

Fourth International Congress on Catalysis

ACTIVITY AND SPECIFICITY OF THE PLATINUM METALS

The Fourth International Congress on Catalysis took place in Moscow during the last week in June, and was followed by three specialised Symposia, two of which were also held in Moscow and one in Novosibirsk. This Congress provided, as did its predecessors, a useful forum for the exchange of ideas and experience: an impression of the Congress and a review of the papers relevant to the platinum metals is given in this article.

The Fourth International Congress on Catalysis was held at the Moscow State University, a vast and impressive edifice situated in the Lenin Hills in the outskirts of Moscow. It was attended by 1,130 active participants of whom almost two-thirds came from the Soviet Union. Other countries sending major delegations were the United States, France, Czechoslovakia, the United Kingdom and Holland.

The theme of the Congress chosen by the Organising Committee was "Problems concerning the Prediction of Catalytic Activity". However, within this somewhat unpromising framework were fitted 86 papers, the majority of which had a substantial theoretical content and were more or less directly pertinent to the chosen theme, but a few papers regrettably contained no new theoretical or experimental work. Plenary lectures were given by Professors J. H. de Boer (Holland), S. Z. Roginsky (U.S.S.R.), D. A. Dowden and C. Kemball (U.K.), G. Rienäcker (East Germany, read by Dr J. Völter), and Y. Yoneda (Japan).

The first of the three ensuing symposia was organised by Professor S. Z. Roginsky and was also held at Moscow State University: its subject was "Mechanism and Kinetics of Complex Catalytic Reactions". Twenty-five papers and a number of plenary lectures were given. As certain of the Congress and Symposium papers had close affiliations, it will be convenient to review them together.

The purpose of a number of papers was to present evidence on how the activity and specificity of a catalytic reaction depended on the nature of the metal employed as catalyst. C. Horrex, R. B. Moyes and R. C. Squire (Universities of St Andrews and Hull) studied the exchange of toluene with deuterium over evaporated films and supported metals; large variations were noted in the relative rates of exchange of the different kinds of hydrogen atom in the toluene molecule. R. Merta and V. Poneč (Institute of Physical Chemistry, Prague) observed that in the hydrogenation of cyclopropane to propane, hydrogenolysis to smaller hydrocarbons occurred on rhodium and certain base metals, but not on palladium and platinum. The hydrogenation of methylacetylene over a number of metals was examined by R. S. Mann and K. C. Khulbe (University of Ottawa). The hydrogenolysis of cyclohexane over certain of the platinum group metals was investigated by O. V. Bragin and A. L. Liberman (Zelinsky Institute of Organic Chemistry, Moscow) who found that ruthenium and osmium were more active than rhodium and iridium. It has long been recognised that platinum has certain unique properties in hydrocarbon reforming processes and a further example of its singular behaviour was provided by J. M. Muller and F. G. Gault (University of Caen) who showed that of the metals they examined only plati-

num successfully isomerised 1,1,3-trimethylcyclopentane to xylenes. Work of the kind described in this paragraph forms an essential contribution to the construction of general theories of catalytic action.

Crystallite Size Effects

Five papers on this subject aroused considerable interest, as there is a general feeling that we can now talk meaningfully about the properties of metal crystallites in the 10 to 100 Å range. G. C. Bond (Johnson Matthey) presented calculations on the variation in the density of edge and corner atoms on regular cubo-octahedra of increasing size, while O. M. Poltorak, V. S. Boronin and A. N. Mitrofanova (Moscow University) presented similar calculations based on an octahedral model and gave evidence to suggest that atoms in planes are sometimes more active than edge or corner atoms. R. van Harveld and F. Hartog (Dutch State Mines) showed how the density of specific configurations of surface atoms might be estimated through the infra-red absorption of chemisorbed species; P. C. Aben, J. C. Platteuw and B. Stouthamer (Shell, Amsterdam) reported that the activity of palladium and platinum catalysts for benzene hydrogenation was independent of crystallite size to very high degrees of dispersion. Somewhat reluctantly, workers in this field are coming to the conclusion that "demanding" reactions (i.e. those sensitive to crystallite size) are the exception rather than the rule.

Mechanisms of Olefin Hydrogenation

This formally simple catalytic reaction continues to attract both experimental and theoretical attention. L. Guzci and P. Tétényi (Institute of Isotopes, Budapest) studied the reactions of ethylene and propylene with tritiated hydrogen over platinum black, unfortunately using conditions close to diffusion limitation. G. V. Smith (Southern Illinois University) reported work on the addition of deuterium to α,β -unsaturated

compounds and concluded that classical mechanisms can satisfactorily explain most but not quite all the observations. J. Horiuti (Hokkaido University) and T. Keii (Tokyo Institute of Technology) both reported continuations of their previous theoretical analyses of olefin hydrogenation mechanisms.

Old and New Theoretical Approaches

Theoretical approaches of various kinds loomed large in the proceedings of the Congress. Predictably the Multiplet Theory of the late A. A. Balandin frequently featured in contributions from the Soviet Union, and S. L. Kiperman (Zelinsky Institute of Organic Chemistry, Moscow) attempted to derive the adsorption energies of intermediates in a variety of catalytic processes. The paper by R. A. Gardner (Sohio Laboratory, Cleveland) on his Intermediation Theory was one of the few presenting a relatively new theoretical approach of some generality. The application of Statistical Recognition Theory to catalysis by I. I. Ioffe and his collaborators (Institute of Petrochemical Processes, Leningrad), and of Information Theory by N. I. Kobozev and B. V. Strachov (Moscow University), is of some general interest.

The Porous Structure of Catalysts

The important subject of the proper physical design of catalysts was discussed at the last of the post-Congress Symposia which was held at Akademgorodok (the Academic Town), near Novosibirsk, an elegant new town containing a number of the Research Institutes of the Siberian branch of the Academy of Sciences. Twenty-seven papers were presented and discussed, particular interest being shown in the application of Mössbauer and NMR spectroscopy to the study of porous solids. Parts of the discussion were not improved by tedious polemical arguments between specialists, but all participants welcomed the opportunity to visit Akademgorodok and G. K. Borezkov's impressive Institute of Catalysis. G. C. B.