1. Reasons for attempting a particular research topic

Every year, several million people die globally because of air pollution.[1] These deaths are caused indirectly - by diseases of the respiratory system (such as cancer and chronic obstructive pulmonary disease), the heart (ischemic disease) or stroke.[1] The International Agency for Research on Cancer (IARC) has now classified air pollution in group 1 of carcinogenity.[2] What's more, studies have been carried out to prove the genotoxic effect of pollutants contained in the ambient air on reproductive cells.[3] These impurities include, among others, nitrogen oxides, sulphur oxides, PM_{10} and $PM_{2.5}$ suspended particulates. Their source may be, for example, industrial plants, passenger cars and improperly incinerated waste. Taking into account the annual global production of cars (50 million units) and estimates that there will be approximately 1.3 billion used cars in the world in 2030,[4] the issue of more effective air purification seems to be particularly important.

2. The project goal

The aim of the project is to assess the possibilities of catalyst improvement, particularly of those applied to air purification. The data quoted in the paragraph above show an urgent need to improve the catalysts. This is not only about efficiency, but also concerns availability and price. The use of catalysts does not only cover health-related applications. Catalysts make it possible to obtain products used in the chemical and cosmetic industries much faster. Catalysts are increasingly used *in situ* - in the places where emissions are generated (for example, in cars and mines). Such applications require reactors of reduced size and increased catalyst efficiency.

Catalysts consist of two main elements - a substance that allows faster reaction (the catalytic phase) and a carrier on which this substance is deposited. These elements affect each other, so they should be improved in parallel. In practice, however, far fewer scientific publications focus on the catalyst carriers than on the catalytic phase. Therefore, it was decided to investigate the possibilities of improving the carriers by changing their geometry.

This can be done based on human experience of several decades, or by trust to a much older developer of effective solutions - nature. Fish gills, heat and mass exchangers, thanks to natural selection and evolution, are constantly being improved. The best example of their effectiveness is the fact that they have been operating continuously for over 400 million years.

To sum up - the goal of the project is to explore the possibility of improving catalysts by changing the geometry of the catalytic support based on the construction of fish gills.

3. Description of research

Different types of carrier shapes will be examined using computer simulations reflecting the conditions of the experiment. This method, called computational fluid dynamics (CFD), will allow pre-examination of the potential of a given geometry. After this, carriers will be pre-selected according to which of them display the most promising properties. The best ones will be manufactured from metal using the 3D printing, and then tested experimentally. The carrier(s), the shape of which allows to obtain the most desirable values of test parameters, will then be covered with a layer of the active phase and tested in the process of catalytic combustion of methane.

4. Substantial results expected

If theoretical predictions coincide with the results of experiments, it is possible to:

- initiate a new generation of catalyst carriers with significantly improved properties
- increase the number of catalytic systems in operation
- perhaps improve air quality and reduce the occurrence of diseases caused by air pollution

5. References

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