Hydrodynamic and process characteristics of an electromagnetic field-assisted absorption column

During 21st century, the development of technology has reached a speed that was never seen before in the history of humankind. Every day we learn about new inventions in every area of our life. Industrial development, the computerisation of society, sociological changes and constantly growing consumerism have contributed significantly to triggering the next industrial revolution. However, for the first time in history, this revolution seems to be sustainable. Despite a significant increase in production, we are simultaneously trying to reduce emissions of harmful substances and pollutants such as greenhouse gases and to recycle waste, not only household waste but also energy waste. Moreover, we have also started to recognise the consequences of our actions leading to the progressive devastation of the planet. This led to the idea of 'green industry,' that is idea of progressive reduction of emissions of hazardous substances until they are eliminated. The global consciousness began to accept the vision that, without a change in our attitude towards the environment, we might ourselves create a climate catastrophe. More than 27% of the world's greenhouse gases emissions is produced by the industrial sector, of which as much as 85% is CO_2, which with the help of today's technology can be 'captured' out of the waste stream to be used in the production of new products, significantly reducing emissions of hazardous substances and helping to limit further damage caused by humankind.

The aim of the project is to analyse the effect of an electromagnetic field on the process of absorbing pollutants in a new type of absorption column assisted by different types of electromagnetic field. The project also includes proposing a novel packing capable of increasing the efficiency of CO_2 capture from polluted post-process streams. An additional aim will be to study the effect of nanofluid, which consist of ferromagnetic particles added to a contaminant-absorbing liquid, on absorption in a magnetic field assisted column.

Chemical engineering is becoming increasingly concerned with miniaturising chemical apparatus, increasing the accessibility of novel solutions, and finding ways to increase production while reducing emissions of hazardous substances into the environment. The influence of electromagnetic fields on chemical and physical processes is of increasing interest to researchers. Many research groups from all over the world are making more and more discoveries every year relating to the influence of this force. We already know that the electromagnetic field affects water electrolysis, plant physiology and mass transfer processes. Nevertheless, we still do not know the mechanisms behind these interactions very well, which points to the need for further investigation.

Research conducted during this project will focus on the 'capture' of CO_2 particles from the atmosphere and their 'uptake' by different solutions. Studies will be performed on a standard column and a column equipped with an electromagnetic field generator, which will affect the process inside the proposed absorption column. Data collected during the tests will allow to describe the effect of the electromagnetic field on the chemical absorption, and further improvement of the process by changing the column packing, process parameters, type and induction of the electromagnetic field and the addition of nanofluid, will be aimed at finding the most effective method of removing the gas pollutants.

An expected outcome of the project is to describe the effects of different types of electromagnetic fields on the absorption of CO_2 and to design a new device aimed at increasing the efficiency of removing pollutants that are released into the atmosphere.