

Study of the catalyst load for a microwave susceptible catalytic DPF

Motivated by increasingly stringent emissions regulations, Diesel Particulate Filters (DPFs) have seen widespread use as the only technically and economically feasible means for meeting current and future Particulate Matter (PM) emissions limits.

The development of a fast, safe and cost effective Diesel Particulate Filter (DPF) regeneration procedure is the major remaining technological challenge in the use of this device. In our previous works we showed that the simultaneous use of a microwave applicator and a specific catalyst loaded DPF, with 15%wt of CuFe_2O_4 , allows the reduction of the temperature, the energy and the time required for the DPF regeneration. Starting from these very promising results, our research activity is focused on the further improvement of the performances of the catalyzed DPF in terms of catalytic activity, with the aim to reduce the temperature and the microwave energy required for the regeneration. So the objectives of our work are to optimize the preparation procedure of the catalytic DPF, to study the effect of the active species load, and to verify the feasibility of the microwave technology by assessing the energy balance of the regeneration phase, comparing it to the actual employed regeneration technologies. In this assessment, one of the important characterization tests on the prepared catalysts is the Hydrogen – Temperature Programmed Reduction (H_2 -TPR): these measurements are carried out using a SiC catalytic monolith from room temperature to 900°C at a heating rate of $5^\circ\text{C}/\text{min}$ in 5% H_2/N_2 flow. The reaction parameters (temperature and concentrations) are monitored by means of a customized Hidden Analytical system based on **HPR-20 QIC R&D & Proteus Multi-stream Sampling Valve** configuration, able to periodically sample up to 20 discrete gas streams, which were then subsequently analysed by a mass spectrometer (Figure 1).



Figure 1: The Hidden Analytical System in the Lab

As an example, Figure 2 shows the result of a H_2 -TPR performed using a SiC monolith loaded with 15%wt of CuFe_2O_4 .

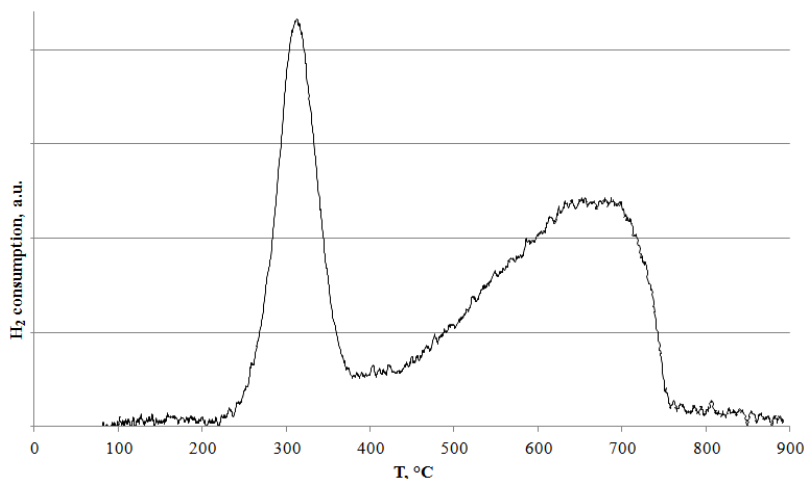
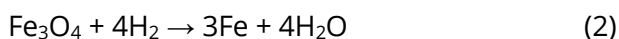
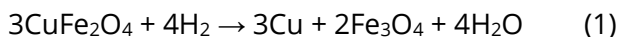
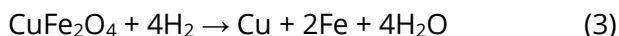


Figure 2: H_2 -TPR profile of a SiC monolith loaded with 15%wt of $CuFe_2O_4$

The H_2 -TPR profile shows two pronounced reduction peaks were observed at about 300 °C and 610 °C; these peaks are attributed to the reduction of $CuFe_2O_4$ to Cu and Fe_3O_4 , and subsequently of Fe_3O_4 to Fe. The two reactions are:



The total amount of H_2 consumed per mole of Cu (H_2 /Cu ratio) was 4.4, which is consistent with that for the complete reduction of $CuFe_2O_4$ to Cu and Fe according to the following reaction:



The value of 4.4 corresponds to about 17%wt of $CuFe_2O_4$ which is in good agreement with the estimated 15%wt of $CuFe_2O_4$ on the monolith. Furthermore, as reported in the literature, after the reduction, the mixture of Cu and Fe is favourable for the formation of $CuFe_2O_4$ at high temperature (about 800 °C in air). The TPR profile shows that the catalyst loaded monolith is able to act as a redox oxidation catalyst active in the temperature range 300 – 800°C due to the presence of a very good and homogeneous copper ferrite dispersion.

Project Summary by:

V. Palma & E. Meloni

University of Salerno, Department of Industrial Engineering

Via Ponte don Melillo, 84084 Fisciano (SA)

Italy



Reference:

V. Palma, P. Ciambelli, E. Meloni & A. Sin (2013) "Study of the catalyst load for a microwave susceptible catalytic DPF" *Catalysis Today*, **216**, 185-193

Hidden Product:

[HPR-20 QIC R&D \(with Proteus\)](#)