# Pt-ZY and Pt-ZSM-5 as potential catalysts for VOCs elimination in a microchannel reactor

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Volatile organic compounds, VOCs, include a variety of chemicals with very low vapour pressure, i.e. 0.01kPa, at room temperature, some of which may have short and long adverse effects in health and the environment, indoor and outdoor. The VOCs oxidation reaction can represent a good method to eliminate them, especially when their concentration is in the ppm range. The challenge is to achieve a high conversion at low temperatures to optimize energy consumption, by using the apropriate catalyst and reactor. The oxidation of VOCs, in particular benzene and hexane, using a nanoporous Pt-zeolite catalyst either in a fixed bed or a microreactor is carried out.

Zeolites are especially interesting candidates as catalyst supports, due to its ability to grow as films on a variety surfaces and their high ion exchange capacity (e.g. Pt). In addition, the large ratio of zeolite coated microchannels provides an excellent contact between reactants and catalyst [2]. In Pt-zeolites, platinum provides the catalytic activity.

On the other hand, microchannel reactors, that could be defined as three-dimensional structures with inner dimensions in the range of 10 to 100 microns offer many advantages over convectional reactors. Their high surface area to volume ratio, with values between 10000 and 50000 $m^2 \bullet m^{-3}$, enhances their mass and heat transport properties, and make them ideal candidates for process intensification. Mass transfer processes can be accelerated considerably in microreactors because of their small dimensions so it is possible to strongly reduce diffusion times. The high heat transfer coefficient allows, for instance, carrying out highly exothermic reactions under near isothermal conditions and avoiding hot spots.

In this work, Pt-ZY and Pt-ZSM-5 have been synthesized as powder or coated in microchannel reactors. Both types of materials have been evaluated for the catalytic combustion of hexane at low concentration, 200ppm.

## Experimental

The synthesis of the zeolite layer on the microchannels was carried out by a seeded (secondary) growth method. A 5wt.% seeds suspension of zeolite (ZSM-5 or ZY) was deposited in the microchannels, after that the stainless steel plates were placed vertically in the autoclave with the synthesis gel. The molar composition of ZY and ZSM-5 gel was $17Na_2O:12,8SiO_2:1Al_2O_3:975H_2O$ and $21SiO_2:3NaOH:0,102Al_2O_3:1TPAOH:MH_2O$ (M=1974) respectively. The synthesis was carried out at 90 ºC for 24 h in the case of ZY and 150 ºC for 12 h for the ZSM-5 microreactor. Pt was introduced into the framework by convectional ion-exchange method with an aqueous $[Pt(NH_3)_4](NO_3)_2$ solution. Pt-ZY powder was prepared from commercial NaY zeolite by the same ion exchange method. Pt-ZSM-5 powder was prepared starting from a more concentrated gel than the used for microreactor (M=987), and the synthesis was carried out at 175 ºC for 8 h-

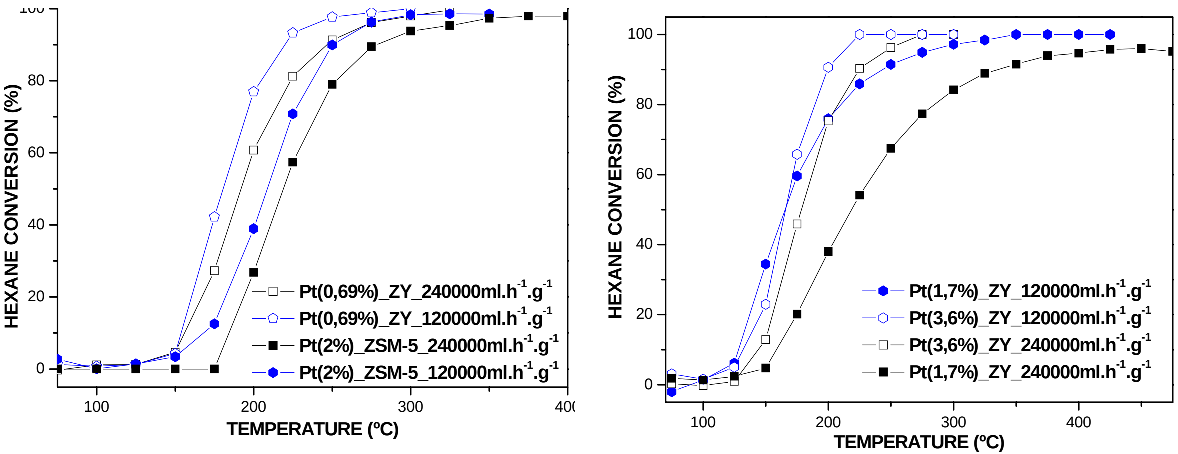
Hexane oxidation was carried out in a conventional fixed bed reactor: The reactive flow was composed of air and 200 ppm of gaseous hexane. The flow rate through the reactor was set to produce a space velocity between 60000 and 240000 $ml.h^{-1}.g^{-1}$.

## Results and discussion

Hexane oxidation curves versus temperature are presented in Fig. 1 and Fig. 2. The observed products are only carbon dioxide and water indicating complete combustion occurring during the reaction.

Fig. 1 shows catalytic activity of Pt-ZY and Pt-ZSM-5 with a 0,69 % and 2 % of Pt respectively. Despite that Pt-ZY have less amount of Pt, it reached 50 % of conversion at a temperature 30 ºC lower than Pt-ZSM-5. It is necessary to increase the temperature up to 350ºC, with Pt-ZSM-5 catalysts, in order to obtain the complete conversion of hexane. Pt-ZY is more active for catalysis than Pt-ZSM-5

Fig. 2 shows catalytic activity of Pt-ZY with a 3,6 % and 1,7 % of Pt. In both catalysts Pt(3.6 wt%)/Y and Pt(1.7 wt%)/Y, the oxidation of hexane reached 50% of conversion at 164 ºC for the lower value of GHSV.



**(a)** **(b)**

Figure 1. Hexane conversion curves versus temperature: a) Catalytic activity of Pt(2%)_ZSM-5 and Pt(0,69%)_ZY. b) Catalytic activity of Pt/Y solids with different amount of Pt. Hexagon symbols: GHSV = 120,000 ml.h$^{-1}$.g$^{-1}$, square symbols: GHSV = 240,000 ml.h$^{-1}$.g$^{-1}$.

The effect of the space time in converson is less pronounced for the Pt(3.6 wt%)/Y, compared to the Pt(1.7%wt.)/Y. The latter could not achieve a 100% conversion at the highest GHSV value.

It is important to note that in all cases the total conversion is achieved at relatively low temperatures compared to published results. Furthermore, it is foreseen that the use of these zeolites in a microchannel reactor would decrease, even more, this temperature as it was observed for other reactions [3].

## References:

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