

REPORT

2nd TwiNSol-CECs Summer School on Innovative Technologies for Water Treatment: Removal of Micropollutants with Contaminants of Emerging Concern in Focus

University of Novi Sad, Faculty of Technology Novi Sad (TFNS)

Novi Sad, Serbia

June 8-12, 2024

The 2nd TwiNSol-CECs Summer School entitled “Innovative Technologies for Water Treatment: Removal of Micropollutants with Contaminants of Emerging Concern in Focus”, was organized by TFNS on June 08-12, 2024, as a part of activities planned within Work Package no. 3 “Reinforcing research knowledge and skills of TFNS” of the TwiNSol-CECs project (GA 101059867).

The 2nd Summer School was organized as a 5-day long scientific event at TFNS. It included both theoretical and practical sessions with the following main topics:

- Membrane Technologies
- Biosorption Technologies
- Advanced Oxidation Processes.

There were also parallel topics important for creation of international research projects and multidisciplinary research teams on the latest challenges in front of the transition towards a toxic free environment:

- Preparation and implementation of the Horizon Europe project
- Life Cycle Assessment: the most inclusive method to analyze environmental benefits and trade-offs resulting from complex systems

The Committees of the School, chaired by Prof. Zita Šereš (TFNS), consisted of the researchers from NOVA University of Lisbon (UNL), Lisbon, Portugal, and TFNS, as follows:

<u>Scientific Committee</u>	<u>Organizing Committee</u>
Prof. Dr. Joao Crespo, UNL* Dr. Vanessa Pereira, UNL* Dr. Carla Brazinha, UNL* Prof. Dr. Nataša Đurišić - Mladenović Dr. Vesna Vasić, TFNS Dr. Sanja Panić, TFNS Dr. Nikola Maravić, TFNS Dr. Ferenc Kiss, TFNS Dr. Dragana Lukić, TFNS Dr. Mirjana Petronijević, TFNS Dr. Igor Antić, TFNS	Prof. Dr. Biljana Pajin, TFNS Prof. Dr. Dragana Šoronja-Simović, TFNS Dr. Jelena Živančev, TFNS Dr. Ivana Lončarević, TFNS Dr. Jovana Petrović, TFNS Dr. Maja Buljovčić, TFNS Dušan Rakić, MSc, TFNS
<u>Committee for Summer School Grant Approval</u>	
Prof. Dr. Joao Crespo, UNL* Dr. Vesna Vasić, TFNS Dr. Nikola Maravić, TFNS	

The participants were selected according to the procedure accepted by the Project Steering Team. The Call for the 2nd TwiNSol-CECs Summer School was opened on December 21, 2023, with the deadline for receiving the applications on March 22, 2024. It was announced on the project website: <https://twinsol-cecs.com/index.php/news-events/51-announcement-of-the-call-2> and the project social media profiles: LinkedIn, Facebook, Twitter, Instagram.

The Committee for the Summer School's Applications and Grant Approval evaluated all the timely-received applications and the accepted applicants were informed about the Call results. Report on the evaluation is published at the project website: https://twinsol-cecs.com/images/documents/r3_3-report_on_2nd_summerschool_committee_on_grant_approvals.pdf

However, one vacancy arose after the withdrawal of one selected applicant from Western Balkan Country in May, and the applicant, who had been left without the grant during the Call procedure, was invited to join the School, which was accepted. On June 6, 2024, another grantholder withdrew from the 2nd Summer School, proposing the colleague from the same institution as a candidate interested to participate, which was accepted by the Organizing Committee.

In total, there were 10 grantholders whose place of residence is more than 80 km from Novi Sad, including those from Western Balkan countries other than Serbia, and there were 3 registered participants from the University of Novi Sad. There were 7 PhD students, 3 Assistant Professors, 1 Associate Professor, 1 Full Professor, 1 Senior Research Associate. 2 participants came from North Macedonia, 2 from Bosnia and Herzegovina; 2 were from University of Niš in Serbia, 3 from University of Belgrade, 1 from University of Kragujevac, and 3 from University of Novi Sad.

The School theoretical lectures held in the Blue Hall of TFNS were opened for all interested researchers from TFNS. The lectures and practical sessions were delivered by TwiNSol-CECs researchers from the NOVA University Lisbon (UNL), Portugal; Faculty of Engineering, University of Szeged, Hungary; Public Utility Company on Waterworks and Sewerage from Subotica, Serbia; Institute of Food Technology Novi Sad, and TFNS. The Program of the School is attached to the Report.

On the first day of registration, all grantholders and registered participants from the University of Novi Sad received a promotional package. This package included bags containing the following items: the 2nd Summer School program, a project brochure, a pencil, a notebook, a folder, and a USB drive. All items were marked with the mandatory visual elements to identify the funding source, the EU, and the project itself. Participants signed the attendance lists daily. By signing, they granted permission and consent to the TwiNSol-CECs team to use photographs or electronic media images taken at the 2nd TwiNSol-CECs Summer School for any legal presentation purposes. Additionally, they consented to have their email addresses added to the mailing list for project information and event invitations. Participants were also given the option to withhold their personal data and photos from being used.

The breaks for refreshments and lunch during the five-day school program, as well as the official dinner, were fully covered by the project budget. Additionally, there was a social event organized by TFNS: a guided tour of Novi Sad with a professional tourist guide.

In accordance with the 2nd Summer School Program (outlined in Annex I of the Report), the 2nd TwiNSol-CECs Summer School commenced with a welcome speech by Prof. Biljana Pajin, Dean of TFNS. Prof. Pajin, who is also responsible for administrative, financial, and legal issues as the Project

Manager and WP6 leader, emphasized the significance of enhancing institutional, national, and regional excellence of TFNS through TwiNSol-CECs. Following her speech, Prof. Zita Šereš, Vice-dean for Science at TFNS and the Project Manager for strategic issues, highlighted the importance of the TwiNSol-CECs summer schools, including the aims and topics of the 2nd Summer School. Prof. Nataša Đurišić-Mladenović, TwiNSol-CECs Project Coordinator, presented the main goals and the consortium of the TwiNSol-CECs project, underscoring the expected impact. Before lunch break, Igor Antić from TFNS delivered a lecture titled “Contaminants of Emerging Concern - What Is It All About?”. In the afternoon session on the first day, the registered participants introduced themselves, emphasizing the motivation to participate in the Summer School.

On the second day of the Summer School, Dr. Joao Crespo from UNL gave a presentation on “Fundamentals of Membrane Processes in Water Treatment.” Following this, Dr. Vanessa Pereira from UNL presented on “Advanced Technologies for Water Treatment and Reuse: UV Photolysis, Oxidation Processes, and Membrane Filtration.” After a coffee break with refreshments, Dr. Szabolcs Kertesz from the Faculty of Engineering, University of Szeged, introduced the participants to the topic “Potential Strategies for Reducing Fouling in Low-Pressure Membrane Systems.” The day concluded with an official dinner at a restaurant near the Faculty.

The third day of the Summer School began with a lecture titled “Heavy Metal Pollution in the Aquatic Environment: Sources and Effects,” presented by Dr. Vesna Vasić from TFNS. Following this, Dr. Dragana Lukić, also from TFNS, explained basics of biosorption in removal of heavy metals from water systems in the presentation, “Heavy Metal Pollution in the Aquatic Environment: Biosorption as a Solution and Its Challenges.” After a coffee break, Dr. Petar Pižurica from the Public Utility Company from PUC Subotica introduced participants to wastewater treatment in the City of Subotica. This lecture was followed by lunch break, after which practical lessons were conducted. In the first part of the practical session, there was a demonstration of cross-flow filtration using ultrapure water samples in a filtration unit with a ceramic membrane. The demonstration included setting up operating conditions such as transmembrane pressure, cross-flow velocity, and permeate flux. In the second part, dead-end filtration of ultrapure water spiked with methylene blue was performed using the METCell filtration unit. The retention and recovery of polyphenols were calculated based on spectrophotometric measurements.

On the fourth day of the 2nd Summer School, Dr. Sanja Panić from TFNS began with a presentation titled “Historical Development of Carbon (Nano)materials and Their Catalytic Applications for the Removal of Contaminants of Emerging Concern from Wastewater.” Following this, Dr. Mirjana Petronijević delivered a lecture on “Utilization of Enzyme-Based Biocatalytic Processes for CECs Removal from Water.” After a coffee break, the participants attended two more lectures. The first was by Dr. Sanja Panić, who explained the “Design and Synthesis of Carbon-Based Heterogeneous Catalysts as Persulfate Activators for the Removal of Contaminants of Emerging Concern from Wastewater.” The final lecture of the day was by Dr. Aleksandra Mišan from the Institute of Food Technology in Novi Sad, on “The Employment of Microalgae in Nutrients and Pollutants Removal from Wastewater.” In the afternoon session, practical lessons were conducted. Participants tested different materials as potential biosorbents for the removal of the dye methylene blue in batch mode using a laboratory shaker. The

first part of practical session covered various factors influencing the biosorption process, such as contact time, dose, particle size, initial concentration of the pollutant, and pH. Initial and residual concentrations were measured spectrophotometrically, and participants calculated the adsorption capacity and removal efficiency. The session also included the presentation and interpretation of the experimentally obtained data and a demonstration of adsorption in a column. The second part of practical lessons implied the application of three types of advanced oxidation processes – UV, UV/H₂O₂ and heterogeneous catalytic persulfate oxidation for the removal of dye methylene blue from the aqueous solution. Each participant calculated the removal efficiency of dye in each process using the UV-Vis spectrometric data. All the equipment present in the laboratory for physical chemistry and catalysis of TFNS (pyrolysis oven, high energy ball mill, equipment for carbon nanotubes synthesis, UV reactor, etc.) was also presented and explained to participants.

On the last day of the Summer School, Dr. Ferenc Kiss from TFNS concluded the theoretical part of the program with a lecture titled “Life Cycle Assessment of Advanced Wastewater Treatment Technologies”, which was followed by a very interesting discussion of the participants with the lecturer on carbon footprint of wastewater treatment and in general of environmental protection technologies. Afterwards, a coffee break with refreshments was organized, which was a perfect opportunity to continue discussion on various topics and issues raised during the School. The participants were asked to complete a questionnaire about the School's organization. The results of the questionnaire are presented in Annex II. Before the lunch, Prof. Nataša Đurišić-Mladenović summarized all the information presented during the School and handed out attendance certificates to the participants.

Selected photos taken during the 2nd TwiNSol-CECs Summer School are available in Annex III of the Report.

Disclaimer

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Annex I

2nd TwiNSol-CECs Summer School

Innovative Technologies for Water Treatment: Removal of Micropollutants with Contaminants of Emerging Concern in Focus

**University of Novi Sad, Faculty of Technology Novi Sad (TFNS)
Novi Sad, 8-12 June 2024**

Program

Saturday – 8 June, 2024

10:00 – 10:30 Registration
10:30 – 10:40 Biljana Pajin, Dean, TFNS – **Welcome speech**
10:40 – 10:55 Zita Šereš, Chair of the Summer School, TFNS – **About the Summer School**
10:55 – 11:25 Nataša Djurišić Mladenović, Coordinator of TwiNSol-CECs, TFNS – **Horizon Europe twinning projects – TwiNSol-CECs from application to implementation**
11:25 – 12:00 Igor Antić, TFNS - **Contaminants of emerging concerns- What is it all about?**
12:00 – 13:00 *Lunch with coffee*
13:00 – 14:00 “Ice breaker” session – introduction of the attendees (5 minute-ppt presentation per attendee)
18:00 – 20:00 *Organized city tour*

Sunday – 9 June, 2024

9:30 – 10:00 Registration
10:00 – 10:45 Joao Crespo, NOVA School of Science and Technology, NOVA University Lisbon – **Fundamentals of Membrane Processes in Water Treatment**
10:50 – 11:35 Vanessa Pereira, Institute of Experimental and Technological Biology, NOVA University Lisbon – **Advanced Technologies for Water Treatment and Reuse: UV Photolysis, Oxidation Processes, and Membrane Filtration**
11:40 – 12:40 *Coffee break with refreshments*
12:40 – 13:25 Szabolcs Kertesz, Faculty of Engineering, University of Szeged – **Potential strategies for reducing fouling in low-pressure membrane systems**
18:00 – 21:00 *Welcome dinner (timing to be confirmed)*

Monday – 10 June, 2024

9:30 – 10:00 Registration
10:00 – 10:45 Vesna Vasić, TFNS – **Heavy metal pollution in the aquatic environment: sources and effects**
10:45 – 11:30 Dragana Lukić, TFNS – **Heavy metal pollution in the aquatic environment: Biosorption as a solution and its challenges**

11:30 – 12:00 *Coffee Break*

12:00 – 12:30 Petar Pižurica, Wastewater treatment plant, PUC Subotica Waterworks and Sewerage
–**Wastewater treatment in the City of Subotica**

12:30 – 13:30 *Lunch*

13:30 – 16:00 Practical lessons

Tuesday – 11 June, 2024

9:30 – 10:00 Registration

10:00 – 10:30 Sanja Panić, TFNS - **Historical development of carbon (nano)materials and their catalytic applications for the removal of contaminants of emerging concern from wastewater**

10:30 – 11:00 Mirjana Petronijević, TFNS – **Utilization of enzyme-based biocatalytic processes for CECs removal from water**

11:00 – 11:30 *Coffee Break*

11:30 – 12:00 Sanja Panić, TFNS – **Design and synthesis of carbon-based heterogeneous catalysts as persulfate activators for the removal of contaminants of emerging concern from wastewater**

12:00 – 12:30 Aleksandra Mišan, Institute of Food Technology in Novi Sad – **The employment of microalgae in nutrients and pollutants removal from wastewater**

12:30 – 13:30 *Lunch*

13:30 – 16:00 Practical lessons

Wednesday – 12 June, 2024

9:30 – 10:00 Registration

10:00 – 10:45 Ferenc Kiss, TFNS - **Life cycle assessment of advanced wastewater treatment technologies**

10:45 – 11:30 Presentation of the attendees (to be confirmed)

11:30 – 12:30 *Coffee with refreshments*



12:30 – 12:45 Questionnaire on the School organization

12:45 – 13:00 Certificates award

13:00 – 13:15 School Wrap-up

Annex II

Print screen of two pages of Questionnaire on the 2nd TwINSol-CECs Summer School

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SUMMER SCHOOL EVALUATION SURVEY

2nd TwINSol-CECs Summer School on Innovative Technologies for Water Treatment: Removal of Micropollutants with Contaminants of Emerging Concern in Focus

Organized within TwINSol-CECs project (GA101059867)

University of Novi Sad, Faculty of Technology,
June 8-12, 2024

<p>1. How would you rate the overall quality of the 2nd TwINSol-CECs Summer School on Innovative Technologies for Water Treatment: Removal of Micropollutants with Contaminants of Emerging Concern in Focus</p> <p>a) Excellent b) Good c) Average d) Poor e) Very Poor</p>
<p>2. Did the Summer School meet your expectations in terms of content coverage?</p> <p>a) Yes, it exceeded my expectations b) Yes, it met my expectations c) No, it fell short of my expectations</p>
<p>3. Which specific lecture/activity did you find most valuable during the Summer School?</p>
<p>4. How likely would you to attend the TwINSol-CECs Summer School again?</p> <ul style="list-style-type: none"> • Very likely • Likely • Neutral • Unlikely • Very unlikely
<p>5. Do you have any suggestions or comments for improving the 2nd TwINSol-CECs Summer School on Innovative Technologies for Water Treatment: Removal of Micropollutants with Contaminants of Emerging Concern in Focus?</p>




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<p>6. Would you attend Summer School if there were no grants for attendees?</p> <p>a) Yes b) No</p>
<p>7. Would you attend Summer School if there was a registration fee for attendees?</p> <p>a) Yes b) No</p>

Thank you for your participation!

Assessment of the completed questionnaires

11 questionnaires were completed.

1. Question “How would you rate the overall quality of 2nd TwINSol-CECs Summer School on Innovative Technologies for Water Treatment: Removal of Micropollutants with Contaminants of Emerging Concern in Focus” all the participants answered **excellent**.
2. Question “Did the 2nd Summer School met your expectations in terms of content coverage?” 9 participants answered that the Summer School **exceeded their own expectations**, while 2 participants felt that their **expectations are met** by the Summer School
3. Question “Which specific lecture/activity did you find the most valuable during the Summer School?” was answered with different answers, with 2 participants answered that the lecture “**Contaminants of emerging concerns- What is it all about?**” was the most valuable, 1 participant answered that **practical lessons** were the most valuable, 1 participant answered that the lesson “**Life cycle assessment of advanced wastewater treatment technologies**” was the most valuable, while the others answered that **all lectures** were equally valuable.
4. Question “How likely would you attend the 2nd Summer School again” 9 participants answered with **very likely**, while 2 answered with **likely**.
5. Question “Do you have any comments or suggestions on improving 2nd Summer School on Innovative Technologies for Water Treatment: Removal of Micropollutants with Contaminants of Emerging Concern in Focus” 2 participants answered that they would like **more practical lessons**, while the others answered that everything was **great/excellent**.
6. Question “Would you attend the Summer School if there were no grants for attendees?” all participants answered with **yes**.
7. Question “Would you attend the Summer School if there were registration fee for attendees?” 9 participants answered with **yes**, while 2 answered **no**.

Annex III

Selected photos during the Summer School



Welcome speech of Prof. Biljana Pajin, Dean of TFNS, on opening of 2nd TwINSol-CECs Summer School



Presentation of TwINSol-CECs project by Prof. Nataša Đurišić-Mladenović



Lecture of Dr. Igor Antić



Official dinner for the registered participants, lecturers, and the Organizing Committee members



Lecture of Dr. Joao Crespo



Lecture of Dr. Vanessa Pereira



Participants and organizers of the 2nd Summer school in front of TFNS



Lecture of Dr. Szabolcs Kertesz



The lecture of Dr. Vesna Vasić



The lecture of Dr. Dragana Lukić



The lecture of Dr. Petar Pižurica



The first Practical lessons of 2nd Summer School



The lecture of Dr. Sanja Panić



The lecture of Dr. Mirjana Petronijević



The lecture of Dr. Aleksandra Mišan



The second Practical lessons of 2nd Summer School



The lecture of Dr. Ferenc Kiss



At the very end of the 2nd TwiNSol-CECs Summer School after the certificates award

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