Goncalves C. et al. (2010). Adaptation of dinitrosalicylic acid method to microtiter plates. *Analytical Methods*, **2**, 2046-2048.

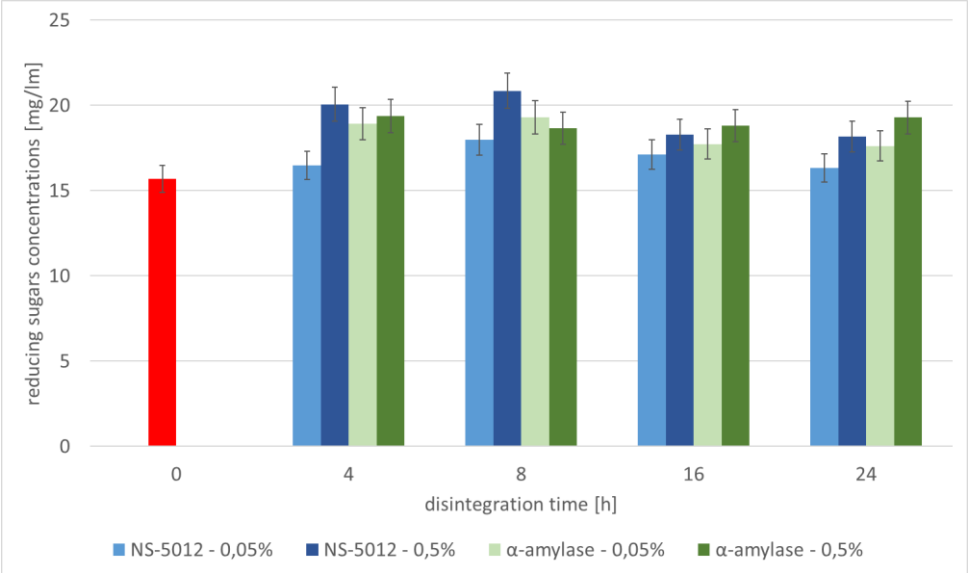


Figure 1 Changes in reducing sugars concentrations after LT-PT combined with enzymatic hydrolysis using a-amylase and NS-50012 enzymes.

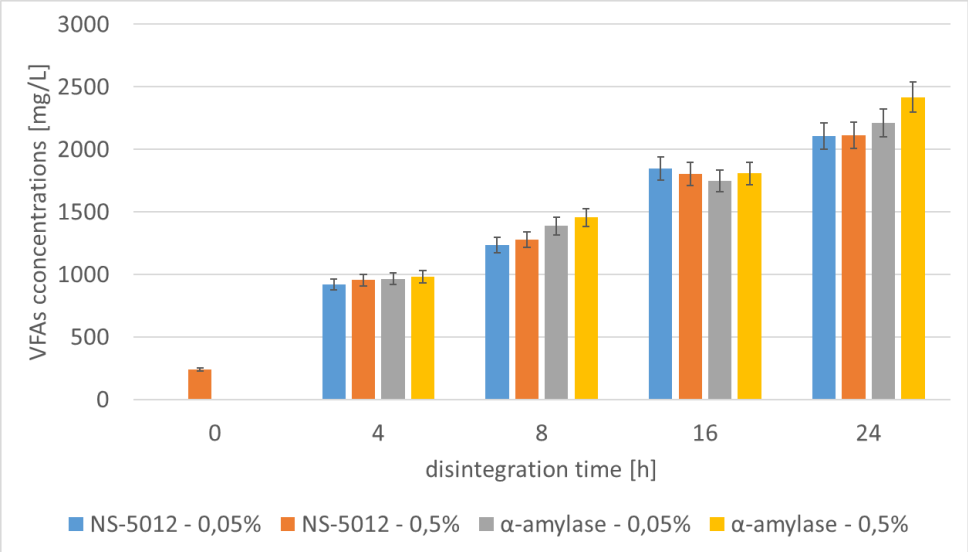


Figure 2 Changes in VFAs concentrations after LT-PT combined with enzymatic hydrolysis using a-amylase and NS-50012 enzymes.

In situ bio-methanation of sewage sludge biogas using a mesophilic CSTR system

G. Cema[1], K K. Kadimpati[1], M.S. Hellal[1,2], A. Ziembińska-Buczyńska[1], J. Surmacz-Górska[1]*
*[1]Environmental Biotechnology Department, Faculty of Power and Environmental Engineering, Silesian University of Technology, Akademicka St. 2, 44-100 Gliwice, Poland (joanna.s.gorska@polsl.pl)
[2] Water Pollution Research Department, National Research Centre, 33 El-Bohouth St., Dokki, Giza 12622, Egypt.

Keywords: Anaerobic digestion; biogas; Bio-methanation; CSTR; hydrogen

Abstract: This study evaluates in-situ biological hydrogen methanation in a mesophilic continuous stirred-tank reactor (CSTR) for biogas upgrading. CSTRs with an effective capacity of 5L were installed and loaded with inoculum sludge with 1.5% VS concentration and fed with mixed waste sludge with 1.9 g VS/L organic loading rate and 14 days sludge retention time at 37°C in mesophilic conditions. The H_2 was injected into one reactor using a microceramic membrane diffuser at a ratio of 4:1 H_2:CO_2 and the control reactor was used. Biogas production was monitored continuously via gas counters and gas chromatography. Bio-methanation process performed well in the upgraded CSTR as CH_4 yield increased to 215 mL/g VS compared with 135 mL/g VS in the control reactor. In addition, gas constituent analysis showed good improvement in biogas quality as CH_4 reached 75% from 56% without H_2. About 88% of the hydrogen injected into the reactor was utilized in the bio-methanation process. According to these results, biogas produced from sewage sludge is promising for upgrading, and further research will focus on the effect of gas recirculation and thermophilic conditions to maximize H_2 utilization for high-performance biomethanation.

Reactors set-up and operation: We built two AD reactors each with a capacity of 5 L. One reactor is injected with hydrogen gas, and the other is the control (Figure 1). A water jacket connected to circulating water baths with temperature controllers was used to keep the temperature in the reactors (VWR International, USA). A precision digital mass flow controller (MFC- DPC07) was used to supply H_2 through a ceramic membrane micro-bubble diffuser (ED 60) made from ultra-fine nano porous aluminum oxide. We analyzed soluble COD, TS, VS, TN, ammonia, VFA, and alkalinity in substrates and digestates from each reactor.

Evaluation of in-situ hydrogen bio-methanation: As per the control reactor gas flow rate, H_2 was injected into the CSTR reactor at 1.4-1.5 mL/min to achieve a 4:1 H2:CO2 ratio (Wahid and Horn, 2021). The performance of bio-methanation during the study period is summarized in Table 1. In the control reactor, the average biogas production was 2510 mL/d and the hydrogen addition was 3150 mL/d. As depicted in Fig. (2a) shows the variation of CH4 yield over time in control and upgraded CSTRs. CH_4 yield increased by 59% (from 135 to 215 mL/g VS) and methane production rate increased from 260 to 415 mL/Lvr.d. without hydrogen addition. In addition, the H2 conversion rate ranged from 83 to 92% with an average rate of 88%. Gas composition analysis showed an acceptable increase in % CH4 (Fig. 2b) from 59% to 75%. Luo and Angelidaki (2013) investigated the biogas upgrading by hydrogen bio-methanation in 1L CSTR for digestion of manure at thermophilic condition (55 °C) with H_2: CO_2 ratio of 4:1. They obtained CH_4 content of 75% at retention time 92h and methane production rate of 1.2 L/L_{vr}.d.

Conclusion: During the upgraded CSTR, the average methane yield increased to 215 mL/g, and the gas constituent analysis showed good improvement in biogas quality as 75% of the hydrogen injected into the reactor was utilized, indicating good biogas quality. This suggests that upgrading biogas produced from sewage sludge is promising, and further studies are needed to maximize H_2 utilization for high-performance bio-methanation under thermophilic conditions and gas recirculation.

Acknowledgement: This work is within the framework of project WasteValue funded by Norway grant No. (NOR/POLNOR/WasteValue/0002/2019-00)

Table 1. Process performance variables in control CSTR and upgraded CSTR with H_2 addition.

Parameters	Control CSTR	Upgraded CSTR
H_2 addition	No	Yes
H_2:CO_2 ratio	--	4:1
H_2 added (L/L_{gas}. d)	-	1.3
% CH_4	52	68
% CO_2	32	18
%H_2	--	1
CH4 production rate (L/L_{rv}.d)	260	415
CH_4 yield (mL/g VS)	135	215
% H_2 consumption	-	88

References:

Luo, G. and Angelidaki, I. (2013). Co-digestion of manure and whey for in situ biogas upgrading by the addition of H2: Process performance and microbial insights. Applied Microbiology and Biotechnology, **97**(3), 1373–1381.

Wahid, R. and Horn, S. J. (2021). The effect of mixing rate and gas recirculation on biological CO_2 methanation in two-stage CSTR systems. Biomass and Bioenergy, **144**, 105918.

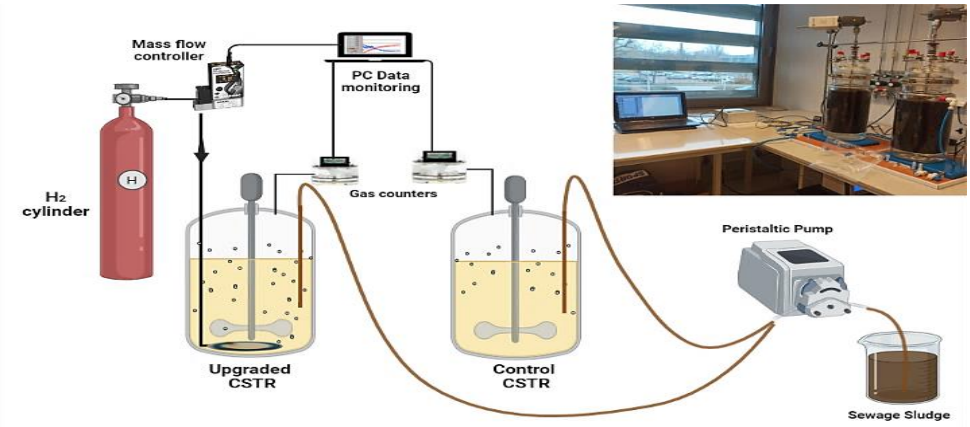


Figure 1. Schematic diagram of in-situ methanation system

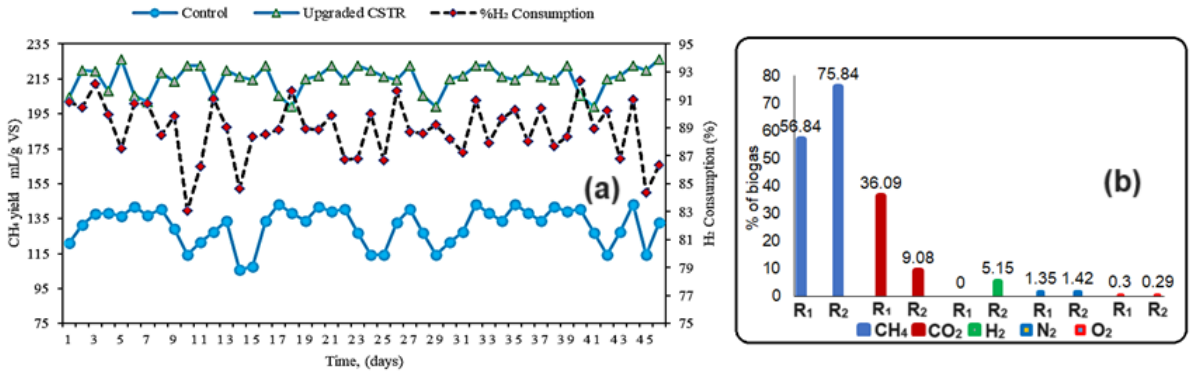


Figure 2. (a) Variation in CH_4 yield and H_2 consumption in R1 and R2, (b) Biogas composition from R1 (control) and upgraded R2 (CSTR).

The influence of UV disinfection method on the concentration of micropollutants in treated wastewater – Case study o Jastrzębia Góra (Baltic Sea Region)

E. Bączkowska*, M. Szopińska, Katarzyna Jankowska, Rafał Bray

* emilia.baczkowska@pg.edu.pl

Keywords: organic micropolutants; pharmaceuticals and personal care products, treated wastewater; uv disinfection

Abstract:

The study area - Jastrzębia Góra is located in the Costal Landscape Park. It covers areas of exceptional natural values and diversity of landscapes (e.g. the presence of bogs and protected species). It is known that during the summer season over 500 thousand people visit the Costal Landscape Park and its nearby area which results among others in fluctuating an amount of discharged treated wastewater. This can have a negative impact on the ecosystem. Especially in the Czarna Wda river, because it recives the effluent from the WWTP in Jastrzębia Góra (Bączkowska et al., 2022). Over the past decade wastewater treatment plants were identified as a major point source of pollution (Corominas et al., 2013). Moreover, considering the global socio-economic development generates a stream of substances that almost immediately appear in the environment (Szopińska et al., 2022), there is a need to limit those substances in the aquatic environment. One of the point sources of various organic micropollutants are the WWTPs. Since conventional wastewater treatment plants are unable to eliminate many of the compounds detected in wastewater the purpose of this study was to determine pharmaceuticals and personal care products (PPCPs) and other emerging contaminants (ECs) present in the treated wastewater discharged into the Czarna Wda River from the Jastrzebia Gora WWTP during UV disinfection process.

More than 80 samples collected during five series of field campaigns (July and September 2022, February, May and July 2023) were analysed. PPCPs and selected pesticides have been determined using ultra high performance liquid chromatography tandem mass spectrometry (UHPLC-MS/MS, Nexera LC-40, SPD-M40, LC-MS-8050; Shimadzu). Twenty analytes were determined using multiple reaction monitoring mode (MRM). Furthermore, solid phase extraction using HPL 500 mg, (OASIS, Waters) column was applied as a sample preparation step.

The aim of the study was to assess the potential environmental risks they pose to the research area. In addition, it was tested whether disinfection of treated wastewater with UV light causes a reduction in the amount of analysed micropollutants. Among others sulphamethoxazole, metoprolol tartrate and benzophenone-3 were detected in studied samples with the variation of the concentration between field campaigns. The overall results indicate that regular monitoring of PPCPs and other ECs is of great importance in this environment.

References

Bączkowska, E., Kalinowska, A., Ronda, O., Jankowska, K., Bray, R., Płóciennik, B., & Polkowska, Żaneta. (2021). Microbial and chemical quality assessment of the small rivers entering the South Baltic. Part I: Case study on the watercourses in the Baltic Sea catchment area. *Archiwum Ochrony Środowiska*, 47, 55-73.

Szopińska, M., Potapowicz, J., Jankowska, K., Łuczkiewicz, A., Svahn, O., Björklund, E., Nannou, C., Lambropoulou, D., & Polkowska, Żaneta. (2022). Pharmaceuticals and other contaminants of emerging concern in Admiralty Bay as a result of untreated wastewater discharge: Status and possible environmental consequences. *Science of The Total Environment*, 835, 155400.

Corominas, L., Acuña, V., Ginebreda, A., & Poch, M. (2013). Integration of freshwater environmental policies and wastewater treatment plant management. *Science of The Total Environment*, 445–446, 185–191.

Title: Comparative Analysis of Lactic Acid Fermentation Using Rice and Potato Substrates, and Profiling of Volatile Fatty Acids

Aisha Khan Khanzada[*], Hussein Al-Hazmi[*], Jacek Mąkinia[*], Ewa Zaborowska[*], Joanna Majtacz[*], Xiang Li[**]
[*]Faculty of Civil and Environmental Engineering, Gdansk University of Technology, Gdansk, 80-233, Poland
[**] School of Environmental Science & Engineering, Donghua Univerisity, Shanghai, 2999, China

Abstract

Lactic acid fermentation is a pivotal biotechnological process with diverse applications, ranging from food production to bioplastics. This study investigates lactic acid production using rice and potato substrates under controlled conditions. Additionally, the study profiles the production of volatile fatty acids (VFAs), including acetic acid, propionic acid, n-butyric acid, 2-ethylbutyric acid, valeric acid, and hexanoic acid. The aim is to compare the efficiency of these substrates in terms of lactic acid production, unravel the reasons behind observed differences, and explore the concurrent VFA production.

Keywords: Lactic acid fermentation, L-lactic acid, D-lactic acid, VFA

Introduction

Experiencing a surge in interest, lactic acid (2-hydroxypropionic acid) is now in high demand across chemical, food, pharmaceutical, and cosmetic sectors [1]. Additionally, it serves as a crucial feedstock for producing polylactic acid, an environmentally friendly biodegradable plastic poised to replace traditional, non-renewable petrochemical-based plastics [2].

Methodology

In this study, potato and rice substrate was prepared by boiling and mashing for increased surface area. Mashed potatoes and rice mixed with distilled water at 200 g/L solid loading were stored at 10°C. Lactic acid bacteria from a wastewater treatment plant's anaerobic digester served as the inoculum. Batch fermentation was conducted at 35°C, 100 RPM, and pH 6, with daily sampling for a week. Analysis methods included HPLC for lactic acid, GC for volatile fatty acids, Hach-Lange kits for SCOD (0-60 g/L), and standardized techniques for carbohydrate content, providing a comprehensive chemical profile for analysis.

Results and Discussion

For the potato-based substrate, the maximum L-lactic acid production of 52.3 g/L was achieved after 24 hours of fermentation. In contrast, the maximum D-lactic acid production of 12.7 g/L was reached after 72 hours. For the rice-based substrate, a maximum L-lactic acid production of 53.8 g/L was recorded after 72 hours, accompanied by a higher D-lactic acid production of 20.1 g/L within the same timeframe. Notably, the hydrolysis stage for the rice substrate was observed to be longer than that for the potato substrate. Figure 1 illustrates the L-lactic acid and D- lactic acid production along with SCOD. Regarding VFA production, both substrates exhibited distinct profiles. Rice-based fermentation generated higher concentrations of acetic acid, propionic acid, butyric acid, 2- ethylbutyric acid, and valeric

acid, indicating a more extensive VFA production. Potato-based fermentation, on the other hand, resulted in higher levels of hexanoic acid.

Rice-based fermentation takes longer due to complex carbohydrates, delaying lactic acid production compared to potato-based fermentation. Microbes from municipal wastewater adapt differently to these substrates, with rice favoring a prolonged fermentation process and higher L- and D-lactic acid production. VFA profiles vary due to microbial composition and nutrient differences between rice and potato. Nutrient availability impacts microbial growth and influences VFA production. Rice-based fermentation yields more diverse VFAs, including acetic, propionic, butyric, 2-ethylbutyric, and valeric acids. Potato-based fermentation primarily produces hexanoic acid, indicating a distinct microbial community with different metabolic pathways. These differences highlight the role of substrates and microbial communities in shaping fermentation outcomes.

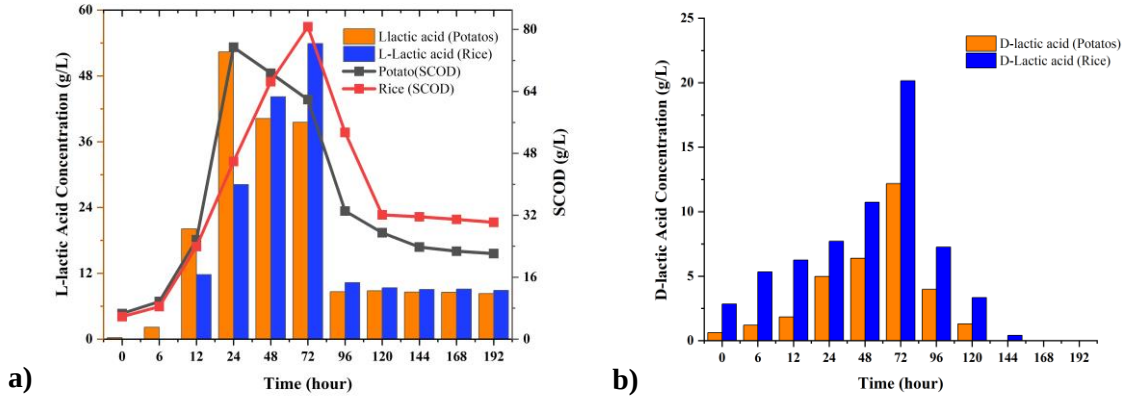


Figure 1 Lactic acid and SCOD production using potato and rice sustrate a) L-lactic acid and SCOD b) D-Lactic Acid.

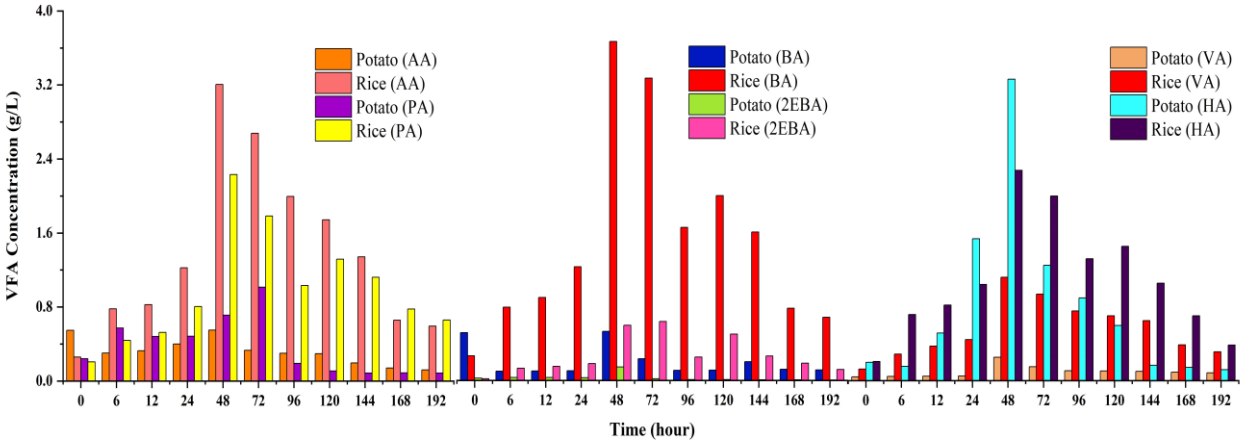


Figure 2 Volatile fatty acid concentration using potato and rice sustrate, Acetic acid (AA), Propinoic Acid (PA), Butyric acid (BA), 2 Ethylbutyric Acid (2EBA), Valeric Acid (VA), Hexanoic Acid (HA).

1. Liu, S.; Wang, Q.; Li, Y.; Ma, X.; Zhu, W.; Wang, N.; Sun, H.; Gao, M. Highly Efficient Oriented Bioconversion of Food Waste to Lactic Acid in an Open System: Microbial Community Analysis and Biological Carbon Fixation Evaluation. *Bioresource Technology* **2023**, *370*, 128398, doi:10.1016/j.biortech.2022.128398.

2. Zhang, W.; Li, X.; Zhang, T.; Li, J.; Lai, S.; Chen, H.; Gao, P.; Xue, G. High-Rate Lactic Acid Production from Food Waste and Waste Activated Sludge via Interactive Control of pH Adjustment and Fermentation Temperature. *Chemical Engineering Journal* **2017**, *328*, 197–206, doi:10.1016/j.cej.2017.06.174.

Biodegradation of the dissolved fraction of organic nitrogen in leachate from biogas plants located at wastewater treatment plants

Wilinska – Lisowska Anna*, Czerwionka Krzysztof,**

* Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Gabriela Narutowicza 11/12, 80-233 Gdansk, Poland (E-mail: annwilin@pg.edu.pl)
** Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Gabriela Narutowicza 11/12, 80-233 Gdansk, Poland (E-mail: kczer@pg.edu.pl)

Keywords: biodegradability; dissolved organic nitrogen (DON); leachates

Abstract:

A potential problem related to the use of sludge digestion, is the potential increase in the concentration of pollutants that are found in leachate from the separation of digestate into solid and liquid fractions. These leachates, are sent to the main line of the wastewater treatment plant. Research shows that they have high concentrations of biogenic compounds such as nitrogen and phosphorus. With this type of methodology, it can result in an increase in the cost of wastewater treatment or even contribute to a degradation in the quality of treated wastewater discharged to the receiving water source.

One important practical aspect that may concern the operation of wastewater treatment plants (WWTP) is the biodegradability of compounds in which organic nitrogen is present in leachate. It is important to point out that the dissolved fraction of organic nitrogen (DON), which is the dominant component of organic nitrogen in leachate, can be removed mostly by biological methods. With the increase of DON concentration in leachate as a result of the co-digestion process and assuming its inert nature, this may result in an increase of organic nitrogen concentration in the treated effluent form WWTP of approx. 10% of the legislative limit. There are no studies in the literature on the biodegradation of dissolved nitrogen in leachate, only information for treated wastewater is available.

The aim of this research was to determine the biodegradability of the DON fraction contained in leachate from a municipal biogas plant under activated sludge chamber conditions. The biodegradability of DON was analyzed on the basis of leachate samples taken from digesters located at three wastewater treatment plants in northern Poland (Słupsk, Swarzewo and Dębogórze).

References

Fux C. and Siegrist H. (2004). Nitrogen removal from sludge digester liquids by nitrification/denitrification or partial nitritation/anammox: environmental and economical considerations, *Water Science and Technology*, **50**(10), pp. 19-26.

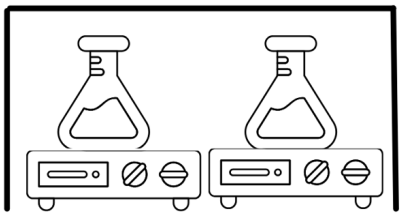
Pagilla, K.R., Urgun-Demirtas, M., Ramani, R., (2006). Low effluent nutrient treatment technologies for wastewater treatment. *Water Science and Technology*, **53**(3), pp. 165-172.

ACKNOWLEDGEMENTS

This study was financially supported by European Regional Development Fund within the framework of Smart Growth Operational Programme 2014-2020 under the project no POIR.04.01.02-00-0022/17

Figures and Tables

PHASE I
OF THE RESEARCH



- **Isolated from light**
- **Mechanical mixer (250 rpm)**
- **Samples analyzed at 0 day and after 1, 2, 3, 4, 5, 7 and 10 days.**

PHASE II
OF THE RESEARCH

Determination of the DON fraction

filtration through Millipore nitrocellulose filter with a pore size of 0.1 µm.

Total nitrogen was determined in the filtrate using a TOC analyzer with a TN determination attachment (SHIMADZU Corporation, Japan)

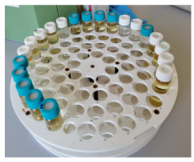


Figure 1 Graphical representation of the research methodology

The application of advanced reduction processes for the removal of halogenated compounds

Zahra Askarniya, Grzegorz Boczkaj*

Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Department of Sanitary Engineering, Poland, 80-233 Gdańsk, 11/12 Narutowicza Str., Poland.

*e-mail: grzegorz.boczkaj@pg.edu.pl

Advanced reduction process (ARP) is regarded as a new class of advanced treatment processes which are working based on the generation of reductive free radicals including hydrated electron (e^-_{eq}), hydrogen atoms (H°), sulfite radical ($SO_2^{\circ-}$), and carboxyl anion radical ($CO_2^{\circ-}$). The performance of ARPs depends on the molecular structure of pollutants and they are usually suitable for the degradation of halogenated compounds. Since sole reductants are usually unable to lead to the complete degradation, the combination of reductants with activation methods is recommended for the generation of adequate amount of desired reductive radicals. UV is one of those activation methods which is commonly employed in ARPs. Sulfite-based ARPs is popular due to the generation of e^-_{eq} having high reductive potential and high resistance towards the adverse effect of dissolved oxygen although it might generate problematic sulfur-containing intermediates. $CO_2^{\circ-}$ is also a strong reductive radical possessing high reduction potential, high stability, and long lifetime.

The paper presents the basics of ARPs, the removal results achieved by the application of a variety of ARPs, and the influence and optimum range of effective parameters.

Keywords: Advanced reduction processes, Halogenated compounds, Wastewater treatment, Catalysts, radicals.

Acknowledgements

The authors gratefully acknowledge financial support from the National Science Centre for project UMO-2021/40/Q/ST8/00124.

Novel method for methyl violet dye determination in contaminated river water – a natural deep eutectic solvent based ultrasound assisted liquid-liquid micro-extraction approach

Hameed Ul Haq1, Grzegorz Boczkaj1,2*

1Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Department of Sanitary Engineering, 80 – 233 Gdansk, G. Narutowicza St. 11/12, Poland. E-

2EkoTech Center, Gdansk University of Technology, G.Narutowicza St. 11/12, 80-233 Gdansk, Poland.

*e-mail: grzegorz.boczkaj@pg.edu.pl

Abstract

This paper presents a novel, simple and green natural deep eutectic solvent (NADES) based ultrasound assisted liquid-liquid micro-extraction (UA-LLME) method for extraction and determination of methyl violet dye in contaminated river water samples. Final determination stage is performed by means of UV/Vis spectrophotometry. Several DESs were tested and choline chloride - decanoic acid based NADES was selected as extractive solvent. Developed method was optimized in respect to pH, deep eutectic solvent volume/phase ratio, tetrahydrofuran volume, sonication time, and temperature were optimized. Limit of detection (LOD) and limit of quantification (LOQ) were 2.20 μg/L and 7.34 μg/L respectively. Relative standard deviation was 2.35-3.21%. Linearity of method was investigated in a concentration range 10-400 μg/L. Enrichment factor was calculated as 20. For 20 mL sample, the optimized parameters were as deep eutectic solvent volume 1.5 mL, tetrahydrofuran volume was 0.6 mL, pH=6, sonication time 2 minutes. The optimized method was used for analysis of methyl violet pollution in real water samples confirming its applicability in routine environmental analysis.

Keywords: Dyes; Green extraction; Methyl violet analysis; Sample preparations; Water analysis; Wastewater.

Acknowledgment

The authors gratefully acknowledge the financial support from the National Science Centre, Warsaw, Poland – decision no. UMO-2018/30/E/ST8/ 00642

Advanced reduction processes (ARPs) in degradation of pesticides in wastewater by $CO_2^{\bullet-}$ reducing radicals generated in the HCOOH/UV system

Łukasz Cichocki, Grzegorz Boczkaj

Department of Sanitary Engineering, Faculty of Civil and Environmental Engineering, Gdansk University of Technology, Gdańsk, Poland

The widespread use of various groups of pesticides in agriculture is associated with some biotoxic organic compounds entering rivers, lakes and drinking water. Many pesticides undergo biodegradation into other groups of compounds, sometimes as toxic as the initial ones. It is therefore important to find methods to reduce the toxicity of a number of organic compounds found in water through their dechlorination, decarboxylation and reduction to simpler forms capable of degradation by microorganisms [1-4]. Advanced reduction processes (ARPs) as a novel alternative to the commonly used advanced oxidation processes (AOPs) open up a new group of wastewater treatment processes that can find application in wastewater treatment [5-6].

The work presents a complete technological and economic analysis of the topic of pesticides polluted wastewater treatment and shows the feasibility of ARPs-based methods in real systems containing anions and a high dissolved organic matter (DOM) load with high process efficiency.

Acknowledgements

The authors gratefully acknowledge financial support from the National Science Centre for project UMO-2021/40/Q/ST8/00124.

[1] - J. Cui, P. Gao, Y. Deng, 2020, Destruction of Per- and Polyfluoroalkyl Substances (PFAS) with Advanced Reduction Processes (ARPs): A Critical Review. *Environmental Science & Technology*, 54(7), 3752–3766.

[2] - Liu, Xiaowei, et al. 2016, Trichloroacetic acid reduction by an advanced reduction process based on carboxyl anion radical. *Chemical Engineering Journal* 303, 56-63.

[3] - Xiao, Q., Yu, S., Li, L., Wang, T., Liao, X., & Ye, Y., 2017. An overview of advanced reduction processes for bromate removal from drinking water: Reducing agents, activation methods, applications and mechanisms. *Journal of Hazardous Materials*, *324*, 230-240.

[4] - Liu, Xu, et al., 2014, Degradation of 1, 2-dichloroethane with advanced reduction processes (ARPs): effects of process variables and mechanisms. *Chemical Engineering Journal* 237, 300-307.

[5]- Vellanki, Bhanu Prakash, Bill Batchelor, and Ahmed Abdel-Wahab. 2013, Advanced reduction processes: a new class of treatment processes. *Environmental engineering science* 30.5, 264-271.

[6] - D. B. Fenell, S. P. Mezyk, G. McKay, 2022, Critical Raview of UV-Advanced Reduction Processes for the Treatment of Chemical Contaminants in Water, *ACS Environmental*.

Model-Based Evaluation of Strategies for Mitigating N_2O emissions in Activated Sludge Systems: Insights from Poznan's Wastewater Treatment Plant

Mohanad Awad*, Ewa Zaborowska*, Jacek Mąkinia*

* Gdansk University of Technology, Faculty of Civil and Environmental Engineering, ul. G.Narutowicza 11/12, 80-233 Gdansk, POLAND, (E-mail: mohanadd2m@gmail.com)

Abstract: N_2O emissions were assessed within the activated sludge treatment line at the Poznan central wastewater treatment plant in Poland. The GPS-X software served as the modelling tool for conducting simulations. This study unequivocally establishes that dissolved oxygen (DO) plays a pivotal role in restraining the activity of nitrification bacteria, specifically ammonia-oxidizing bacteria (AOB) and nitrite-oxidizing bacteria (NOB). The research findings underscore that the lowest N_2O production occurs at a DO concentration of 3 mgO_2/L. Various control strategies, denoted as CS1 and CS2, were investigated for their efficacy in mitigating carbon emissions. CS1 encompasses the integrated impact of liquid temperature and solids retention time (SRT) on N_2O emissions, while CS2 encapsulates the integrated influence of DO concentration and mixed liquor recycling (MLR) on N_2O emissions. The results of this investigation affirm that it is feasible to curtail the carbon footprint through the implementation of these strategies, all while maintaining the total nitrogen (TN) concentration within acceptable limits in the effluent. Specifically, the application of CS1 yielded a noteworthy 14% reduction in potential N_2O emissions.

Keywords: Nitrification; denitrification; mitigation

Introduction

N_2O is a powerful greenhouse gas that contributes significantly to global warming and climate change. It is commonly referred to as "laughing gas" due to its use in dental anaesthesia, but its environmental consequences are unpleasant. On a per-molecule basis, N_2O is roughly 300 times more powerful than carbon dioxide (CO_2) in trapping heat in the atmosphere, and it also has a comparatively long atmospheric lifespan, lasting around 114 years (IPCC, 2014). The European Commission's Report, concerning greenhouse gas (GHG) emission from sewerage systems, shows that wastewater treatment plants produce around 3% of global emission of N_2O, Zawartka et al. (2020). Nitrification and denitrification processes are considered the main source for N_2O production during biological nitrogen removal from wastewater. The main portion of N_2O production (90%) occurs mainly in the activated sludge bioreactor, Domingo-Félez and Smets (2019). Denitrification occurs under anoxic conditions when the heterotrophic bacteria use nitrogen as an electron acceptor. During denitrification, N_2O production is an intermediate in this process. So, N_2O can be produced if incomplete denitrification occurs. Another pathway for N_2O production is nitrification. Nitrification is mediated by two different autotrophic bacteria, ammonia oxidizing bacteria (AOB) and nitrite oxidizing bacteria (NOB). Incomplete nitrification leads to accumulation of NO_2 which stimulates N_2O production. Some studies in literature stated that N_2O can be produced from reactions occur in environment contains hydroxylamine and nitrite, Soler-Jofra et al. (2016). In the presence of high NH_4 concentration and low NO_2 hydroxylamine oxidation pathway can be a major contributor to the production of N_2O at sufficient dissolved oxygen (DO) concentration, Wunderlin et al. (2012). The primary objective of this study is to assess greenhouse gas (GHG) emissions originating from the Poznan central wastewater treatment plant and to formulate operational approaches for reducing these emissions.

Material and Methods

Study site: Poznań central WWTP (1,200,000 PE). Six biological reactors have the A_2O (anaerobic/anoxic/oxic) configuration, dedicated to nitrogen and phosphorus removal.

Data collection: Lab-scale tests, full-scale experiments and routine data were used for model calibration and validation. The samples were analysed in the laboratory using standard methods.

General procedure: GPS-X software version 8.0 was used in this study as a modelling tool. The Mantis3 model was adopted in this study for estimating N_2O emission, where it includes N_2O production during denitrification. The effect of different DO concentrations in the aerobic zone and SRT values on the production of N_2O were investigated. In regard to control strategies for mitigation N_2O production, CS1 represents the combined effect of liquid temperature (LT) and SRT on N_2O production. The LT was changed within a range 14 to 30 °C (with a step of 2 °C) and the SRT within the range 6 to 40 days (with a step of 2 days). CS2 demonstrates the combined effect of DO concentration and MLR on N_2O production, where the DO concentrations in the three aerobic tanks were changed within a range 0.1 to 3.5 mgO_2/L (with a step of 0.1) and the MLR within the range of 340% to 1060% of primary influent (with a step of 30%). The surfer software (Golden Software LLC. /USA) was used to develop the 3D contour graphs, where the Kriging method was used to interpolate the data.

Results and Discussion

Growing DO concentration in the aerobic tanks leads to minimize the efficiency of conversion NH_4 to N_2O by AOBs during autotrophic nitrification, while at low DO concentration, AOBs use NO_2 as the electron acceptor to keep O_2 for oxidation of ammonia to hydroxylamine. However, at DO setpoint equals 3.5 mg/l the N_2O production started rising, that could be related to increase DO concentration in anoxic tanks through RAS. Also, high oxygen feed could force the release of N_2O from their soluble form to gaseous form (stripping), Figure 1a. As shown in Figure 1b, extending SRT leads to decrease the production of N_2O, where longer SRT inhibits NO_2 accumulation in bioreactor. In regard to CS1, the results showed that maintaining liquid temperature in the range 15-20°C and increasing the SRT (>30 days) could reduce N_2O emission up to 14%, Figure 3. Applying CS2 demonstrated that a slight reduction on N_2O emissions could be achieved by increasing DO over 2 mgO_2/L, while keeping MLR ratio at reference state, Figure 3.

Conclusion

The DO concentration in aerobic zone is the principal variable that has the greatest effect on N_2O emission. The DO concentration is a key limiting factor for the inhibition of nitrification bacteria (AOB and NOB). Regarding to SRT, a higher SRT limits N_2O stripping by aeration due to the extended time would be available for microorganisms to consume it. Therefore, to avoid NO_2 accumulation during nitrification, it is significant to have an appropriately long SRT and sufficient DO concentration to proceed nitrite oxidation. It was possible to reduce N_2O emission using CS1 and CS2 without compromising the effluent total nitrogen (TN) concentration. 14% and 3% potential reduction in N_2O emission was achieved by applying CS1 and CS2, respectively.

Ultimately, the primary factors driving N_2O emissions in the bioreactor stemmed from the nitrification and denitrification processes. Consequently, to effectively restrain N_2O emissions within the biological treatment process, the greatest influence can be exerted by regulating heterotrophic denitrification in both anoxic and aerobic zones.

List of Figures

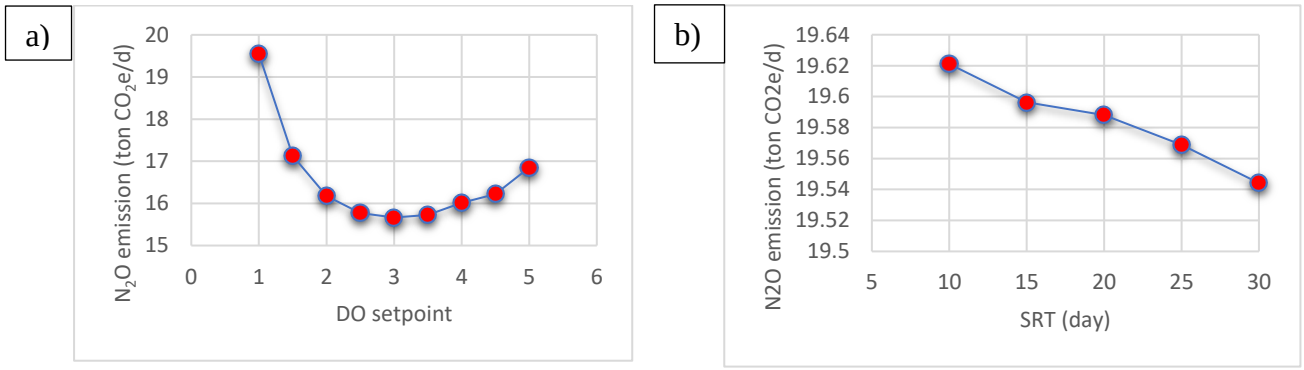


Figure 1. N_2O emissions in bioreactor of Poznan WWTP; **a)** under a function of DO setpoint in the aerobic zone; **b)** with a function of SRT

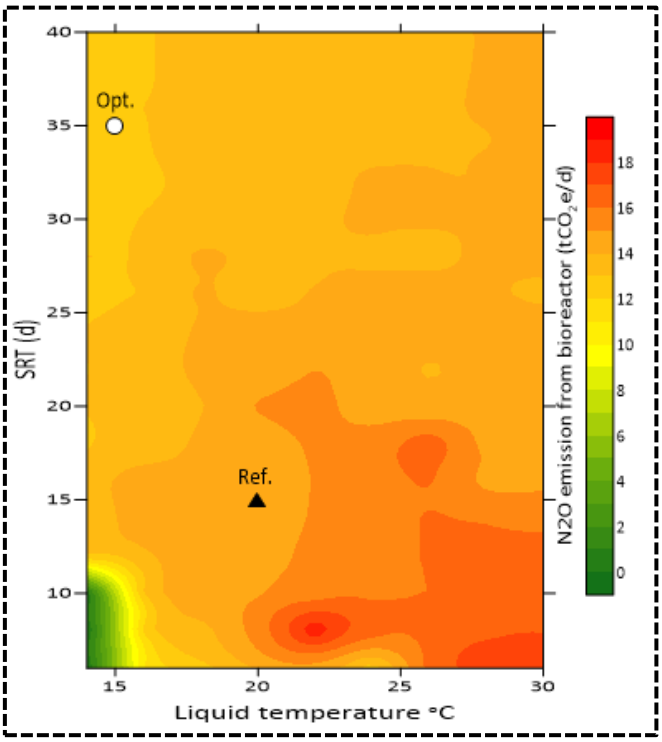


Figure 2 N_2O emission rates from the aerobic zone (colour scale); ("Ref. "-the reference state), ("Opt. "- the optimal state).

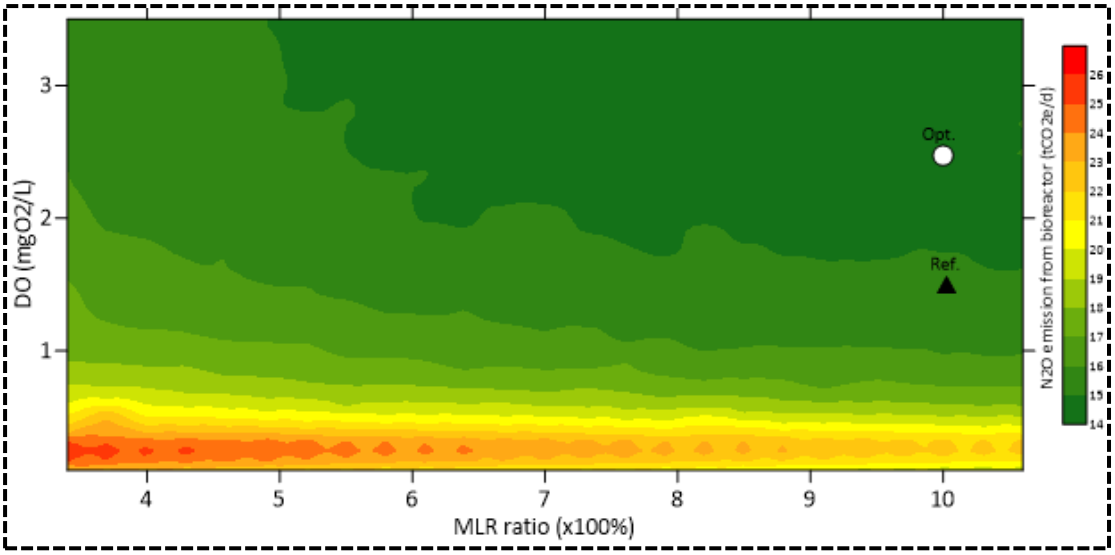


Figure 3 N_2O emission rates from the entire bioreactor (colour scale); ("Ref. "-the reference state), ("Opt. "- the optimal state).

References

Zawartka, Paweł, Dorota Burchart-Korol, and Agata Blaut, 2020. Model of carbon footprint Assessment for the Life cycle of the System of Wastewater collection, transport and treatment. Scientific reports 10(1):1-21.

Domingo-Félez, D., Smets, B.F., 2019. Regulation of key N_2O production mechanisms during biological water treatment. Curr. Opin. Biotechnol. 57, 119–126.

Soler-Jofra, Aina et al., 2016. Importance of abiotic hydroxylamine conversion on nitrous oxide emissions during nitritation of reject water. Chemical Engineering Journal 287:720-726.

Wunderlin, Pascal et al., 2012. Mechanisms of N_2O production in biological wastewater treatment under nitrifying and denitrifying conditions. Water research 46(4):1027-1037.

Energy and material valorisation of corn-syrup by uncontrolled pH fermentation

M. Eugenia Ibañez-López[1], Encarnación Díaz-Domínguez[1], Miguel Suffo[2], Jose Luis García-Morales[1], Jacek Makinia[3], Francisco Jesús Fernández-Morales[4]*

[1] Department of Environmental Technologies, Faculty of Marine and Environmental Sciences, IVA-GRO-Wine and Agrifood Research Institute, University of Cadiz, Spain.
[2] Department of Mechanical Engineering and Industrial Design, High Engineering School, Universidad de Cádiz, Campus Río San Pedro S/n 11510, Puerto Real, Cádiz, Spain.
[3] Faculty of Civil and Environmental Engineering, Gdansk University of Technology, 80-233 Gdansk, Poland.
[4] Department of Chemical Engineering, University of Castilla-La Mancha, Avda. Camilo José Cela S/N, 13071, Ciudad Real, Spain; fcojesus.fmorales@uclm.es

Keywords: Corn-syrup; Uncontrolled pH; Hydrogen; Volatile Fatty Acids

Abstract:

This study is focused on the viability of non-controlled pH acidogenic fermentation of corn-syrup. This effluent is generated during the biodiesel generation and presents a very high dextrose concentration. When operating under non-controlled pH, the initial pH value is of crucial importance. Because of that, uncontrolled pH acidogenic fermentation tests of corn-syrup, varying the initial pH values across a spectrum ranging from 4 to 6, were performed in this work and the results analysed.

The empirical data clearly demonstrated a decline in pH levels throughout the fermentation process. This behaviour was due to the generation of short-chain acids. Th pH reduction experienced, coupled with an increasing undissociated acids concentration caused an inhibitory effect that affected the fermentation dynamics.

When starting at pH 4, the pH decreased to about 3.5 units which leads to an incomplete fermentation of the dextrose contained in the corn-syrup due to an inhibitory effect. This inhibition was presumably caused by the excessively acidic pH conditions and the presence of undissociated acids in the liquid bulk (Rodriguez et al., 2006). However, when the fermentation was initiated with initial pH levels of 5.0 and 6.0, a complete dextrose fermentation was observed. As the operational conditions became increasingly acidic, biomass growth exhibited an uncoupled response, being the microbial growth threshold undissociated fatty acid concentration of about 65 mM. Regarding the generation of fermentation products, it is noteworthy that the greatest economic value was obtained when fermentation was initiated at an initial pH of 5.

Finally, to provide a quantitative evaluation of the main kinetic and stoichiometric parameters, their values were determined by using mathematical modelling. The values obtained accurately predicts the behaviour of the system, indicating that the assumptions of the model were correct.

References

Rodríguez, J., R. Kleerebezem, J. M. Lema, and M. C. M. Van Loosdrecht. (2006). Modeling product formation in anaerobic mixed culture fermentations. Biotechnology and Bioengineering 93 (3):592-606.

Efficiency Analysis of Selected Methods for Sustainable Management of Rainwater

Iwanek M.*, Suchorab P.**

* Lublin University of Technology, Faculty of Environmental Engineering, Department of Water Supply and Wastewater Disposal, m.iwanek@pollub.pl
** Lublin University of Technology, Faculty of Environmental Engineering, Department of Water Supply and Wastewater Disposal, p.suchorab@pollub.pl

Keywords: management of rainwater, financial efficiency, sustainable drainage system

Abstract:

Sustainable management of rainwater is undoubtedly beneficial in terms of hydrology and ecology, but its financial profitability is a debatable issue. The factors determining the profitability of the rainwater management (investment and operating costs and possible profits) depend on various considerations, e.g. the location of the system, the scope of ecosystem services or the price level. The purpose of this paper is to evaluate the financial profitability of selected sustainable methods for management of rainwater discharged from the roofs of 2 buildings located in the East of Poland – a hotel building and a residential and service building, paying particular attention to the importance of financial support for the investment.

For each of the two objects, 3 sustainable methods for rainwater management were proposed (a dual installation system with rainwater harvesting, local management using infiltration boxes and local management using infiltration tunnels) and traditional disposal to a stormwater system. The efficiency analysis of the methods was carried out on the basis of the indicators considered to be main investment evaluation criteria: Net Present Value, Benefits-Costs Ratio, Discounted Payback Period and Internal Rate of Return. The calculations were carried out for 2 cases – without and with financial support offered by local government units in Poland as a part of pro-ecological programs. The conducted research indicated that the dual installation and infiltration tunnels are profitable investments for both the buildings, while the solution with infiltration boxes is not profitable for any of the considered buildings. The current value of the financial support offered by local government units is too low to make the solution with infiltration boxes profitable. The presented results refer to specific design solutions for specific buildings, therefore, they are not universal. Nevertheless, they can be helpful for making the investment decisions for similar objects.

References

Pappalardo V. and La Rosa D. (2020). Policies for sustainable drainage systems in urban contexts within performance-based planning approaches. *Sustainable Cities and Society*, **52**, 101830.
Zeleňáková M., Hudáková G., and Stec A.(2020). Overview of Rainwater Management Facilities. In: *Rainwater Infiltration in Urban Areas*, Water Science and Technology Library, Springer: Cham, **89**, 53-69
Gwoździej-Mazur J., Jadwiszczak P., Kaźmierczak B., Kózka K., Struk-Sokołowska J., Wartalska K. and Wdowikowski M. (2022). The impact of climate change on rainwater harvesting in households in Poland. *Appl. Water Sci.*, **12**, 15.
Fraga J. P. R., Okumura C. K., Guimarães L. F., de Arruda R. N., Becker B. R., de Oliveira A. K. B., Veról A. P. and Miguez M.G. (2022). Cost-benefit analysis of sustainable drainage systems considering ecosystems services benefits: case study of canal do mangue watershed in Rio de Janeiro city, Brazil. *Clean Techn. Environ. Policy*, **24**, 695–712.

Humic acids and their influence on the environment and climate changes

D. Łomińska-Płatek*, A.M. Anielak, J. Górka*****

* Cracow University of Technology, 24 Warszawska, 31-155 Kraków, dominika.lominska@pk.edu.pl
** Cracow University of Technology, 24 Warszawska, 31-155 Kraków, anna.anielak@pk.edu.pl
*** Cracow University of Technology, 24 Warszawska, 31-155 Kraków, justyna.gorka@pk.edu.pl

Keywords: humic acids, climate changes, sewage sludge

Abstract:

Climate changes (CC) are an irreversible and undeniable problem for our, but especially future generations. CC are long-term processes that affect the overall state of the atmosphere, oceans and the Earth's ecosystems in general. Among the most important changes are: raising air temperatures, which directly affects the melting of glaciers, extreme weather events causing hurricanes, typhoons and other dangerous weather changes to occur in greater numbers and intensity, changes in the ecosystems of flora and fauna. Changes in the animal world affect their migration and contribute to the endangerment of species that are unable to adapt to rapid changes in environmental conditions. Emissions of carbon dioxide, methane and other greenhouse gases increase temperatures, leading to changes in the greenhouse gas balance. Therefore, it is important to take measures to reduce greenhouse gas emissions and counteract further climate change.

The growth of sewage sludge and increasing environmental pollution pose significant challenges to modern society. Humic acids can play an important role in reducing climate change due to their properties and effects on various environmental processes. First of all, on maintaining soil structure, increasing water retention, promoting plant growth and even reducing greenhouse gas emissions. All of these processes affect the carbon cycle and, consequently, the balance of the climate. Protecting and restoring humic acid-rich soils is an important strategy for combating climate change and achieving sustainable management of natural resources.

This paper analyzes the structure and elemental composition of fulvic acids extracted from wastewater and sewage sludge and their potential impact on climate change. In the context of growing public awareness and concern about the environment and global climate change, the work aims to present the role of organic compounds contained in sewage sludge as a potential source or mechanism for reducing greenhouse gas emissions. Analysis of the chemical composition and properties of humic acids can provide important information regarding their ability to sequester carbon and impact on climate processes.

References

Sheikha-Bagemghaleh S., Babazadeh H., Rezaie H., Tabrizi M.S. (2023). The effect of climate change on surface and groundwater resources using WEAP-MODFLOW models. *Applied Water Science*, 13(121).

Abbass K., Qasim M.Z., Song H., Murshed M., Mahmood H., Younis I.. (2022) A review of the global climate change impacts, adaptation, and sustainable mitigation measures. *Environmental Science and Pollution Research*, 29, (28), 42539.

Characteristics of microplastics in municipal wastewater treatment plants

Paulina Ormaniec*

* paulina.ormaniec@pk.edu.pl, Division of Environmental Technologies, Faculty of Environmental and Power Engineering, Cracow University of Technology, Warszawska 24, 31-155 Cracow, Poland

Keywords: microplastics; wastewater treatment plant

Abstract:

Microplastics (MP) are pollutants that are causing increasing concerns, and their presence, confirmed in many environments, continues to rise. To address the growing issue of MP in the environment, we need to understand their sources, pathways, fate in sewage systems and municipal wastewater treatment plants, as well as their spatial distribution and concentrations. Wastewater treatment plants are treated as one of the main sources of environmental pollution by MP (Alvim et al., 2020). Originally, Thomson coined the term "microplastics" to describe clusters of very small plastic fragments present in marine sediments and waters. In 2009, Arthur and his colleagues introduced a size limit to this concept, defining microplastics as plastic particles with a size smaller than or equal to 5 mm (Frias and Nash, 2019).

The research was carried out in one of the municipal wastewater treatment plant in southern Poland. MP isolated from raw wastewater, treated wastewater and sewage sludge with the size of 45 μm to 5 mm was subjected to interpretation. The research methodology has been developed based on the current knowledge regarding the identification of MP (Lares et al., 2018; Masura et al., 2015; Quinn et al., 2016). The analysis methodology involved an initial sample purification process, which included the removal of organic matter using hydrogen peroxide and the separation of inorganic matter through density separation using a saturated solution of zinc chloride. The isolated MPs underwent both physical and chemical analyses. The physical analysis, carried out using a stereoscopic microscope, enabled visual identification of micropollutants, as well as determination of their size, shape, and color. Chemical identification was performed to ascertain the polymer type constituting the tested material, using Fourier transform attenuated infrared spectroscopy (FTIR-ATR) for this purpose.

In all analysed samples, the most common shape among the identified MPs were synthetic fibers (raw sewage - 42.25%, treated sewage - 45.92%, dehydrated sludge - 58.15%) (Figure 1A). Which clearly indicates the problem of the sewage treatment plant related to the presence of synthetic fibers, most likely originating from the washing of textiles (De Falco et al., 2019). Confirmation of the structure of the polymer from which the tested MP is built allows us to notice that the dominant polymer in raw wastewater, treated wastewater and sewage sludge is poly(ethylene terephthalate) (32.32%, 29,59%, 25.56% respectively), which is widely used in the production of textile fabrics (Figure 1B). Which coincides with the content of synthetic fibers in the samples. The analysis of the size distribution of the isolated MPs showed that the dominant fraction in the raw and treated wastewater was MP of size 2 to 1 mm. However, in sewage sludge the dominant fraction decreases to the range from 1 to 0.5 mm (Figure 1C).

The conducted analysis will allow to extend the existing knowledge on the occurrence of MP in municipal wastewater treatment plants. In addition, it will allow to define of MP sources and better understand the fate and transport of MP in municipal wastewater treatment plants.

References

Alvim C.B., Mendoza-Roca J.A. and Bes-Pi A. (2020). Wastewater treatment plant as microplastics release source – Quantification and identification techniques. *Journal of Environmental Management*, **255,** 109739.

De Falco F., Di Place E., Cocca M., Avella M. (2019). The contribution of washing processes of synthetic clothes to microplastic pollution. *Scientific Reports*, **9**, 6633.

Frias J.P.G.L and Nash R. (2019). Microplastics: Finding a consensus on the definition. *Marine Pollution Bulletin*, **138**, 145–147.

Lares M., Ncibi M.C., Sillanpää M. and Sillanpää, M. (2018). Occurrence, Identification and removal of microplastic particles and fibers in conventional activated sludge process and advanced MBR technology. *Water Research*, **133**, 236–246.

Masura J., Baker J., Foster G. and Arthur C. (2015). Laboratory methods for the analysis of microplastics in the marine environment: recommendations for quantifying synthetic particles in waters and sediments. NOAA Technical Memorandum NOS-OR&R-48.

Quinn B., Murphy F. and Ewins C. (2016). Validation of density separation for the rapid recovery of microplastics from sediment. *Analytical Methods*, **9**, 1491–1498.

Figures and Tables

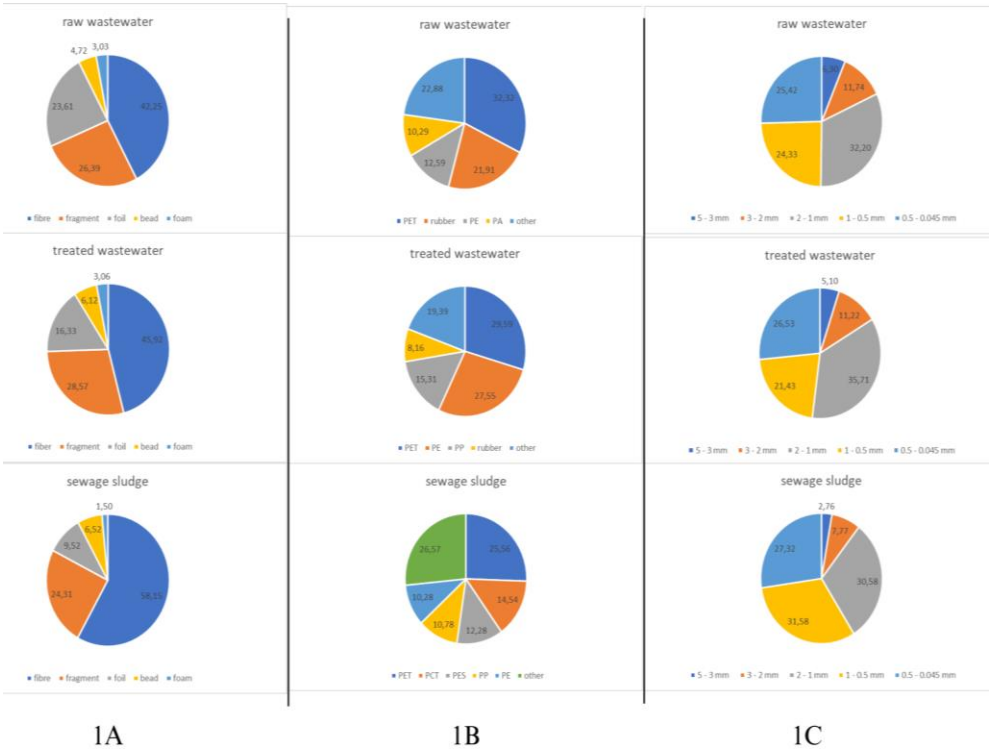


Figure 1 List of percentages of shapes (1A), types (1B) and sizes (1C) of isolated MP for raw wastewater, treated wastewater and sewage sludge (PET-poly(ethylene terephthalate); PE-polyethylene; PA-polyamide; PP-polypropylene; PES-polyester; PCT- poly(cyclohexylenedimethylene terephthalate)

Ocena skuteczności usuwania wybranych zanieczyszczeń ze ścieków przy wykorzystaniu osadów z klarowania wody.

Krzysztof Kwiatkowski*, Małgorzata Cimochowicz-Rybicka, Dominika Poproch*, Justyna Górka**, Bartosz Łuszczek***,**

* Szkoła Doktorska Politechniki Krakowskiej, ul. Warszawska 24, 31-155 Kraków (e-mail: k.kwiatkowski@doktorant.pk.edu.pl, dominika.poproch@doktorant.pk.edu.pl)
** Politechnika Krakowska, Wydział Inżynierii Środowiska i Energetyki, Katedra Technologii Środowiskowych (e-mail: mcrybicka@pk.edu.pl, justyna.gorka@pk.edu.pl)
***Wodociągi Miasta Krakowa S.A, ul. Senatorska 1, 30-106 Kraków (e-mail: bartosz.luszczek@wodociagi.krakow.pl)

Słowa kluczowe: osady z klarowania wody, oczyszczanie ścieków, odzysk surowców, gospodarka cyrkulacyjna

Streszczenie

W publikacji przedstawione zostały zagadnienia związane z analizą wpływu osadów powstających podczas uzdatniania wody na procesy oczyszczania ścieków.
Do lat 80 dwudziestego wieku, osady z klarowania wody odprowadzane były bezpośrednio do odbiorników (1). Obecnie w związku z coraz bardziej rygorystycznymi przepisami i regulacjami prawnymi dotyczącymi jakości i ochrony wód powierzchniowych, osady z klarowania wody, w myśl ustawy o odpadach (2), ujęto w XIX grupie klasyfikacji i nadano kod 19 09 02. To spowodowało większe możliwościami wykorzystania tych odpadów w celu ograniczenia kosztów wywozu oraz poszukiwania racjonalnego ich wykorzystania. Osady z klarowania wody można wykorzystać w budownictwie (3), w technologii ścieków (4); kondycjonowaniu osadów ściekowych (5,6) oraz w ich procesach przeróbki (7,8).
W pracy skupiono się na ocenie skuteczności usuwania zanieczyszczeń z odcieków pochodzących z procesu odwadniania przefermentowanych osadów ściekowych. Wstępne badania prowadzono w testach porcjowych przy ciągłym mieszaniu. Objętość próbek odcieków wynosiła 200 ml. Zastosowano dawki osadów z klarowania wody równe: 10g, 20g, 50g. Założono czas kontaktu odcieków z osadami na poziomie: 1h, 2h, 3h i 4h. W trakcie badań wykonano analizy: pH, ChZT, $N\text{-}NH_4$ oraz $P\text{-}PO_4$. Zarówno w badanych próbkach i próbie kontrolnej.
Analizując wskaźniki ChZT oraz $N\text{-}NH_4$ można zwrócić uwagę na tendencję spadkową omawianych parametrów w analizowanych próbach wraz ze zwiększającą się dawką zastosowanych osadów z procesów uzdatniania wody – dla podanego zakresu wartości dawek. Odnotowano również wpływ czasu kontaktu odcieków z osadami. Największą skuteczność redukcji zanieczyszczeń odnotowano dla wskaźnika $P\text{-}PO_4$ dla dawki 50g osadów z klarowania wody. Przeprowadzone badania są wstępne, ale można jednoznacznie stwierdzić potencjał do wykorzystania osadów z klarowania wody w procesach oczyszczania ścieków.

Bibliografia

Jaroszyński T., *Osady żelazowe z procesów uzdatniania wody*, Wodociągi–Kanalizacja 10/2010 (80) (1)
Ustawa z dnia 14 grudnia 2012 r. o odpadach, *Dz.U. 2013 poz. 21* (2)

Zdeb T. i in., *Characterisation of baisic properties of mineral binders with calcined water treatment sludge (3)*
Kang C., Zhao Y., Tang C., Addo-Bankas O. 2022. *Use of aluminum-based water treatment sludge as coagulant for animal farm wastewater treatment.* Journal of Water Process Engineering. 2022, 46, 102645 (4)
Ahmad T., Ahmad K., Alam M. 2016. *Sustainable management of water treatment sludge through 3R concept.* Journal of Cleaner Production. 2016, 124, str. 1-13.(5)
Górka J., Cimochowicz-Rybicka M., Kryłów M. 2018. *Use of a water treatment sludge in a sewage sludge dewatering process.* E3S Web of Conferences, 30, 02006 (6)
Górka J., Cimochowicz-Rybicka M. 2019. *Water and sewage sludge co-digestion: characteristic of the process and its possible applications.* Archives of Environmental Protection, 2019, 45/1, p. 84-91. (7)
Górka J., Cimochowicz-Rybicka M., Poproch D., 2022. *Sludge management at the Kraków-Płaszów WWTP – case study.* Sustainability, 2022, 14, 7982.(8)

Effect of short-term oxygen concentration variations on nitrification process and microbial community structure

W. Borowska*, M. Żubrowska-Sudoł *, N. Doskocz*
*Warsaw University of Technology, Faculty of Building Services, Hydro and Environmental Engineering, Nowowiejska 20, 00-653 Warsaw, Poland (email: weronika.borowska.dokt@pw.edu.pl; monika.sudol@pw.edu.pl; nina.doskocz@pw.edu.pl)

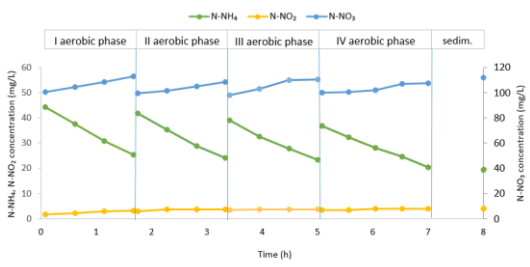
Keywords: MBSBBR; oxygen concentration; microbial community

The nitrification process is a fundamental step in wastewater treatment. Central to the successful execution of this process is the activity of ammonia-oxidizing bacteria (AOB) and nitrite-oxidizing bacteria (NOB), which are linked to various environmental factors, such as oxygen concentration (Cui et al., 2020). The growth and adaptation of nitrifying bacteria occur over prolonged periods (Lee et al., 2009), raising questions about the potential influence of short-term oxygen concentration variations on their activity. Could short-term changes in oxygen levels disrupt the nitrification process by affecting the balance of microbial interactions and adaptation?

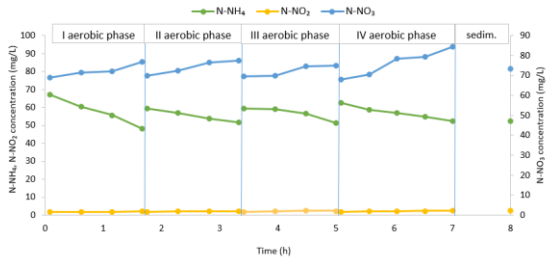
The objective of this study was to investigate the impact of short-term oxygen concentration changes on the nitrogen removal processes and biofilm community in a lab-scale Moving Bed Sequencing Batch Biofilm Reactor (MBSBBR) treating ammonium-rich wastewater. Prior to the start of this study, the reactor was operated with a constant oxygen concentration of 3.0 mg O_2/L. In the experiment, the following oxygen concentration changes were analyzed: first oxygen concentration was reduced to 2.0 mg O_2/L, then to 1.0 mg O_2/L and subsequently increased to 3.0 mg O_2/L. The study involved the application of monitoring tests and next-generation sequencing (NGS) analysis. The monitoring test consisted of measurement of the N-NH_4^+ consumption, N-NO_2^- accumulation and N-NO_3^- production during aerobic phases in one operational cycle. Each MBSBBR cycle lasted 8 hours and consisted of 4 steps: 4 dosings, 4 aerobic phases, sedimentation and decantation. Monitoring tests were conducted 16 hours after the change in oxygen concentration and biofilm samples were collected for NGS 24 hours after the introduced change.

The lowest N-NH_4^+ consumption rate was noticed for 1.0 mgO_2/L (Figure 1). This suggests that a short-term reduction in oxygen concentration led to a decline in AOB activity, consequently diminishing the efficiency of ammonia removal. A reduction in N-NO_2^- throughout the entire cycle was noticed solely for 3.0 mgO_2/L. This observation implies that NOB was the most active at the highest oxygen concentration. These findings aligned with the highest N-NO_3^- production rates for 3.0 mgO_2/L. This highlights that higher oxygen concentration indirectly fosters complete nitrification by enhancing the activity of AOB and NOB.

(a)



(b)



(c)

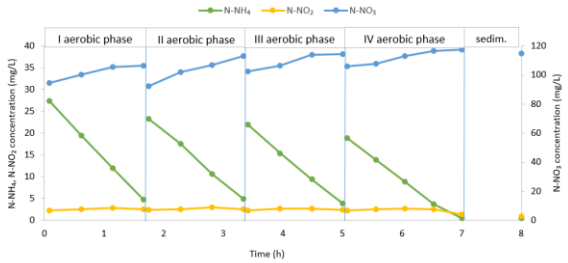


Figure 1 MBSBBR performance in one operational cycle for different oxygen concentration (a) 2.0 mg O_2/L, (b) 1.0 mg O_2/L, (c) 3.0 mg O_2/L

The microbial community at 1.0 mg O_2/L did not exhibit significant alternations compared to 2.0 mg O_2/L (Figure 2). The predominant phyla present in the biofilm were Firmicutes and Proteobacteria. Contrary, at 3.0 mg O_2/L a notable shift in the microbial community was observed. The abundance of Proteobacteria, which encompasses phyla associated with AOB, NOB and denitrifying bacteria phylum (Wang et al., 2021) increased significantly to 96%. This observation confirmed the results from monitoring tests suggesting that a short-term increase in oxygen concentration fostered AOB and NOB activity. These results underscore that microbial community dynamics underwent alterations within 24 hours following changes in oxygen concentration. Furthermore, these outcomes indicate that short-time modification in operational parameters, such as oxygen concentration can potentially disrupt the balance among functional microbial groups.

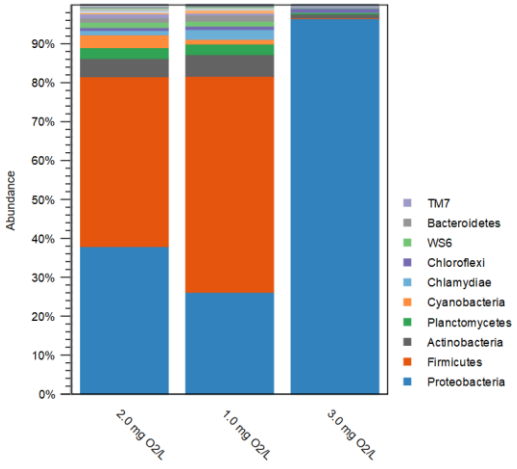


Figure 2 Microbial community structure at the phylum level

References

Cui B., Yang Q., Liu X., Huang S., Yang Y., Liu Z. (2020). The effect of dissolved oxygen concentration on long-term stability of partial nitrification process. Journal of Environmental Sciences, 90, pp. 346–354.

Lee C., Fletcher T.D., Sun G. (2009) Nitrogen removal in constructed wetland systems. Engineering in Life Science, 9 (1), pp.11–22.

Wang F., Xu S., Liu L., Wang S., Ji M. (2021). One-stage partial nitrification and anammox process in a sequencing batch biofilm reactor: start-up, nitrogen removal performance and bacterial community dynamics in response to temperature. Science of Total Environment, 772, 145529.

Application of low-thermal pretreatment of waste activated sludge with/without addition of cow dung in technological scale

Alicja Jeżewska, Hubert Byliński, Małgorzata Szopińska, Anna Remiszewska-Skwarek, Aneta Łuczkiewicz, Sylwia Fudala-Książek

Faculty of Civil and Environmental Engineering, Gdansk University of Technology, 11/12 Narutowicza St., Gdansk 80-233, Poland. (e-mail: alicja.jezewska@pg.edu.pl)

Keywords: agricultural waste; biogas; low-thermal pretreatment

Abstract:

Dynamic development of livestock industry result the high amount of different types of agricultural waste such a cow dung (CD). One way of sustainable CD management is to use it as a cosubstrate with sewage sludge in anaerobic digestion (AD). However, chemical structure of CD can limit the effectiveness of AD process. To avoid such drawbacks, the pretreatment of substrates prior to AD can be applied.

The objective of this work was to investigate the effect of a temperature (45°C, 50°C and 55°C) and time (up to 48h) applied to waste activated sludge (WAS) with/without addition of CD on further biogas production, while AD.

LT-PT experiments were performed in technological scale, in the specially designed digestion system with bioreactor of total volume equals 0.5m^3. WAS (100%) and the mixture of WAS with CD (70/30% w/w) was subjected to LT-PT at: 45, 50 and 55°C. The effects of LT-PT were evaluated mainly by increase of volatile fatty acids (VFAs), soluble chemical oxygen demand (sCOD) (using XION 500 spectrophotometer Dr. Lange (GmbH, Germany)) and biogas production using Automatic Methane Potential Test System (AMPTS, Bioprocess Control, Sweden).

Based on the sCOD concentrations, it can be possible to calculate disintegration degree (DD) values [1]. Figure 1 shows DD values obtained for both substrate after pretreatment by 24 hours. It can be observe that the highest values were received after pretreatment at 50°C for WAS and WAS mixed with CD. Addition of CD to WAS does not affect significantly the DD values. In the Figure 2, the changes in VFAs concentrations for both substrates pretreated while 24h are presented. Based on the obtained data, we can observe that the addition of CD to WAS resulted in higher VFAs concentrations after pretreatment at 45 and 50°C.

Application of LT-PT to WAS with addition of CD is very promising method, which can be applied in small WWTPs, located near local agricultural farms.

Acknowledgements

This work was as part of the project entitled: Bio&EnergyRecovery system for sustainable energy and product recovery at small wastewater treatment plants (S-WWTPs) (Ventus Hydrogenii Redivivus Program, Research University, Gdańsk University of Technology).

References

Remiszewska – Skwarek A. et al. (2021). The Influence of Low-Temperature Disintegration on the Co-Fermentation Process of Distillation Residue and Waste-Activated Sludge. *Energies*, **15** (2), 482.

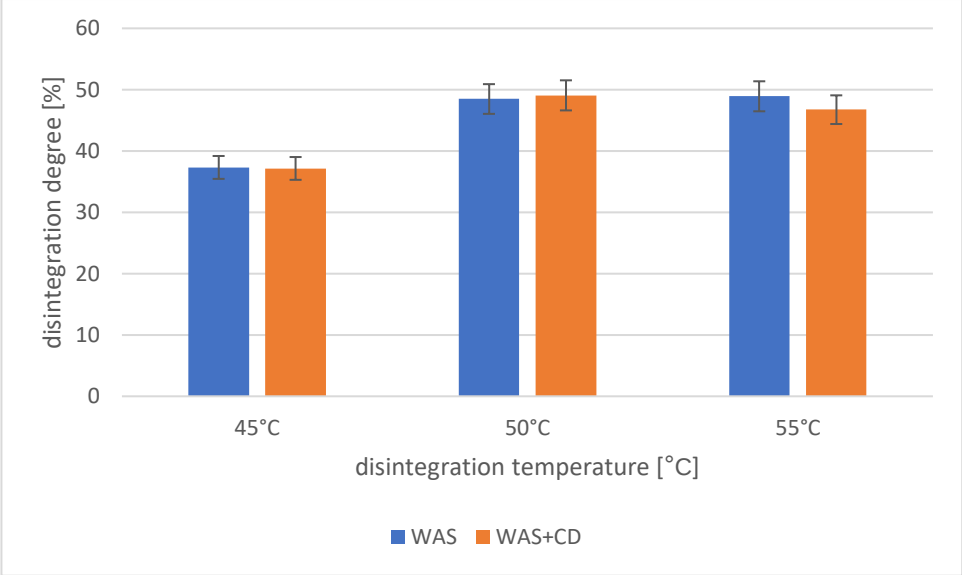


Figure 1 Comparison of disintegration degree (DD) values for both substrates used in this study after 24 hours pretreatment (WAS – waste activated sludge, WAS+CD – waste activated sludge with cow dung).

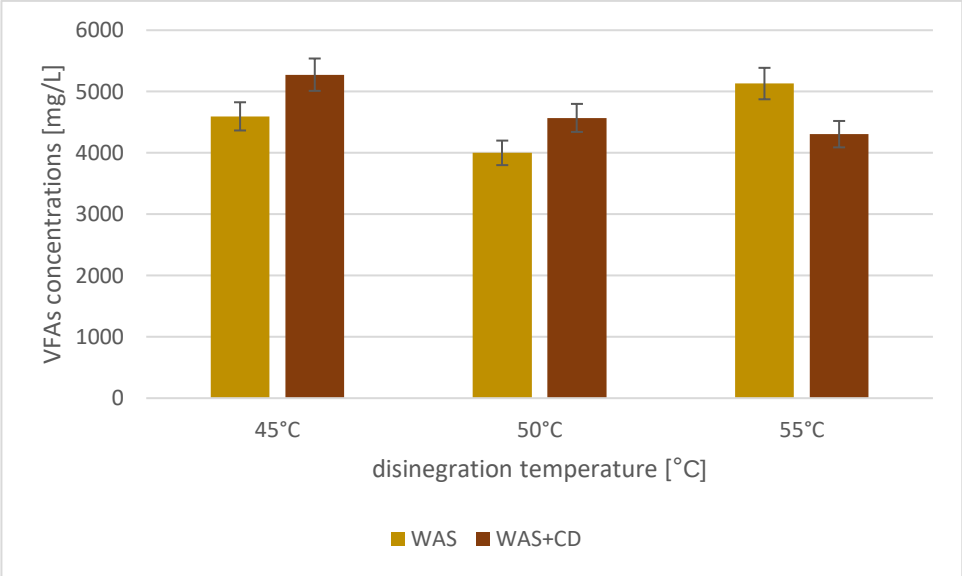


Figure 2 Comparison of volatile fatty acids (VFAs) concentrations for both substrates used in this study after 24 hours pretreatment (WAS – waste activated sludge, WAS+CD – waste activated sludge with cow dung).

Classification of the nodal demands in 3 case study water supply networks

P. Suchorab*, D. Kowalski**

* Department of Water Supply and Wastewater Disposal, Faculty of Environmental Engineering, Lublin University of Technology, Nadbystrzycka 38D, 20-618 Lublin, PL (E-mail: *p.suchorab@pollub.pl*)
** Department of Water Supply and Wastewater Disposal, Faculty of Environmental Engineering, Lublin University of Technology, Nadbystrzycka 38D, 20-618 Lublin, PL (E-mail: *d.kowalski@pollub.pl*)

Keywords: demand structure; nodal demand; water supply network

Abstract:

Each of the water supply networks has its own specificity and individual character. This applies to both the geometric structure of the networks as well as the distribution of nodal demands and water demand patterns. However, when analysing the geometric structures created by water supply networks, some common features can be distinguished (systems closed in loops, branched structures). Perhaps analogous similarities also occur in the structure of water demands. The aim of this article is an attempt to find certain regularities in the structure of nodal water demands in 3 exemplary water supply networks. The analysed water supply networks differ in terms of the total length of pipes (100-300 km) and number of consumers (30 000-50 000).

The three considered networks were analysed in terms of a) the percentage share of water-demand nodes among all nodes forming the water supply network model, b) the percentage share of the maximum unit demand for water generated by a single node in the total demand for water, c) the structure of water consumption, i.e. individual groups of recipients in the total demand for water. For the purposes of the analysis, the water consumers were classified into 3 groups: small (unit demand < 0.5% of the total network demand), medium (unit demand between 0.5% and 1% of the total network demand) and large (unit demand ≥ 1% of the total network demand). The detailed assessment of the analysed networks was based on their numerical representations in the form of hydraulic models. Hydraulic models were of a basic character, including only main distribution pipes without household connections in accordance do the (Walski et al., 2004) classification.

The average percentage share of demand nodes among all nodes forming the network models was 41.7%. The average percentage share of the maximum unit demand was 4.54%. The largest consumers accounted on average for about 25% of all consumer nodes. Subsequently, medium consumers accounted for about 10% of consumer nodes and the majority (65%) are small consumers. The conducted analysis showed some similarities in the structure of nodal water demands in the analysed networks, which allows us to risk a statement that they may be of a general nature. However, to confirm this thesis, it is required to carry out an analogous analysis on a larger number of objects of different sizes.

References

Walski T.M., Chase D.V., Savic D.A., Grayman W., Beckwith S., Koelle E. (2004), *Advanced Water Distribution Modeling and Management*, Haestad Press: Waterbury, Connecticut.

Error analysis in estimating shallow water retention using airborne laserscanning data

R. Ciepłuch*, M. Kurnatowski**

* Westpomeranian University of Technology in Szczecin, Piastów av. 50A, 70-311 Szczecin, rciepluch@zut.edu.pl
** Westpomeranian University of Technology in Szczecin, Piastów av. 50A, 70-311 Szczecin, mkurnatowski@zut.edu.pl

Keywords: shallow water; water retention; verification of digital surface model

Abstract:

One method of preventing drought is surface water retention. In order to calculate the volume of water retained in shallow floodplains, it is necessary to recognise the geometry of the flooded area. This means that bathymetry has to be measured under conditions where, on the one hand, the use of traditional surveying methods is completely uneconomical and, on the other hand, the use of modern survey platforms is impossible due to the measurement conditions.

Hydrological engineers therefore usually use data acquired by aerial laser scanning in their analyses. In this study, LIDAR data was acquired and used to produce a situational-elevation map of the permanently wetland. This was followed by traditional tachymetric surveying, verified in real time by a survey using GNSS technology, in an area of more than 64 ha in order to check the accuracy of the mapping of the bottom surface of the flooded area by aerial data. For the verification of the digital surface model, GIS software is required for precise data sampling for comparative analysis of data from both sources at specifically defined coordinates. The compiled data was subjected to statistical analysis.

The directly measured data showed varying error values in the representation of terrain heights by the LIDAR data due to the vegetation that covered the wetland. The largest average error in the set was found in data acquired in reed and sedge habitats. The error values ranged beyond the declared mean error of the LIDAR data. By correcting the height by a fixed value in the area characterised by the highest mean error, an improvement in the bathymetry representation of up to 35 % was achieved.

The key areas in the developed surface model, from the point of view of further hydraulic modelling, have been mapped with high accuracy. This will allow for a more precise description of the water balance, which brings the primary benefit of being able to estimate the risk of drought. The improved digital surface model can also be used for hydraulic modelling in order to improve flood safety in the areas surrounding the developed area through better mapping of areas subject to periodic or permanent surface water flooding.

References

Ackermann F. (1994). *Digital elevation models – techniques and application, quality standards, development*. International Archives of Photogrammetry and Remote Sensing, 30(4), 421-432.
Höhle J., Potuckova M. (2005). *Automated quality control for Orthoimage and Digital Terrain Model*. Photogrammetric Engineering & Remote Sensing, vol. 71, 81-87.
Kraus K., Briese C., Attwenger M., Pfeifer N. (2004). *Quality measures for digital terrain models*. International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences. 35.

Kraus K., Pfeifer N. (1998). *Determination of Terrain Models in Wooded Areas with Airborne Laser Scanner Data*. ISPRS Journal of Photogrammetry and Remote Sensing. 53, 193-203. 10.1016/S0924-2716(98)00009-4.
Lian W., Li S., Zhang G., Wang Y., Chen X., Cui H. (2020). *Accuracy Verification of Airborne Large-Footprint Lidar based on Terrain Features*. Remote Sensing. 12(5):879.
Paszotta Z., Szumiło M. (2006). *Verification of the digital terrain model*. Archiwum Fotogrametrii, Kartografii i Teledekcji, vol. 16, 457-466.

The role of the combined nitrogen-sulfur-carbon cycles for efficient performance of anammox-based systems

D. Derwis*, H. E. Al-Hazmi, J. Majtacz, Przemysław Kowal, Sławomir Ciesielski, Jacek Mąkinia**

* Faculty of Civil and Enviromental Engineering, Gdańsk University of Technology, Gabriela Narutowicza Street 11/12, 80-233 Gdańsk, Poland; dominika.derwis@pg.edu.pl
** Faculty of Civil and Enviromental Engineering, Gdańsk University of Technology, Gabriela Narutowicza Street 11/12, 80-233 Gdańsk, Poland; hussein.hazmi1@pg.edu.pl

Keywords: Anammox; Mixotrophic denitrification; Sulfur-dependent autotrophic denitrification, N

Abstract:

This study assessed anammox/mixotrophic denitrification in two granular sludge SBRs. The research utilized inoculum from a WWTP's deammonification system, setting up two automated sequencing batch reactors (10 L). Operating for 200 days at 30±1°C, pH 7.5-7.8 and DO < 0.2 mg/L. NH_4^+ and NO_2^- concentrations were varied, with COD adjustments supporting denitrification. SO_4^{2-} was introduced to SBR2. DNA sequencing was done via Illumina, followed by diverse analyses. Network analysis identified bacterial correlations. Concentrations of various compounds were measured spectrophotometrically, and MLSS/MLVSS followed APHA standard. See Al-Hazmi et al. (2021) for details.

Regarding specific process rates (AUR, NiUR, NPR/NUR, CUR, SPR/SUR), SBR2 with SO_4^{2-} had higher AURs and NiURs during COD on-phases. Maximum AUR and NiUR were higher in SBR2 during COD on-phases. CUR were notably higher in SBR2 with COD. Addition of SO_4^{2-} led to SO_4^{2-} production during COD on-phases and reduction during COD off-phases.

Relationships were observed between CUR and SPR (R2 = 0.98) and CUR and NUR (R2 = 0.17), see Figure 1. Sankey diagrams depicted N-S-C transformations, revealing the complex interaction of SRAO, SDAD, and other processes, see Figure 2. SO_4^{2-} addition boosted NH_4^+ oxidation and SO_4^{2-} reduction via SRAO. Bacterial community structure shifted in response to feeding patterns, with significant differences between SBR1 and SBR2. *Chloroflexi* dominated, but their prevalence varied. Notably, *Ca. Brocadia* increased with SO_4^{2-} addition, while *Nitrosomonas* abundance decreased.

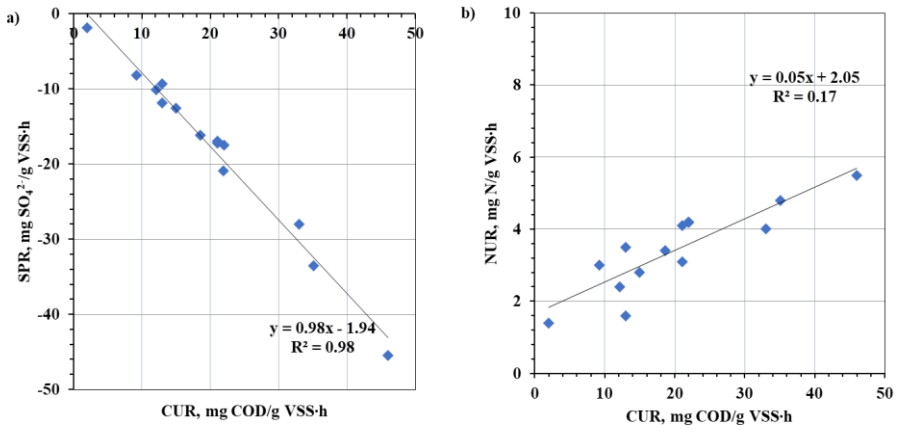


Figure 1 C and S transformations in SBR2 with COD addition: a) relationship of CUR and SPR; b) relationship of CUR and NUR (note: SPR is a negative SUR).

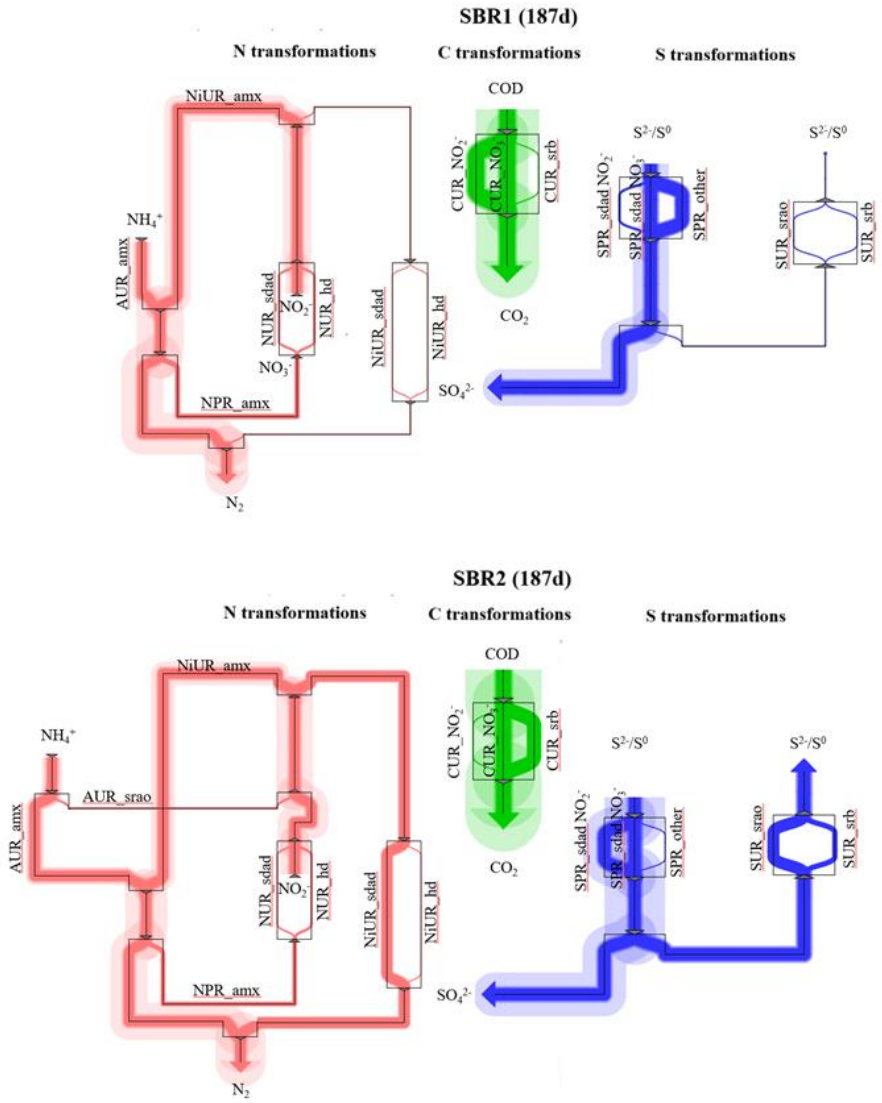


Figure 2 Sankey diagrams showing the transformation pathways of N, S and COD based on the stoichiometric analysis on day 187 a) in SBR1 b) in SBR2

To ensure successful treatment, it is crucial to prevent AnAOB inhibition and incorporate alternating COD on/off conditions. This approach allows for the regeneration of AnAOB (during COD off periods) and denitrifiers (during COD on periods). The combination of N-S-C cycles is a sustainable alternative to traditional nitrification-denitrification and can lead to energy savings and improved carbon management.

References

Al-Hazmi H., Lu X., Grubba D., Majtacz J., Kowal P. and Mąkinia, J. (2021). Achieving Efficient and Stable Deammonification at Low Temperatures—Experimental and Modeling Studies. *Energies*,**14** (13), 3961.

Universal method for the determination of estrogens in water, wastewater and soil

M. Piosik*, J. Antos, J. Zembrzuska, I. Kruszelnicka, D. Ginter-Kramarczyk**

Poznan University of Technology
Faculty of Environmental Engineering and Energy
Department of Water Supply and Bioeconomy
Berdychowo 4,
60-965 Poznan
* marianna.cislak@doctorate.put.poznan.pl
** joanna.antos@doctorate.put.poznan.pl

Keywords: estrogen; HPLC-MS/MS; QuEChERS

Abstract:

Environmental matrices are often complex and difficult to prepare for the quantification of target analytes. They contain compounds that can interfere with the analyte response and require rigorous sample purification before high performance liquid chromatography-tandem mass spectrometry (HPLC-MS/MS) analysis. Solid-phase extraction is commonly used for the extraction and concentration of estrogens, but complications can arise in wastewater and soil samples, including impaired adsorption or desorption from the bed. The QuEChERS (Quick, Easy, Cheap, Effective, Rugged, and Safe) method may be an alternative.

A universal methodology was developed for the determination of natural estrogens in slurry, water, and soil. Analyses were performed using HPLC-MS/MS and the QuEChERS extraction technique. The method is based on the work of Rechsteiner, et al. with modifications. Samples were extracted in acetonitrile using a mixture of salts (magnesium sulfate, sodium chloride, disodium hydrogen citrate and trisodium citrate). The cleaning mixture consisted of a mixture of salts and sorbents (silica pulp PSA, LiChrolut RP-18 (40-63 μm) and magnesium sulfate). Before HPLC-MS/MS analyse, samples were derivatised with dansyl chloride. The mobile phase consisted of acetonitrile and 0.1% formic acid. Chromatographic separation of the estrogens was successfully performed using a C18 column.

The type of matrix and analyte affects the efficiency of estrogens extraction (recovery range for different estrogenic compounds in water samples R=65%-91%; slurry samples R=84%-99%; soil samples R=71%-84%). The developed LC-MS/MS method is characterized by a wide range of linearity of the determined estrogens (from 0,01 μg/mL to 0,2 μg/mL for water and slurry samples; from 0,1 μg/g to 1,5 μg/g for soil samples) and low limits of detection and quantification (LOD from 0,002 μg/mL, LOQ from 0,01 μg/mL for water and slurry samples; LOD from 0,005 μg/g, LOQ from 0,05 μg/g for soil samples), making it useful for the determination of estrogens with low concentration in all types of environmental samples. However the procedure is very complex and time-consuming.

References

Rechsteiner D., et al. (2020). Occurrence and fate of natural estrogens in Swiss cattle and pig slurry, *Journal of Agricultural and Food Chemistry*. ACS Publications, Washington.

Konwersja zanieczyszczeń farmaceutycznych z wykorzystaniem immobilizowanej lakazy

Agnieszka Rybarczyk*, Jakub Zdarta*, Teofil Jesionowski*

* Instytut Technologii i Inżynierii Chemicznej, Politechnika Poznańska, Berdychowo 4, 60-965 Poznań

Słowa kluczowe: oczyszczanie ścieków, usuwanie zanieczyszczeń farmaceutycznych, immobilizacja enzymów, materiały 3D

Streszczenie

Jedynym z najważniejszych wyzwań XXI wieku jest ochrona różnorodności biologicznej pochodzącej z ekosystemów wodnych. Problem coraz szerzej występujący na terenie naszego kraju stanowi obecność środków farmaceutycznych w wodach powierzchniowych, stąd kluczowe jest opracowanie innowacyjnych rozwiązań obejmujących oczyszczanie zasobów wodnych. Szczególną uwagę należy zwrócić na estrogeny, naturalne lub syntetyczne związki steroidowe, które w nadmiernych ilościach prowadzą do zaburzeń hormonalnych, fizjologicznych czy metabolicznych [1]. Poszukiwanie efektywnych metod usuwania tego typu zanieczyszczeń doprowadziło do opracowania rozwiązania wykorzystującego proces immobilizacji enzymów. Innowacyjną metodą umożliwiającą bezpośrednie wytworzenie materiału nośnego jest technologia druku 3D [2]. Niewątpliwą zaletą tej techniki jest możliwość wytworzenia złożonych struktur w stosunkowo krótkim czasie, bez stosowania szkodliwych dla środowiska odczynników chemicznych. Materiały wykorzystywane w technologii wytwarzania addytywnego są zwykle tworzywami degradowalnymi, które można w późniejszym czasie poddać recyklingowi [3].
W ramach pracy opracowano układ biokatalityczny, w którym lakaza została unieruchomiona na polilaktydowym nośniku wytworzonym z wykorzystaniem technologii druku 3D. W trakcie przeprowadzanych analiz dobrano najkorzystniejsze parametry unieruchomienia, a także przeprowadzono szereg badań, które umożliwiły określenie ilości związanego enzymu, efektywności unieruchomienia, zachowanej aktywności oraz scharakteryzowanie parametrów kinetycznych enzymów. Zbadano możliwość ponownego wykorzystania układu biokatalitycznego, jak również stabilność termiczną i stabilność podczas przechowania. Określony został wpływ temperatury
i pH na właściwości katalityczne unieruchomionej lakazy, a uzyskany układ katalityczny przetestowano pod kątem degradacji 17β-estradiolu i 17α-etynyloestradiolu z roztworu ścieków rzeczywistych, co stanowiło kluczowy aspekt przeprowadzonych badań.

Podziękowania

Badania zostały sfinansowane w ramach projektu badawczego Narodowego Centrum Nauki nr 2021/43/B/ST8/01854.

Bibliografia

[1] Gonsioroski, A., Mourikes, V.E., Flaws, J.A., (2020). *Endocrine Disruptors in Water and Their Effects on the Reproductive System*. Int. J. Mol. Sci., 21(6), 1929.

[2] Shao, Y., Liao, Z., Gao, B., He, B., (2022). *Emerging 3D Printing Strategies for Enzyme Immobilization: Materials, Methods, and Applications*. ACS Omega, 7, 11530-11543.
[3] Shen, J., Zhang, S., Fang, X., Salmon, S., (2022). *Advances in 3D Gel Printing for Enzyme Immobilization*, Gels, 8, 460.

Effect of artificial infiltration process on non-steroidal anti-inflammatory drugs and antibiotics concentrations

J. Antos *, M. Piosik **, A. Borisławska, J. Zembrzuska, D. Ginter-Kramarczyk, I. Kruszelnicka, J. Jeż-Walkowiak, F. Uwimpaye

* Poznan University of Technology
Faculty of Environmental Engineering and Energy
Department of Water Supply and Bioeconomy
Berdychowo 4,
60-965 Poznan
joanna.antos@doctorate.put.poznan.pl
** Poznan University of Technology
Faculty of Environmental Engineering and Energy
Department of Water Supply and Bioeconomy
Berdychowo 4,
60-965 Poznan
marianna.cislak@doctorate.put.poznan.pl

Keywords: antibiotics, monitoring, surface water

Abstract:

The pharmaceutical market is growing significantly from year to year, all over the world, it could be said that it is one of the fastest growing industries. Among the chemicals released into the environment, much attention is being paid to emerging contaminants such as antibiotics and non-steroidal anti-inflammatory drugs. Their concentrations in aquatic environments have been reported as ng/L, μg/L. Even such low concentrations can negatively affect aquatic organisms by altering their life processes or have harmful effects directly on humans. The presence of antibiotics in the natural aquatic environment causes bacteria to become resistant to the mechanisms of action of these drugs.

The purpose of this study was to analyze the effectiveness of surface water treatment through the process of artificial infiltration with regard to contamination by the antibiotics and non-steroidal anti-inflammatory drugs. The investigated drugs are constantly present in surface water in the Poznan area. This presence testifies to the ineffective process of water treatment in the process of infiltration.

The research was conducted with financial support from the Ministry of Education and Science, research project 0911/SBAD/2304.

References

Makała A., et al. (2021). Impact of Artificial Infiltration on the Removal of Nonsteroidal Anti-Inflammatory Drugs during Treatment of Surface Water, *Energies*. 14(24), 8406.
Li J. et al. (2021). Abiotic transformation and ecotoxicity change of sulfonamide antibiotics in environmental and water treatment processes: A critical review. Water Res. 202, 117463.
Bengtsson-Palme J. et al. (2016). Concentrations of antibiotics predicted to select for resistant bacteria: Proposed limits for environmental regulation. Environ. Int. 86, 140–149.

Technologia wody basenowej w Polsce i USA – doświadczenia z badań

M.Narojczyk*, K.Ratajczak, E.Blatchley III***, M.Komorowska-Kaufman****

*Politechnika Poznańska, Szkoła Doktorska, michal.narojczyk@doctorate.put.poznan.pl
**Politechnika Poznańska, Wydział Inżynierii Środowiska i Energetyki, katarzyna.m.ratajczak@put.poznan.pl, malgorzata.komorowska-kaufman@put.poznan.pl
***Purdue University, blatch@purdue.edu

Słowa kluczowe: Jakość wody, Technologia wody basenowej, Basen, Pływalnia, Polska, USA

Streszczenie

Czy technologia wody basenowej na całym świecie jest taka sama? Czy wytyczne dotyczące jakości wody basenowej są jednakowe? Jak mają się wytyczne dotyczące parametrów wody basenowej do wyników badań w obiektach rzeczywistych? Przeprowadzono serie badań jakości wody i powietrza w 4 obiektach basenowych w dwóch krajach – w Polsce i w Stanach Zjednoczonych. Poszukiwano podobieństw oraz różnic w układach technologii wody basenowej w tych dwóch krajach. Wykonano serie pomiarów podstawowych parametrów wody basenowej: temperatura, pH, stężenie chloru wolnego, stężenie chloru całkowitego, całkowity węgiel organiczny, alkaliczność, stężenie związków azotu. Badania przeprowadzono w Poznaniu oraz w West Lafayette stosując te same techniki pomiarowe oraz wykonując pomiary w przy podobnych warunkach klimatu zewnętrznego. Oprócz parametrów wody basenowej mierzono również parametry powietrza wewnętrznego. Stosowane w Polsce i USA systemy uzdatniania wody basenowej są bardzo podobne. Jako dezynfektant podchloryn sodu. W każdym z basenów stosowane były filtry oraz lampy UV. W basenach Polskich dodatkowo stosuje się koagulację. Główna różnica występuje w utrzymywanych parametrach jakości wody basenowej. W tabeli 1 zestawiono główne parametry, które były mierzone oraz ich wartości rekomendowane w każdym z krajów. Podstawową różnicą są wartości pH oraz wartości stężenia chloru wolnego. Duże różnice występują również w uzyskanych wynikach w przeprowadzonych badaniach doświadczalnych (tabela 2). W polskich basenach A i B utrzymywano stężenie chloru wolnego wynoszące 0,46 i 0,50 mg/L, podczas gdy w basenach amerykańskich C i D było ono wyższe 4-5 razy wynosząc 2,75 i 1,89 mg/L. Pozostałe parametry wody były zbliżone. Uzyskane wyniki pomiarów pokazują, że mimo, że układy technologiczne są zbliżone, to wartości stężenia chloru wolnego na basenach w dwóch krajach różnią się od siebie znacząco. Wynika to oczywiście ze stosowanych norm i przepisów w każdym z krajów. Wydaje się, że podejście europejskie, w którym stężenie chloru wolnego jest niższe jest podejściem bardziej prawidłowym. Zbyt wysokie stężenie chloru, przy jednoczesnej obecności związków organicznych może prowadzić do tworzenia się ubocznych produktów dezynfekcji wody basenowej, w tym m.in. trichloraminy. Trichloramina powoduje podrażniania oczu i skóry, a jej zapach jest odczuwany w obiektach basenowych. W konsekwencji obecności trichloraminy w wodzie występuje również w powietrzu. Ponieważ woda jest źródłem tego zanieczyszczenia w badaniach zmierzono również stężenie trichloraminy w powietrzu. Wyniki przedstawione w tabeli 3 pokazują, że w obiektach basenie amerykańskim C, stężenie trichloraminy w powietrzu wynosiło 340 $\mu g/m^3$ i było 15 razy wyższe niż w obiektach polskich A i B. Szczegółowe analizy wszystkich uzyskanych wyników będą tematem dalszych badań.

Tabele

Tabela 1 Główne mierzone parametry wody basenowej i rekomendacje co do ich wartości

Parametr	Polska	USA
Temperatura wody [°C]	28	28-30
pH	6,5 – 7,6	7,2-7,8
Stężenie chlory wolnego [mg/L]	0,3 – 0,6	Od 2
Stężenie chlory związanego [mg/L]	0,3	0,4

Tabela 2 Wyniki pomiarów parametrów wody basenowej w obiektach w Polsce (A i B) oraz w USA (C i D)

Parametr	Basen A	Basen B	Basen C	Basen D
Temperatura wody [°C]	28,1	27,9	27,0	28,0
pH	7,41	7,21	7,59	7,55
Stężenie chlory wolnego [mg/L]	0,46	0,60	2,75	1,89
Stężenie chlory związanego [mg/L]	0,14	0,20	0,50	0,15
Stężenie całkowitego węgla organicznego [mg/L]	3,34	7,70	3,29	3,32

Tabela 3 Wyniki pomiarów parametrów wody powietrza w obiektach w Polsce (A i B) oraz w USA (C i D)

Parametr	Basen A	Basen B	Basen C	Basen D
Temperatura powietrza [°C]	28,1	27,9	28,2	28,0
Wilgotność względna powietrza [%]	54	55	56	54
Stężenie trichloraminy [$\mu g/m^3$]	21,8	22,5	340,0	brak danych

Budownictwo zrównoważone – woda jako ważny element certyfikacji BREEM i LEED

Urszula Derkacz*, Katarzyna Ratajczak**

*Politechnika Poznańska, Koło Naukowe Inżynierii Środowiska, urszula.derkacz@student.put.poznan.pl
**Politechnika Poznańska, Wydział Inżynierii Środowiska i Energetyki, katarzyna.m.ratajczak@put.poznan.pl

Słowa kluczowe: Budownictwo zrównoważone, BREEM, LEED, Cele zrównoważonego rozwoju

Streszczenie

Woda jest niezbędna do życia człowieka oraz funkcjonowania wielu organizmów na świecie. Umożliwia zrównoważony rozwój społeczeństwa ludzkiego. Jednakże wzrost demograficzny oraz stale rosnące standardy życia przyczyniły się do nadmiernego zużycia wody przez ludzi [4] [9]. Woda słodka stanowi jedynie 2,5% zasobów wodnych na świecie, z czego jedynie 1% to woda pitna [6]. Polska jest jednym z krajów europejskich o najmniejszych zasobach wody do picia w przeliczeniu na jednego mieszkańca. Mniejsze zasoby wody w odniesieniu do mieszkańca mają jedynie Czechy, Malta i Cypr. W Polsce na jedną osobę przypada około 1580 m^3 wody na rok [5]. W związku z tym tak ważne jest, aby oszczędzać wodę we wszystkich możliwych dziedzinach aktywności człowieka. Jedną z nich jest budownictwo, w ramach którego istotne jest, aby wprowadzać liczne rozwiązania umożliwiające zmniejszenie zużycia wody. Systemy certyfikacji budynków zrównoważonych BREEAM i LEED umożliwiają ocenę budynków pod kątem wielu aspektów środowiskowych. Są to dwa najpopularniejsze systemy certyfikacji na świecie [10], które określają wymagane praktyki oraz zachęcają do projektowania budownictwa zrównoważonego 0. Zarówno w systemie BREEAM jak i LEED znajdują się kryteria oceny budynków związane z minimalizacją zużycia wody [8]. Budynki powinny zostać wyposażone w urządzenia sanitarne charakteryzujące się niskim zużyciem wody, a zespół projektowy powinien przeanalizować możliwość wykorzystania wody szarej. Zgodnie z treścią tych systemów rekomendowane jest opomiarowanie odpowiednich odcinków instalacji za pomocą liczników oraz podliczników. Dodatkowo system BREEAM zwraca uwagę na monitoring wycieków wody oraz instalację zaworów elektromagnetycznych, umożliwiających odcięcie dopływu wody na wypadek wycieku lub też nieużytkowania budynku. Niemniej ważnym aspektem jest również zagospodarowanie wód opadowych oraz ich ponowne wykorzystanie przykładowo do podlewania zieleni. Ma to na celu niedopuszczenie do przeciążenia instalacji kanalizacji, a także zmniejszenie zużycia wody w budynku [2] [7] [3]. Uwzględnienie elementów zwiazanych z oszczedzaniem wody gwarantuje uzyskanie wyższego wyniku certyfikacji.

Bibliografia

[1] Aspinal, S., Sertyesilisik, B., Sourani, A., Tunstall, A. 2012. How Accurately Does Breeam Measure Sustainability? *Creative Education*, 3, 1-8.

[2] BREEAM International New Construction 2016. Technical Manual. Document reference: SD233. Version: 2016. Issue: 2.0.

[3] Certyfikacja wielokryterialna budynków. Poradnik. Dostęp 10.09.2023r. Pobrano z lokalizacji: https://www.sweco.pl/wp-content/uploads/sites/17/2021/11/Certyfikacja-wielokryterialna-praktyczny-poradnik-branzowy.pdf

[4] Gordeeva L., Solovyeva M, Sapienza A., Aristov Y. 2020. Potable water extraction from the atmosphere: Potential of MOFs. *Renewable Energy,* volume 148, pages 72-80.

[5] Konieczny R., Rataj C. (Instytut Meteorologii i Gospodarki Wodnej Kraków). 2020. Zasoby wodne i zapotrzebowanie na wodę – sytuacja Polski na tle innych krajów. *Woda w rolnictwie. Ekspertyza* str. 16-22.

[6] Kuczyński W, Żuchowicki W. (Politechnika Koszalińska). 2010. Ocena aktualnej sytuacji w zaopatrzeniu w wodę w Polsce na tle sytuacji w świecie. Środkowo-Pomorskie Towarzystwo Naukowe Ochrony Środowiska *Rocznik Ochrona Środowiska* Tom 12, str. 419-465.

[7] LEED v4 for Building Design and Construction. Updated July 25, 2019

[8] Rezaallah A., Bolognesi C., Khoraskani R.A. 2012. LEED and BREEAM; Comparison between policies, assessment criteria and calculation methods.

[9] Simonovic S., Breach P. 2020. The Role of Water Supply Development in the Earth System. *Water* 12, no. 12: 3349.

[10] Wodo M. 2015. Międzynarodowe systemy certyfikacji LEED, BREEAM i DGNB. Wstępna analiza porównawcza poparta studium przypadku. *Journal of Civil Engineering, Environment and Architecture*. XXXII.

Concept of development of the Wierzbak valley in Poznań using surface runoff modeling tools

Estera Matczak*, Anna Januchta-Szostak**,

* Poznan University of Technology, Faculty of Architecture (estera.matczak@student.put.poznan.pl; estera.matczak@gmail.com)
** Poznan University of Technology, Faculty of Architecture (anna.januchta-szostak@put.poznan.pl)

Keywords: rainwater management; river restoration; Wierzbak valley

Abstract:

The adaptation plan of the city of Poznań to climate changes as well as the rainwater management strategy assumes the use of blue and green infrastructure. Meanwhile, many small streams have been transformed into rainwater collectors. The aim of the article was to examine the possibilities of surface management of rainfall runoff in the Wierzbak catchment area in Poznań and to present solutions for a buffer park in the Wierzbak Stream valley between the Bonin and Winiary housing estates in Poznań.

The concept of developing the Wierzbak Valley was created using SCALGO Live surface runoff modelling tools. This software supports the identification of urban flood risk areas and allows the analysis of surface runoff and the testing of alternative spatial solutions. Land cover is reflected based on the BDOT10k topographic feature database. Unfortunately, the software is not integrated with the database of underground stormwater drainage systems. Therefore, it requires manual modifications to make the runoff simulation more realistic.

Functional and spatial analyses and runoff simulation enabled the development of the concept of a multi-functional buffer park with 3 rainwater retention ponds, which is a recreational space for residents and a diverse habitat for flora and fauna. The concept is a response to climate challenges and a proposal to use blue-green infrastructure to improve the city's retention capacity, the quality of the natural environment and the well-being of residents.

References

Biedroń I., Brzóska P. Dondajewska-Pielka R. i in. (2020). Podręcznik dobrych praktyk renaturyzacji wód powierzchniowych. Oprac. w ramach przedsięwzięcia „Opracowanie krajowego programu renaturyzacji wód powierzchniowych". Państwowe Gospodarstwo Wodne Wody Polskie, Krajowy Zarząd Gospodarki Wodnej, Warszawa.

Birx-Raybuck D. A., Price S. J. & Dorcas M. E. (2010**)**. Pond age and riparian zone proximity influence anuran occupancy of urban retention ponds. *Urban Ecosystems*, *13*(2), 181–190. doi.org/10.1007/s11252-009-0116-9.

Januchta-Szostak A. (2020). *River-friendly cities*. Peter Lang, Berlin, Bern, Bruxelles, New York, Oxford, Warszawa, Wien, 252 pp. ISBN: 978-3-631-82652-2, DOI: https://doi.org/10.3726/b17144

Kundzewicz Z. W., Januchta-Szostak A., Nachlik E., Pińskwar I., & Zaleski J. (2023). Challenges for Flood Risk Reduction in Poland's Changing Climate. *Water*, *15*(16), 2912. MDPI AG. Retrieved from http://dx.doi.org/10.3390/w15162912

Lange K, Nissen S. (eds.),(2012) *Urban rivers - vital spaces. Guide for Urban River Revitalisation*, REURIS Project Team, Leipzig, pp. 87. ISBN 978-3-00-035317-8

Figures and Tables

Figure 1 Analysis of the functional structure of the Bonin and Winiary housing estates and the Wierzbak Valley in Poznań, with the study area marked (red dotted line)

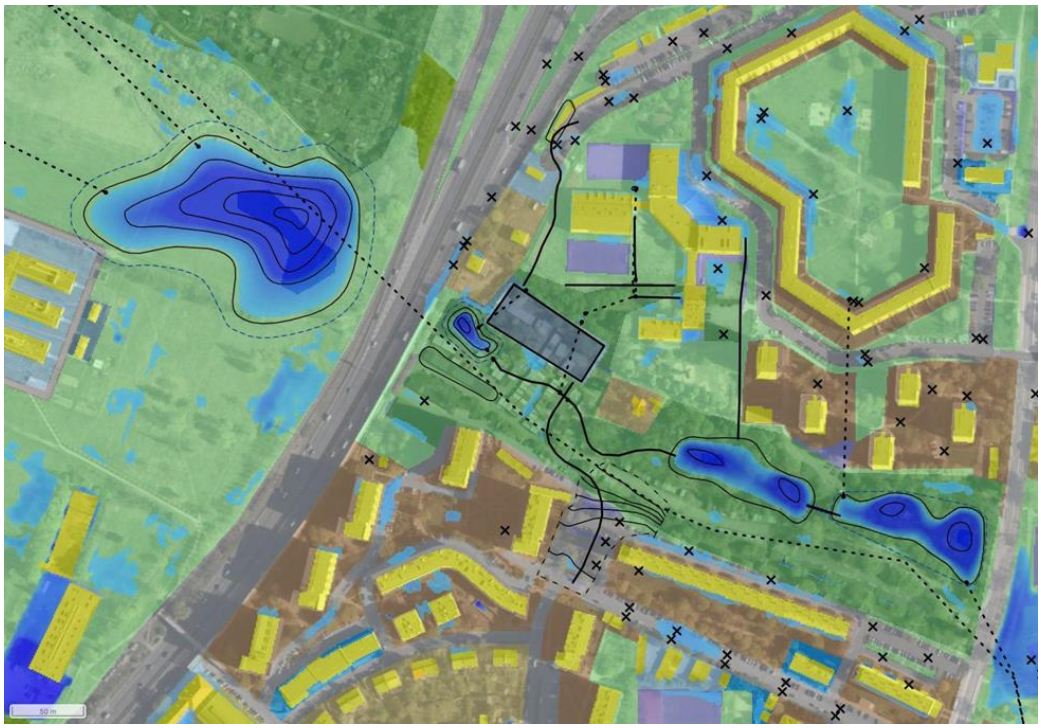


Figure 2 Simulation of surface runoff for the tested land development concept in the Wierzbak Valley in Poznań (by Estera Matczak).

Validity of recovering humic substances from reject water using opoka and concrete

Joanna Surmacz-Górska[1], Jolanta Turek-Szytow[1, 2], Justyna Michalska[1], Agnieszka Dudło[1]

[1]Department of Environmental Biotechnology, Faculty of Energy and Environmental Engineering, Silesian University of Technology, Akademicka 2A, 44-100, Gliwice, Poland

[2]Centre for Biotechnology at Silesian University of Technology, Krzywoustego 8, 44-100 Gliwice, Poland

A serious problem for all wastewater treatment plants is the proper management of significant and annually increasing amounts of sewage sludge. Currently, the process of anaerobic digestion of sewage sludge (ADSS) is one of the leading strategies of sewage sludge processing that significantly reduces the energy consumption of sewage facilities. Although ADSS allows the stabilization of organic matter and the bioenergy recovery, an unavoidable result of this process is the generation of reject water rich in biogenic substances, in particular humic substances (HSs). The recovery of HSs from reject water using an adsorption technique offers the possibility of reusing these compounds in agriculture and land reclamation. Such an approach can provide a solution to the environmental and economic concerns related to the problem of progressive soil degradation and contribute to rebalancing the soil ecosystem by increasing organic matter. The presented research demonstrates that opoka (OP) and autoclaved aerated concrete (AAC) can be efficiently applied as adsorbents for HSs in reject water before (RW_R) and after the struvite precipitation (RW_P). It has been suggested that phosphates may compete with HSs for the surface of minerals, thereby reducing their adsorption on such materials. However, herein it found that both adsorbents were able to remove nearly 60% of HSs within 2 h of their contact with HSs and retain approximately 200 mg of HSs per 1 g, regardless of the reject water type. Although the struvite precipitation did not affect the concentration of HSs dissolved in the RW_R, it was found that some of the HSs found in the suspended solids of this waste may have co-precipitated with the struvite crystals as was evidenced by the decrease in the value of $SUVA_{254}$ in RW_P from 17.70 to 14.63. The spectroscopic analyses of the HSs remaining in the RWR and RWP after the adsorption process allowed the determination of the sorption mechanisms of these compounds. For instance, the increase in the values of the A_{465}/A_{665}, A_{250}/A_{365}, and A_{280}/A_{365} coefficients obtained for RW_R+OP, RW_R+ACC, RW_P+OP, and RW_P+ACC with respect to their values determined before the adsorption process, could indicate that the adsorption of the HSs with higher molecular weight (humic acids) on the studied materials has prevailed over that of the humic fractions with lower molecular weight (fulvic acids), leaving them in the RW. The post-sorptive OP and post-sorptive ACC obtained after the adsorption process of HSs from RW_R, which was chosen as a better site for the recovery of HSs, were further evaluated in terms of their potential phytotoxic effects on garden cress, sorghum, mustard, and radish. It was found the effect of the post-sorptive humic preparations depended largely on their concentration and type of adsorbent.

MXene as emerging sustainable materials for wastewater treatment – a review

Farooque Janjhi, Grzegorz Boczkaj*

Gdansk University of Technology, Faculty of Civil and Environmental Engineering, Department of Sanitary Engineering, Poland, 80-233 Gdańsk, 11/12 Narutowicza Str., Poland.

*e-mail: grzegorz.boczkaj@pg.edu.pl

Abstract

MXenes, being a novel group of 2D materials, exhibits a wide range of potential applications in the realm of water and effluent treatment owing to their unique characteristics and appealing suitability. These include remarkable electrical conductivity, higher thermal stability, hydrophilicity, and a notable capacity for sorption-reduction. Due to their remarkable sorption selectivity, these substances are exceptionally well-suited for the removal of hazardous contaminants. At present, MXene-based materials hold significant prominence in the realm of membrane separation processes. This study provides an extensive examination of the latest advancements in water treatment materials utilizing MXene. The discussion revolves around the utilization of MXene-based membranes, adsorbents, and photo-catalysts for the purpose of mitigating the presence of antibiotics and heavy metals in water. A comparison of MXene-based membranes with other 2D membranes is presented. In conclusion, the potential opportunities and obstacles for forthcoming scientific investigations are thoroughly examined.

Keywords: MXene; 2D materials; Heavy metals; Antibiotics; Membranes; Wastewater treatment.

Strategizing for Sustainability: A Deep Dive into Optimizing Energy Efficiency in Wastewater Treatment Plants

A. Czapla*, G. Mannina, M. Ganesapillai***, J. Drewnowski***

* Faculty of Civil and Environmental Engineering, Gdansk University of Technology, Narutowicza 11/12, 80-233 Gdańsk, Poland, a.czapla.1993@gmail.com , jdrewnow@pg.edu.pl
** Department of Civil, Environmental, Aerospace, Materials Engineering, University of Palermo, Piazza Marina 61, 90133 – Palermo, Italy, giorgio.mannina@unipa.it
***Mass Transfer Group, School of Chemical Engineering, Vellore Institute of Technology, Vellore 632014, India, maheshgpillai@vit.ac.in

Keywords: WWTP; energy neutrality; sustainability; modelling and computer simulations

Abstract:

The pursuit of energy neutrality in Wastewater Treatment Plants (WWTPs) is paramount in the current environmental context, and this study underscores a multitude of strategies and innovative technologies aimed at augmenting energy efficiency and mitigating energy consumption within these facilities. By analysing extensive research and real-world applications it outlines transformative and sustainable strategies, emphasizing minimizing ecological impacts and refining operational processes in WWTPs worldwide.

The study provides an overview of various techniques and practices, emphasizing their potential to improve energy conservation and reduce environmental impacts. By addressing key challenges and presenting potential solutions, the study illuminates the pathways toward implementing sustainable operations and achieving energy neutrality in wastewater treatment settings. This involves the integration of renewable energy resources, innovations in biogas utilization, and the advancement of anaerobic digestion processes. By evaluating these elements, the study aims to contribute to a broader understanding and application of energy-efficient practices and sustainable strategies in wastewater treatment management.

Reviewing successful WWTPs in terms of energy self-sufficiency proved the point that the existing inefficient WWTPs should take a series of actions reviewed in this publication. The priorities of the actions should be analysed separately for each case study depending on several parameters, such as the operational cost and the environmental impact to predict performance of WWTPs and analyse detailed information in terms of the influent and effluent quality as well as energy consumption. The advanced and complex analysis procedures, techniques and simulation tools (plant-wide models) can support decision-making to meet the paradigm of sustainable WWTPs combining dynamic process model including GHG, detailed energy models, operational cost and LCA was also proposed. Simulation tools (such as GPS-X, WEST, AQUASIM, DESASS, SIMBA,) and modelling also allows comparison of different strategies to achieve energy neutrality. These tools have been developed and widely applied worldwide, however the lack of data, poor knowledge of newly developed processes, uncertainty in prediction GHG emissions and over parameterization are still a challenge.

References:

Maktabifard M., Zaborowska E., Mąkinia J. (2018). *Achieving energy neutrality in wastewater treatment plants through energy savings and enhancing renewable energy production. Springer*.

Seco A., Ruano M. V., Ruiz-Martinez A., Robles A., Barat R., Serralta J., Ferrer J. (2020). *Plant-wide modelling in wastewater treatment: showcasing experiences using the Biological Nutrient Removal Model. Water Science & Technology.*

WERF (2015). *Demonstrated energy nuetrality leadership: a study of five champions of change. Water Envvironment Reseearch Foundatioon. 635 Slaters Lane, Suite GG-110 Alexandriaa.*

Yang Z., Pei H., Hou Q. et al. (2018). *Algal biofilm-assisted microbial fuel cell to enhance domestic wastewater treatment: nutrient, organics removal and bioenergy production. Chemical Engineering Journal.*

Zaborowska E., Czerwionka K., Makinia J. (2017). *Strategies for achieving energy neutrality in biological nutrient removal systems—a case study of the Słupsk WWTP (northern Poland). Water Science & Technology.*

The concept of estimating the risk of water losses in the water supply network

Barbara Tchórzewska-Cieślak, Dawid Szpak*, Jakub Żywiec**, Mateusz Rożnowski****

* first author's address (dsz@.prz.edu.pl)
** second author's address (cbarbara@prz.edu.pl, j.zywiec@prz.edu.pl, m.roznowski@prz.edu.pl)

Keywords: risk assessment, water losses, water supply

Abstract:

The need to manage water losses in water supply systems is highlighted in the new Directive (EU) 2020/2184 of the European Parliament and of the Council of 16 December 2020 on the Quality of Water Intended for Human Consumption. It was indicated that the main cause of water losses is underinvestment in the maintenance and renovation of network infrastructure. The new legal provisions require a risk assessment to be carried out in the water supply system, taking into account the risk of leaks. The paper presents the concept of estimating the risk of water losses in the water supply network using the three-parameter method and risk maps. The framework of the water balance proposed by IWA were also presented, including the ILI index for assessment of the water supply network technical condition. The analysis was carried out for a water supply system used by 200,000 inhabitants. The technical condition of the network was determined based on the ILI index. Then the water supply network pipes that could potentially be a source of leaks were identified. The analysis of the risk of water losses for the examined pipes allowed to determine which pipes should be first chosen to reduce the risk of water losses, i.e. active search for leaks.

References

Boryczko K., Piegdoń I., Szpak D., Żywiec J. (2021). Risk Assessment of Lack of Water Supply Using the Hydraulic Model of the Water Supply. *Resources*, **10**, 43.

Directive (EU) 2020/2184 of the European Parliament and of the Council of 16 December 2020 on the Quality of Water Intended for Human Consumption.

Hirner W., Lambert A. (2000). Losses from Water Supply Systems: Standard terminology and recommended performance measures. IWA, London.

Sousa J., Ribeiro L., Muranho J., Sá Marques A. (2015). Locating Leaks in Water Distribution Networks with Simulated Annealing and Graph Theory. *Procedia Engineering*, **119**, pp. 63 – 71.

Zhang L., Wu Y., Guo L., Cai P. (2013). Design and Implementation of Leak Acoustic Signal Correlator for Water Pipelines. *Inf. Technol. J.*, **12**, 2195–2200

Wpływ gęstości prądu stałego na efektywność oczyszczania ścieków szklarniowych

Artur Mielcarek*, Karolina Kłobukowska**

* Katedra Inżynierii Środowiska, Uniwersytet Warmińsko-Mazurski w Olsztynie, ul. Warszawska 117a, 10-720 Olsztyn, e-mail: artur.mielcarek@uwm.edu.pl
** Katedra Inżynierii Środowiska, Uniwersytet Warmińsko-Mazurski w Olsztynie, ul. Warszawska 117a, 10-720 Olsztyn, e-mail: karolina.klobukowska@student.uwm.edu.pl

Słowa kluczowe: elektrokoagulacja, redukcja azotu, defosfatacja, ścieki szklarniowe

Streszczenie

Uprawy bezglebowe prowadzone w systemie otwartym generują ścieki, zawierające wysokie stężenia azotu (ok. 270-615 mg N/L), i fosforu (35-104 mg P/L) a odprowadzane do środowiska zagrażają ekosystemom wodnym powodując np. eutrofizację (Mielcarek i in. 2019). Z tego powodu coraz częściej rozwijane są technologie pozwalające na sprawne oczyszczanie ścieków pochodzących ze szklarni.

Celem badań było określenie wpływu gęstości prądu stałego na usuwanie związków fosforu i azotu ze ścieków pochodzących z bezglebowej uprawy pomidorów.

Badania przeprowadzono w reaktorach z wbudowaną anodą aluminiową oraz katodą ze stali nierdzewnej. Zastosowano 3 różne gęstości prądu stałego: 2 A/m^2, 4 A/m^2 i 8 A/m^2. Czas oddziaływania prądu stałego wynosił 4h. Próbki do analiz pobierano po 1, 4 i 24h. Porównanie próbek po 4 i 24h pozwoliło na określenie ilości nieprzereagowanych jonów glinu. Zakres analiz obejmował zawartość węgla organicznego, azotu ogólnego, fosforu ogólnego, azotanów i azotynów, amoniaku, pH, temperatury, oraz przewodności elektrolitycznej.

Najwyższą efektywność usuwania azotu ogólnego i fosforu ogólnego po 4 h i 24 h odnotowano tam, gdzie zastosowano przepływ prądu stałego o najwyższej gęstości (8 A/m^2). Sprawności te wyniosły kolejno 3,8 % i 7,6 % dla azotu i 99,9 % dla fosforu.

Założone wartości prądu stałego nie pozwoliły na uzyskanie wysokiej efektywności usuwania azotu ogólnego ze ścieków, jednocześnie zanotowano redukcję azotanów (V) do azotynów (III) i azotu amonowego. W przypadku fosforu ogólnego osiągnięto wysoką (>95 %) sprawność elektrokoagulacji, która pozwala na redukcję stężenia fosforu do wartości dopuszczalnych przy odprowadzeniu ścieków do środowiska. W celu zwiększenia efektywności denitryfikacji zasadne byłoby m.in. zastosowanie zewnętrznego źródła węgla organicznego w celu zainicjowania i wspomagania biologicznych procesów redukcji azotanów (V).

Bibliografia

Mielcarek, A., Rodziewicz, J., Janczukowicz, W. and Dobrowolski, A. (2019). Analysis of Wastewater Generated in Greenhouse Soilless Tomato Cultivation in Central Europe. *Water (Switzerland)*, **11**(12), 2538.

Badania finansowane przez Narodowe Centrum Badań i Rozwoju w ramach realizacji projektu pt. „Opracowanie technologii precyzyjnego oczyszczania ścieków z bezglebowej uprawy pomidorów z wykorzystaniem elektrobiologicznego reaktora hybrydowego” LIDER/4/0019/L-10/18/NCBR/2019.

Introduction to the algorithm of carbon footprint calculation for municipal wastewater treatment plants according to EU legislation

P. Szulc-Kłosińska[1*], Z. Dymaczewski[1*]
[1]Faculty of Environmental Engineering and Energy, Poznan University of Technology, Berdychowo 4, 60-965 Poznan, Poland
*Corresponding Author: zbyslaw.dymaczewski@poznan.put.pl

Keywords: GHG emissions, carbon footprint, wastewater treatment

Abstract:

In the forthcoming years, urban wastewater management utilities will be required by the European Union to perform Carbon Footprint (CF) calculations in accordance with the Corporate Sustainability Reporting Directive (CSRD) and European Sustainability Reporting Standards (ESRS) indicators. Yet, there is still no standardized approach that expressly addresses the rules for Wastewater Treatment Plants (WWTPs) in respect to GHG emissions, giving the water bodies a clear instruction to evaluate their CF.

This work provides an algorithm for calculating the CF of a municipal WWTP (MWWTP) is developed and described in detail by the authors. The analysis also included a thorough investigation into the significance and sources of GHG Protocol Scope 1, 2, and 3 emissions within the larger framework of CF, particularly in relation to the legislative goals of CSRD reporting with its upcoming obligations imposed on waterworks organizations. The Greenhouse Gas Protocol (GHG Protocol) [1] methodology, the basis of the algorithm, however, is widely acknowledged as a set of principles for calculating the CF of organisations, it does not provide specific guidelines for WWTPs. As a result, detected gaps are filled with methods based on the Intergovernmental Panel on Climate Change (IPCC) 2006 and 2019 [2, 3] combined with 2023 update of Australian National Greenhouse Accounts (NGA) [4] and National Greenhouse and Energy Reporting (NGER) protocols [5] dedicated to WWT area with the gaps filled with 2013 U.S. Protocol [6].

The proposed CF algorithm encompasses 7 distinct stages that adhere to the guidelines set forth by the GHG Protocol and meet the requirements of the CSRD. The following steps are: (1) consolidation process evaluation: organisational and operational materiality analysis (calculation boundaries), (2) Scope 1 emission calculation: (2a) GHG emissions from the supportive activities (e.g., fuel combustion by the fleet cars), (2b) N_2O direct fugitive emissions, (2c) CH_4 direct fugitive emissions from WWT path, (2d) CH_4 direct fugitive emissions from sludge management, biogas production and utilisation (3) Scope 2 (location- and market-based method calculation, (4) Scope 3 calculation, (5) results summary, uncertainty discussion and report preparation, (6) conclusions in the area of data aggregation, (7) carbon footprint results analysis and GHG emission reduction planning. In total, the proposed CF calculation algorithm satisfies each of the steps given and consists of 7 decision-making trees. For the purpose of this abstract one chosen tree is presented Figure 1. The tree shown below is placed as the second of forementioned seven parts of the algorithm and comes right after Scope 1 non-process (supportive, e.g., fuel combustion) activities. It prefaces the process-related CH_4 emissions. Some of the steps presented refers to IPCC - 2006 methodology with 2019 Refinement [3], as well as IPCC Sixth Assessment Report (AR6, 2021) [7].

References

[1] WRI, WBCSD. (2014). World Resources Institute and World Business Council for Sustainable Development, Greenhouse Gas Protocol. A Corporate Accounting and Reporting Standard REVISED EDITION

[2] Intergovernmental Panel on Climate Change. (2019). 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Guidelines for wastewater treatment and discharge (Vol. 5, Chapter 6). Retrieved from https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html

[3] WRI, WBCSD. (2014). World Resources Institute and World Business Council for Sustainable Development, Greenhouse Gas Protocol. Corporate Value Chain (Scope 3) Accounting and Reporting Standard. Supplement to the GHG Protocol Corporate Accounting and Reporting Standard

[4] Commonwealth of Australia, Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education. (2023). Australian National Greenhouse Accounts National Greenhouse Accounts Factors.

[5] Commonwealth of Australia, Department of Industry, Innovation, Climate Change, Science, Research and Tertiary Education. (2023). Australian National Greenhouse and Energy Reporting System Measurement Technical Guidelines for the Estimation of Greenhouse Gas Emissions by Facilities in Australia.

[6] U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions by International Council for Local Environmental Initiatives - Local Governments for Sustainability USA . (2013). Retrieved from https://icleiusa.org/us-community-protocol/

[7] IPCC Sixth Assessment Report - Climate Change 2021: The Physical Science Basis. https://www.ipcc.ch/report/ar6/wg1/

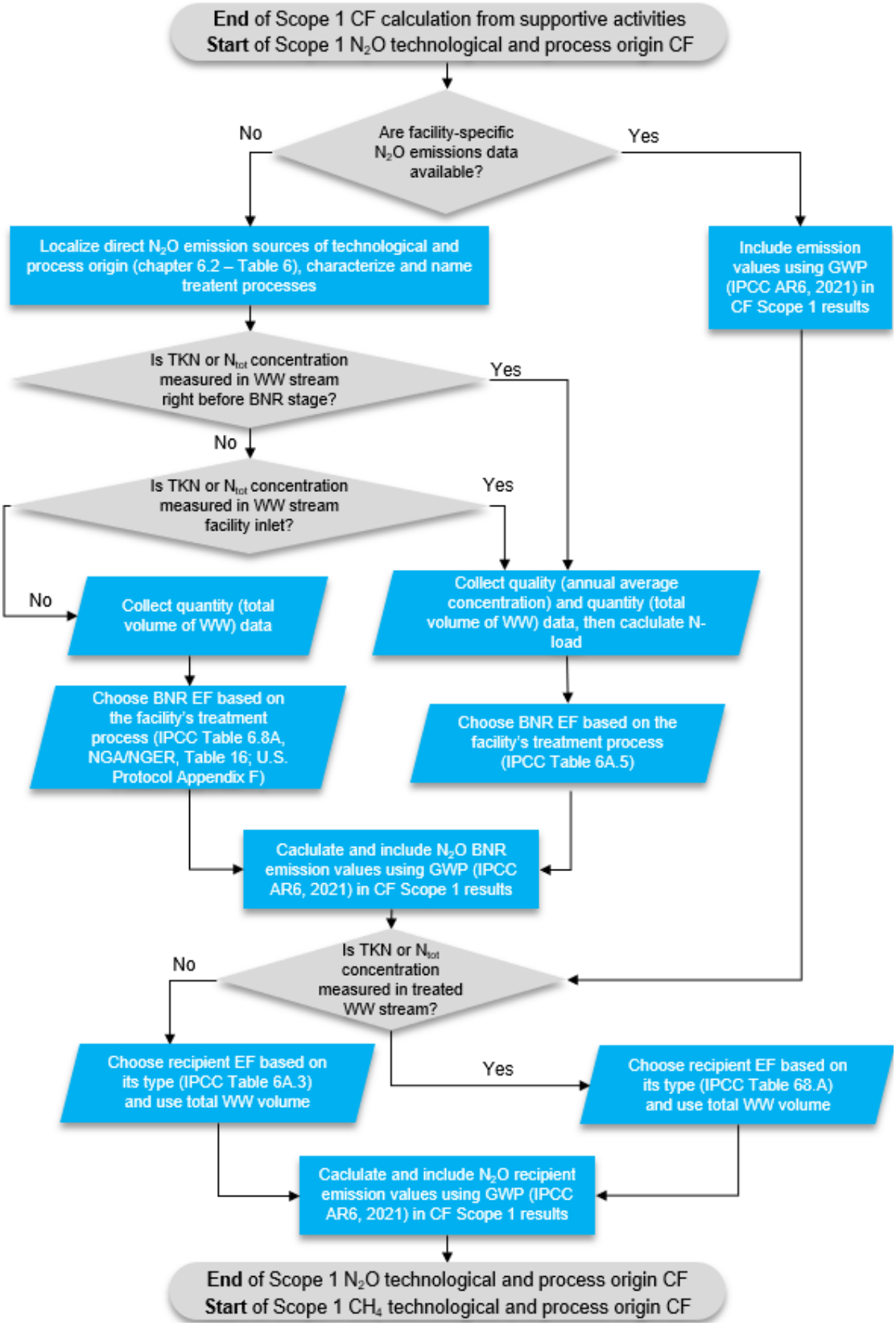


Figure 1 Decision tree and instructions for CH_4 direct fugitive emissions from WWTP: wastewater treatment path.

The use of Raman spectroscopy in the identification of plastic particles in water intended for human consumption

E. Nowak*, A. Szuster-Janiaczyk, M. Szybowicz, *, T. Runka*, M. Komorowska-Kaufman**, A. Pruss****

* Poznan University of Technology, Faculty of Materials Engineering And Technical Physics, ul. Piotrowo 3, 60-965 Poznań , e-mail: ewelina.nowak@put.poznan.pl; **Poznan University of Technology, Institute of Environmental Engineering, ul. Berdychowo 4, 60-965 Poznań, e-mail: agnieszka.szuster-janiaczyk@put.poznan.pl;

Keywords: microplastic; water quality; spectroscopy

Abstract:

Zgodnie z Dyrektywą Parlamentu Europejskiego i Rady z grudnia 2020 roku, w sprawie jakości wody do spożycia (2020/2184), do stycznie 2024 roku, Komisja Europejska ma przyjąć akty delegowane, w celu uzupełnienia dyrektywy poprzez przyjęcie metodyki pomiaru zawartości mikroplastiku, z myślą o umieszczeniu jej na liście obserwacyjnej substancji do celów monitorowania w ramach unijnej polityki wodnej. Spośród kilku istniejących metod identyfikacji drobin plastiku, metody spektroskopowe wydają się być tymi, która prawdopodobnie będą przyjęte jako metody referencyjny, podobnie jak w stanie Karolina (USA) (Policy Handbook, 2022). W tym kontekście, spektroskopia Ramana oraz spektroskopia podczerwieni wyróżniają się jako nieniszczące, dynamiczne narzędzia do identyfikacji materiałów, opierając się na analizie drgań atomowych. Techniki te, dzięki małej inwazyjności w strukturę próbki mają znaczą przewagę nad innymi metodami wykorzystywanymi do identyfikacji mikroplastików. Literatura obfituje w wiele przykładowych algorytmów badawczych, które mogą znaleźć zastosowanie w analizie zanieczyszczenia wody mikroplastikami. W przypadku wszystkich stosowanych metod, proponowane analizy obejmowały środki ostrożności dotyczące pobierania i przygotowania próbek, unikania zanieczyszczenia próbek, przetwarzania danych i ich walidacji (Schymanski et al., 2021). W niniejszej publikacji zaproponowano dwuetapową procedurę badawczą, pozwalającą na identyfikację mikroplastików zawartych w wodzie. W ramach tej procedury, zastosowano etap filtracji wody w środowisku wolnym od elementów polimerowych, następnie, zebrane cząsteczki przeanalizowano za pomocą mikroskopu optycznego i metod spektroskopowych, w celu uzyskania przejrzystej charakterystyki materiałowej poprzez porównanie z widmami referencyjnymi znanych polimerów.

References

Directive (Eu) 2020/2184 Of The European Parliament And Of The Council of 16 December 2020, on the quality of water intended for human consumption

Policy Handbook Establishing a Standard Method of Testing and Reporting of Microplastics in Drinking Water ,(2022), Prepared by: The Division of Drinking Water, State Water Resources Control Board State of California

Schymanski D., Oßmann B.E., Benismail N., Boukerma K., Dallmann G., von der Esch E., Fischer D., Fischer F., Gilliland D., Glas K., Hofmann T., Käppler A., Lacorte S., Marco J., El Rakwe M., Weisser J., Witzig C., Zumbülte N., Ivleva N.P. (2021). *Analysis of microplastics in drinking water and other clean water samples with micro-Raman and micro-infrared spectroscopy: minimum requirements and best practice guidelines*, Anal. Bioanal. Chem. 413, 5969–5994. https://doi.org/10.1007/s00216-021-03498-y.

Preliminary research on membrane filtration for surface water treatment

Fasilate Uwimpaye *, Julia Jakubowska *, Beata Konopczyńska **, Karolina Mazurkiewicz *
Joanna Jeż-Walkowiak *
*Faculty of Environmental Engineering and Energy, Poznan University of Technology, Berdychowo 4, 60-965 Poznań, Poland;
**Faculty of Chemical Technology, Poznan University of Technology, Berdychowo 4, 60-965 Poznan, Poland;
*Corresponding Author: fasilate.uwimpaye@doctorate.put.poznan.pl

Keywords: surface water treatment, artificial infiltration intake, membrane filtration,

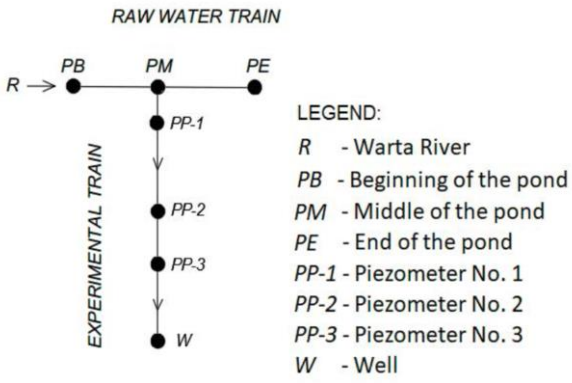
Abstract:

The membrane filtration process has been used in separation technologies for decades. Membrane filtration is now becoming an increasingly used process in technological systems for the treatment of marine, mixed, and fresh water.

The aim of the presented research was to determine the possibility of using membrane filtration for surface water treatment using the artificial infiltration process as a preliminary treatment.

The results are referred to the raw water quality parameters, membrane filtration process parameters, and membrane materials.

The research was conducted using the experimental field installation presented on following figure. Membrane filtration tests were performed on the SEPA set shown in the photo. Water was collected from the infiltration intake pond and one of the siphon wells.



Scheme of field installation

SEPA installation

Chemical analyses were performed according to Standard Methods

The efficiency of membrane filtration processes depends on the material which is made of the membrane.

The effect of membrane filtration like MF, UF, and NF for infiltrated water (water from the well or piezometers) was better than membrane processes of Surface water (pond or river water) in terms of filtration parameters and water quality.

To improve raw water quality we can get the comparable effectiveness of treatment when:

- two-step membrane filtration is applied or
- the infiltration followed by nanofiltration is applied

Thus, the infiltration may serve as an effective pretreatment before membrane filtration..

Acknowledgement:

The research was financed by the PUT Research Project 01/13/SBAD/0913

References

[1] Jeż-Walkowiak, J., Makała, A., Mądrecka-Witkowska, B., Michałkiewicz, M., Kolwicz, N., 2021. Effect of initial treatment of surface water at an artificial infiltration intake. Desalin. Water Treat. 226, 62–76. https://doi.org/10.5004/dwt.2021.27264
[2] www.sterlitech.com