Siloxanes are a group of chemical compounds, linear or cyclic, whose silicon atoms are connected by covalent bonds with oxygen atoms. Siloxane molecules may contain hydrocarbon groups that are bonded to silicon atoms. Siloxanes can differ significantly in molecular weight and volatility. Due to some advantageous properties (plasticity, good spreading over the surface of human skin, physiological inertness), siloxanes are used in the production of cosmetic products for softening, smoothing and moisturizing the skin and hair, and their production is increasing. For obvious reasons, after use, siloxanes become a component of municipal sewage, from which biogas is produced, which is used as fuel in engines used in the so-called cogeneration of electricity and heat. Due to the significant volatility of some siloxanes, they become a component of biogas. Combustion of biogas containing siloxanes in engines results in a significantly increased failure rate of these devices. Therefore, siloxanes are removed from the biogas, which is typically done by their adsorption on activated carbon beds. Adsorption processes are burdened with disadvantages in the form of periodic operation and the occurrence of competitive adsorption/desorption, which results in the release of adsorbed molecules of some siloxanes from the adsorbent as a result of adsorption of others. Other methods of removing siloxanes from biogas (absorption in solvents, use of adsorbents alternative to activated carbon, membrane techniques and chemical methods) are known but not used.

The main goal of the project is to identify the possibilities and study the mechanism of photocatalytic conversion of siloxanes (linear and cyclic) in the aqueous phase, using titanium dioxide as a photocatalyst. Conversion of siloxanes in the liquid (aqueous) phase using the photocatalytic process is a process for which there are no literature reports. There are literature reports on the photocatalytic oxidation of some siloxanes, but they concern only the process carried out in the gas phase (air), with the effect of deactivation of the photocatalyst by the formed SiO2. Such a gap in knowledge makes it necessary to undertake research by conducting the photocatalytic process in the aqueous phase. Therefore, the project plans to conduct research that will answer several questions that are the project's objectives. It is planned to investigate whether - and if so - according to what mechanism the photocatalytic conversion of siloxanes takes place in the liquid phase. Studies of the decomposition of siloxanes will be carried out in a batch reactor, in which a photocatalyst and siloxane will be introduced into the liquid phase, and the reaction mixture will be stirred and aerated. For comparative purposes, the tests will be carried out with and without UV radiation, while ensuring a constant process temperature. This will be accompanied by studies of chemical transformations of siloxanes, as well as the potential deactivation of the photocatalyst, including its causes and ways of preventing it. In order to avoid the deposition of silica on the TiO2 surface, it is planned to carry out the conversion of siloxanes with the addition of ammonia to the reaction system. It is also planned to investigate the effect of temperature and the properties of the photocatalyst on this process. It is planned to conduct research using commercially available photocatalysts that differ in phase composition and surface area. In addition to conducting research on the photocatalytic conversion/removal of siloxanes in the water phase, it is planned to recognize the possibility of mutual complementation of this process with photocatalytic decomposition in the gas phase on the photocatalytic bed. A particularly important element of the research will be checking the possibility of decomposition of cyclic siloxanes, the removal of which is the main problem.

The expected research results should be the basis for explaining the essence of the problem and give a general view of the photocatalytic conversion of siloxanes in water, and at least indicate the need for further research to fully understand the process proposed in the project.