

Catalysis research in Venezuela

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Introduction

The existence of oil, gas and coal resources in Venezuela led directly to the country's need for research and development in the field of catalysis. With the intention of contributing to the development of the chemical industry, especially relating to the refining processes in the Venezuelan oil industry (PDVSA), catalysis studies began in 1964 with a cooperation agreement between the Chemistry School of the Science Faculty of the Universidad Central de Venezuela and the Research Institute of Catalysis of Munich. To begin with personnel were recruited; before the establishment of research activities. The provision of infrastructure and equipment took a little longer, but once established the growth in research activities never stopped. The pioneering effort of Prof. Noller from Germany and his students (P. Andréu from Spain and Edmundo Schmidt, from Venezuela) led to the creation of all the existing catalysis groups in the country and in 1983^[1,2] to the foundation of the Venezuelan Catalysis Society.

Academia

Table 1 shows the academic institutions involved in research and development, and their areas of expertise. The significance of academic contributions to the open literature can be seen by carrying out a search in Chemical Abstracts (1967 – present) using *Venezuela* and *Catalysis* as keywords. The search reveals 304 papers, of which more than 100 were written in the last ten years, despite the search not including topics such as homogeneous or theoretical works, surface chemistry, adsorption, etc., which are undoubtedly indexed by different keywords^[1]. These papers show the nature of the sustained research efforts continuously pursued by the Venezuelan catalytic community.

Catalysis Society

The Venezuelan Catalysis Society, founded in 1983, periodically hosts scientific meetings of members and provides national and international courses for undergraduate and postgraduate students. In addition, the Society organizes a National Congress on Catalysis every two years. The 18th Congress, held last year, was the forum for more than 100 oral and poster presentations. The Society now has more than 200 members, of which approximately 60

Institutions and areas of research within academia

Academia

Universities: Universidad Central de Venezuela, Universidad de Oriente, Universidad de los Andes and Universidad del Zulia.

Polytechnic Institutes: Instituto Universitario de Tecnología: Región Capital and Cumaná.

Research Centres: IVIC.

Areas of Research

- C1 Chemistry
- Environmental monolith
- Fine Chemical
- Polymerization
- Process simulation
- Pillared clays
- Upgrading of heavy oil fractions
- Hydrotreatment reactions
- Characterization of metal and oxide catalysts
- Activated carbon
- Zeolites and molecular sieve catalysts
- Light alkanes transformations
(aromatization, hydrocracking, hydroisomerizaaton, etc.)
- Bifunctional catalysis (kinetics, mechanism, deactivation)
- Electronic and crystalline properties of transition metal sulphides

Table 1

are research leaders. It also has a periodical journal (Revista de la Sociedad Venezolana de Catálisis), which covers the Iberoamerican region.

The catalytic community of Venezuela also participates in specialized international meetings and has an active publication policy in international and national journals. This results in approximately 35 publications per year.

Iberoamerican Meeting

The major venue for the Venezuelan discussions is the Iberoamerican Catalysis Symposium, which has taken place on even-numbered years since 1968. The last event, in September 2002 and held on Margarita Island (Venezuela), attracted 85 papers, a significant increase on the 35 presented in 1992.

To encourage the participation of young researchers and postgraduate students, the 18th symposium saw the creation of a pre-symposium catalysis school in the area of preparation of heterogeneous catalysts and of scaling up catalytic processes.

International Congress

Venezuela has also participated in the International Congress on Catalysis, where economic restraints or council policies sometimes impose limitations. The number of papers accepted grew from two papers in Moscow in 1968 to thirteen in Granada in the year 2000. Venezuela has now been accepted as a full member of the International Association of Catalysis Societies (IACS).

International Cooperation

International cooperation has always been important for Venezuela. While initially cooperation was focused on human resources, it is now usual to see joint research and development projects. International cooperation projects are now running with Spain, Portugal, Argentina, Brazil, Bolivia, Chile, Colombia, Cuba and Mexico. These are administered through the international CYTED program (Science and Technology for the Development of Iberoamerican Countries). Within Europe, cooperation with France, Great Britain, Italy and Hungary has been enacted through French and European Community programs. Some projects with the U.S. were funded through the National Science Foundation and the Department of Energy.

Research and development in Venezuela

Catalyst development activity has been carried out mainly at Intevep (the PDVSA Research and Development Center), concentrating on the enormous energy potential of Venezuela. Two directions were followed, one leading to improvements on existing catalysts and the other towards the development and applications of new materials.

Among the main projects, Intevep is responsible for research activities in the different business areas of PDVSA subsidiaries such as: exploration and production, refining, petrochemicals and fertilizers, Orimulsion®, and natural gas^[3,4]. Twenty-eight years of technological and scientific research has led to significant achievements that have generated business opportunities for the Venezuelan oil industry^[3]. Table 2 shows the strong growth in the number of patents related to catalytic technologies.

Typical projects carried out simultaneously by different groups from academia and PDVSA-Intevep are:

Natural Gas Conversion Catalyst development for Fischer-Tropsch synthesis (conversion of gas to liquid), reforming of methane and other hydrocarbons, auto thermal reforming, and direct conversion of methane to other hydrocarbons and fuel cells, are among several research programs developed in the Universities in cooperation with Intevep^[5,6].

Catalyst development at the industry

Concentrated at PDVSA-Intevep

Work is focused on

- Refining
- Polymerisation

The numerous patents already issued by several world patent offices is testament to the developmental work.

From the Espacenet database, 165 patents related to catalytic technologies (catalysts and adsorbents) have been reported worldwide.

Those correspond to 90 inventions, which have been patented in USA independently.

Table 2

Environmental catalysis The use of monoliths for environmental catalysis: theory and practice. Application to the elimination of VOCs, NO_x, SO_x and R-S-R^[7]. Nitrates/nitrites reduction in water for human consumption. Reduction of dyes at industrial effluents. Phenol oxidation in acid waters coming from refineries^[8].

Hydro cracking and hydro treating Among the main technologies developed by PDVSA-Intevep for heavy oil treatment is the HDH process, developed in 1986^[9]. This process was further improved in the 90s by replacing the natural catalyst by a petroleum-coke based catalyst^[3]. The AQUA CONVERSION® technology was developed in 1997^[10]. The main feature of the process is the catalytic system and the way it is incorporated in the process. The ISAL® process hydrotreats gasoline range feedstock by means of selective hydroconversion reactions for full recovery of iso-octane. It allows operation at the correct severity with light and heavy fractions of the FCC naphtha^[3].

The use of hydrogen donor solvents for underground crude oil upgrading^[11] and ultrasound application for heavy oil upgrading^[12] is currently under investigation.

New materials The majority of research groups in catalysis are involved in fundamental and applied research on molecular sieves. This in the context of characterization and testing of catalysts to enable the understanding of catalytic properties and to support high quality fundamental and applied research^[13]. This has encouraged industry and brought them into contact with Universities. Consequently there are several cooperative projects in progress. In the last decade, PDVSA-Intevep had developed new mesoporous molecular sieve materials. One of these is a mesostructured array of tortuous and highly interconnected channels with a tunable uniform pore diameter between 1.5–10 nm and a high surface area (600–1,300 m²/g)^[14]. Another PDVSA-Intevep family of mesoporous materials is one with nano-crystalline microporous phases defining mesoporous channels^[15]. Such materials aim to join micro and mesoporosities in particles in order to improve accessibility of large hydrocarbons to highly active centers in the microporous regions. Nowadays, these mesoporous materials are

under study by several catalysis groups working to meet the requirements of new processes.

Finally, it is worthwhile to mention that, due to the high level reached by catalysis research in Venezuela, PDVSA is supporting the building of a catalyst factory for refining technologies and petrochemicals-based catalysts, for the national and international markets.

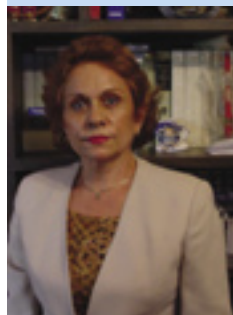
Final Remarks

The author would like to stress that this contribution aims to give an informative, easy to read view of catalysis in Venezuela. It is not meant to be an exhaustive account. If required, more detail is given in reference [2].

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curriculum vitae



Professor Goldwasser was born in Venezuela. She graduated as *Licentiate in Chemistry* from Venezuela Central University.

Followed postgraduate studies and research at Boston University in USA in the Physical Chemical Department working in the area of gas kinetics.

In 1976 she obtained DIC and Ph.D. diplomas in Chemical Engineering at Imperial College, London, working with Prof. David Trimm in the area of "Support Effects in Catalytic Oxidations."

During her sabbatical leave in 1993 she spent a year at the Institute Des Recherches sur la Catalysis in Lyon, France working with Dr. Claude Naccache in the area of "Electron Spin Resonance Applied to Zeolites."

In 1996 she was invited to serve as Professor at the University of Lille, France working with Professor Ginette Leclercq in the area of "Conversion of Synthesis gas to Alcohols."

She has been:

Chairman of the Chemistry School in the Science Faculty at Central University (1980–1982). Elected president of the Venezuelan Catalysis Society (1988–1991). Delegate for Iberoamerican to the Council of the International Congress on catalysis (since 1996).

In 1991 she was awarded the order "José Maria Vargas" for her academic work.

In 1992 she was awarded the Francisco De Venanzi award for her research work.

She has published over 100 scientific papers and technical reports and has been invited lecturer at many universities in Venezuela and at international conferences and symposia mainly in Iberoamerican and France.

At present, she is Titular Professor at the Chemistry School of Science Faculty, Chief Editor of the Venezuelan Catalysis Journal, "Revista de la Sociedad Venezolana de Catálisis," elected member of the Council of the Center of Catalysis, and President of the National Committee for Petroleum Research (Conipet).

Her actual research interest is in the area of CI chemistry and synthesis of fine chemicals.