Screening of catalysts for H_2S abatement from biogas to feed molten carbonate fuel cells

Our research project concerns the H_2S abatement from a biogas stream to feed to molten carbonate cells (MCFC) for energy production.

Biogas is a renewable energy source that can be produced from biomass, agricultural and industrial waste and sewage sludge. Its main constituents are CH_4, CO_2 but unfortunately sulphur based compounds are present as H_2S, COS.

The main limitation to the use of biogas as fuel in these systems is linked to the presence of sulphur compounds such as H_2S that can poison the fuel cells components, anode and electrolyte.

For the small scale plant, a very interesting solution can be represented by the direct and selective H_2S oxidation to sulphur at low temperature by using a suitable catalyst.

The aim of the work is the study of the catalytic behavior of V_2O_5/CeO_2 samples at various vanadium loading (2.55 - 20 wt % as V_2O_5) to determine the optimal catalyst formulation and operating conditions to obtain a very high H_2S conversion and the SO_2 selectivity minimisation.

The catalytic tests were carried out in a fixed bed flow reactor, made of a steel tube 21 cm long and a 14 mm of internal diameter. The reactor is inserted in an electrical furnace equipped with a PID electronic temperature controller. A thermocouple is inserted in a steel sheath of the inner diameter of 6 mm concentric to the reactor.

Catalytic activity tests were carried out at atmospheric pressure and GHSV=9.5·104 h-1 (40 ms), in the temperature range 150 – 250 °C, by feeding a mixture of 200 ppm of H_2S, 100 ppm of O_2 and N_2 to balance (see Fig. 1)

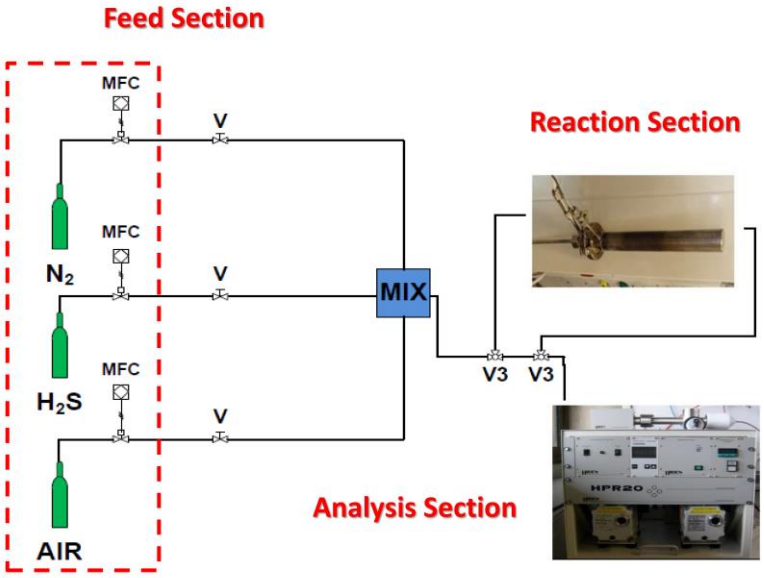

***Fig. 1**: Experimental apparatus for the catalytic tests*

The exhaust system was equipped with a sulphur trap and analysed by a quadrupole mass spectrometer (Hiden Analytical, HPR-20 QIC). Figure 2 shows typical behaviour of a catalytic activity test carried out by using a catalyst using the highest vanadium loading (20%). With this condition being the optimal catalytic performance and more selective to sulphur (99%) at lower temperature.

HIDEN ANALYTICAL LTD
420 Europa Boulevard, Warrington, WA5 7UN, England
t: +44 (0) 1925 445225 f: +44 (0) 1925 416518
e: info@hiden.co.uk **w: www.HidenAnalytical.com**

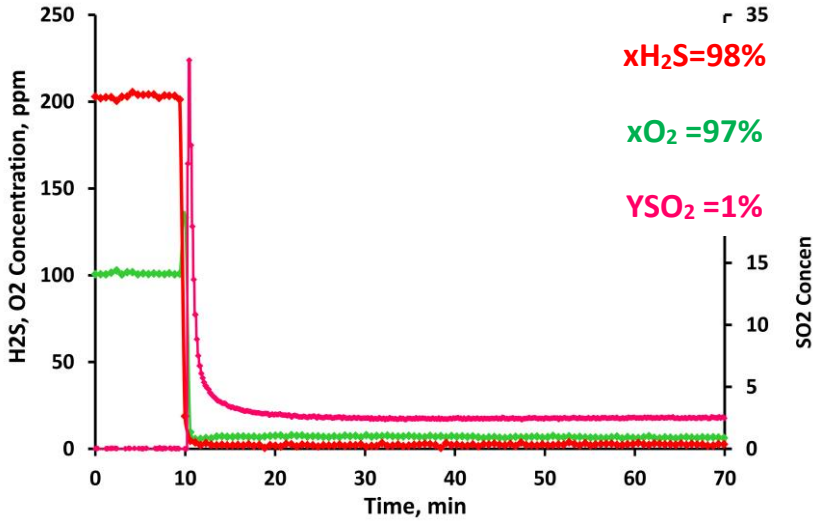

Fig.2: *Catalytic activity test of 20% V_2O_5/CeO_2 catalyst at 150 °C*

It can be seen from the data above, in the first 10 minutes of the experiment, that the feed stream was added in the by-pass position to stabilise the initial concentrations of H_2S and O_2. After this time, the feed stream was sent to the reactor, and large increases in the concentrations of H_2S, SO_2 and O_2 were observed. After a further 10 minutes the concentrations stabilised, showing high activity and stability of the catalyst.

The H_2S and O_2 conversions were 97 and 98% respectively, while the SO_2 concentration remained very low (~1%).

Project summary by:
V. Palma & D. Barba
Department of Industrial Engineering
University of Salerno
Via Ponte Don Melillo
Fisciano (SA)
Italy

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