High Loading Fe-based Catalysts for Fischer Tropsch Synthesis: Optimization of Synthesis Procedure

D.C. Boffito, C. Pirola, C.L. Bianchi, E. Moretti, V. Ragaini

Dipartimento di Chimica Fisica ed Elettrochimica, Università degli Studi di Milano, Via Golgi 19, 20133 Milano, Italy. daria.boffito@unimi.it

Fischer-Tropsch synthesis (FT) is one of the great processes of the industrial chemistry. Starting from syngas (CO + H2), it is possible to produce a wide range of hydrocarbons, from 1 to 100 carbon atoms, using mainly cobalt or iron-based (promoted by potassium and copper) catalysts. Iron-based catalysts are widely investigated for FT due to their low costs and their good performance. Iron-based catalysts are industrially used without any support. Notwithstanding the major inconveniences, related to the employment of massive catalysts, are their fast physical degradation and their low superficial area. Instead several advantages derive from the use of supported iron catalysts, such as improved catalytic stability and lower deactivation rate, catalysts containing a support usually display a lower activity than the unsupported ones.

In this work supported iron catalysts on silica for FT with high amount of metal have been prepared, characterized and tested. The iron loading has been changed between 10 and 50%wt in the presence or non-presence of promoters K and Cu. The quantity of promoters has been changed too in order to optimize the catalysts performance. An optimized catalysts, containing 30% of Fe, 2% of K and 3.75% of Cu has been identified and then prepared using different preparation methods, i.e. traditional impregnation or using ultrasound (US) and microwave (MW) in different conditions.

To correlate the modification of the catalysts features (caused by the preparation method) with their performances in reaction, characterizations by BET, SEM, TEM, TPR, XRD and micro-Raman techniques have been also performed.

Aim of this work is to assist the traditional impregnation method using ultrasound (US) or microwave (MW) to optimize the iron deposition.

The main advantages of catalysts prepared by US derived from acoustic cavitation: bubbles formed by ultrasonic waves tend to collapse preferentially near the solid surfaces (i.e. silica surface) and collapsing bubbles generate localized hot spot. The effect of acoustic cavitation is favoured by the presence of noble gases dissolved like argon.

Microwave treatment is a promising technique for catalyst preparation because of its dielectric heating characteristic, due to the possibility to generate an electric field able to polarize charges in a material. This effect is enhanced if the irradiated material presents a strong dipolar nature, as SiO_2, an oxide with many surface polar OH groups.

FT synthesis were carried out in a fixed bed reactor under reaction condition of 210-310 °C, 20 bar and H2/CO ratio of 0.5, 1, 2, 3 for 60 h. The catalysts performance is strictly correlated with their activation, depending both by the gas and by the temperature of this step, and the treatment in syngas at T= 350°C at P=3 bar for t=4 h gives the best results. A complete characterization of catalysts after different activation procedures has been performed.