Institute of Chemical Engineering

Adres artykułu: https://iich.gliwice.pl/en/article/laboratory-of-reactors-and-catalytic-processes

Laboratory of Reactors and Catalytic Processes

Head

dr hab. inż. Anna Gancarczyk, professor of the institute

Staff

prof. dr hab. inż. Andrzej Kołodziej

dr inż. Marzena Iwaniszyn, assistant professor

dr inż. Mateusz Korpyś, assistant professor

dr inż. Katarzyna Sindera, assistant professor

mgr inż. Mikołaj Suwak, assistant

dr inż. Mirzokhid Abdirakhimov, assistant professor

Current research activities

Process engineering in catalytic reactors

Experimental work is conducted on mass, heat, and momentum transfer processes. In particular, these studies focus on air protection processes, including the oxidation of low-concentration methane, volatile organic compounds, nitrogen oxides, and hydrogen sulfide emitted into the atmosphere from gas streams in catalytic reactors. New catalyst supports are being developed to provide enhanced heat transfer, tailored to the specific requirements of each process, and manufactured using 3D printing techniques. Hybrid ceramic-metallic packings are also being developed to improve both mass and heat transfer, particularly for processes requiring precise temperature control. At the same time, theoretical studies are carried out, including reactor modeling using simplified pseudo-homogeneous or heterogeneous models, as well as process modeling of pollutant removal from gas streams in computational environments such as Aspen and gPROMS.

CAD and CFD modeling in chemical reactors

CAD (Computer-Aided Design) and CFD (Computational Fluid Dynamics) modeling are employed to simulate transport and flow phenomena, including chemical reactions, occurring within chemical reactors. Numerical modeling of mass, heat, and momentum transfer is carried out in structured reactors (e.g., monoliths, short-channel or 3D cellular structures, woven or expanded metal meshes) as well as in packed-bed reactors (e.g., spheres, rings, disks, or rosettes). Furthermore, modeling tools are used to optimize the geometry of existing packings—including their shape, dimensions, and arrangement within the reactor—and to develop innovative reactor internals tailored to the specific requirements of individual processes. These include biomimetic structures inspired by fish gills, as well as advanced 3D architectures based on fractal geometries such as Menger cubes.

Mitigation of methane emissions from mine ventilation Air

Research on the oxidation of low-concentration methane–air mixtures addresses the ongoing challenge of methane emissions in the form of Ventilation Air Methane (VAM), which is released into the atmosphere through ventilation shafts of hard coal mines. Experimental studies are conducted using various ceramic packings, both catalytic and non-catalytic. The investigations are performed for high-purity gas streams as well as for mixtures containing significant amounts of water vapor and particulate matter. Operating conditions of the reactor that enable complete methane oxidation are identified, and the tested packings are evaluated for their resistance to high temperatures in the reaction environment and their operational stability in the presence of solid contaminants. Furthermore, kinetic studies of both thermal and catalytic oxidation processes are carried out. The experimental results serve as a basis for validating mathematical models that describe the phenomena occurring in chemical reactors.

Synthesis and modification of zeolites

Zeolites, owing to their distinctive physicochemical properties—including porous structure, thermal stability, high specific surface area, adsorption capacity, and catalytic activity—are widely used in numerous processes as adsorbents, ion exchangers, and catalysts. Current research focuses on the synthesis of new zeolites or the modification of existing ones to obtain structures with precisely tailored properties. Zeolite synthesis is performed using natural kaolin as a raw material, employing conventional hydrothermal methods and alkaline fusion. The materials are further functionalized with selected metals, including Ag, Cu, Zn, and Co, to enhance their performance in targeted applications. The developed zeolites are evaluated for applications such as the removal of hydrogen sulfide from ventilation air or natural gas, the catalytic oxidation of that gas, and the adsorption of CO2.

Metryczka

Created by:	Head: dr hab. inż. Anna Gancarczyk
Published at:	17.06.2025 14:29
Last edited by:	Marek Tańczyk
Last edited at:	07.05.2026 15:28
Number of views:	158