***Justification for the research topic***

Water treatment systems are increasingly facing challenges related to the presence of emerging contaminants, including microplastics (MPs), which are now widespread in aquatic environments. Previous studies have shown that MPs can release various toxic chemical additives from their structure, particularly when exposed to strong oxidizing agents commonly used in water disinfection processes, such as chlorine, ozone, or ultraviolet (UV) radiation. Over 16,000 different substances can be used in the production of plastics, yet only about 6% of them are subject to international regulations. Plastics contain various additives such as fillers, stabilizers, plasticizers, dyes, pigments, antistatic agents, antioxidants, and flame retardants, which influence their functional properties. Many of these substances have **harmful effects on the endocrine system and are associated with an increased risk of health disorders, including infertility, obesity, and cancer.**

However, there is still a lack of comprehensive data on how process parameters and MPs' properties influence the emission of contaminants from their structure. This knowledge gap limits the ability to design effective methods for preventing contamination of drinking water. The use of natural and modified sorbents, such as magnetite, offers a promising alternative to conventional water treatment methods by enabling both the physical removal of MPs and the reduction of harmful substance release from their structure.

***Project objective***

The aim of the project is to **analyze the impact of water disinfection processes on the emission of toxic substances from MPs** and **to develop strategies for minimizing this phenomenon using natural sorbents.** The project involves examining the effects of various disinfection methods and their operational parameters on the intensity of chemical migration from MPs and on the formation of disinfection by-products (DBPs). Simultaneously, the efficiency of natural and modified sorbents in removing MPs and limiting the release of toxic additives from plastic materials will be assessed. Another key goal is **the development of a predictive model of pollutant emission using machine learning techniques**, which will enable the identification of critical factors affecting contaminant levels and the optimization of process conditions to minimize the risk of secondary water contamination.

***Research description***

The project will include experimental studies aimed at assessing the impact of water disinfection processes (UV radiation, ozonation, chlorination) on the emission of toxic compounds from MPs and identifying the resulting disinfection by-products. The research will involve different types of MPs with varied physicochemical properties and particle sizes. Experiments will be conducted under a wide range of process conditions, including different pH levels, MPs concentrations, contact times, and the presence of natural organic matter. In the subsequent phase, the effectiveness of sorbents - both natural magnetite and its modified forms—will be evaluated in terms of MPs removal and reduction of toxic compound migration. Based on the collected data, a predictive emission model will be developed using machine learning techniques.

***Expected results***

The project will provide **a detailed understanding of the effects of various water disinfection methods on the migration of toxic substances from MPs and the formation of disinfection by-products.** An important outcome will also be **the evaluation of the effectiveness of natural and modified sorbents -** particularly magnetite and its modified forms - in removing MPs and limiting the release of toxic additives. Based on the data obtained, **an innovative predictive model using machine learning methods will be developed** to allow efficient forecasting of pollutant emissions **and the optimization of disinfection and sorption conditions.** This model will serve as a tool to support the design of safe and effective water treatment processes.