Catalysts for Fischer-Tropsch Synthesis

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Fischer-Tropsch synthesis provides a sustainable alternative route to petroleum hydrocarbons. Today this route is uneconomical due to the low price of hydrocarbons from crude oil, but this situation will be different in the future, when crude oil will be depleted[1]. Syngas obtained from gasification of biomass (agriculture and forestry residues) has a low hydrogen to carbon monoxide ratio (1:1) and is not suitable for the industrial developed Fischer-Tropsch process which requires a 2:1 ratio. Thus, new catalysts, with good performance in low hydrogen to carbon monoxide ratio, are needed. In addition, a high selectivity to low olefins is desired[2] because the demand for these products has increased heavily at present.
This aim of this study is to find adequate catalysts preparation methods that afford high selectivity to hydrocarbons (especially low olefins) using low content of hydrogen in the syngas for the Fischer-Tropsch synthesis.
Although iron catalyst deactivates more quickly than cobalt based[3], they are preferred due to higher selectivity to low olefins and tolerance to low hydrogen to carbon monoxide ratio. As consequence, iron was selected as active metal for catalysts formulation in this study. Several supported iron catalysts (on SiO_2 and Al_2O_3) with different promoters (K, Cu, Ni, Mn) were prepared by conventional incipient impregnation method: $Fe_{30}K_2Cu_{3.75}/SiO_2$, $Fe_{30}K_2Cu_{3.75}//Al_2O_3$, $Fe_{30}K_2Ni_4Mn_1/SiO_2$, $Fe_{30}K_2Ni_4Mn_1/SiO_2$ and Fe_4Ni_6/SiO_2. The obtained catalysts were tested in a fixed bed Fischer-Tropsch reactor operated at atmospheric pressure and 250-400^{0}C temperature range, at 3 different H2/CO ratios: 1/1, 1.5/1 and 2/1. The reactor was coupled on-line with a gas chromatograph (Buck Scientific 910) which performed the quantification of gas products (carbon dioxide, methane, ethane, ethylene, propane, propylene, butane, butylene, isobutane, isobutylenes) and unreacted carbon monoxide. Conversion, selectivity and yield to different products were estimated to compare the performance of different catalysts formulation. One particular formulation (Fe_4Ni_6/SiO_2), which was obtained by custom incipient impregnation method, has a good performance as methanation catalyst. The results are shown in figure 1.

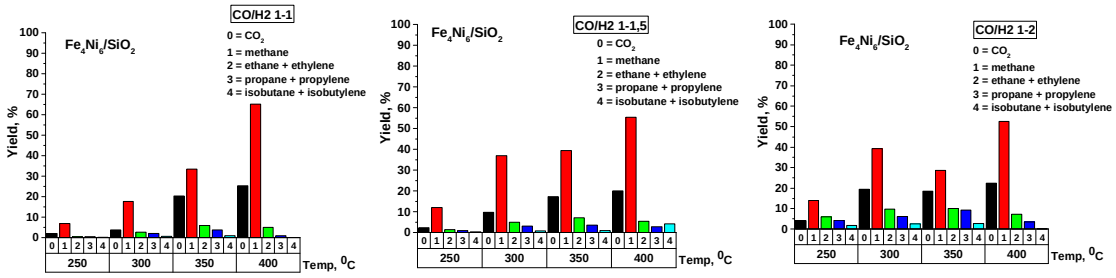

Figure 1. The yield in different products of Fischer-Tropsch reaction at atmospheric pressure and different CO/H2 molar ratio using Fe_4Ni_6/SiO_2 catalyst.

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1. Anon, *Chem. Eng. Prog.*, 2007, **103**, 2.
2. J. Zhang, S. Lu, X. Su, S. Fan, Q. Ma and T. Zhao, *J. CO2 Util.*, 2015, **12**, 95-100.
3. J. Falbe, C. D. Frohning, B. Cornils and K. Moraw, *CHEMSA*, 1984, **10**, 419-422.