The main scientific goal of the project is to analyze the impact of aging microplastics (MPs) on the effectiveness of coagulation. Aging will include both abiotic and biotic factors separately, as well as the impact of all factors to ensure conditions close to those in the environment. Although coagulation is a well-known and widely used technique for removing suspended particles, there are no detailed data on its effectiveness in eliminating MPs. The research available on the removal of MPs by coagulation is in a preliminary stage, and little research is available on the mechanism and effectiveness of removal and the factors that increase the efficiency. A significant limitation of the research conducted so far on the coagulation process to eliminate MPs is the following:

(1) removal of only one type of MPs, while in the environment there is a mixture of particles differing primarily in composition, but also in size and shape,

(2) ignoring the fact that MPs present under environmental conditions are transformed/aging under the influence of abiotic and biotic factors. These particles then change not only their appearance, size/mass or density but also their surface and chemical composition. These changes may have both positive and negative effects on the efficiency of microplastic elimination in the coagulation process.

The second goal is to use natural and ecological coagulants to remove primary and aged microplastics present in a mixture of various types of polymers of various sizes and shapes. Most of the available research concerns the use of conventional (chemical) coagulants. Although coagulation appears to be a promising technique for water treatment, the chemical coagulation process has drawbacks, such as excessive and toxic sludge production and high production cost. Most inorganic coagulant sources are corrosive, consume large amount of energy and are also very expensive. To overcome these shortcomings, the feasibility of alternative coagulants should be investigated.

The third goal of the project is to optimize the coagulation process, use artificial neural networks to predict optimal parameters, and analyze the costs of the coagulation process. One of the main challenges in using coagulation processes is the selection of experimental conditions that can be implemented to ensure effective treatment. Many factors influence the effectiveness of coagulation, and the selection of optimal parameters of the coagulation process plays aa important role in the costs of operating the wastewater treatment plant. For these reasons, process optimization became necessary. Using traditional optimization, the optimal value for each variable is achieved by changing one factor while keeping all other factors constant. The disadvantage of this method is that it is time consuming and does not allow one to examine the impact of interactions between the variables studied. The results of many studies conducted in recent years have shown that it is possible to create a model that allows for the prediction of optimal conditions. The advantage of artificial neural networks (ANNs) in solving this type of problems is the fact that, to a greater extent than physical models, they have the ability to reproduce non-linear relationships between various data included in the model. Economic and environmental impact analysis is a common decision-making tool that is used to determine the practical feasibility of any existing or new technology. There is no data on the optimization of coagulation processes and cost assessment. The cost of purification should be as low as possible while maintaining an appropriate degree of purification to ensure effective commercialization of coagulation technology. Determining the optimal conditions for the coagulation process is crucial in calculating the total cost. It is also important to conduct a postprocess coagulant recovery cost analysis to determine the feasibility of using alternative coagulants on a large scale.

The research will be conducted under laboratory conditions using artificially prepared and real water samples (distilled, surface, and rainwater). Water samples will be enriched with microplastics that have previously been subjected to various aging methods. Primary microplastics purchased in the form of particles <5 mm and larger plastic fragments crushed to appropriate sizes will undergo abiotic and biotic aging as well as physicochemical and catalytic processes. The following aging methods are planned to be used: mechanical stress, thermal oxidation, UV aging, chemical treatment, physicochemical and catalytic processes (ozonation, Fenton process, photocatalytic oxidation, ultrasound) and colonization by microorganisms.

The implementation of the project will significantly expand knowledge in the field of environmental sciences and environmental engineering in three aspects:

(1) new and unique information will be obtained about the impact of environmental factors and the impact of physicochemical processes on the properties of microplastics;

(2) the research results will contribute to expanding knowledge about the possibility of replacing toxic and chemical coagulants with ecological and waste materials;

(3) the method of optimizing the coagulation process in this project can be used to design other water and wastewater treatment processes.