

Catalysis update from Brazil

Martin Schmal* and Dilson Cardoso

Brazilian Catalysis Society, Rio de Janeiro, Brazil. *Author email: schmal@peq.coppe.ufrj.br

Introduction

Activities in catalysis started in Brazil in early 1970. The first attempt to organize a Brazilian catalysis meeting was during the preparation of the "VI Ibero-American Symposium on Catalysis," which was held in Rio de Janeiro in 1978.

The success of this symposium motivated the participants to organize the first meeting on Catalysis two years later in 1981, in Rio de Janeiro, which attracted approximately 15 contributions. Again, motivated by the success of this meeting, it was decided to organize similar meetings every two years, but in different regional locations, giving the opportunity for all participants to explore different activities of industry and research institutes. It was decided to create a **Catalysis Committee**, partly for the organization of meetings and other related activities—such as short courses and updates from Brazilian industries and Universities—but mainly so there would be an organization representing the future of catalysis in Brazil. To begin with a Committee was created and affiliated with the Brazilian Institute of Petroleum, (IBP), which subsequently supported our activities in Brazil up until today, fully 20 years.

Petrochemical and Petroleum industries in Brazil were built in the sixties and seventies, operating modern and large factories. However, the human resources at that time were restricted to engineers employed by Petrobrás and Petroquisa, and the laboratories in the Brazilian Universities were poorly equipped for catalysis. The great demand for catalysis in industry and the enthusiasm of the newly established catalysis community undoubtedly induced the National Council on Research (CNPq) to allocate specific funds for a Brazilian Program on Catalysis, the *Programa Nacional de Catalise (Pronac)*, in 1983. The main goal was to plan conditions for research and teaching on catalysis in 20 laboratories at different Universities. Over an eight year period this program was very important in developing fundamental and applied catalysis and in providing human resources for several groups. In a very short time it became a tremendously important impulse for research and teaching. The astonishing growth in catalysis favored the formation of four regional groups, from north to south, which offered good opportunities for young researchers.

From the industrial point of view big changes occurred in the 1980s. Besides the growth of three existing petrochemical pools (Camaçari, S.Paulo and Copesul), an important factory for FCC catalyst production was built in Rio de Janeiro by a joint venture of Petrobrás, Akzo and Oxi-

teno. The first big factory for automotive exhaust catalytic converters was built in 1988 in Sao Paulo by Newtechnos-Degussa, supplying catalysts for all Latin America markets.

The Brazilian Catalysis Society made four important decisions in the 1990s. First, at the *8th Catalysis Meeting* in 1995 (with approximately 250 participants and 150 contributions), it was decided to transform the *Meeting* to the (*9th Brazilian Congress on Catalysis*), which duly took place in 1997. The second decision was to formalize an independent Catalysis Society, leading, in 1998, to the election of the first director. Third, the Brazilian Catalysis Society requested official membership of the International Association of the Catalysis Societies (IACS), a request which was granted in 2000 in Granada, Spain. The last important decision was to bring together Brazil, Argentina, Uruguay, Chili and Paraguay at the *10th Brazilian Congress on Catalysis* in 2001, implementing formally the *1st Mercosul Congress on Catalysis*, held every two years these countries (see <http://www.ufscar.br/~sbcatal/history.htm>).

The Brazilian Catalysis Society

The Brazilian Catalysis Society (SBCat) now has 204 members and six associated industries, details of which can be found at <http://www.ufscar.br/~sbcatal/socios.htm>. Noteworthy is the affiliation of six major companies that work with catalysis, as listed in Table 1.

The Brazilian Congresses on Catalysis

Since 1981 the Brazilian Catalysis Society has organized a Congress on Catalysis every two years. The 11th Congress was held last year, attracting more than 180 oral and poster presentations. The growth of participants and contributions are presented in Figure 1. Of note is the big growth in the last ten years and the marked improvement in the quality of contributions. The selected papers are published in *Annals* and distributed during the congress. After the congress, approximately 20 contributions are selected for publications in special issues of international journals. Prizes for young

company	location
Copene S.A.	Camaçari / Bahia
Degussa S.A.	Americana / S. Paulo
Oxiteno S.A.	S. Paulo
Fabrica Carioca De Catalisadores (FCC)	Rio de Janeiro
Polialden	Camaçari / Bahia
Petrobrás	Rio de Janeiro

Table 1 Major companies that work with catalysis in SBCat

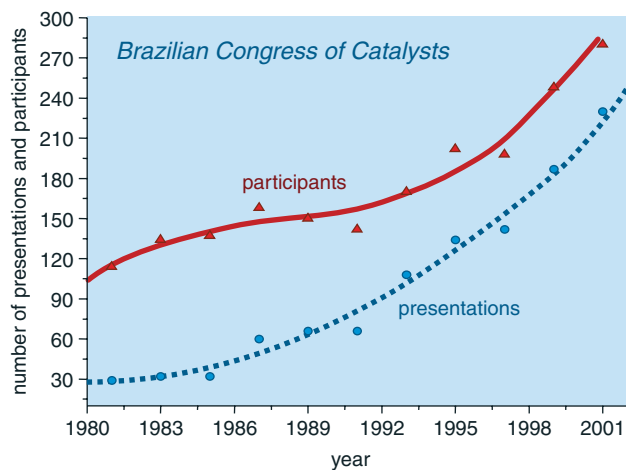


Figure 1 Evolution of the Brazilian Congress of Catalysts.

researchers and best doctoral thesis are judged by the Brazilian Catalysis Society at the Congress.

Publications of SBCat members

In the years 1995–2001 the members of our Society have had more than 300 published works in various international catalysis journals and more than 250 published works in International Congresses (in English) related to catalysis, among them 28 in the last International Congress on Catalysis, held in Granada in 2000. International agreements with different countries on research and doctoral sandwich programs, supported by CNPq and CAPES, include those with CNRS (France), with NSF (USA), CONICET (Argentina), DFG (Spain), DAAD (Germany) and the British Council, as well as specific research programs with the Ibero-American program—CYTED—in different fields of catalysis (see <http://www.ufscar.br/~sbcat/iacscolabora.htm>).

These excellent international cooperations support the growth in the quality of the Brazilian research development. Important scientists were invited for plenary lectures at the Brazilian Congress on Catalysis (for example, Somorjai, Prins, Hölderich and Corma) as well as special courses and exchanges between Universities. Invited scientists gave special attention to different areas, much to the benefit of catalysis in Brazil.

In the 1980s the CNRS-CNPq agreement encouraged exchanges between more than 20 researchers from France and Brazil. Alongside this the agreements with the National Science Foundation, DAAD, the British Council and CONYCEP produced around a dozen exchanges of doctoral or post-doc students. These programs gave scholarships to more than 40 Brazilian students, funded (to US\$3 million) on the Brazil side by CAPES and CNPq. Special Workshops on Catalysis and Materials were held in the last 10 years in collaboration with the National Science Foundation, DAAD and CYTED.

Markets for catalysts in Brazil

Brazil has two important factories of catalyst production: the FCC (*Fabrica Carioca de Catalisadores*) for cracking catalysts, a joint venture between Petrobrás, Oxiteno and Akzo (capacity of approximately 30,000 ton/Year), and the *Newtechmos* (Degussa) for vehicle exhaust catalysts (around 1.5 million converters), among other products. Catalysts markets are shown in <http://www.ufscar.br/~sbcat/mercadocat.htm>.

There are some important research centers on catalysis and process developments in industries (Cenpes/Petrobrás, Oxiteno, Degussa) and also more than 30 laboratories in different departments of the Chemical and Chemical Engineering Schools. Parts of these laboratories are presented at <http://www.ufscar.br/~sbcat/catalisebrasil.htm>.

Cracking catalysts—FCC

PETROBRÁS has 16 units and an inventory of 2,275 m³ of catalysts. Considering existing units, the total consumption needed is approximately 20,500 tons/year. These numbers do not include two future plants. Both will increase the annual consumption to 23,000 ton/year (RECAP) and later to 31,000 ton/year (RLAM II).

Catalyst production in Brazil

There are industries manufacturing their own catalysts for the production of petrochemicals and fine chemicals. The quantity is relatively small but sufficient to supply their internal needs. The main manufacturers of catalysts in Brazil are shown in Tables 2–4.

Petrochemistry - polymers			Polialden owns the technology
company	location	type of catalyst	annual production (ton)
Polialden Petroquímica	Camaçari/BA	Ziegler-Natta Phillips	6,030
Ipiranga Petroquímica	Canoas/RS	Ziegler-Natta	2

Table 2

Fine chemistry			
company	location	type of catalyst	annual production (ton)
Degussa-Huls	Guarulhos/SP	noble metals supported on carbon	50
Degussa-Huls	Guarulhos/SP	platinum and palladium supported on alumina	10
Degussa-Huls	Americana/SP	automotive catalysts	2 million pieces / year

Table 3

Production of other catalysts

company	location	type of catalyst	annual production (ton)
Oxiteno	Mauá/SP	Zinc Oxide base	130
Oxiteno	Mauá/SP	Regeneration of platinum catalyst	25
Oxiteno	Mauá/SP	Nickel/molybdenum supported on alumina	100
Oxiteno	Mauá/SP	Regeneration of catalyst for hydrotreatment Ni/Mo and Co/Mo	130
Oxiteno	Mauá/SP	Zinc Oxide catalyst for dehydrogenation of alcohol E ketone	150

Table 4 Tables 2 to 4 denote main manufacturers of catalysts in Brazil

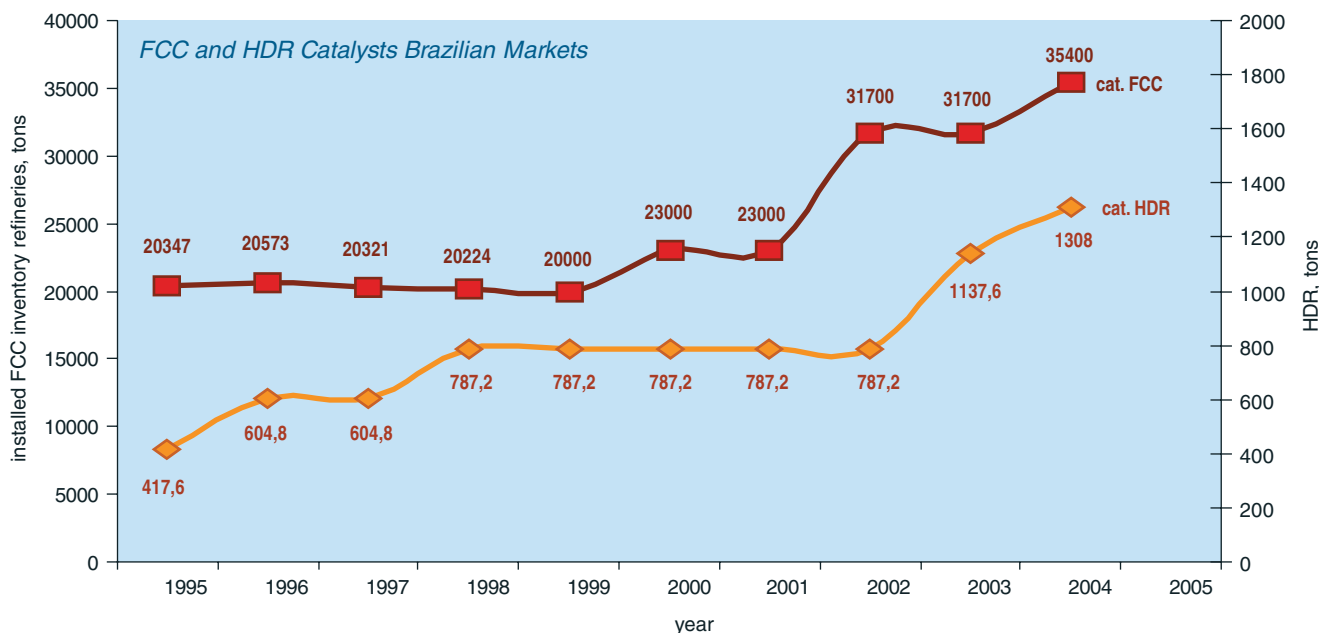


Figure 2 The evolution of catalyst consumption for HDR and FCC (forecast from 2002).

Students and human resources

Marked improvements in research and human resources on catalysis have been achieved in different Brazilian Universities in the last ten years. They are supported by special funds from the Federal government of the Science and Education ministries. Recently, using funds from royalties of Petrobrás, the government has put together special research programs in Natural Gas Conversion, Petroleum and Fundamental studies. In the last two years a huge amount (approximately 150 million dollars) has been released to support research in the Universities. These projects are either 50% shared with Petrobrás or totally supported by CNPq for fundamental researches.

Selected research programs

Topics with great impact are being developed in different research groups in collaboration with industries and research centers:

- 1. Environmental catalysis** Elimination of NO_x , SO_x , HC and oxygenates from exhaust gases and FCC cracking units. Of interest to Petrobrás and Newtechnos. Fundamental studies of these and other systems, such as VOCs, have been developed in research groups in the Universities.
- 2. Natural gas conversion** Reforming of methane and HC as well as conversion of gas to liquids (Fischer-Trop-

sch synthesis) are research programs developed in the Universities in collaboration with Petrobrás. The main goal is to develop an autothermal process for an industrial plant, of sufficient quality to provide synthesis gas for a Fischer-Tropsch unit, and to produce high quality diesel fuel.

- 3. Hydrocracking and hydrotreating** HDS, HDN, HDO, as well as hydrogenation or hydrogenolysis are main projects of interest to Petrobrás and several Petrochemical industries (Copene, Copesul, Petroquímica União, etc.). These projects are run in collaboration with research groups. The goal is to develop new catalysts, to test commercial catalysts and give support to the selection of catalysts in the industries.
- 4. Total and selective oxidation** Oxidation of ethylene and propylene processes and development of catalysts are of interest to Oxiteno, a petrochemical company. Other selective oxidations of different hydrocarbons are being developed in Camaçari and Copesul, in collaboration with research institutes.
- 5. New materials** The majority of research groups in catalysis are involved in fundamental and applied research on zeolites, niobium oxide and supported metals. Facilities in characterization and testing of catalysts enabled the understanding of catalytic properties and supported high

quality fundamental and applied research. This encouraged industry and brought them into contact with Universities. As a consequence, there are now several ongoing projects, in partnership with the industry.

- 6. Homogeneous Catalysis** The research in homogeneous catalysis started in the 1980s with few researchers using coordination compounds to perform organic synthesis. Only a very limited number of studies were devoted toward designing novel catalysts and their catalytic behavior. With the support of PRONAC (National Program on Catalysis of the Brazilian National Research Council—CNPq) the study of catalysis by organometallic compounds has increased markedly, including in areas such as olefins polymerization (usually called Ziegler-Natta catalysts) and two phase catalysts. Many industrial organizations have been involved; in particular, OPP Petroquímica, Petrobrás, Ipiranga, Politeno and Polibrasil. Research in homogeneous catalysis is diversified, covering many families of important reactions including polymerization, oligomerization, hydrogenation, hydroformylation, oxidation and metathesis.

The research in homogeneous catalysis started slowly in the Brazilian community during the 1980s. It was led by a few researchers using coordination compounds to perform organic synthesis and during these times just a handful of studies were devoted to designing novel catalysts and observing their catalytic behavior. At that time most of the research efforts were concentrated at the University of Campinas (UNICAMP). After that, based on the support of PRONAC, catalysis by organometallic compounds took great steps, including in areas such as olefin polymerization (usually called Ziegler-Natta catalysis) and biphasic catalysis. Many industrial and academic laboratories have been involved in this process. Nowadays many industrial R & D groups are active in catalysis by using organometallic compounds. Examples include OPP Petroquímica, Petrobrás, Ipiranga, Politeno and Polibrasil, all of which interact with academic groups such as those located at UFRGS (Rio Grande do Sul), UNICAMP (Campinas), UFMG (Belo Horizonte), UFRJ (Rio de Janeiro) and USP (São Paulo).

The research in homogeneous catalysis in Brazil is diversified, covering many families of important reactions including polymerization, oligomerization, hydrogenation, hydroformylation, oxidation and metathesis. In many of these areas academic groups have become very productive and internationally competitive.

- 7. FCC catalysts** Zeolites of different materials have been developed by Petrobrás and university research groups. In particular, ZSM and Y catalysts were developed in the research center of Petrobrás. These catalysts have substituted old technologies. The materials were produced commercially by Petrobrás. Besides, while research groups are developing new mesoporous materials for applications in petrochemistry.

Internet and the Catalysis Society

Since 1995 the Society has maintained through the University of Sao Carlos two main email lists for catalysis, one with 570 members, including Ibero-American countries, and the other with around 300 emails of Brazilians. In May last year our Society created its own web page (<http://www.ufscar.br/~sbcatal/index-eng.htm>), containing information about our organization and other activities, including other catalysis societies. The site has already received more than 25,000 visitors, 20% of them coming from outside Brazil.

acknowledgement

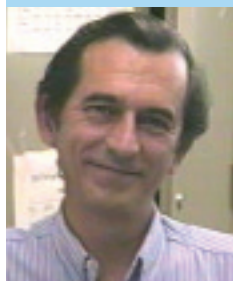
Thanks to Professor Roberto de Souza for information on homogeneous catalysis.

curricula vitae



Martin Schmal. Born in Germany and of Brazilian citizenship, Martin Schmal received his Chemical Engineering degree in 64, his Master of Science at COPPE/UFRJ, Brazil, in 65 and his doctorate in 1970 at the Technische Universität Berlin, Germany. Since 1971 Dr.

Schmal has been a faculty member at the Chemical Engineering Department in COPPE and at the School of Chemistry of the Federal University of Rio de Janeiro. He has authored over 120 scientific publications in international journals and delivered 250 papers in Brazilian and International Congresses. He is currently Director of the Catalysis Nucleus at COPPE/NUCAT, President of the Brazilian Catalysis Society and a member of the International Catalysis Society (IACS). He is also a consultant on several projects with Petrobras, Oxiteno and others in the petrochemical industries.



Dilson Cardoso was born in Santos, Brazil and received his PhD in Chemistry in the Martin Luther University, Halle, Germany. Since 1980 he has been a faculty member at the Chemical Engineering Department of the Federal University of Sao Carlos, Brazil. In 1981 he began

his research in the field of heterogeneous catalysis. A post-Doctoral was spent at University of Poitiers, France, in 1985 and since then his main research topics have been related to the synthesis of molecular sieves and their application in catalysis. At the present time he is the Vice-President of the Brazilian Catalysis Society.