Karlsruhe Institute of Technology

Topics in Water Chemistry and Water Technology

Annual Report of the Chair of Water Chemistry and Water Technology and the DVGW Research Center at the Engler-Bunte-Institut 2024

Dear colleagues and friends,

after more than 30 years as Academic Director at our institute, we are saying goodbye to Dr. Gudrun Abbt-Braun not just as a colleague, but a cornerstone of our research group at the Engler-Bunte-Institut. Her dedication and commitment to excellence have left a lasting mark, from managing the teaching and administrative responsibilities to sharing her deep expertise through courses on humic substances and water chemistry. Working with her was always a privilege. Her thoughtful leadership, warm approach, and unwavering professionalism made every interaction a joy. She was also a mentor and guide to young scientists, inspiring them with her passion and insight into the secrets of humic substances and their interaction in the aquatic environment. As she steps into retirement, we feel the loss of a cherished part of our institute's history, but we are grateful for the legacy she leaves behind. We wish her all the happiness and fulfillment in this next chapter, knowing she has more than earned it.

As we look back on this year in general, we realize more than ever that we have the rare privilege of living and working in a protected and comfortable environment. In times when political, religious and cultural differences and/or social inequalities are still and again dividing countries and people, leading to war and so much misery in so many places around the world, we often forget to acknowledge and be grateful for this "bubble". The shift to an illiberal mindset in so many countries in Europe and beyond is extremely worrying and it is a shame that this is happening in Germany. We very much hope that these divisive tendencies will give way to the realization that none of our common problems can be solved in this way. In science - that very special bubble - it seems so natural and logical that we tackle them together - in our institute and this year alone we had the pleasure of working in a multicultural group consisting of more than 10 different nationalities. Let's hope that this spirit spreads to other contexts outside academia.

One of the scientific highlights was the successful completion of our ERDF project "KoalAplan", where PhD candidate Nikhil Shylaja Prakash from Kerala, India, demonstrated a solution to recover quite a share of the particulate organic carbon as short-chain fatty acids for further biotechnological refinement rather than "only" producing methane in anaerobic digestion. It was lovely to host Ms. Willow Neske from Philadelphia, USA, during her Fulbright scholarship of 10 months, who assisted with the work.

A major non-scientific highlight was certainly this year's Aquamasters tournament of the German water and waste water research institutes, in which a highly motivated and obviously even more talented group of eight soccer players from our institute took second place in the final on June 8. Rumor has it that the EBI team only lost to Berlin because everyone would like to play in the capital next year.

In this report, we would like to give you a brief insight into our research activities this year. We hope you enjoy reading it and wish you all the best for 2025,

Andrea Hille-Reichel and Harald Horn

DVGW Forschungsstelle ebi

Effect of biofouling on concentration polarization in pressure driven membrane systems assessed by means of Raman micro-spectroscopy

Szilard Bucs

Oliver Jung

Michael Wagner

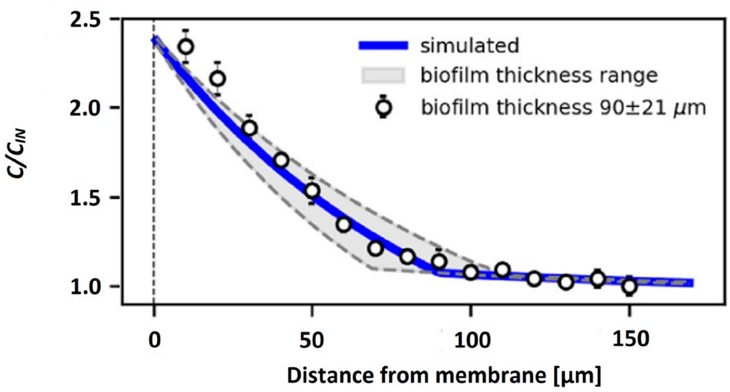
Florencia Saravia

Harald Horn

Cristian Picioreanu

Accumulation of biofouling on membranes results in the enhancement of the concentration polarization layer. In order to estimate the impact of biofilm on the solute concentration in a nanofiltration experimental setup, *in situ* biofouling visualization by means of optical coherent tomography (OCT) has been combined with confocal Raman micro-spectroscopy (RMS) and mathematical modelling. A Bacillus subtilis biofilm was grown as model for biofouling for six days in a nanofiltration (NF) flow cell. The morphological properties of the biofilm have been resolved using OCT. The concentration polarization layer was evaluated prior and after the biofilm development on the NF membrane in the experimental setup.

The results confirm that biofouling enhanced osmotic pressure (BEOP) is indeed a mechanism responsible for flux decline in (spiral wound) membrane systems facing biofouling issues. Moreover, the measurements indicate a critical biofouling thickness of approx. 60 µm which has to be reached before the osmotic pressure increases by ≥ 15 % due to the accumulation of biofouling. OCT and RM data supported the development of the mathematical model which accurately represents the solute concentration profile in the investigated scenarios in the presence of biofouling.



The developed mathematical model describes the concentration polarization (c/c_{in}) measured by means of RM (markers) well. The presented results have been achieved for a mean biofouling/biofilm thickness of 90 ± 21 µm and a c_{in} = 10 g SO_4^{2-} L^{-1} with a cross-flow velocity of 0.04 m s^{-1} and a system pressure of 10 bar.

Funding:

Gesellschaft der Freunde des Engler-Bunte-Instituts

German Technical and Scientific Association for Gas and Water (DVGW)

King Abdullah University of Science and Technology (KAUST)

Partners:

Prof. Dr. Cristian Picioreanu, Water Desalination and Reuse Center, King Abdullah University of Science and Technology (KAUST)

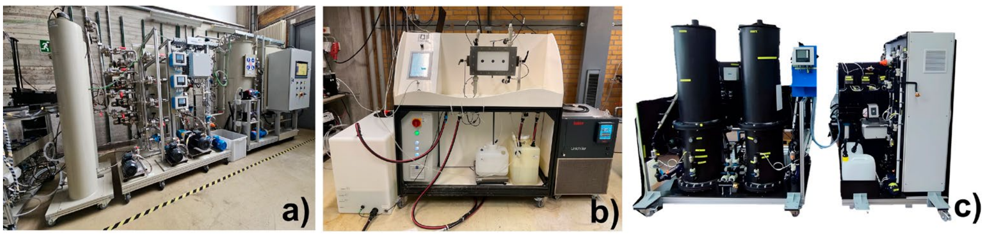
Publications:

Bucs, S., Jung, O., Wagner, M., Saravia, F., Horn, H., Picioreanu, C., 2024. Raman micro-spectroscopy for the study of concentration polarization in the presence of biofouling in pressure driven membrane systems. Journal of Membrane Science, 713, 123219.

H_2Mare PtX-Wind: Water management for offshore Power-to-X plants

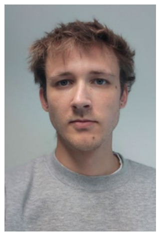
H_2Mare is one of the hydrogen flagship projects of the BMBF which focuses on the offshore generation of green hydrogen along with Power-to-X (PtX) products such as methane, methanol and Fischer-Tropsch synthetic fuels. The DVGW Research Center at the Engler-Bunte-Institut at KIT, Water Chemistry and Water Technology is a key player within the subproject PtX-Wind, leading the water management works and collaborating with project partners on experimental research of different processes. Our team looks into the process chain to supply ultra-pure water. These investigations focus on two membrane-based technologies as well as fouling potential and monitoring in desalination applications.

Reverse osmosis (RO) is being studied in an experimental setup with 4-in membrane modules and flat sheet flow cells. An automated monitoring system with optical coherence tomography is implemented to evaluate fouling development and different operating configurations for offshore applications. Membrane distillation (MD) is studied in lab-scale as a desalination alternative that can be coupled with waste heat sources such as from water electrolyzers. Current experiments with different commercial membranes demonstrate the capacity of MD to continuously provide high quality water (< 6 µS cm^{-1}) from sea water on a single pass. Additional efforts are being carried out to characterize waste water streams from different PtX-processes and develop suitable treatment approaches. Our results show the significant dependency of the waste water quality on the PtX-processes and their operating conditions. Current experimental works include pilot and lab-scale testing of an anaerobic membrane bioreactor and advanced oxidation processes for the treatment and reuse of these waste waters. Furthermore, first insights in the project elucidate the relevance of a proper water management to ensure a sustainable application of PtX-plants.



Experimental setups in H_2Mare PtX-Wind: a) RO desalination plant for fouling monitoring, b) lab-scale MD desalination plant, and c) anaerobic membrane bioreactor for treatment of Fischer-Tropsch waste water.

Yair Morales



Ben Schädlich

Sophie Oeppling

Jonas Ullmann

Florencia Saravia

Partners:

Institute of Micro Processing Engineering (IMVT), KIT
Institute of Chemistry, Catalysis and Materials Engineering Group, TU Berlin
DVGW Research Center, Gas Technology at the Engler-Bunte-Institut, KIT
EnviroChemie GmbH, Rossdorf
INERATEC GmbH, Karlsruhe
DECHEMA e.V., Frankfurt am Main
Helmholtz-Zentrum Hereon, Geesthacht
Siemens Gamesa Renewable Energy GmbH & Co. KG, Denmark
And other partners from universities, research institutions and companies in Germany

Funding:

Federal Ministry of Education and Research (BMBF)

Publications:

Morales, Y., Samanta, P., Tantish, F., Horn, H., Saravia, F., 2023. Water management for Power-to-X offshore platforms: an underestimated item. Scientific Reports, 13, 12286.

KA4H$_2$: Determination of General Conditions for the Use of Biologically Treated Waste Water for Water Electrolysis

Florencia Saravia

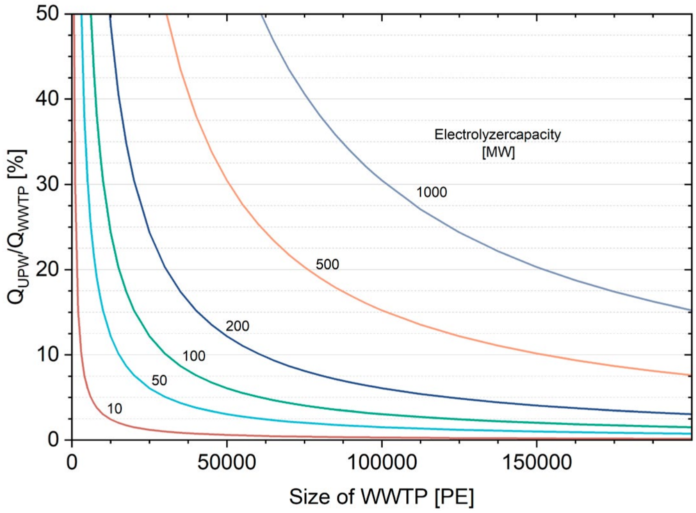
Yair Morales

Jan Singer

Green hydrogen is emerging as a key player in the transition to an environmentally sustainable energy system. It has the potential to decarbonize various sectors such as transportation, industry and power generation. Approximately 10 L of ultra-pure water (UPW) are required to produce 1 kg of hydrogen by water electrolysis. UPW quality is needed to maintain a long-term stability and durability of electrolyzers.

The project **KA4H$_2$** focuses on the use of biologically treated waste water effluent to supply UPW for water electrolysis. The required water qualities for different types of electrolyzers have been researched and possible process steps for UPW production are being investigated. Treatment concepts are being developed in the project for effluent samples of different waste water treatment plants (WWTPs) in Baden-Württemberg.

During the production of ultrapure water, waste and backwash water are generated which include partly concentrated constituents and treatment chemicals such as anti-scalants. The handling of these streams is being researched and possible impacts on the WWTP process or water bodies are under investigation. The combination of WWTPs with electrolyzers gives the advantage of being independent from fresh water sources, as well as further synergies. During the electrolysis process, oxygen is also produced which can be used at a WWTP in aeration tanks or for ozone generation and oxidation as a potential advanced purification stage. Excess heat from the electrolysis could be used for thermal water demineralization technologies or locally for district heating.



Required amount of UPW from the WWTP effluent (Q_{UPW} / Q_{WWTP}) over the size of the WWTP (PE = population equivalent). The curves show the results for different electrolyzer capacities. Specific energy consumption of 52.5 kWH kg_{H2}^{-1} and PE-value of 150 L $(PE\ d)^{-1}$ are chosen for the calculation.

Baden-Württemberg

Funding:

Ministry of the Environment, Climate Protection and the Energy Sector Baden-Württemberg

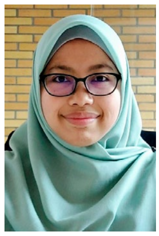
Partners:

Urban Water Engineering, University of Kassel; Kassel
Umwelttechnik BW GmbH, Stuttgart

Publication:

Singer, J., Morales, Y., Horn, H., Morck, T., Otter, P., Schmidtke, J., Saravia, F., 2024. Nutzung von biologisch gereinigtem Abwasser für die Wasserstoffproduktion. Energie Wasser Praxis, 6+7.

Study on wetting in membrane distillation using optical coherence tomography

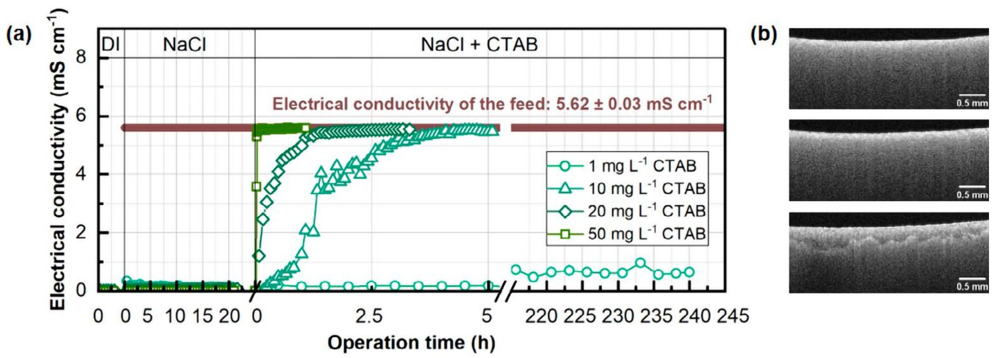


Nurul F. Himma

Florencia Saravia

Wetting is a major and unique drawback in membrane distillation which hinders its application for long-term operations, especially for treatment of waste water containing surfactants and low-surface-tension contaminants. Although a hydrophobic microporous membrane is used to allow only vapor transport from the hot feed-side to the cold condensate-side, depending on the feed water compositions and operating conditions, liquid from the feed may also be able to penetrate into the membrane pores. This phenomenon can lead to loss in rejection and even complete process failure. Therefore, comprehensive understanding of wetting development is necessary.

In this work, optical coherence tomography (OCT) was applied to noninvasively study the wetting development in membrane distillation. Experiments were carried out at maintained feed concentrations by recirculating both feed and condensate. Experiments were carried out initially with deionized water for 3 hours and then with a 3 g L^{-1} NaCl solution for 21 hours. After that cetyltrimethylammonium bromide (CTAB) was added, as a cationic surfactant, at varied concentration from 1 to 50 mg L^{-1}. Results showed that the concentration of surfactant highly influences the wetting rate and distribution. While the electrical conductivity of condensate was almost stable during 240-hours operation at a low CTAB concentration of 1 mg L^{-1}, dramatic increases at different rates were observed at higher concentrations (Figure (a)). Wetting layer formed during operation with CTAB has been successfully visualized by OCT (Figure (b)). Within few minutes, at the high concentration of 50 mg L^{-1}, wetting was distributed throughout the monitored membrane area at varying depths. Future work will focus on quantitative evaluation of wetting by means of analysis of OCT datasets.



(a) Electrical conductivity of condensate measured during membrane distillation experiments at different CTAB concentrations. (c) Visualized membrane wetting development by optical coherence tomography (from top): deionized water, 3 g L^{-1} NaCl for 21 hours, and 3 g L^{-1} NaCl + 50 mg L^{-1} CTAB for 10 minutes. Scale bar: 0.395 pixel aspect ratio. CTAB: Cetyltrimethylammonium bromide.

Funding:

Karlsruhe Institute of Technology

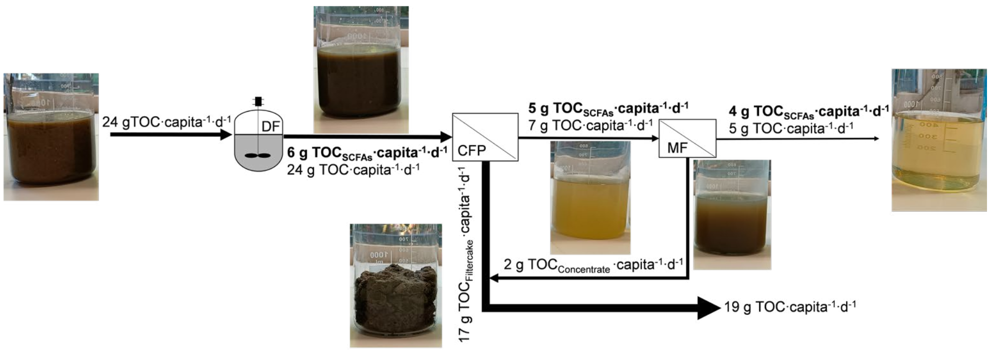
Baden-Württemberg Ministry for Science, Research, and Arts (MWK) for the funding of NFH within the framework of the Graduate Funding from the German States Program ("Landesgraduiertenförderung").

KoalAplan: Recovery of organic carbon from primary sludge via dark fermentation and membrane separation in a waste water biorefinery

Andrea Hille-Reichel

Nikhil Shylaja Prakash

Approximately 24 g_{TOC} capita^{-1} d^{-1} could be recovered from the inflow stream of 40 g_{TOC} capita^{-1} d^{-1} of a municipal waste water treatment plant through a combination of primary sedimentation and microsieving. This high load of total organic carbon (TOC) was processed via dark fermentation at favorable conditions (hydraulic retention time HRT = 36 h, pH = 7, T = 32 °C) to obtain a hydrolyzate which contains about 20 to 30 % of TOC in the form of short-chain fatty acids (SCFAs). The remaining TOC is still present in the form of particles, i.e., suspended solids (SS). To generate a particle-free hydrolyzate for further use in, say biotechnological processes, firstly, a chamber filter-press (mesh size = 100 µm) was utilized to reduce a significant portion of the SS load. To improve the retention of SS on the coarse-sized mesh, a pea-based cationic polymer, hydroxypropyl trimethyl ammonium starch (HPAS), was used as a flocculating agent. Approximately 60 to 70 % of the solids from the hydrolyzate could be removed, and 85 % of the hydrolyzate volume was recovered in the effluent (filtrate). Thus, the concentration of SS in the filtrate was reduced to 300 to 600 mg L^{-1}. The filtrate from the chamber filter press was then subjected to microfiltration (MF). MF (material: α-Al_2O_3, pore size 0.2 µm) was conducted at a cross-flow velocity of over 3 m s^{-1} with backwashing cycles every 600 s for 20 s. A stable permeate flux of 50 to 60 L m_{eff}^{-2} h^{-1} could be maintained for the filtration of 900 L per m² of effective membrane area, after which chemical cleaning was required. The ceramic membrane achieved a 99.9 % removal of SS, with an average SCFAs-retention of 5 %. With MF, a volume recovery of 70 % was achieved and the product was a particle-free permeate with a high proportion of SCFAs compared to the total dissolved organic carbon, between 85 and 97 % as carbon equivalents.



Cascade depicting the recovery of SCFAs from the solids stream of a municipal waste water treatment plant in a particle-free permeate. (DF = Dark fermentation; CFP = Chamber filter press; MF = Microfiltration)

Co-funded by the European Union

Baden-Württemberg

Funding:

European Regional Development Fund (ERDF): Ministry of the Environment, Climate Protection and the Energy Sector Baden-Württemberg, co-financed by the European Union

Partners:

CUTEC Clausthal Research Center for Environmental Technologies, TU Clausthal;
Fraunhofer Institute for Interfacial Engineering and Biotechnology (IGB), Stuttgart;
Institute of Technical Microbiology, Hamburg University of Technology;
Umwelttechnik BW GmbH, Stuttgart;
Treatment Plant for Education and Research at the University of Stuttgart

Using RDBER for Selective Purification of Hydrolyzate from Dark Fermentation of Food Waste

Andrea Hille-Reichel

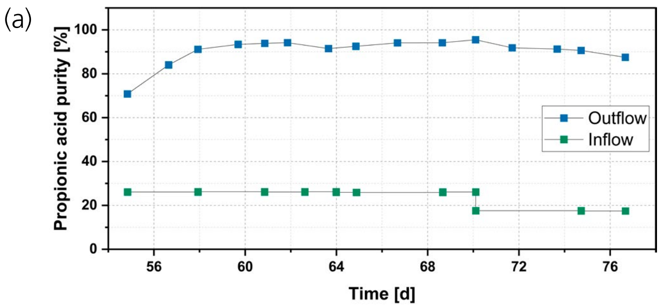
Zhizhao Xiao

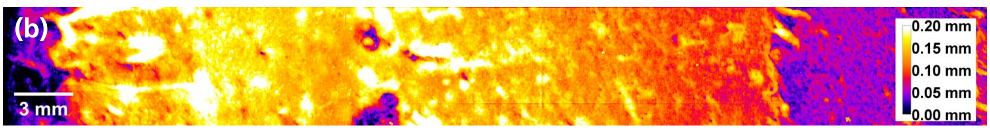
The joint research project BROWSE aims to design a reaction cascade to produce biopolymers from organic waste streams. Dark fermentation is typically used to decompose complex organic compounds (for example, food waste) into biohydrogen and short-chain fatty acids, which could be further utilized for chemicals production. However, the complexity of hydrolyzate composition limits the possibilities of real applications, which requires efficient separation.

Microbial electrolysis cells (MECs) are novel technologies to anodically oxidize organic compounds using microorganisms as biocatalysts, while electrons and protons released from the organic substrate combine at the cathode to form hydrogen. Therefore, a 10 L rotating disk bioelectrochemical reactor (RDBER) was used as MEC to purify hydrolyzate with the aim to achieve high concentrations of propionic acid for further use in a subsequent process.

The hydrolyzate produced via dark fermentation is usually a mixture of acetate, lactate, propionate and butyrate. Hence, *Geobacter sulfurreducens* and a selective butyrate-oxidizing consortium from our project partner (TUHH) were applied as inoculum. The experiments were operated under different operational conditions (operation mode, hydraulic retention times (HRTs), pH conditions and micro-aeration) to investigate the impact on propionate recovery and hydrogen production.

In continuous operation mode, with a hydraulic retention time of 8 days, the propionic acid purity (propionic acid conc./total volatile fatty acids conc.) increased from approx. 20 % to 90 % (Figure (a)). During operation, optical coherence tomography (OCT) was employed to monitor the biofilm development on the anode surface. Figure (b) shows the height map derived from 3D OCT-datasets of the first anode of the stack. After operation for 89 days, the monitored area was fully covered (99 %) with biofilm and the average and maximum biofilm thicknesses amounted to 116 µm and 368 µm, respectively.





(a) Propionic acid purity development during continuous operation with an HRT of 8 days and (b) OCT-height map of anodic biofilm distribution along the radius of the anode disk at cultivation day 89; the first 5 cm of the radius (10.5 cm) are shown, starting on the left with the outer edge of the anode disc.

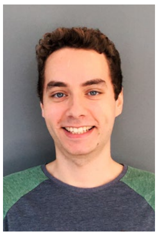
Partners:

Institute of Applied Biosciences, KIT;
Institute of Technical Microbiology, Hamburg University of Technology;
Institute of Organic Chemistry, Material Science Center, KIT;
Research Group Environmental Process Engineering, University of Bremen;
Fraunhofer Institute for Solar Energy Systems ISE

Funding:

Federal Ministry of Education and Research (BMBF)

Oxidative Degradation of anti-cancer drugs in the aqueous phase



Stephan Zimmermann

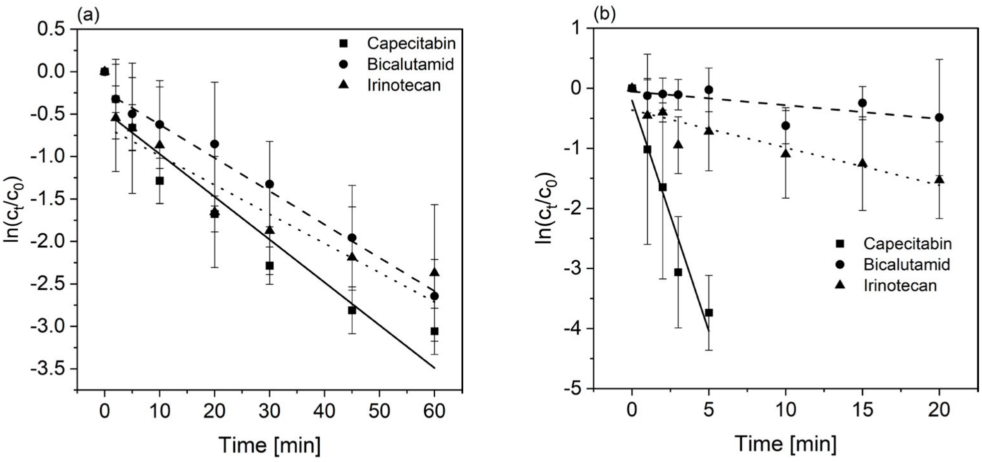
Harald Horn

Anti-cancer drugs (ADs) are detected in low concentrations in the environment. However, due to their high toxicity they might still be harmful to aquatic organisms. They enter the environment through waste water treatment plants (WWTPs), since traditional biological treatment is unable to degrade many of these substances. Two treatment processes that might be able to reduce the input of three ADs (Capecitabin CAP, Bicalutamid BIC, Irinotecan IRI) into the environment, ozonation and irradiation with UV-light, were tested in a bench-scale reactor.

In experiments in ultrapure water (UPW), UV light is capable of reducing the concentration of all three of the tested ADs to below detection limit and mineralizing up to 70 % of them. However, the radiation dose required for transformation and especially mineralization of the substances is so high, that it seems not to be economically feasible. Ozone rapidly transforms two (CAP, IRI) of the tested compounds in UPW while the concentration of the third stayed the same.

Tests in biologically treated waste water showed a lower efficiency for the transformation with UV radiation of the three substances than in UPW (Figure (a)). The same is true for the two compounds that in UPW are quickly degraded by ozone. The third compound (BIC) is actually degraded quicker, probably due to the reaction with OH-radicals (Figure (b)).

The data from these experiments show that treatment with UV radiation is not suitable for efficiently reducing the concentration of these substances in treated waste water. Ozonation on the other hand should be able to transform two of the three tested compounds sufficiently.



Relative concentrations of three ADs in biologically treated waste water during treatment by (a) UV and (b) ozone in a bench scale reactor. The starting concentration was 1 µg L^{-1} in both experiments.

Funding:

Karlsruhe Institute of Technology (KIT)

Publication:

Zimmermann, S., Revel, M., Borowska, E., Horn, H., 2024. Degradation and mineralization of anti-cancer drugs Capecitabine, Bicalutamide and Irinotecan by UV-irradiation and ozone. Chemosphere, 356, 141780.

New and Ongoing Research Projects

WATER QUALITY		
Stephan Zimmermann	Photocatalytic PFAS degradation with simulated sunlight	Karlsruhe Institute of Technology (KIT)
WATER TECHNOLOGY		
Jan Singer Yair Morales Florencia Saravia	Determination of General Conditions for the Use of Biologically Treated Waste Water for Hydrogen Electrolysis - Requirements for the Production of Ultra Pure Water and Treatment of Waste Water Streams	Ministry of the Environment, Climate Protection and the Energy Sector Baden-Württemberg
Florencia Saravia	Development of a Monitoring System for Detection of Biofilm Formation in Reverse Osmosis Membranes	Central Innovation Programme for Small and Medium-Sized Enterprises (ZIM); Federal Ministry for Economic Affairs and Climate Action (BMWK)
Nurul Faiqotul Himma Florencia Saravia	Membrane Distillation – Fouling and Wetting of Membranes	Karlsruhe Institute of Technology (KIT)
Yair Morales Sophie Oeppling Florencia Saravia	*H_2Mare TransferWind* – Research, Transfer, Technology Platform	Federal Ministry of Education and Research (BMBF)
Florencia Saravia	*ThermIon* – Extraction of Lithium from thermal brine	Federal Ministry for Economic Affairs and Climate Action (BMWK)
Florencia Saravia Luis Pino Soto	Characterization of recycled and saturated reverse osmosis membranes	National Agency for Research and Development of Chile (ANID)
Andreas Netsch Michael Wagner	*DEMO-BioBZ* – Development and Demonstation of an Energy-Efficient Bio-Electrochemical Waste Water Treatment	Federal Ministry of Education and Research
BIOLOGICAL WASTE WATER TREATMENT		
Willow Neske Andrea Hille-Reichel	Waste Water Reprocessing and Renewable Energy in Germany *	Fulbright-Fellowship, Temple University; KIT
Nikhil Shylaja Prakash Andrea Hille-Reichel	Municipal waste water as a source of ammonium nitrogen, hydrogen and bioplastics – the Büsnau biorefinery (KoalAplan)	ERDF, Ministry of Environment, Climate Protection and the Energy sector Baden-Württemberg, co-financed by the EU
BIOLOGICAL INTERFACES		
Süheyla Duran Andrea Hille-Reichel	Application of Membrane Biofilm Reactors for Biotechnological Production of Platform Chemicals	The Republic of Türkiye, Ministry of National Education; KIT
Johannes Reiner Max Hackbarth Andreas Netsch Zhizhao Xiao Andrea Hille-Reichel	*BROWSE* – Reaction Cascades Generating Biopolymers from Waste *	Federal Ministry of Education and Research (BMBF)
Michael Wagner	Visualization of the Mesoscopic Biofilm Structure by Means of Optical Coherence Tomography	Helmholtz Association
Max Rümenapf Andrea Hille-Reichel	Establishing a carbon dioxide- and glucose-based 2,3-butanediol production process based on the activity of a bacterial dual-species biofilm thriving on an electron-donor delivering membrane substratum	German Research Foundation (DFG)
Maximilian Miehle Andrea Hille-Reichel	Scalability of gas fermentation processes in membrane biofilm reactors	Ministry of Science, Research and Arts, Baden-Württemberg

*completed in 2024

THE WATER CHEMISTRY AND WATER TECHNOLOGY GROUP

Head of Chair

Prof. Dr. Harald Horn	
Dr. Gudrun Abbt-Braun	Prof. Dr. Fritz H. Frimmel (retired)

DVGW Research Center

Dr.-Ing. Florencia Saravia	Deputy head, team leader research and development

Supervising Functions and Postdoctoral Positions

Apl. Prof. Dr. Gisela Guthausen	NMR/MRI
Dr. Andrea Hille-Reichel	Biological interfaces
Dr.-Ing. Prantik Samanta	Treatment of Fischer-Tropsch waste water
Dr.-Ing. Ulrike Scherer	Water Research Network BW
Dr. Michael Wagner	Biofilm structure and function
Dipl.-Ing. (FH) Stephanie West	Head of the laboratory

DVGW Research Center

M. Sc. Yair Morales	Water treatment

PhD Students

M. Sc. Mehran Aliaskari	Bipolar membrane electrodialysis
M. Sc. Mélanie Apitzsch-Delavault	Evaluation of environmental impact of electrolysis capacity increase in Germany and Morocco by 2050
M. Sc. Süheyla Duran	Biotechnological production of platform chemicals
M. Sc. Max Hackbarth	Microbial electrosynthesis
M. Sc. Steffen Hertle	Aerobic metabolic degradation processes (TZW, Dr.-Ing. since Nov. 2024)
M. Sc. Nurul Faiqotul Himma	Membrane distillation
M. Sc. Oliver Kehl	Modelling the treatment performance of activated sludge plants
M. Sc. Lukas Lesmeister	Treatment processes for removal of PFASs (TZW)
M. Sc. Maximilian Miehle	Bioproduction using biocatalyst for electrode assisted fermentation
M. Sc. Andreas Netsch	Energy-efficient bioelectrochemical waste water treatment
M. Sc. Nikhil Shylaja Prakash	Waste water biorefinery
M. Sc. Tim Schwarzenberger	Mono- and polychromatic UV disinfection (TZW)
M. Sc. Zhizhao Xiao	Bioelectrochemical systems
M. Sc. Stephan Zimmermann	Degradation of cytostatic drugs in water by oxidation processes (Dr. rer. nat. since Jul. 2024)

DVGW Research Center (Project Engineers)

M. Sc. Sophie Oeppling	Water management in PtX processes
M. Sc. Jan Singer	Hydrogen production in municipal water treatment plants
M. Sc. Jonas Ullmann	Microbially catalyzed hydrogen production from urine
Dipl.-Ing. Alina Schlösser	Extraction of lithium from thermal brines

Guest Researchers

B. Sc. Willow Neske	Waste water processing (USA; until July 2024)
Dr. Luis Pino Soto	Characterization of recycled and saturated reverse osmosis membranes (Chile; until March 2024)

Technical Staff

Axel Heidt	GC/ECD, GC/MS, IC, AOX
Rafael Peschke	HPLC, LC/MS, IC
Matthias Weber	LC/OCD, DOC/TOC

DVGW Research Center

Ulrich Reichert	ICP-MS, AAS, ICP-OES, IC
Reinhard Sembritzki	

Secretarial Office

Ursula Schäfer

DVGW Research Center

Sylvia Heck

Apprentices

Maya Frey
Julia Gretschmann
Melvin Herzog

RECENT PUBLICATIONS

Peer-Reviewed Publications

Du, R., Liu, Q., Xu, X., Horn, H., Cao, S., Peng, Y., 2024. Enhancing Competitiveness of Anammox Bacteria with Domestic Waste water as Electron Donor for Nitrate-Preferential Denitrification: Experimental Evidence and Metagenomic Mechanism, ACS Sustainable Chemistry & Engineering, 12, 2, 1007-1008.

Wang, Y., Feng, C., Guo, H., Sun, P., Zhu, T., Horn, H., Liu, Y., 2024. Permanganate (PM) pretreatment improves medium-chain fatty acids production from sewage sludge: The role of PM oxidation and in-situ formed manganese dioxide. Water Research, 249, 120869

Telgmann, L.; Horn, H., 2024. The behavior of pharmaceutically active compounds and contrast agents during waste water treatment – Combining sampling strategies and analytical techniques: A critical review. Science of The Total Environment, 946.

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From left to right: (first row) Matthias Weber, Rafael Peschke, ***Yair Morales, Jan Singer,*** *Mina Ahsani,* ***Mehran Aliaskari,*** *Mélanie Apitzsch-Delavault, Süheyla Duran, Andrea Hille-Reichel, Anna Lena Dahn, Michael Wagner, (second row) Melvin Herzog, Maximilian Miehle, Nikhil Shylaja Prakash, Zhizhao Xiao, Nurul Himma,* ***Stephan Zimmermann****, Stephanie West, Sylvia Heck, Florencia Saravia, Harald Horn. Members of Team EBI-FC are printed in bold. Additional members were Willow Neske and Andreas Netsch (front), Simardeep Sethi and Christopher Fischer (back).*

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Contact
Prof. Dr. Harald Horn
Chair of Water Chemistry and Water Technology and
DVGW Research Center at the Engler-Bunte-Institut of KIT

Engler-Bunte-Ring 9
76131 Karlsruhe, Germany

Phone: +49 721 608-42581
Fax: +49 721 608-46497
Web: https://wasserchemie.ebi.kit.edu/

All e-mail addresses have either the form:
name.surname@kit.edu or
name.surname@partner.kit.edu or
surname@dvgw-ebi.de

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