1. The purpose of the project

The aim of the research will be the development of a mathematical model for thermal separation of substances in innovative systems, in which energy consumption is estimated to be diametrically lower in comparison with the systems currently used. The existing limitations in the implementation of this type of innovative technologies result from the fact that there still fundamental aspects that have not been studied yet in the scope of thermal and flow phenomena occurring in the presence of mass transfer in the process of substance rectification in a complex geometry channels. This project, including the scope of basic research, is aimed to raise this issue and provide necessary scientific studies on the processes of heat and mass transfer in complex geometry. An additional effect of the actions undertaken in this proposal will also be the future development of new rectification technology.

2. Research carried out in the project

In this research, both the experimental and numerical approach will be used to study two-phase flows occurring in the complex flow geometry simultaneously with heat and mass transfer. The thermal interactions of the two-phase mixture streams through the channel walls will be analyzed. Numerical models will be verified experimentally. Finally, mathematical description of thermal-flow phenomena with simultaneous rectification of substances taking place in the channel will be formulated. The dynamic states of the system will also be taken into account.

3. Reasons for undertaking a given research topic

About 95% of all substance separation processes take place in distillation columns, and energy consumption accounts for 3% of global energy consumption. For this reason, energy-saving technologies for the separation of substances are sought for.

Authors intend to investigate and create a mathematical model for new approach to thermal separation of substances, taking into account the integration of phenomena that have not yet been considered simultaneously in this aspect, i.e. two-phase flow in a channel of complex geometry, where the vapors flow countercurrent to the liquid simultaneously with diaphragm heat transfer and substance rectification.

As a result of many years of work in the field of energy-saving and thermal integration, authors of the proposal estimated the potential savings in future technologies resulting in 2-3 times the reduction of energy consumption for the process maintenance.

The results of research can also be used as source data in research on innovative solutions for transfer of large heat fluxes in cooling systems for electronic equipment or in the miniaturization of heat exchangers and process systems.