

In January 2024, there was a nationwide change in available petrol at petrol stations. The previously available E5 fuel, which was available until the end of 2023, was replaced by E10, causing great interest and uncertainty among drivers and many adult citizens. E10 contains twice as many biocomponents as E5 — 10% compared to 5% while maintaining the same octane number (95). This reform aims to reduce the negative environmental impact of the transport sector and decrease the European Union countries' dependence on fossil fuels. Importantly, this change caused significant disruption not only in the consumer market but also in the industry. Fuel companies were forced to quickly revolutionize fuel production, including the production of the new, more biocomponent-rich fuel. This involved the need to increase the production of pure, anhydrous ethyl alcohol, which is a key component in biocomponents.

In the petrochemical industry, membrane separation technology, especially pervaporation, is used to produce anhydrous bioethanol. This process allows for the removal of residual water, which forms a difficult-to-separate azeotropic mixture with ethanol at high concentrations. Due to the weaker interaction of ethanol compared to water with a magnetic field, it is possible to use this dependence in membrane technology. Magnetic membranes containing particles that generate a magnetic field increase the efficiency of the pervaporation process. The application of magnetic membranes encountered numerous difficulties because magnetic particles tend to form aggregates in the membranes, resulting in their uneven dispersion and consequently uneven interaction of the membrane with the mixture being separated. Our project aims to solve this problem by applying an external magnetic field during membrane preparation, which has not been considered so far. As a result of this innovative approach, it is expected that appropriate magnetic channels will form throughout the membrane, improving the selectivity of water-ethanol separation.

Planned laboratory experiments will assess the impact of these channels on pervaporation efficiency. Membranes produced using conventional methods will be compared with those in which we will apply an external magnetic field. A detailed physicochemical analysis will also be conducted, including hydrophilicity, morphology, composition, and the modelling of molecule transport through the formed magnetic channels. This research will also include mechanical tests of the membranes, evaluating their durability and stability in long-term use. Additionally, it is planned to investigate how the efficiency of water-ethanol separation changes under different operational conditions, such as various feed temperatures and concentrations. Microscopic and spectroscopic techniques will also be used to precisely visualize the membrane structure and the distribution of magnetic particles within them.

We are convinced that the membranes obtained using an external magnetic field will prove to be competitive with those used today and will definitely improve the technology of water/ethanol mixture separation. Even more efficient magnetic membranes can significantly improve the bioethanol production process, which in turn will help reduce the production costs of new E10 fuels, increasing the availability of more environmentally friendly energy sources.