POLITECNICO DI MILANO

PhD in INGEGNERIA AMBIENTALE E DELLE INFRASTRUTTURE / ENVIRONMENTAL AND INFRASTRUCTURE ENGINEERING - 40th cycle

Research Area n. 3 - Environmental and Hydraulic Engineering and Geomatics

THEMATIC Research Field: REMOVAL STRATEGIES FOR CONTAMINANTS OF EMERGING CONCERN IN WASTEWATER BASED ON QUATERNARY TREATMENTS

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	The European Union's Urban Wastewater Treatment Directive (UWWTD) has long served as a regulatory framework for addressing traditional pollutants in wastewater. However, the widespread occurrence of micropollutants in wastewater has introduced new environmental challenges. Wastewater treatment plants (WWTPs) are not designed to remove these contaminants, leading to their accumulation in the environment, posing risks to aquatic ecosystems and human health. The recent revision of the UWWTD mandates the adoption of quaternary treatments to address these threats, creating a pressing need for effective removal strategies. The objective of this project is to establish a comprehensive framework for the management of micropollutants contamination in WWTPs, encompassing all aspects from their occurrence to their effective removal. The project will provide strategic insights and recommendations for the efficient implementation of quaternary treatments, taking into account not only their removal efficiencies but also the residual environmental risks and associated costs of these advanced processes. This holistic approach will contribute to enhance WWTP performance in compliance with the revised UWWTD and safeguard water resources.

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Methods and techniques that will be developed and used to carry out the research	To tackle the challenge of emerging contaminants in wastewater the PhD project is structured around three core components: (1) large-scale monitoring campaigns to assess micropollutants occurrence and degradability in WWTPs, (2) advanced fate modelling to predict micropollutants behaviour through the current and future treatment stages, and (3) laboratory experiments to optimize quaternary treatments, particularly adsorption using sustainable materials, to find the best solution for the targeted micropollutants.The first step will involve large-scale monitoring campaigns across different WWTPs to map the occurrence, concentration, and persistence of micropollutants. They will provide a comprehensive understanding of the occurrence and resistance of micropollutants to conventional biological treatment, identifying priority compounds that require advanced treatment solutions and for understanding the factors influencing micropollutant removal. Building on the monitoring data, advanced fate modelling will be used to simulate the transport, transformation, and potential removal of micropollutants across the entire WWTP. These models will predict how micropollutants behave in different treatment conditions, including variations in WWTP influent, design and operational parameters. The outcome will inform the design of optimized treatment strategies and guide the selection of the best quaternary treatment options for each WWTP. Laboratory experiments will focus on optimizing quaternary treatments, particularly adsorption, for the removal of targeted micropollutants. Ozonation will be studied to assess its impact on the adsorption process performance. The experiments will aim to identify the most effective materials and conditions to maximize removal efficiency, while minimizing environmental risks and costs. This integrated approach, combining field data, predictive modelling, and lab-based optimization, will provide a robust framework for improving micropollutants removal in WWTPs and advancing sustainable water treatment technologies.The outcomes of this research are expected to contribute to several Sustainable Development Goals

	(SDGs), particularly SDG6, ensuring availability and sustainable management of water and sanitation for all. Additionally, the project will support SDG3 by promoting health and well-being through improved water quality and SDG12 by fostering responsible patterns in wastewater management practices.It is requested to the PhD student: i) to be autonomous in transferring to the sites selected for the research by car (no public transportation available to the WWTP managed by Gruppo Hera); ii) to have a basic knowledge of Italian in order to interact with plant technicians; iii) to be able to write technical reports in Italian.
Educational objectives	The main objective is the formation of professionals who can: - develop autonomous research and become experts in environment-related topics, - plan and design interventions, - assess their implications on the environment and human health. The PhD student will take advantage from internal know-how transfer and from the continuous exchange with the experienced senior members. Moreover, the researcher will have the opportunity to combine expertise collaborating with experts of Gruppo Hera, managing the integrated water system from which case studies are selected, to synergistically exploit research and technical practice.
Job opportunities	Industrial sector (water and wastewater treatment and management, consulting), senior consultants for engineering companies, public bodies and authorities involved in environmental policies, research agencies and institutions.
Composition of the research group	0 Full Professors 1 Associated Professors 1 Assistant Professors 5 PhD Students
Name of the research directors	Manuela Antonelli

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Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

Educational activities (purchase of study books and material, funding for participation to courses, summer schools, workshops and conferences): the Ph.D. programme supports the educational activities of its Ph.D. students with an additional funding equal to 10% of the scholarship, starting from the first year.

Teaching assistanship (availability of funding in recognition of support to teaching activities by the PhD student): there are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.

Computer availability and desk availability: 1st year +2nd year +3rd year: individual use.