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# Chemists for Industry on the Periphery of Europe: Training and the Rise of Professionalism in Spain during the First Half of the Twentieth Century\*

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## Introduction

The entrepreneurs of the mainland European chemical industries, at the end of the XIX<sup>th</sup> Century thought it was necessary to incorporate new specialists to manage new factories, whose scale and volume of production had increased significantly compared to that in earlier times. Chemical Engineering was one of the new disciplines which emerged slowly in United States and Europe, especially in Great Britain.<sup>1</sup> Different subjects and areas grew in other mainland European countries. For example, in France the 'Instituts Annexes de Science Appliquées', programmes of Industrial Chemistry were aimed at the resolution of practical problems of local industries.<sup>2</sup> The influence of organic chemical industry in Germany determined the numbers and the relationships between chemists and mechanical engineers. At the same time, Assistant Professors of Industrial Chemistry in the German Technischen Hochschulen claimed that technicians assigned to inorganic industry had to receive a specialised training. Meanwhile, German University Science Faculties incorporated Technical Chemistry as a way to introduce chemists into the study of chemical processes and their products.<sup>3</sup>

## Key players and places in the first third of xx century in Spain

During these years, Spain went through an intense process of industrialisation; this raised the necessity of producing qualified personnel in order to manage the new factories being built. All the teaching institutions of Science and Technology

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offered several models of training which however had the following characteristics in common:<sup>4</sup> (a) They all had young professors who had carried out postdoctoral studies in Europe; (b) All of them believed that in technical education the scientific aspects should dominate over the technological ones.

This approach was called the “*culture and engineering of laboratory*”. Two types of training institutions for specialists who wanted to work in chemical industry can be distinguished during the first years of the twentieth century, those in the public sphere and those in private institutions. In the public sphere there were three kinds of educational institutions, namely, Schools of Engineering, Industrial Schools and Faculties of Sciences of the Universities. The first offered little specialisation from the middle of the nineteenth century, in the few courses of Chemistry available the theoretical and descriptive aspects were given more importance than the practical ones. In the mid-nineteenth century some Schools of Industrial Engineering appeared in the most important cities in Spain. A few years later most of them closed because of lack of funds, with the exception of that in Barcelona which received financial support from the Catalan bourgeoisie.<sup>5</sup> Students could qualify as a chemical engineer, but studied just a few areas of chemistry (Organic and Inorganic Applied Chemistry and one course of Chemical Analysis); however there was a great shortage of equipment and laboratories.<sup>6</sup> In the early twentieth century two new Schools of Industrial Engineering opened, in Bilbao and Madrid, in response to the need of engineers in the growing Spanish industry. Despite the “renewal movement” in technical education that appeared in Spanish society, the teaching of chemistry in these Schools barely changed in the first 30 years of twentieth century.

The second were the Industrial Schools, a new type of educational institution established at the beginning of the twentieth century, with instruction at a low technical level and aimed to the training of foremen. In 1901 a Government decree established these Schools in the main cities of the country. They were earmarked to train personnel that would be able to replace the more than a thousand foreign technicians, at the time, in Spanish industry. Over three courses foremen for chemical industry received intensive training in the laboratory, and began to explore practical content of new disciplines, such as Electrochemistry or Metallurgy, which were not studied then in other establishments in Spain

The third type training of specialists was that given in University Science Faculties. During the last third of the nineteenth and the early years of the twentieth Century they underwent an intensive period of diversification, creating different subject area sections. In 1902 the chemistry section was created, in which over four courses chemists studied a few subjects of chemical nature, in a highly

theoretical manner and with almost no laboratory work. In 1922 came a new curriculum that extended the number of chemical disciplines studied and created new areas such as in Electrochemistry and Technical Chemistry. This last discipline aimed to study the procedures employed in industry and the operations of control laboratories. Due to the lack of specialists, Technical Chemistry was taught by Professors of other specialties (Chemical Analysis, Inorganic or Organic Chemistry). Because of this, the courses focused on descriptive aspects of the different chemical industries (organic or inorganic) and the main type of analysis that industrial chemists would have to carry out. The advent of the Second Republic allowed this situation to change. The Educational authorities increased to five the number of courses and also the number of optional subjects of an applied character, and promoted practical work for students in the industry. They established two chairs of Technical Chemistry in Spanish universities at Madrid and Oviedo. The Professors tried to introduce the study of unit operations in the same way as was studied in American schools of chemical engineering, but the beginning of the Civil War prevented this initiative.

In the private sphere, two educational institutions were of importance, both were supported by the industrial Catalan bourgeoisie, these were the Institute of Applied Chemistry (IQA) and the Chemical Institute of Sarrià (IQS). Most of the Spanish chemical industry was at the time installed in Catalonia; hence the Catalan employers were concerned about the training of technicians and specialists. They were convinced that they were unable to manage properly their factories, and sought to obtain the formal training not otherwise available for their staff.

The first institution, promoted by the regional government, trained technical staff over four courses of intense work in the laboratory. For this purpose the Government of Catalonia built a modern and well equipped laboratory, which gave a joint training facility for students of the School of Industrial Engineering, the Industrial School and IQA. In the late 1910's, IQA created a course for the studies of *Directores de Industrias Químicas* (Directors of Chemical Industry). Over four courses, these students got on hands on laboratory experience in the synthesis and analysis of organic and inorganic substances. At the end of the course they had to carry out a project on an industrial plant and which they then had to defend in public. In addition, they were expected to attend courses and conferences organized by IQA, which were taught by the Professors of IQA, directors of the main Catalonian chemical industries or by reputed chemists such as Wilhelm Ostwald or Paul Sabatier.<sup>7</sup>

The second private initiative was that by the Jesuits, who believed that their novices had to learn the foundations of modern science at the same time as they studied theology. The head of IQS was Eduardo Vitoria, a Jesuit priest who since 1905 led the Laboratorio Químico del Ebro (Chemical Laboratory of Ebro), after he had ended his doctoral studies in Organic Chemistry in the University of Leuven, directed by Louis Henry. The growing interest that Laboratorio del Ebro aroused among the Catalan industrial class forced the Jesuits to transfer their chemical studies in 1916 to Barcelona. Vitoria maintained in the IQS the same practical approach to the study of chemistry that he had acquired during his stay in Leuven. Long hours of work within the laboratory, a good library with a comprehensive collection of journals, were the keys to the success that the IQS achieved during its early years. Its students were the sons of the Catalan bourgeoisie that previously had studied as chemists, pharmacists or engineers in the official establishments of education. During almost the twenty years that IQS was open, 312 students graduated from its three courses, all of them with a strong industrial approach. One of the IQS signs of identity was the immediate incorporation of their pupils to the industrial world, a result of the ties that the IQS alumni association established with Catalan chemical entrepreneurs. It seems not unreasonable to assert that the IQS was the first European institute to offer the specialty, Chemical Engineering,<sup>8</sup> even if none of what are now regarded as the distinctive elements of it were present in the training given during this time.

### **After the Civil War (1936-1939)**

After the Civil War, those chemists that remained loyal to the Spanish Republic were expelled from their University Chairs.<sup>9</sup> The new pro-Franco authorities looked for ways to fill the vacant chairs with followers and supporters of the new regime. In the same way, it was necessary to create new scientific and technological research centers that replaced the republican ones, as CSIC (Spanish Science Council). One of the professional groups that took good advantage of this situation after the Civil War were chemists, they stayed close to political and economical power. As happened in the Italian and the German fascist governments, Franco's regime decided that the new economic system was to be based on economic self-sufficiency, autarky. The chemists that maintained close to the Franco's power supported these economic ideas, this allowed them to acquire influence, occupy some of the most important positions in the government, the Universities and the new institutes for scientific and technical research.

Some of the educational institutions where specialists for chemical industry were trained before the Civil War remained open. Attention will be focussed on two of them, namely the Schools of Industrial Engineering and Faculties of Sciences. In 1954 the Professor of Chemical Engineering in Yale, Barnett F. Dodge, thought that Chemistry had been given too much emphasis in Spanish Schools of Engineering, "...few of Chemical Engineering and too much of Industrial Chemistry".<sup>10</sup> These types of School inherited the course model in use previous to the Civil War and were not able to propose new studies that gave answer to the economic self-sufficiency ideals of the Franco regime. Since the forties, industrial engineers perceived the massive arrival of chemists in industry as a threat to their profession.

Significant changes of opinion were made over time by some Professors that were involved in the training of Spanish engineers. José Martínez Roca, Professor of Organic Industrial Chemistry thought in the nineteen twenties that his discipline had to be centred in the descriptive aspects of processes and apparatuses, and dedicated special attention to the "scientific foundation on which their operations are based".<sup>11</sup> Twenty years later he thought that it was necessary to teach all those operations that are made most use of in the chemical industries, "all chemical industry can be viewed like a unit of several operations...".<sup>12</sup>

Other Professors such as Carlos Abollado tried to change this situation, promoting the introduction of a course of Physical Chemistry and another of Chemical Technology into the curriculum for industrial engineers. Trained as an industrial engineer, at the end of his studies he went to Germany to work in the electrochemical department of the Siemens Halske Company. When he returned to Spain he worked as an engineer in some industries, completing diverse production procedures. After the Civil War, he reached excellent positions within the pro-Franco administration and in the Institute of Applied Investigation (Instituto Juan de la Cierva). In respect to the training of new industrial engineers, his model was close to the German one. He thought "to use the development of descriptive chemistry to study each physicochemical theory...".<sup>13</sup> By this means, a student could simultaneously make contact with theory and its practical application, without it first being considered as a simple abstraction. In order to realise this aim it was necessary to modify the chemistry curriculum for industrial engineers, eliminating the discipline of Industrial Chemistry, diminishing the previous importance of Chemical Analysis and reinforcing the studies of Physical Chemistry with two courses, one of general chemistry and another of Chemical Technology, where "...[students could study] the technique of the operations and the methods to make the apparatuses".<sup>14</sup>

In the faculties of Science, chemists of different specialities, close to Franco's regime or close to the new academic authorities, occupied the first chairs of Technical Chemistry that became vacant. This implied different focuses for the discipline, two approaches mainly prevailed: a) to continue with descriptive aspects characteristic of the Industrial Chemistry; b) to incorporate concepts of the Chemical engineering such as unit operations.

In the second option, two different modes are to be found. Firstly, many Professors tried to maintain relationships with the political and academics authorities by incorporating unit operations inside the discipline of Technical Chemistry. The first to use this approach was Fernando Calvet Prats, the Professor of Technical Chemistry of the University of Barcelona. He had been Professor of Organic Chemistry in Barcelona before the Civil War; he was removed from of his Chair but reinstated in 1945 as Professor of Organic Chemistry in the University of Salamanca. Meanwhile, he worked as technical director of some chemical and biological companies, and created others, Instituto Bioquímico Miguel Servet and Laboratorio Zeltia. This experience later helped him to improve the discipline of Technical Chemistry. In the fifties, he obtained the Chair of Technical Chemistry in Barcelona; in 1952 he introduced the American model of Chemical Engineering, based on the study of unit operations. With the idea to give an impulse to new direction, Calvet invited the Professor of Chemical Engineering of the University of Yale, Barnett F. Dodge, in 1954. Throughout fifteen lectures, Dodge explained the main concepts related to the unit operations.<sup>15</sup> In his opinion, the course of Professor Calvet had designed was similar to that which he himself taught in Yale, but with an enormous deficiency of materials needed for practical learning. For that reason Dodge recommended that the University build a pilot plant for the training of Catalan chemists.

The second approach is represented by Antonio Rius Miró, Professor of Technical Chemistry in Central University of Madrid since 1940. He was trained as chemist, and later he obtained his PhD whilst at the same time that he taught Chemical Analysis and Electrochemistry in the Industrial School of Santander. He carried out postdoctoral studies in Switzerland and Germany, under the influence of well-known electrochemists such as Erich Müller (Dresden) and Carl Fichter (Basle). Upon his return from these studies, he moved to Zaragoza, where he began teaching in its Industrial School. At that time collaborated with the Laboratory of Biochemical Research led by Antonio de Gregorio Rocasolano, a renowned chemist who investigated in Colloid Chemistry. His relations with Rocasolano allowed him to teach Physical Chemistry and Electrochemistry in the Faculty of Science. Among his disciples was Jose Maria Albareda (Rius Miró directed his PhD disser-

tation in 1920's), who reached in Franco's time the position of Secretary of the CSIC (Spanish Research Council created in 1939). Rius Miró worked together local entrepreneurs in resolving some industrial problems, which allowed him to know Juan Abelló, an important entrepreneur close to the Franco authorities in the post-war period.<sup>16</sup> This chemist and pharmaceutical manufacturer asked Rius Miró to manage its chemical factories in León and Madrid in the middle of the 1930's.

When Rius Miró was appointed to the Chair of Technical Chemistry he had a good relationship with the economic and academic authorities of the Franco's new regime. Initially, he organised the mixing of aspects of discipline of German Chemical Technology with that of the American Chemical Engineering. In his view, more attention should be directed to the general foundations of Chemistry, leaving the descriptive aspects of chemical industries to illustrate the chemical laws.<sup>17</sup> Some years later, he wrote a handbook of Chemical Engineering, in which he described some of the unit operations used in industry (filtration, distillation, etc.) with precise descriptions of the laws of Physical Chemistry.<sup>18</sup> According to his staff, he was of the view that when trying to resolve the problems of the chemical industry a chemist well-trained in Physical Chemistry was preferable to an industrial engineer.<sup>19</sup>

With the idea of creating new studies that would produce chemists highly suited to the industrial world, Rius Miró devised a Doctorate in Industrial Chemistry. Thanks to the support received from the academic authorities, the new doctorate became a reality in the last months of 1944, and for nineteen years the University of Madrid was the only authorised centre to provide these PhD. Despite being conceived as doctoral degree, initially it was not necessary to present dissertation. Over two courses students received knowledge of Industrial Chemistry, Industrial Physics, Metallurgy and Physical Chemistry of Industrial Processes. At the end student had to submit an industrial project, for which was necessary to carry out bibliographical as well as experimental work. The organisation of the four disciplines in the course mainly followed the same approach that Arnold Eucken had devised for the German Technischen Hochschulen in thirties. Some of the professors who taught these subjects held important positions in the Government of Franco.

## Conclusions

For more than thirty years, there was no single model for training of specialists for the chemical industry in Spain. Official centres, Schools of Engineering, Indus-

trial Schools and Faculties of Sciences, and some private ones in the area of Barcelona that were close to the needs of the Catalan chemical industry as the Institute of Applied Chemistry and the Chemical Institute of Sarria, played different roles. After a fratricidal war that forced the best scientific and technical personnel outside Spain, chemists close to Franco's regime took advantage of their power and influence to impose their training model, which used the need for internal self-sufficiency by the regime as a way to justify their labour. With some characteristics of the German model of training chemists for industry and others from the Anglo-Saxon chemical engineering model, a Doctorate in Industrial Chemistry established by Antonio Rius Miró and his colleagues in the Central University of Madrid, prevailed over other alternatives in forties and the first half of fifties. Meantime industrial engineers tried to minimise the influence of chemists by suggesting the renewal of their studies, introducing different aspects of Physical Chemistry such as Kinetics and Thermodynamics into the Schools of Engineering. The result led to nonsense, denounced few years later by Jose German Vega, a member of the department of Chemical Engineering at the University of Wisconsin, according to whom there were "...two professions for a single task,..." engineers with knowledge of the chemical processes and chemist versed in physical processes of chemical industry.<sup>20</sup>

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