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Introduction

Environmentally benign petrochemical catalytic chemistry and reaction engineering

Based on an agreement reached by NSFC and SINOPEC to support jointly an applied basic research program (with the title 'environmentally benign petrochemical catalytic chemistry and reaction engineering'), a guideline for research proposals was issued in 1996. The program was designed to encourage basic research to give new scientific knowledge concerning novel catalytic materials and new reactor engineering for 'green' processes in a number of specified areas covering alkylation of hydrocarbons, selective oxidation of hydrocarbons, hydroformylation of olefins, and hydrogenation of hydrocarbons.

After the announcement of the guidelines, a total of 17 projects were selected to take part in the research program, these include the following.

1. Alkylation of hydrocarbons: development of solid acid catalysts to replace $HF_7H_2SO_4AlCl_3$ catalysts. The key approaches were: correlation between acidity of supported heteropolyacids and their activity and selectivity for iC_4/C_4^{2-} alkylation; preparation and characterization of supported heteropolyacids for iC_4/C_4^{2-} alkylation; synthesis, characterization and catalysis of nanomolecular sieves for long-chain olefin/benzene alkylation; and alkylation reaction under supercritical conditions.
2. Selective oxidation of hydrocarbons: improvement of reaction selectivity to reduce and eliminate wastes.
   - 2.1. Selective oxidation catalyzed by titanium silicalite: synthesis of low cost titanium silicalite; epoxidation of propylene to epoxypropane with catalytic distillation reactor; process integration of propylene epoxidation and H_2O_2 production; and process research of ammoxidation of cyclohexanone to cyclohexanone oxime.
   - 2.2. Selective oxidation catalyzed by lattice oxygen of catalyst: synthesis, characterization and catalytic performance of nanometer-complex metal oxides; VPO catalyst formulation and selective oxidation of butane by lattice oxygen; and butane selective oxidation under non-steady-state reaction conditions.
3. Hydroformylation of olefins: improvement of "atomic economy" of hydroformylation reaction; mechanistic study of interface reaction and catalyst deactivation of long-chain olefin hydroformylation in biphasic catalytic systems; synthesis of new aqueous phase metal complexes for long-chain olefin hydroformylation; design and evaluation of liquid–liquid–gas phase reactors for long-chain olefin hydroformylation; catalytic study of hydroformylation of propylene with aqueous phase catalyst; and thermoregulated reaction of phase-transfer rhodium complexes in two-phase hydrofornylation of olefins.
4. Hydrogenation of hydrocarbons and metal catalysts: to reduce wastes formed during catalyst activation; nature of the catalytic active center and interaction between nickel alloy and support; synthesis, characterization and hydrogenation performance of supported Ni–P and Ni–B amorphous alloys; and hydrogenation of adiponitrile with amorphous alloys in magnetically stabilized fluidized beds.

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The organizations participating in the program included four chemistry departments and four chemical engineering departments from the universities, one research institute from the Chinese Academy of Sciences and two industrial research institutes. A management committee and academic committee were organized to supervise the research activities.

By the end of 2000, all of main tasks planned for every project had been fulfilled. Two hundred and fifty-two papers had been published or accepted for publication in international or domestic periodicals (including those collected in this issue), and 134 papers had been submitted to conferences on green chemistry, catalysis and chemical engineering and were accepted as oral presentations or posters. The research groups participating in this program have applied for 75 patents, of which three have already been granted.

Among these patents, some have led to further developments at pilot plant level or even to commercial application, such as an amorphous skeletal nickel alloy, long-chain olefin/benzene alkylation, ammoxidation of cyclohexanone to cyclhexanone-oxime, epoxidation of propylene with titanium silicalite as catalyst and hydroformylation of ethylene with aqueous catalysts.

We hope the special issue will let our international academic and industrial colleagues have a better understanding of the research activities on the environmentally-benign petrochemical catalysis and technologies in China.

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