The steady growth of energy needs, along with slow withdrawal from traditional energy production modes, i.e. burning of fossil fuels, creates demand for alternative energy sources. Since nuclear power plants require very high investment costs and take long time to build, there is more and more emphasis put on renewable energy sources. One of the leading trends in renewable energy, especially in Europe, is biogas.

Biogas is a result of anaerobic fermentation of organic matter, mainly agricultural waste, food scraps and sewage. It is composed mostly of methane and carbon dioxide, but often contains hydrogen, carbon monoxide, and other gaseous compounds in trace amounts. The most desired compound of the biogas is methane which, when concentrated, can be used as fuel. The so-called biogas enrichment is carried out by selective removal of fermentation byproducts, mostly carbon dioxide. There are several methods of biogas enrichment, like membrane separations, cryogenic distillation or pressure swing adsorption, but reactive absorption remains the number one separation process.

Reactive absorption is a process which combines interfacial mass transfer with chemical reaction. In principle, particular gas phase compounds migrate toward the liquid phase, where they subsequently react with the compounds present in the liquid phase. With a proper chemical system, the process of reactive distillation can achieve very high efficiency and selectivity without the need for extreme temperature or pressure conditions. However, traditional, that is stationary packed bed (column) absorption processes pose several drawbacks. As the liquid flow in columns is limited by the gravitational force, stationary packed bed processes offer relatively low mass transfer coefficients, as well as limited operational windows, especially in the case of viscous solvents. Therefore, the reactive absorption process can be significantly intensified with the use of rotating packed bed (RPB, see Figure 1), which substitute gravitational force with up to a thousand times higher centrifugal force. In RPBs, the phases flow in the radial direction, usually in counter-current regime. Due to high centrifugal acceleration, they offer very strong phase mixing and wide operational windows.

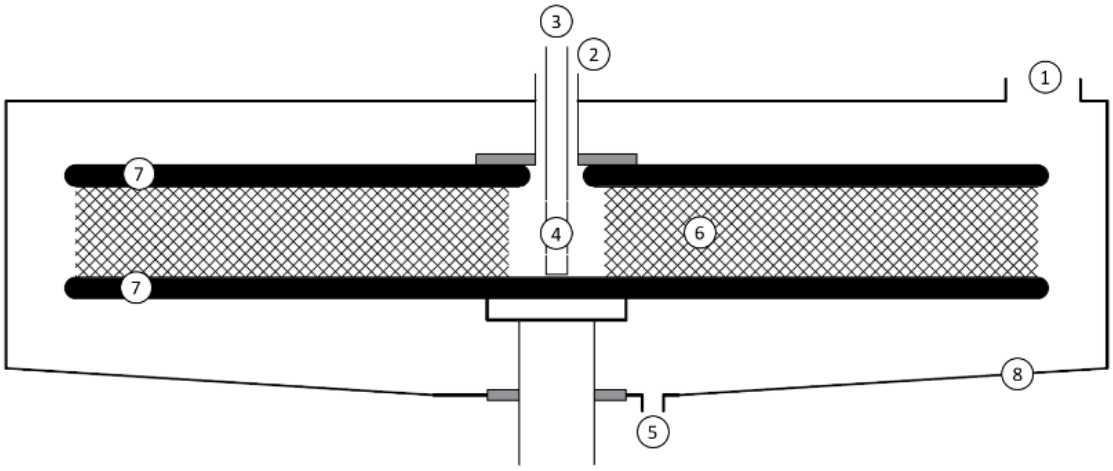

Figure 1. Schematic of an RPB apparatus: gas inlet (1), gas outlet (2), liquid inlet (3), liquid distributor (4), liquid outlet (5), packing (6), rotor plates (7), stationary casing (8).

In this project, rotating packed bed reactive absorption process will be investigated as a means for biogas enrichment. Different reactive systems will be tested for selective absorption of CO_2 with the use of RPB, and the process itself will be thoroughly tested for various process conditions, inlet gas compositions, packing types and sizes. The project will be carried out in trilateral cooperation between Lodz University of Technology, Technical University of Berlin, and Brno University of Technology, and the goal of the project will be to provide fundamental analysis of the rotating packed bed absorption process for the enrichment of biogas. The three-sided cooperation will allow RPB experts in various areas to thoroughly investigate the process in terms of chemistry, fluid dynamics, and process engineering.

The project will be divided into six major tasks. The first task will include solvent screening and investigation of reaction kinetics. The second one will be concerned mostly with the investigation of hydrodynamics in traditional and novel types of RPB packings. The following task will include preliminary absorption process investigations with the use of simplified, non-explosive gas mixture. Within the next task, a comprehensive hydrodynamic model of RPB will be developed. The following one will be concerned with rate-based modeling of the mass transfer. The final task will finalize the experimental section of the project with the investigation of enrichment of simulated biogas streams containing methane, and the resulting data will be used for model validation.