MODELLING CARBON DIOXIDE CAPTURE FROM FLUE GASES WITH CHEMICAL ABSORPTION

Dariusz ASENDRYCH
Institute of Thermal Machinery, Częstochowa University of Technology
Częstochowa, Poland

Continuous growth of CO_2 emission is one of the most important threats of today's power industry. Among the alternatives allowing to solve that problem, the post-combustion carbon capture and storage (CCS) technology seems to be a very promising option. With this method the flue gases flow through the absorber where CO_2 is captured by aqueous amine solution flowing countercurrently. Both phases pass through the packed bed where most of the chemical reaction occurs due to the enlarged contact area between phases. Decarbonised flue gases quit to the atmosphere while the loaded amine solution is recycled in the stripper with the use of the external heat. Released carbon dioxide is compressed and sent in liquid form to the storage location.

The method has been proved to be technically viable, however, its costs reduce the overall efficiency of the power plant cycle by 40-50%. In order to make it commercially attractive the process requires further exhaustive research investigations aimed at its optimisation, especially in terms of energy consumption.

The high complexity of the process makes it extremely difficult to investigate, that is why the so-far research has been mainly carried out with the use of experiments on pilot plants and simplified 0D or 1D modelling. The present project approaches the problem with the use of computational fluid dynamics (CFD) - the numerical tool enabling for a detailed insight into the process. The proposed numerical model treats the CO_2 capture as complex phenomenon including hydrodynamics of gas-liquid two-phase flow in an unstructured porous region, chemical reaction with accompanying thermal effects due to its exo-/endothermic character as well as water evaporation/condensation. The two-fluid Eulerian/Eulerian approach was implemented to describe the two-phase countercurrent flow. Special attention has been paid on adequate modelling of the flow through the porous region, deciding about the mass and heat transfer and in turn CO_2 capture efficiency.

The simulation results have been found to be in a good agreement with the experimental data from pilot CCS plant, proving the relevance of the model and its usefulness for industrial applications.