Foam-metal catalysts for neutralization of gas emissions

A.N. Pestryakov[a*], V.V. Lunin[b], N.E. Bogdanchikova[c]

[a] Department of Inorganic Chemistry, Fritz-Haber-Institute of the MPG, Faradayweg 4-6, 14195 Berlin, Germany
[b] Moscow State University, Chemistry Department, Moscow 119899, Russia
[c] Centro de Ciencias de la Materia Condensada, UNAM, Ensenada 22800, Mexico

[*] Corresponding author: e-mail alex@fhi-berlin.mpg.de, phone +49 30 8413 5408

Abstract

Foam metals represent a very promising type of structural materials for heterogeneous catalysis. Catalysts based on foam metals showed high efficiency in the processes of deep and partial oxidation of organic compounds. Foam metals have uniform cellular structure having high mechanical strength and gas permeability. Good mechanical and gas-dynamic properties of foam metals promise to make them an efficient alternative of the traditional granular and honeycomb catalysts for neutralization of gas emissions.

Any corrosion-resisting metal or alloy - Cu, Ni, Fe, Cu-Ni, Ni-Cr and steel - can be foam support stock. Although all these metals have intrinsic catalytic activity in the processes of deep oxidation, the efficiency of pure foam metals is not high because of their low surface area - 0.05-0.1 m^2/g. Therefore, in order to increasing the surface area the method of applying the Al_2O_3 intermediate support has been worked out. The use of the intermediate support complicates somewhat the catalyst preparation process but then permits to raise the surface area up to 20-50 m^2/g and, accordingly, the catalytic activity. On the foam support with the intermediate layer the active cover of any composition can be deposited (both oxide and Pt- or Pd-containing).

Foam catalysts have been tested in the processes of hydrocarbon deep oxidation and neutralization of automotive exhaust gases. The experiments revealed that activity of the foam catalyst is higher than that of the honeycomb sample with the same composition of active cover. This is explained by distinctions of the foam metal structure. Cellular structure of the foam metal gives rise to high turbulency of gas flow that affords better contact of reacting gas with the catalyst surface. The activities of foam and granular catalysts are similar but mechanical and gas-dynamic properties of the block catalysts are much higher.

Activity of the foam catalysts depends strongly on the cell size. This is concerned with better use of the catalyst surface in fine-cellular samples. However, the fine-cellular catalysts have worse strength and gas permeability. The foam metals of 1.5-2.2 mm cell diameter are optimal for catalytic neutralizers.