Exhaust gas treatment

Screening, characterizing and testing of commercial and proprietary catalysts

Introduction

The *Catalysis for Energy Group* at the Paul Scherrer Institute has more than 20 years of expertise in exhaust gas treatment techniques, with a special focus on catalysts for diesel engines, i.e. the selective catalytic reduction of NO_x with NH_3 and urea: SCR, diesel oxidation catalysts: DOC, NOx storage and reduction catalysts: NSR, diesel particulate filtration: DPF, etc.

In these processes, know-how encompasses basic research up to prototype level, including catalyst preparation and coating on metallic and ceramic supports. Unique test facilities are available at PSI for coated catalysts on different substrates on a laboratory scale.

Catalysts can be characterized by a broad variety of methods. In particular, PSI offers very specific characterization methods at its synchrotron light (SLS) and neutron radiation (SINQ) facilities.

The *Catalysis for Energy Group* was in 1989 among the first research groups world-wide to start exploring the urea-SCR process for mobile diesel applications. Since that time, the group has acquired unique expertise on almost all aspects of this process, ranging from SCR catalyst development and investigation, SCR chemistry, urea dosage and decomposition.

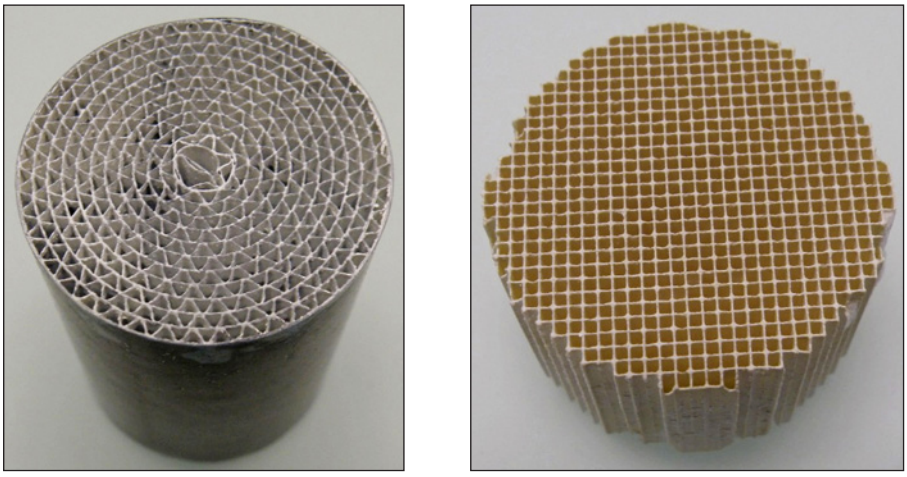

Figure 1: **Examples for catalyst-coated metallic and ceramic substrates.**

Areas of catalyst development

- Vanadia, zeolite and rare-earth metal-oxide-based SCR catalysts
- Urea hydrolysis catalysts
- Soot oxidation catalysts
- Diesel oxidation catalysts
- Coating of catalyst powders on ceramic and metallic substrates (Fig. 1)
- The principle of the testing set-up is shows schematicly in Fig. 2

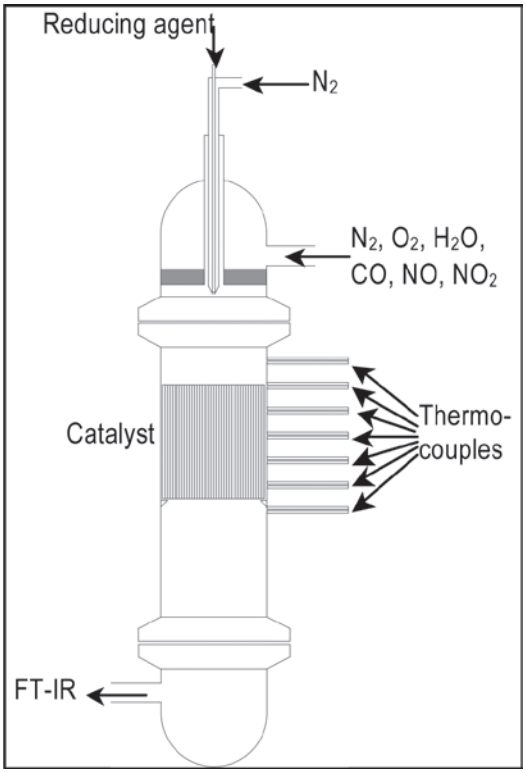

Figure 2: **Schematic of the test reactor for SCR and hydrolysis catalysts with liquid-reducing agents.**

Testing, screening and benchmarking of coated, extruded or powdered catalysts

- Testing of the performance of SCR catalysts with NH_3
- Determination of SCR catalyst kinetics and model parameterization
- Testing of urea hydrolysis catalysts with HNCO gas or liquid urea solution
- Investigation of the hydrolysis of NH_3-storage compounds
- Analysis of aerosols and high-molecular reactions products

Investigation of catalyst deactivation

- Measurement of vanadium emissions from vanadia-based SCR catalysts under practice-relevant conditions (Fig. 3)
- Analysis of metal emissions by ICP-OES (inductively coupled plasma – optical emissions spectroscopy)

Diesel soot characterization

- Investigation of the reactivity of soot samples with different model gases in a TG-FTIR system (Fig. 4)
- Dosing of model gas mixtures with reactive, corrosive and condensable components
- Detailed analysis of the composition of soot samples with TG-FTIR

Figure 3: **Measurement of vanadium emissions from vanadia-based SCR catalysts.**

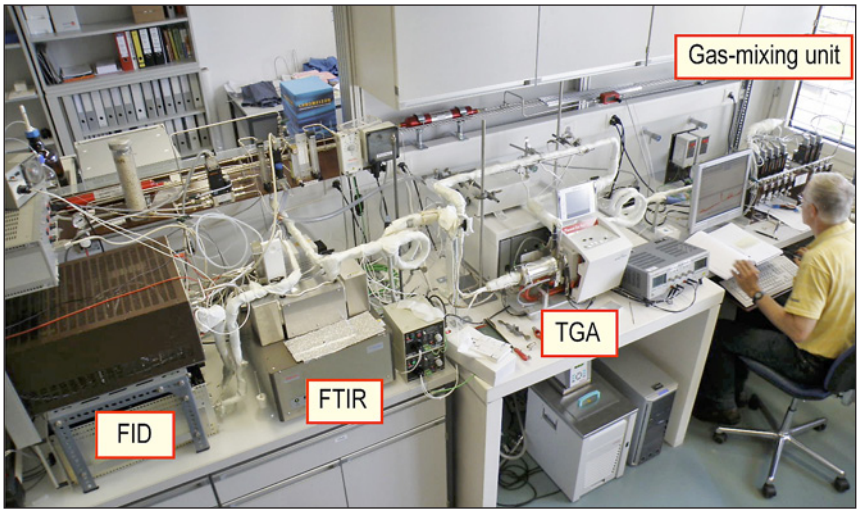

Figure 4: **Picture of the TG-FTIR system. TGA = Thermogravimetric analyzer. FTIR = Fourier-Transform infra-red spectroscopy. FID = Flame ionization detector (optional).**

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ENE-F21_Exhaust, 11.2010