Popular abstract

Catalysis is a queen of sciences. The majority of chemical processes running in the industry is accelerated by catalysts. It goes without saying that catalysis makes our modern world go round. However, for many years technological developments in chemical reactors remained in the enormous disparities in relation to microprocessors, without which the modern civilization also fails. While the structure of microprocessors is controlled down to the atomic scale, catalysts manufacturing for years has stayed far behind which in practice means that catalysts in form of sand grains would be placed in a reactor by an ordinary shovel. Today, about catalytic reactors, we have been beginning to think as of microprocessors. This has become possible thank to a new concept for reactor internals of premeditated geometry. These are the so-called structured reactors. Moving towards smaller scale than that available to a bare eye, modern chemists can juggle atoms and molecules to give them a certain arrangement in this way tuning their properties. Therefore the structure of the reactor can be controlled from the macro to atomic scale. All this to produce more and with higher efficiency.

In this project we have come up with the idea of structured catalytic converters in form of metallic foams that are used as catalyst carriers in the process of methane combustion. Why structured reactors? They provide an opportunity for free process scale-up, as a phenomenon description in a single unit cell of the geometrical structure can be multiplied and expanded to whole reactor filled with it. Why foams? An amazing and nowadays already classic solution for structured reactor internals are ceramic monoliths as for example those used as catalysts in automobiles. But even these have their drawbacks. Foams allow much better mixing of the reactants inside the structure of caves through which the reactants pass than the ceramic monoliths. Better mixing means a more efficient process. Why methane? Methane cannot be underestimated as the most widespread fossil fuel that produces the least amount of carbon dioxide out of all possible hydrocarbons obtained from petroleum, including gasoline. On the other hand methane being released to the air from refineries or engines causes 20 times higher greenhouse effect than carbon dioxide. Thus a reasonable method to reduce its concentration in air seems catalytically enhanced burning. Methane, however, does not burn easily even in the presence of the most efficient noble metal catalysts due to outstanding stability of the fully symmetric molecules. To be combusted it still requires high temperature and concentration. Then a question arises how to get rid of it when only little fraction of it flows at a high rate from chimneys, ventilation systems or pipes.

What we offer in this project is the design of the structured catalytic reactor based on metallic foam internal with the non-noble metal catalyst. To achieve it all the parameters of the reactor geometry and flow inside it, parameters of catalyst layering on top of foams surface and properties of the catalyst structure should be tuned and correlated with each other.