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Methane Conversion Using Platinum Loaded Zeolites

The ability to convert methane to higher alkanes directly would be of value industrially for the production of liquid fuels and chemicals. Recently a two-step process has been reported for higher alkane production from methane using a platinum, ruthenium or cobalt catalyst supported on silica. In the first step the metal is exposed to flowing methane and in the second step the alkanes are released from the surface by flowing hydrogen. Related work on alkane production has also been reported when the second step was performed at a lower temperature than the first step. However, this is a stoichiometric reaction, and is not truly catalytic, and only one monolayer of C_1 is converted at each cycle. The methane also sweeps away hydrogen from the surface, allowing hydrogen deficient species to build up and carbon-carbon bonds to form. For this reaction large surface areas are needed, which will allow reasonable levels of methane conversion to occur.

One way to achieve large surface areas is by using zeolites and filling the cages with the reaction metals. Zeolites are extensively used as catalyst supports, particularly faujasites, as they produce very homogeneously dispersed catalysts with down to nearly atomic sized particles.

Therefore, preliminary work has been undertaken on methane conversion. (E. Mielczarski, S. Monteverdi, A. Amariglio and H. Amariglio, *Appl. Catal. A: Gen.*, 1993, **104**, (2), 215–228). Experiments were carried out by a methane adsorption and a hydrogenation step. Alkanes produced included ethane, propane, *n*- and *i*-butane, *n*-, cyclo- and *i*-pentane and *n*-, cyclo- and other isomers of hexanes and traces of heptanes. Hydrogenolysis was also monitored. At higher reaction temperatures, with Pt/HX, the total amount of homologated methane increased significantly with temperature, even though

hydrogenolysis increased, at the expense of higher alkanes. On Pt/HY the amount of homologated methane reached a maximum at about 275°C but the yield decreased from 52 to 30 per cent when the temperature increased from 250 to 325°C. Hydrogenolysis occurred mainly in the range 250–350°C and was less for Pt/HX than for Pt/HY. The results were compared to those for EUROPT-1 for the same 6 per cent platinum loading. The molar amount of methane homologated in identical operating conditions shows that the catalyst efficiencies are in the order Pt/HX > Pt/HY > EUROPT-1

It is concluded that the beneficial effects of using zeolites for direct methane conversion could be increased by using NaX or NaY zeolites, which should have less hydrogenolysis activity, by performing the reaction sequence at higher temperatures, and by adding a second metallic component to the platinum.

Ruthenium-Niobium-Zirconium System

Efforts to improve the physical properties of alloys have generally proceeded in a quasi-empirical way, but there is a need to improve on the trial and error approach particularly now that materials with special combinations of mechanical and electronic properties are required. As part of a programme to advance the design of intermetallics, a study has been made by researchers at The University of Texas at Austin of the phase stability for the three binary systems of the ruthenium-niobium-zirconium ternary system using first-principles methods (J. D. Becker and J. M. Sanchez, *Mater. Sci. Eng.*, 1993, **A170**, (1–2), 161–167).

The accuracy in calculating properties such as Debye temperature, formation energy and solubility, without empirical input, highlights the potential of this approach to alloy development.