STATUS AND DEVELOPMENT OF HIGHER EDUCATION AND RESEARCH IN TECHNICAL CHEMISTRY IN HUNGARY*

by

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We commemorate an important anniversary of Hungarian higher education and of chemical engineering, an important branch of chemical sciences. The Department of Chemical Technology of the József Polytechnical Institute (the present Technical University of Budapest), the first institution in Hungary for higher education and research in chemical engineering, was founded 100 years ago. This is a rare and significant event, since the last 100 years brought results in the field of chemical sciences, which exceed all earlier expectations. This is particularly true in our days, when a considerable part, if not the very fundamental basis of the scientific-technical revolution has been a contribution by chemistry, and even, by chemical technology.

History of the Department of Chemical Technology of the Technical University, Budapest

In Hungary, there are great traditions in the field of higher chemical education. The first department of chemistry was founded in 1763 at the Mining Academy of Selmecbánya (a joint department for mineralogy, chemistry and metallurgy). Following this, in 1769 a joint department for chemistry and botany has been organized in Nagyszombat, at the Medical Faculty of the University. In 1846, this was followed by the establishment of the "Department of General and Special Chemistry" at the József Industrial Training School, and in 1870 the first Department for Chemical Technology of the József Polytechnical Institute has been founded.

The significance of the foundation of our first chemical department more than 200 years ago does not rest on the date of year alone, but also on the

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pioneering character of its activity [1]. At the Mining Academy of Selmec laboratory exercises, probably the first in the world, have been organized [2], taken later so to speak as a model by many European institutions of higher education, among others, the renowned Ecole Polytechnique of Paris [3]. Manuel del Rio, the discoverer of vanadium, Fausto d'Elhuyar, the discoverer of tungsten and Ferenc Müller, the discoverer of tellur were students at the famous Mining Academy of Selmec.

Chemical training in its present sense began at about 1860 at the University of Budapest under the leadership of Károly Than [4] and at about 1864 at the József Polytechnical Institute, when the technical section of the latter was divided into three sub-groups, one of which was chemistry. In 1871, when the Polytechnical Institute was established, the chemical section, and later the Faculty of Chemical Engineering developed from this group [5]. Actually, the training of chemical engineers at the Technical University began under the leadership of Vince Wartha.

The teaching of chemical technology as a course is still older. József Industrial Training School offered general and industrial chemistry together in a course of 5 hours per week. However, among the courses of the technical department of the József Polytechnical Institute, "special technical chemistry" forms already in 1857 an independent course in the curriculum. An examination of the curriculum of the József Polytechnical Institute, reorganized in 1863, shows that in addition to the chemistry sub-group formed within the technical section, "technical chemistry" was taught in weekly 5 hours also in the agricultural sub-group.

In this period, the subject was taught by the first and in that time the only chemical department of the Technical University, called "Department of General and Special Technical Chemistry". This department was later divided, and the teaching of technical chemistry was handed over to an independent one. Thus, the Department of Chemical Technology was formed and began its activity on October 1, 1870. This event is of particular significance, because this was the first department in the field of chemical technology, and the teaching of chemical technology as well as its whole research basis in Hungary developed from this department.

The organisation and foundation of the Department of Chemical Technology bear witness to the wiseness and prudence of the whole board of professors of that time at the Technical University. I do not think it an exaggeration that the department owes it primarily to Professor Vince Wartha that the deed of foundation has been filled with content. He made his department-founding work in such a way that its favourable effects could be felt over long decades and are even active in our days.

Vince Wartha (1844—1914), the founder of Hungarian chemical technology [6], worked untiring both to strengthen the department and to develop

the Hungarian chemical industry, then labouring under adverse circumstances. His favourite field of activity was ceramics, but his work extended to many other branches of chemical technology. The laboratories of his department were equipped with the most modern oven constructions of that time, and his renowned firing experiments, forming the basis of the preparation of eosine glaze, were performed in the department. His work unraveled the secret of the manufacture of Gubbio lustre majolica, interrupted about 1550, which was of great importance from the viewpoint of the manufacture of Zsolnay eosines, famous all over the world. As scientist, he had a very wide field of interest. He attributed great importance to the distillation of Hungarian coals for the production of gas and coke [7]. Wartha was among the first in Hungary, who recognised the role of photography in sciences [8]. He investigated extensively the analytical and technological problems of water, elaborated a simple method for the determination of the changing hardness of water [9], and the method, used for a long time for the determination of the total hardness of water, is one of his noted works. This was done in collaboration with his pupil and successor Ignác Pfeifer, and is known in the international literature as the Wartha—Pfeifer method [10, 11]. Wartha carried out extensive oenological investigations, among which the optical determination of sugar in wine [12, 13] should be pointed out.

Wartha, who performed twice very actively the duties of a rector, followed an outstanding educational policy. One of his important achievements was to launch the building of the present headquarter of the Technical University. He was known and esteemed as an excellent person of congenial disposition. He was elected in 1873 corresponding member, and in 1891 ordinary member of the Hungarian Academy of Sciences. In 1908 he became vice-president of the Hungarian Academy of Sciences. He has great merits also in the propagation of general scientific knowledge. He was first secretary, then, for more than 10 years, president of the Hungarian Society of Natural Sciences.

Ignác Pfeifer (1867—1941) headed the Department for ten years, from 1912 to 1922. He considered the modernization of the subject of the lectures and of the laboratory exercises as his principal task. He studied intensively the improvement of the utilization of Hungarian coals, their distillation and the possibilities of the utilization of coal tars [14]. In 1919 he published in collaboration with László Zechmeister an important paper "Data on the Pyrogenetic Production of Light Aromatic Hydrocarbons" [15]. In the period of the Hungarian Soviet Republic he was active in the organization of the society of engineers, to place them in the services of the Soviet Republic. Harassments after the era of the Hungarian Soviet Republic forced him finally to leave the University. Pfeifer took then over the organization and the leadership of the research laboratories of the United Incandescent Lamp and

Electrical Co. Ltd. From this time on he investigated the chemical and physical problems of incandescent lamp manufacture. He was a distinguished, highly esteemed member of the society of engineers, reflected also by the fact that from 1926 to 1941, his death, he was managing vice-president of the Hungarian Chemical Society.

Ignác Pfeifer was followed in August 1923 by József Varga (1891—1956) as Head of the Department, a personality in the field of the science of chemical technology. It seems sometimes as if he would emerge from the mist of far centuries surrounding the great classics, though it will be only the next year fifteen years that he suddenly departed, leaving unfinished his great life works [16]. We would be in a difficult position if we had to answer the question which of his works remained unaltered after fifteen years on the same state as he left them to us. Industries the creation and development of which he worked undefatigably on, were further developed, but not of necessity on the lines he followed. His pupils continue teaching and research work, but not necessarily in the direction he did.

But this is all right. Chemical technology as József Varga taught and cultivated it is an engineering science. In the age of scientific and technical revolution the results of an engineering science cannot be evaluated within a short time. From this aspect, natural sciences are in a better position, their task being to acquire knowledge of natural laws as deep and precise as possible. It is unimportant, whether their results can be utilized immediately and directly by society or not. The engineering scientist must, however, adapt himself to the everyday requirements of life, which change constantly in our hurrying age. New demands often request new raw materials, these, in turn need new technologies. Though, the scientific-technical revolution affects not only chemical engineering as a science but also higher education [17].

Professor Varga was engaged over 33 years at the Technical University, and during this period he was for 3 years dean of the Faculty of Chemical Engineering. His international fame is due primarily to research in the field of hydrogenation of coals, tars, petroleum fractions and petroleum residues [18]. He was one of those rare scientists who imparted their scientific knowledge with a marvellous gift of teaching. He was an excellent teacher, and many of his pupils became outstanding representants of chemical engineering. He was a master in the classic sense of the word, similarly to Vince Wartha, who created a school of the discipline marked out for the highest tasks. We can think today only with nostalgy of the strength, love and devoted work characteristic of them when founding a school the like of which we badly miss in our time, a school of enthusiastic people, interested in chemical engineering, which they regarded as a vocation. Their school, as a part of Hungarian higher education was a factor in Hungarian sciences.

Special mention is to be made of the study by Varga "Hydrogenation of Eocene Coals" published in 1928 [19]. He was the first to reject the school of thoughts prevailing till then for the very important discovery that, rather than to be a catalyst poison in the hydrogenation processes of coal and coal products, sulphur and some of its compounds considerably further hydrogenation processes (Varga effect). In addition to this study, several other works are valuable contributions to the special field of hydrogenation [20, 21, 22, 23].

Professor Varga, besides being an excellent lecturer, wrote several books, such as the text-book of three parts "Chemical Technology" written in co-author-ship with his pupil, the author of this lecture, Károly Polinszky.

After the death of Professor Varga, the renowned electrochemist and technologist Professor Béla Lányi (1894—1968) took over the leading of the Department [24]. From the viewpoint of educational policy, his merit is that he not only recognized the importance of the close linking of theory and practice but also proclaimed and consequently pursued it in his educational work. His memorable colourful and captivating lectures were a great success also with his students. His most important research work concerns the digestion of bauxite, the alumina and aluminium industry [25, 26].

Professor Mór Korach was his successor at the Department. Korach left Hungary before World War I, and returned at the beginning of the 1950s, continuing worthily the work of his great predecessors. He combined luckily and very fruitfully the traditions of the Department with the rich experiences of a much travelled man. He professes himself a pupil of Wartha, and even today, often quotes the lectures of the great founder of the department. It is fortunate that as a head of department, he doubled as a scientist, and as a leader interested in educational policy, to give impetus to the life of the Department in the very times when higher education ranged in general as a somewhat neglected field. With his educational and scientific work he not only met the actual high-standard requirements but made creative advances, and this at a rate as nobody before him. In addition to his important research work in the technology of silicate chemistry, among others by the development of "Kervit" tile technology, one of his great merits is to have done research work on the rules, trends of development and methodology of chemical technology [27, 28, 29]. These results were incorporated also in the curriculum of the subject General chemical technology.

It was to the loss of the university, the students and higher education and to the great asset of scientific research when Prof. Korach parted from the leading of the Department in 1963 to devote all his time to the management of the Research Institute of Technical Chemistry of the Hungarian Academy of Sciences, and to the dynamic direction of the research work of this Institute.

Professor László Vajta was appointed next as leader of the Department, where he worked until January 31, 1967. Since February 1, 1967 Assoc. Prof.

Imre Szebényi is head of the Department. The Department is engaged in intensive and successful research work in the field of hydrocarbon chemistry and technology [30, 31, 32], silicate chemistry [33], chemistry of water [34], electrochemical technology [35] and isotope techniques [36].

In the teaching, educational and scientific work of the Department, and in the everyday activity of the present staff, the example, the sense of vocation and the humanity of the great predecessors is present even unspokenly.

Development and activity of the research institutes

Following the establishment of the socialist state, the accomplishment of industrial tasks required the creation and development of two intellectual bases. One of these was a professional-level specialist, higher education, the other the organisation of scientific research. The foundation of research institutes for chemical industry was launched in 1948, and within two years, most institutes within the present network started work [37].

In celebrating the centenary of the Department of Chemical Technology, the four research institutes concerned with chemical engineering science and emerging from the department claim a substantial share in the results attained.

The Hungarian Gas and Oil Research Institute (MAFKI) was the first to be established in 1948. The Institute began its activity at the Technical University of Budapest, but after completion of its headquarters transferred its seat to the Transdanubian city Veszprém. The research institute was competently organized and directed by Mihály Freund, member of the Hungarian Academy of Sciences who as visiting researcher worked earlier for years at the Department of Chemical Technology [38]. It is to be attributed to this fact that in a few years it gained substantial fame, honour and professional recognition both in Hungary and abroad. The personal and objective conditions of research improved to yield a series of scientific, technological and economic results. Yearly production results based on the patented or non-patented technologies of the Institute prove eloquently the multiple return of expenditure allotted to research. Substantial results were attained by the Institute in the formation of close relations and economic co-operation with industries. In addition to this substantial contribution to the national economy, scientific results of the Institute represent worthily the activity which according to our present concepts is expected from a research institute.

It would be difficult to list even by headings the results and the outstanding achievements [39] of the Institute. Research work in connection with the starting of Hungarian research in petroleum chemistry [40], manufacture and refining of lubricating oils [41], refining by adsorption and testing by

liquid chromatography of petroleum products [42], research in the field of machine and industrial lubricating greases, the technology and analysis of bitumina [43, 44, 45, 46], the rheological properties of petroleum products [47] as well as research results at the sections of engine testing, organic and physical chemistry [48, 49, 50] have to be pointed out. Further important research work deals with the partial oxidation of hydrocarbons, primarily with that of methane [51], with oxo-synthesis for the manufacture of alcohols from olefines [52, 53], with additives for lubricants [54] and with the preparation of microcrystalline paraffine from Romaskino crude [55].

The Research Institute for Heavy Chemical Industry (NEVIKI) was established one year after the foundation of the MAFKI [56] under the leadership of Károly Polinszky. In the beginning, the Institute called then Research Institute for Inorganic Chemical Industry was housed similarly in the cramped quarters of the Department of Chemical Technology. Later, the change of name entrained that of the field of activity, to extend in addition to the inorganic industries proper, to chemical industry based on coal processing and the industries of silicate chemistry. At the Veszprém headquarters of the Institute, the scientific basis of the chemical industry arose by this time, as in addition to the two quoted research institutes, the Technical University for Chemical Industries began its activity. The staff of the Institute increased in accordance with its yearly increasing tasks, and parallel to it, its instrument park was developed. Already in the first years, the Institute could claim important results, such as the development of the manufacturing technology of dicalcium phosphate fertiliser, or the improvement of the process for the recovery of fluorine in superphosphate plants [57]. Among the further programs, the determination of rare earth metals in the presence of each other [58], and investigations into the exchange mechanism between ion exchanger and the ions of the solution [59] are to be mentioned.

Owing to the decisive change in the raw material basis of energy carriers, the Institute finished its research on coal chemistry in 1961, handing over the whole scope to the Research Institute for Mining. Liberated intellectual and material capacity was concentrated on two fields: research of pesticides [60] and automation in the chemical industry [61]. Actual research work in the Institute is centered on the research of plant-protecting agents and fertilizers [62] within the large project for the chemisation of agriculture. A substantial capacity is engaged in corrosion prevention [63, 64] and considerable results were attained in the field of derivatographic investigations [65, 66, 67, 68], the manufacturing technology of thorium-uranium [69], spray drying [71] and the preparation of germanium [72, 73].

The results, achievements and professional reputation of the Research Institute for Heavy Chemical Industries earned recognition also outside Hungary for the Institute and for the Hungarian science of chemical engineering.

In 1951, a new institute, the High Pressure Research Institute (NAKI) has been founded [74] within the frames of the centennial Department. Its field of activity named in the deed of foundation includes the research of all high-pressure chemical processes. This is a very large field, and compared to it, the Institute began its activity with a disproportionately small capacity. It can be ascribed to this fact that the Institute restricted its activity on the new petrochemical and chemical technologies involving the use of hydrogen. Professor Varga, the director of the Institute, obtained accommodation possibilities for the management and the library of the new institute, further for the Organic Chemical Section of the institute, engaged in small scale experiments for the elaboration of methods of analysis, in the building of the Technical University of Budapest. Therefore, investment funds could be allotted primarily to the erection of a pilot plant, indispensable for the development of industrial technologies. From this time on, the Institute quickly developed.

The decomposition in the presence of hydroaromatic hydrocarbons of the crude oil of Nagylengyel, with a high asphalt content and therefore of poor quality for the production of motor fuels [75], is one of the most prominent and valuable results of the Institute, known internationally as "Varga hydrocracking process". It is based on the recognition that fractions containing high percentages of asphaltene, sulphur and vacuum residue decompose also at medium pressure, if the feed is passed together with medium or light oil and a few per cent of catalyst through the reactor [75—79]. This prominent result of the 'fifties was parallelled and even facilitated by several other research works in hydrocarbon technology, analytics and thermodynamics, presented in publications [80, 81, 82]. Among results in the field of the chemical industry, the development of the manufacturing technologies of fatty alcohols [83], sorbite [84], furfuryl alcohol [85] and dinitrogen oxide [86] are of importance. Important results were attained also in bringing up to date the petroleum processing, and in the development of reforming over platinum catalysts [87, 88, 89], and of hydrorefining [90]. Even at present, the large Hungarian refineries involve the expert staff of the Institute to the solution of their relevant problems. New additions to the NAKI deal with problems relevant to corrosion, lubrication techniques, firing techniques and quality control in the petroleum industry. One of the recent results is the manufacturing technology of Hungarian acid-resistant molecular sieves according to the NAKI process.

The Research Institute for Technical Chemistry of the Hungarian Academy of Sciences was formed 10 years ago from the research group led by Professor Mór Korach at the Department of Chemical Technology of the Technical University and from the research group directed by Károly Polinszky at the Department of Chemical Technology of the Technical University for Chemical Industries, Veszprém. The task of the new Institute, led by Mór Korach and Károly Polinszky, is fundamental research related to the discipline of chem-

ical engineering, theoretical bases and methodology of chemical technology, the development of new technologies, the scientific study of chemical unit operations and apparatuses, the theory and application of chemical technology processes. It is also the task of the Institute to further the professional and scientific post-graduate education in the discipline, and to bring about a close collaboration with plants, design bureaus, Hungarian and foreign research institutes belonging or affine to chemical engineering.

Four sections are responsible for the activity of the Institute, i.e. those of Fundamental Research, of Unit Operations, of Chemical Machinery and Apparatus, and of Chemical Unit Processes, which attained already importan tresults [91]. Fundamental research includes, among others, the study and classification of the structure of chemical engineering [92], establishment of mathematical models for complicated unit operations [93] and investigation into the general laws of chemical technology [94]. Among the study of processes that of fluidisation [95, 96], foam techniques [97], rotated films [98], diaphragma wall [99] and geyser [100] techniques brought important results, and among the study of unit operations, so did crystallization [101], granulation [102], drying [103] and washing [104]. In the field of chemical equipment the development of the ecosorber and the powder reactor, of adsorbers and desorbers [105], and the elaboration of methods for the design of vibrators, drying-dehydrating and crushing equipment is to be mentioned. Some important applications of the results are: fluid granulation [102], preparation of iron oxide red in a fluid bed [106], nitration [107] and sulphonation [108] in a film reactor, and finally, a process for quick-burning silicate products in a continuous furnace [109].

The four highlighted research institutes are offsprings of the centenary Department of Chemical Technology. Their relation is a very close one as, indeed, not only did the newly founded institutes begin their work on the premises of the Department, but the Department helped also the institutes in starting their individual activity by giving them instruments and experts. The proficient influence of the actual heads of the Department is felt even today in the work and the spirit of the institutes.

Part of the Department of Chemical Technology in higher education

When speaking of the range of the Department, it would be an understatement to mention only the four institutes. The Technical University of Chemical Industries of Veszprém has developed with the prominent help of the Department of Chemical Technology from the Faculty of Chemical Engineering of the Technical University Budapest. The Faculty of Chemical Engineer-

ing educated many of the teachers and offered much equipment to the new socialist engineering educational institutions. One form of help merits special mention. By accepting to head the Department of Mineral Oil and Coal Technology, Professor Varga carried the spirit of the school of Budapest within the newly erected walls of Veszprém. Thus, the department, the very building became filled with life, and the pupils got imbued by force and love of the profession for a life.

The Department of Chemical Technology has an important impact on similar departments in other universities. These departments established at the Eötvös Loránd University in 1951, at the József Attila University of Szeged in 1950, at the Kossuth Lajos University of Debrecen in 1953, obtained from the centenary Department confraternal help both in scientific and educational work. The Department influenced also the teaching of industrial technology at the Károly Marx University of Economics.

Teaching work at the Department of Chemical Technology

During its history, the Department undertook difficult jobs both in the fields of education and scientific work. From its foundation, chemical technology was offered to students in chemical, mechanical and civil engineering and in architecture. After several reorganisations of the Technical University, the Department teaches at present students in chemical, mechanical and transport engineering. The manysided activity of the Department is reflected also by the fact that it teaches several branches of chemical technology [110].

In the course of the years, the curriculum was steadily modernised. At the beginning of the 'thirties, József Varga played an important role in up-dating the subject. He recognized the requirements of a developing industry, and set a higher level to all-university aims for a more thorough preparation of the students. He did much for development of a proper engineering concept in the way of thinking of the students, and in his lectures directed the attention of his students, in addition to technological problems, to economy aspects.

Mention must be made of the important part of the Department in higher education during the last 25 years. Though, foundation of the research institutes impaired research work at the universities, it is hoped temporarily, it can be said that particularly in the last 10 years, our universities and departments could co-ordinate the threefold task of teaching, education and scientific research. In this field, the centenary Department of Chemical Technology attained important results by teaching students in chemical, mechanical and transport engineering.

One fundamental conception in basic and priming teaching of the educational reform, launched in 1961, is to engage already students with tasks likely to meet later as practicing chemical engineers. From this time on, we endeavoured to increase the efficiency of the teaching-educational work at the Faculty for Chemical Engineering, at the University for Chemical Engineering in Veszprém and other institutions engaged in the training of chemical engineers. Special mention should be made of modern workshop teaching of pilot plant character.

A survey of the *Hungarian industry* shows that many graduates from the Department are now in prominent positions. This is of particular importance, as it proves eloquently that the Department did outstanding teaching and educational work. Good co-operation in Hungary, important and fruitful foreign relations contribute also to this result.

Besides the training of engineers, increased attention must be paid to post-graduate education. Indeed, without an ability of orientation in the rapidly growing knowledge matter of our age, no expert can cope with his task. In this work too, the Department of Chemical Technology of the Technical University, Budapest took its share. Its leaders and teachers held several lectures at the Institute of Post-Graduate Education, and attained good results also in training specialist engineers in post-graduate courses. The Department is directing the work in the special sections Nuclear Chemistry and Lubrication Engineering. They had and have an important role also in guiding the work of doctorands and aspirants.

The objectives of our educational policy and the need of experts in the national economy set new tasks. As a consequence, the so-called multiple stage education of chemical engineers has been organized [111, 112]. A similar need gave rise to a co-operation between the Chemical University of Veszprém and the Agricultural University of Keszthely, training in common agrarian chemists for our agriculture.

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When presenting the successful work of a century of the Department of Chemical Technology and the development of the science of chemical engineering in Hungary, we pay tribute to our great predecessors, the great personalities of the Hungarian Academy of Sciences and of the Technical University, Budapest, of the late leaders of the Hungarian Chemical Industry, of the departed representants of the science of chemical technology. Their work will fortify us in the up-to-date education of a new generation of engineers, and in the successful cultivation of the science of chemical engineering.

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