Institutionalisation of Chemistry in Mexico during the Twentieth Century (1934-1970)

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Introduction

Historically, Mexico's rich natural resources have provided a platform for its economic development. New-Spain had been the provider of gold and silver for the Metropolis, generating the extractive and mining industry expansion for the service of the Spanish crown in the XVIII century. Later, independent Mexico has also based its economic development on the exploitation of its main natural resource, oil, from the 1940's onwards. However, today Mexico doesn't own an autonomous economy based on exploitation of oil. The oil industry, major national economic industry, has not overcome its technological dependence on other countries. The industries derived from oil chemistry, pharmaceutical chemistry, and in general the natural resources transformation industries participate only very little in the economic growth of the country. However, world development of these industries, as in Europe and the USA, is based mainly on scientific and technical knowledge, generated, conceptualised, codified and applied by chemists (both engineers and researchers) working in their national academic and productive sectors.

This situation of dependency is the same today in other industrial sectors and in all economic sectors in Mexico and provides much for discussion by politicians responsible for science policy. All of them conclude that the main cause of this circumstance is the lack of links between academic and productive sectors. Since the North American Free Trade Agreement (NAFTA), which has opened trade exchanges with USA and Canada after 1994, the Mexican government has been applying strategies in favour of collaboration between academic and the productive sectors in view of creating a national system for innovation based on permanent partnerships. The objective herein is not to assess this new innovation poli-

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cy in Mexico but to give some of the historical elements which could explain how scientific professionalisation is a key factor to the understanding of the emphasis that national leaders now place on the need for increasing the interactions between the academic and industrial sectors in Mexico.

The process of chemistry institutionalisation in Mexico has been analysed through a review of the interactions between state, academy and productive sectors since the 1940's, a period when Mexico decided to modernise its industry, until the 1970's. The main hypothesis is that a socio-historical analysis of the interactions between political, economic and academic fields will allow the understanding of the present relationship with each other and how the scientific field was structured within a specific context.[1]

Methodology

The process of institutionalisation in chemistry is discussed starting at a certain historical point of two principal institutions: The National School of Chemical Industries, created in 1916 and historically the main training centre for Mexican chemists, which in 1965 became the Faculty of Chemistry; and the Chemistry Institute created in 1941. Today these two bodies are located at UNAM *(Universidad Nacional Autonoma de México)*, the largest and oldest university in Mexico.

The origin and the setting up of the National School of Chemical Industries are not given here because of the limitations of time and space. Instead, it will show how different events favoured the emergence of chemistry as a discipline with an infrastructure. Specific issues will be highlighted, including the a research group devoted to its practice with a legitimacy that was rewarded by several indicators such as diploma, title, journals, training, etc.

It has been explained previously how, until the end of the 1930's, chemistry practised in Mexico did not appear as an institutionalised discipline but as a group of three types of technical knowledge based on areas of professional activity;[2] these were:

1. Chemical-pharmacists devoted to the production of basic substances for medicine manufacturing and pharmaceutical industries;
2. Industrial chemical technicians occupied with quality control and rules inside public organisations;

3. Chemical engineers devoted to the maintenance and control of the production chain in the new national industry.

All of them graduated from the Tacuba School, also called the National School of Chemical Industries, the only school in Mexico devoted to training professionals with a specific education in chemistry.

However, according to their testimonies, by the end of the 1930's graduates from the Tacuba School could not find any good positions in industry. Most of them became either part-time teachers at the school or they went to work full time in the public sector, for example in the *Consejo Superior de Salubridad (Higher Health Council)*, *Secretaría de Industria (Ministry for Industry), Secretaría de Hacienda (Ministry for Treasury), Secretaría de Guerra y Marina (Naval and Army Ministry)*, where they performed in analysis and normalisation (meaning "quality control"), oil production control as well similar duties in sugar and alcohol production laboratories. If they found a position in any of the industries such as in soap, refineries and paper factories, they were placed in subordinate positions under the supervision of foreign technical staff (mostly English in the oil industry and Cubans in sugar refineries).

It will now be shown how in this context, a political shift and the initiative by some academics and industrial tycoons created a framework that allowed the emergence of chemistry as a scientific discipline with its professional practioners.

I. Chemistry as a profession (1941-1965/1970)

I.1. The place of chemistry within political discourses and decisions

The first question to be discussed delves into the *position of chemistry within the political discourse and decisions when it appeared for the first time as a premise for a science policy in the 1940's.*

In 1942, Manuel Avila Camacho's government created the *Comisión Impulsora y Coordinadora de la Investigación Científica (CICIC)*, supported by the *Secretaría de Educación Pública* (Ministry of Education), in order to encourage a basic science education for the first time which would favour industrial development. The recent (1938) re-appropriation of the oil industry invited a preference for achieving technological independence. Since science appeared as an instrument for progress, defined as economic growth, this was translated into the following actions:

1. Provision of postgraduate scholarships to favour the education of human resources.

Between 1943 and 1950, the CICIC gave 107 scholarships of which nearly half were destined to students traveling to foreign countries. A special attention was given to biology with 48.6% of the scholarships, followed by mathematics and physics with 29%. However, only 9.3% of scholarships were destined to chemistry and the rest were given to the Human Social Sciences.

2. Creation of new infrastructure.

Some institutes were devoted to research with specific objectives for solving specific problems of the country; other institutes were devoted to basic research in order to establish a national science base for supporting the technological development of the country. Thus, on the one hand, research institutes for tropical diseases and public health were created and on the other hand the *Instituto de Geología, Instituto de astronomía, Instituto de física, Instituto de matemáticas and Instituto de biología* appeared, but no institute for chemistry.

I.2. "Los Químicos como Académicos" or how the academy becomes autonomous

a) The Chemistry Institute, the first institute of education for chemistry researchers.

Finally in 1941, the Chemistry Institute was created. Fernando Orozco, director of the School of Tacuba, and Antonio Madinaveitia, a Republican Spanish scientist, initiated the creation of the Institute.[3] F. Orozco was one of the students sent in 1921 with a scholarship to the University of Marburg on the program established by Vasconcelos, the first Minister of Education in Mexico[4] after the Mexican Revolution begun in the 1910's. In Marburg, Orozco carried out his Ph.D. in analytical chemistry. Returning to Mexico, he was given a position as Professor in the Tacuba School, he set up a quality control laboratory for the government and finally in 1935 in the context of the reform of the School he took over its direction.[5]

Antonio Madinaveitia, doctor in pharmacy and chemistry, having graduated from the University of Madrid then taught chemistry at the University of Granada and Madrid, was one of the republican Spanish scientists invited by the Mexican government to continue his work in Mexico.[6]

Thanks to the financing by *Casa de España*, an institute especially created for the Spanish scientists,[7] and with the aid of some chemistry students from the Tacuba School by F. Orozco, Antonio Madinaveita opened a research laboratory at the School in 1939.[8] It was named *Instituto de Química* (IQ), with Orozco as director and Madinaveita as Head of Research.[9] However *Casa de España* quickly became *el Colegio de México* keeping only the human and social sciences departments, the IQ was integrated into UNAM in 1941 but without receiving any financial support. The relationship of Madinaveita with the Rockefeller Foundation made possible a financial grant to the IQ[10] which allowed the creation of two laboratories, plus a small library and the purchase of materials. Following this, *El Banco de México* also gave financial help in order to assess the natural resources of the country.

b) The creation of a PhD in chemistry

After vigorous debates in the technical council of the Science Faculty, the IQ was granted permission to start a doctoral postgraduate program specialising in chemistry. However the possibility of becoming full-time researcher or Professor in chemistry did not exist at that time in the UNAM and for this reason training at postgraduate level attracted only very few students. The creation of an institution devoted to research and training in chemistry was not enough for setting up chemistry as a profession. In fact other events linked to the process of autonomy in the UNAM motivated the growth of human resources for chemistry.

c) "El personal de carrera": the status of full-time researcher (1944-1947-1953).

Indeed the attempts by President Lazaro Cardenas for reforming higher education after 1934 and for reinforcing qualified human resources in the new national industries caused resistance in the UNAM teaching corps, which had been fighting to preserve their autonomy. The following two outcomes were delivered:

1. Creation of positions for Professors and researchers.

The 1944 UNAM law[11] defined the different categories of teaching and research staff at the University and established a set of rules forbidding them to practice other activities or to occupy other public positions.[12] In 1947, a new category of professors was created: full-time Professor whose activity was devoted to the teaching or any other activity related to this. As *profesores de carrera*, they were

not allowed to teach in other places. They were recruited from the *profesores ordinarios* after 5 years of service, being nominated by the directors of the faculties.

2. A boom in the recruitment for researchers during the 1950's.

Nabor Carillo, rector of UNAM (1953-1957), created in 1954 a position for full-time researchers and provided a budget for recruiting Professors and researchers. These measures reinforced human resources at the IQ. Until 1951, the IQ recruited an average of 2 to 4 professors per year; in 1954 it recruited 20 professors and researchers, after this date the institute recruited an average of 10 professors per year until 1965.[13]

The events just described show how on the one hand the nationalistic policy of the 1940's allowed the creation of an infrastructure dedicated to research. On the other hand they show how the resistance against the same policy by the UNAM scholars allowed the autonomy process of the academy positions due to the creation of full-time research positions and a corresponding budget.

However if the interactions between political, economic and social fields allow us to understand, as showed previously, how a discipline appeared and acquired a certain social legitimacy, they do not inform us about the content of Mexican chemists' practices. In particular, what did they work on? How did they work? What were their scientific issues? Were they working on specific subjects related to Mexico, or at an international level on scientific universal issues? To answer these questions, the dynamics of chemistry research since the 1940's are reconstructed in the following paragraphs.

I.3. Steroid chemistry: a scientific niche for the internal structuring of chemistry in Mexico

Initially, the researches undertaken by the IQ were related to economic issues of the country. Then in the Second World War context, supported by the CICIC and Banco de México, the researchers focused their study on the country's natural resources in order to find substitutes for imported products. However, since 1948, when Syntex proposed to the head of IQ that they carry out research on steroids, a proper organisation for investigation was developed. Created in 1944, Syntex was the first company in the world to produce steroids on an industrial scale.[14] In 1945 the founders of Syntex, Mexican, North American, and European chemists, succeeded in producing progesterone, a steroid hormone extracted from the *dioscorera* plant and examined its therapeutic effects. Since 1934, progesterone had been produced in Europe

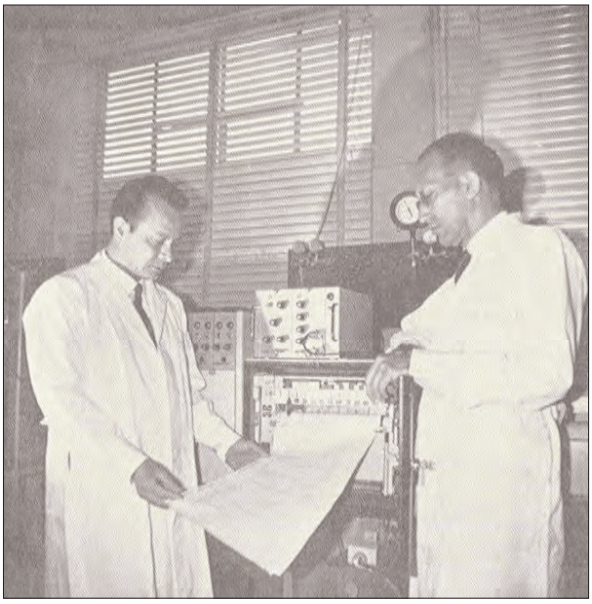

Figure 1. Organic Chemistry Department of Syntex[17]

from animal cholesterol (spinal chord from cattle) but in very low quantities and at a very high price. An American chemist, Russel Marker, discovered in 1940 the *dioscorera* in Veracruz State when researching certain plant steroids, the sapogenins, which molecular structure is very similar to cholesterol.[15] The *dioscorera* plant of Mexico, an endemic climber is very rich in sapogenins, which motivated Russel Marker and his Mexican partners to co-found Syntex in 1944 in Mexico City in order to produce progesterone cheaply and in large quantities.[16] Seeking to synthesize other steroid hormones extracted from plants and new molecules with the same characteristics as human steroid hormones, and to produce them industrially, the head of Syntex sought and obtained the necessary human resources and the scientific infrastructure to enable these activities in IQ.

This collaboration attracted both researchers from the IQ and students preparing for the PhD in organic chemistry, specifically in steroid chemistry, because it offered them opportunities, to devote themselves to full-time research with added salary, to work with new substances and with new equipment such as microanalysis, as well as to enter a new research field that of the chemistry of natural products. In this way, IQ participated in the manufacture of steroid hormones that were naturally produced by the human body, such as cortisone (the miracle medicine that suppresses rheumatic arthritis, heals allergies and other inflammatory diseases[18]) and most importantly in one of the most significant discoveries of the XX century, the contraceptive pill.[19]

Thus the collaboration between Syntex and IQ built the scientific niche for chemistry as a scientific discipline in Mexico during the 1950's. However once again, the involvement of the government was a key factor which allowed a real consolidation of this field.

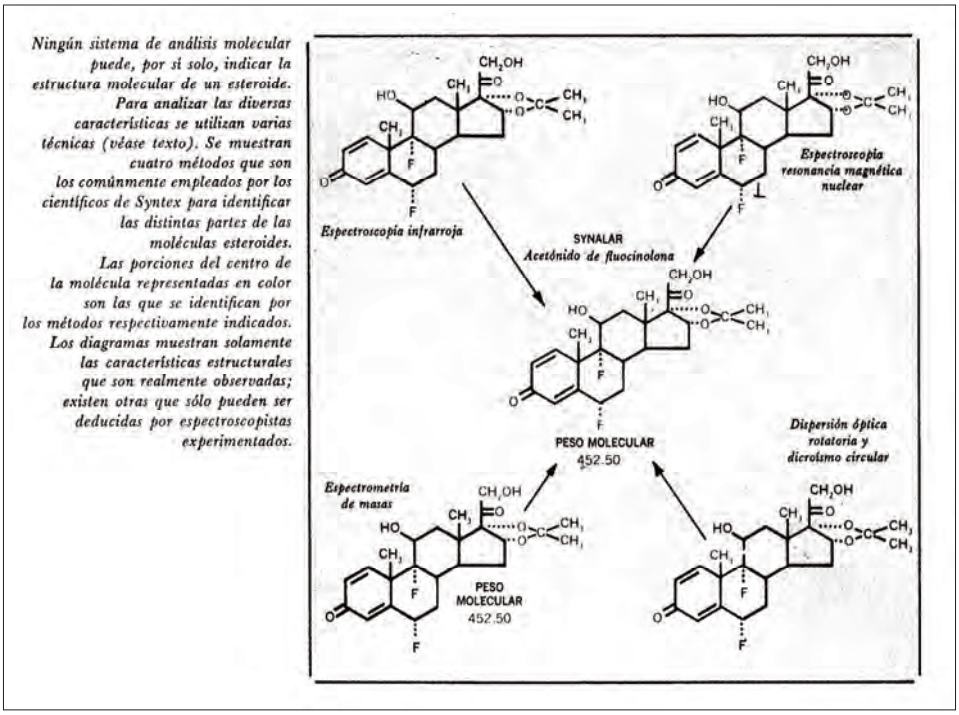

Figure 2. Examples of the processes used in Syntex in order to identify steroids molecules.[20]

II. Consolidation of the autonomy of chemistry

II.1. The Institutional decentralisation and diversification of subjects

Consolidation of the autonomy of chemistry came first of all from the creation of other institutions devoted to chemistry research. In 1961, the UNAM Rector Chavez, who wished to open the University to the intellectual and scientific elite of the country,[21] eliminated the position of researcher at the faculty, raised the salaries and provided budgets for the purchase of laboratory equipments.[22] In this way the *Division de Estudios Superiores* (later the *Division de Post-Grados*) was created in 1965, transforming the school of Chemical Sciences into a faculty, *La Facultad de Química* and reestablished the PhD program once again. This event brought the opening of new departments on areas other than organic chemistry, notably in inorganic chemistry, biochemistry, chemical engineering, theoretical and experimental chemistry and quantum chemistry.

The creation of other research institutes for chemistry in different places initiated the diversification of research subjects as well from the 1960's onwards: the department of chemistry in the CINVESTAV in 1961, the creation of new research lines in the School of Biological Sciences at the Polytechnical National Institute, The Chemical Sciences School in Puebla[23] in 1963 an applied research in the *Instituto Mexicano del Petroleo* (Oil Mexican Institute) in the oil chemistry field (catalysis, polymers and fertilisers) from 1966 onwards.[24]

II. 2. Institutionalisation of a science policy (The 1970's)

The second key movement for consolidation of chemistry was the setting of a science policy in Mexico. Since 1970, Mexican politics were characterised by the renewal of a nationalist debate which considered reducing the economic dependence of the country on external influences. A link between the state and the national private capital was suggested as a means for overcoming the imbalances and inefficiencies of the productive sector and also to protect the country from private and foreign interests.

The government created the *Consejo Nacional de Ciencia y Tecnología* (CONACYT) in 1970 as an organisation in charge of planning, coordinating and assessing science and technology government policies and linking these with national development. In the field of chemistry, an important decision of CONACYT during the seventies was to create the *Centro de Investigación en Química Aplicada (CIQA,* Centre for Applied Chemistry Research) in Saltillo in 1976 in the state of Coahuila, as part of the decentralisation of science that began during this period. The 1970's science policy supported chemistry in a permanent way, which allowed reinforcement of the infrastructure and training of human resources.

Conclusión

One can realise that historically the extractive industry and the industrial modernisation based on oil chemistry spurred the economic development rather than scientific acivity in itself which should have played a main role to support it.

Research in the field of steroid chemistry promoted by the industrial sector, represented a strategy for industrial development as an investment factor, and allowed the building of a participating niche for chemistry in XX century Mexico. Research in this case was not an academic response to the traditional demand by the state.

Indeed, these are the efforts of the state from the 1920's onwards who offered an infrastructure and human resources in favour of industrial development. Following this, the state played an important role in creating science policy allowing the support of research for itself which in turn allowed a diversification of research subjects, the creation of new institutions and, as a consequence of university autonomy as well as consolidation of a new scientific activity: chemistry.

As the position of scientific and technological knowledge was defined in the political projects after 1940, we have analyze the interactions of these representations with the academy and the productive sector. This in turn led to the institutionalisation of chemistry as a field of knowledge by the end the 1960's. Thus, having in mind local and international scientific issues, interactions between academy, productive sector and state, it has been shown that the requirements for the development of a research field are not only the links with social, economic and political issues of a country, but also the presence of an participating scientific niche.

This analysis demonstrates the importance of a specific historical context in the scientific institutionalisation is a key element for understanding the current political discourses of the country leaders expressing the need to stimulate interactions between the academic and productive sectors.

Notes

[1] This paper is extracted from a larger study to be published in 2008: Mina Kleiche-Dray and Rosalba Casas-Guerero, "Institucionalización de un campo científico: el caso de la química en el siglo XX", *Revista REDES (Revista de Estudios Sociales de la Ciencia*, 40 pages, forthcoming.

[2] M. Kleiche-Dray y R. Casas-Guerero, "Universidad/Laboratorio/sectores productivos: La construcción de la comunidad de Químicos en México. Perspectiva sociológica e histórica", in *I Congreso Iberoamericano de Ciencia, Tecnología, Sociedad e Innovación, CTS+I, Sección 13. Universidad, Empresa e Innovación, México D.F.de 19 al 23 de junio de 2006.*

[3] P. Padilla Olivares, "Génesis de una Facultad", *Revista de la Sociedad de Química de Mexico* 45 (2001): 106-114.

[4] Vasconcelos arrived in power with an intensive educational project reaching all over the country. He gave an impulse to higher education by granting scholarships that allowed several Mexican students to train in Europe. Between 1920 and1925, 20 students benefited from these funds, studying chemistry in Germany, France, Switzerland and Great Britain.

[5] Fernando Orozco played an important role as a consultant to Pemex in the production of petrol during oil expropriation, see Andoni Garritz & Juan Antonio Chamizo, *del Tesquite al ADN* (México : Fondo de la Cultura Economica, 1995), p. 32.

[6] He was also the founder of *Sosa Texcoco* Company in 1942, which manufactured caustic soda and sodium carbonate from water in the Texcoco lake, see *del Tesquite al AND*, p. 33.

[7] *"…a refuge for those who could contribute to the cultural progress of the country…",* see "Homenaje a Madinaveitia", *Revista Mexicana de Química*, Vol.24, 4, p. 157.
[8] "Cinco lustros de existencia", *Boletín del Instituto de Química,* XVII(diciembre de 1965), p. 83.
[9] "Cinco lustros de existencia", p. 84
[10] This help would continue until 1963.
[11] See M. Landesmann-Miklos, *Identités académiques et générations. Le cas des enseignants de biochimie de l'Université Nationale Autonome du Mexique(UNAM),* Doctorat es Lettres et Sciences Humaines, option Sciences de l'Education, (Nanterre: Université de Paris X, 1997), Vol.1, chapter 2. Cadre Historique, disciplinaire et institutionnel, p.110-155.
[12] In fact in the foundation project of The National University in 1910, and in its autonomy law of 1929, the scholars sought a way to introduce research in the centre of university life and keep it apart from political influence. An internal standard for nominating Professors was suggested, which became the Academy of Professors. This Academy could not escape political or personal interests which helped to create gradual controversies. For this reason the rector Alfonso Casas promulgated a new constitution: *The organic law of the UNAM* which shifted power from the Academy to the University Council in 1944.
[13] See the paper, "Homenaje a Madinaveitia",p. 159.
[14] J.F.H. Arellano, *Anuario de la Comisión Impulsora y Coordinadora de la Investigación Científica* (México, 1994); C.CE. Lida y J.A. Matesanz, "El colegio de México: una hazaña cultural, 1940-1962", in *Jornadas* 117 (1990), W.B. Murphy, *Science Serendipity. A half century of innovation at Syntex* (New-York: The Benjamín Company INC, 1994); F.G. Pereira, *Productos químicos y farmacéuticos* (México: Atlanta S.A., 1956).
[15] We have to know that diosgenin has an advantage related to cholesterol from which progesterone was manufactured. Cholesterol produced two intermediate substances which could turn into commercial products while diosgenin produced only one intermediary substance, 16-D from which chemists could access to almost all of the other interesting pharmaceutical steroids. This made Syntex the main provider of hormones to several pharmaceutical companies in the US and Europe who manufactured drugs used for human therapy, see Syntex, *Una corporación y una molécula. Historia de la investigación en Syntex* (Cuernavaca : Litoarte, 1967).
[16] Syntex, *Una corporación y una molécula*
[17] Syntex, *Una corporación y una molécula*, p. 100.
[18] It was quickly shown however that cortisone altered the metabolism producing oedema, hypertension and other secondary effects.
[19] In 1951 Rosenkrauz and his group produced the 19-nor-progesterone, and with Djerassi they provided the derivates of this molecule which most important steroid was the German estiron or19-nor-estiron, first synthetic pharmaceutical substance manufactured by Syntex and patented on 15/10/1951. Later, Luis Miramontes produced the 19-nor-17alfa-ethynilesteron and Syntex began producing for business the norentindone since 1951 This substance was sent to the USA for clinical studies and showed its efficiency in ovulation inhibition in 1956, opening a new research field for Syntex. See *Una corporación y una molécula. Historia de la Investigación en Syntex*, p.56, O.M.Lagos, *Estudios económicos de la industria químico-hormonal. Escuela Nacional de economía.* Tesis de licenciatura (Mexico : UNAM, 1962) and C. Lomnitz-Adler, *Las salidas del Laberinto* (México : Loaquim Mortiz-Planeta, 1995).
[20] *Una corporación y una molécula. Historia de la Investigación en Syntex*, p.102.
[21] *"In the arrangement given by the University Council in April 10, 1962, we said that academic activity of university researchers is developed within the Institutes and their work must be focu-*

sed on the conditions and national problems. In this way research received a different structure from the faculties and schools : from this date on, university activity should be carried out within independent and specialized structures", I. Carillo Prieto, *El personal académico en la legislación universitaria* (México: UNAM, 1996).

[22] M. Landesmann-Miklos, *Identités Académiques et générations. Le cas des enseignants de biochimie de l'Université Nationale Autonome du Mexique(UNAM),* Doctorat es Lettres et Sciences Humaines, option Sciences de l'Education, (Nanterre : Université de ParisX, 1997)

[23] In province, the state of Puebla, there had been a tradition for chemical research since the 19th century. In 1939, at Puebla State University, a degree for chemical pharmaceutical biologists was created and transformed in 1944 into the Faculty of Chemical Sciences. This Faculty would open postgraduate positions in 1970.

[24] M. Snoeck, *La industria de refinación en México. 1970-1985.*