Fundamental and Applied Catalysis

Catalytic Ammonia Synthesis

Fundamentals and Practice

Edited by J. R. Jennings

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FUNDAMENTAL AND APPLIED CATALYSIS

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PRINCIPLES OF CATALYST DEVELOPMENT
James T. Richardson

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FOREWORD

The phenomenon of catalysis is found in many homogeneous and heterogeneous systems undergoing chemical change, where it effects the rates of approach to the equilibrium state in processes as diverse as those found in the stars, the earth's mantle, living organisms, and the various chemistries utilized by industry. The economies and the living standards of both developed and developing countries depend to varying degrees upon the efficacy of their chemical industries. Consequently, this century has seen a wide exploration and expansion of catalytic chemistry together with an intensive investigation of specific, essential processes like those contributing to life-supporting agricultures. Prime among the latter must surely be the "fixation" of atmospheric nitrogen by catalytic hydrogenation to anhydrous ammonia, still the preferred synthetic precursor of the nitrogenous components of fertilizers. In each decade contemporary concepts and techniques have been used to further the understanding, as yet incomplete, of the catalyst, the adsorbates, the surface reactions, and the technology of large-scale operation. The contributors to the present volume review the state of the art, the science, and the technology; they reveal existing lacunae, and suggest ways forward.

Around the turn of the century, Sabatier's school was extending the descriptive catalytic chemistry of hydrogenation by metals to include almost all types of multiple bond. The triple bond of dinitrogen, which continued to be more resistant than the somewhat similar bonds in carbon monoxide and ethyne, defied their efforts. During the following decade, Haber and Bosch developed their process for the large-scale production of ammonia by the hydrogenolysis of atmospheric nitrogen over promoted and stabilized, iron-based contacts: it was an epoch-making advance. The work assured not only adequate world food-production, but also gave impetus to the science of catalysis by solids and the associated chemical engineering. Exploding populations could now be properly provisioned with victuals or otherwise provided with munitions, while most of the essential empirical features of catalyst activity were revealed.

Professor Tamaru, prominent among catalytic chemists even as a babe-in-arms (photo page 5), tells something of the formidable minds and institutions which drove the research forward in a style now classic and probably unparalleled outside the German chemical industry. This paradigm of major invention possessed a