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TWENTY YEARS OF THE INSTITUTE OF ANALYTICAL CHEMISTRY OF THE CZECHOSLOVAK ACADEMY OF SCIENCES

A HISTORICAL OUTLINE

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The Institute was founded on April 1st, 1956, in Brno, Czechoslovakia, as The Laboratory for Gas Analysis of The Czechoslovak Academy of Sciences. The first staff of the Laboratory was a group of specialists detached from the Institute for Petroleum Research in Brno. The group was formed by Jaroslav Janák, Miroslav Rusek and Karel Tesařík and, on the establishment of the Laboratory, it was joined by Miloš Krejčí, Josef Novák and Hanniel Dubský.

It is possible to identify three stages in the growth of the Institute, characterizing the natural development of research from modern gas analysis and gas chromatography to the broader field of separation methods, which was further extended by selected methods of structural analysis. These stages follow the existence of The Laboratory for Gas Analysis (1956–1965), which was later changed to The Institute of Instrumental Analytical Chemistry (1966–1973) and, in 1974, to the present Institute of Analytical Chemistry of The Czechoslovak Academy of Sciences.

DEVELOPMENT OF SCIENTIFIC TOPICS AND MAIN RESULTS

The task of The Laboratory for Gas Analysis was to develop modern methods of gas analysis and perform basic research on gas chromatography. The activity was focused on research on the semimicro-analysis of gases and the development of novel methods for the trace analysis of gases. The main results were published in a series of papers on chromatographic semimicro-analysis of gases utilizing the principle of volume detection[1]. This research, which was started in 1949 by J. Janák during his activity at the chemical works near Most (West Bohemia), was further developed at The Institute for Petroleum Research in the 1951–1955 and was completed at the Laboratory for Gas Analysis of the Czechoslovak Academy of Sciences in 1959 by the elaboration of a fully automated gas chromatograph. This work influenced markedly the transformation of classical gas analysis into modern gas analysis not only in Czechoslovakia, but also in other countries[2]. It has been utilized particularly for the analysis of mixtures of permanent gases with gaseous hydrocarbons in the petroleum industry and in the then developing petrochemistry, and it has also served as a teaching tool of a considerable value. The analysis of hydrogen in the presence of hydrocarbons is one of the most exact and absolute methods for its determination and is still in use.

In this series of papers, one can find most of the key elements that arose independently or were later developed by other workers in their systematic research on and utilization of gas chromatography (systems of several columns, by-pass, combination of conventional sorbents and introduction of new types of sorbents, *e.g.*, molecular sieves, trace analysis by chromatographic concentration or by elimination of the main component of the mixture, and methods of manipulation with gases). Investigations on trace analysis led to a renaissance of the frontal chromatographic principle in gas analysis and contributed to the development of an expedient method of concentration of impurities in gases[3], which has found wider use in environmental control and in space research.

With the growing utilization of gas chromatography during 1956–1966, substances with increasingly higher boiling points were studied, the basis model substances being those typical of hydrocarbon chemistry (crude oil, tar). From this research emerged some basic principles that have found wider applicability. For instance, the idea of defined pyrolysis[4], two-dimensional chromatography employing GC as one dimension in combined GC–TLC[5] and the modification of the surface of high-resolution glass capillaries[6] are of particular importance.

The task of The Institute of Instrumental Analytical Chemistry has been to develop promising variants of analytical micro- and submicro-separation methods, especially chromatographic methods, with particular emphasis on instrumentation. While the first stage of development in 1956–1965 was characterised by research into the methodology of gas chromatography and trace analysis, the main feature of the subsequent stage was serious theoretical interest in gas chromatography as a quantitative analytical method[7], the physico-chemical interpretation of the mass balance in two-phase systems, transport phenomena in porous media and the thermodynamic interpretation of retention data[8–10]. Positive results of this investigation include the discovery of the pressure dependence of the response of the flame ionization detector[11], evidence for the selectivity of the alkali flame ionization detector towards sulphur[12] and the characterization of systematic errors incidental to the work with temperature-programmed gas chromatography[13].

The instrumentation-oriented research gave results that led to the development of new instruments. An example is the design of a new instrument for the elemental analysis of organic substances based on the principle of frontal chromatography[14], which is now in commercial production at the N.E. Laboratory Equipment in Prague and has recently also been used in the analysis of gases in metals[15]. Further, the submicro-technique, which permits classical colorimetric reactions to be applied to the analysis of elements and compounds in picogram amounts by measuring the absorbance of coloured microparticles of silica gel under a microscope[16], and the modification of the Eggertsen and Nelson method for surface measurement by thermal desorption so as to permit the measurement of small surface areas in large volumes of the material, have remarkable technical importance[17]. In Czechoslovakia, conditions have been created for the industrial production of gas chromatographs of the CHROM series at the above national enterprise.

The tradition of research and the extension of the methodology used at the Institute have allowed research on high-efficiency liquid chromatography to be started, which has already yielded some useful results in the field of new detectors[18–20] and has led to the industrial production of liquid chromatographs of the L-CHROM

series in Czechoslovakia. The research is now focused on the study of the effect of temperature on sorption equilibria and on its mechanism in liquid–liquid and liquid–solid systems[21].

Another major research topic at the Institute is analytical isotachophoresis. The results obtained so far have shown the possibility of achieving extremely rapid and analytically defined separations of ionic species[22]; the method is capable of displacing, in the near future, classical wet methods of analysis and of contributing to the solution of important biochemical and clinical problems. Conditions have also been prepared for the industrial production of this instrumentation at the Labor Műszeripari Műrek Works in Budapest, Hungary.

Since the beginning of this second stage of the development of the Institute, the choice of models for study has been shifting from substances typical of hydrocarbon chemistry to substances of biological interest and nowadays it forms the basis for the development of modern methodology in clinical chemistry and new methods of human and veterinary diagnostics (*e.g.*, ref. 23).

As a fringe problem, research on thin-layer chromatography also carried out for some time, especially in connection with new gel materials[24].

The synthetic scientific work conducted at the Institute has resulted in some comprehensive reviews[25–32] and monographs, the most important of which are contributions to the chromatographic analysis of gases[33,34], quantitative analysis by gas chromatography[35] and modern liquid chromatography[36].

The main task of the Institute of Analytical Chemistry is to facilitate the progress of Czechoslovak analytical chemistry so that it can meet social demands such as the control of the environment, the development of analytical processes and operations, and also to provide a contribution to the development of the general aspects of analytical chemistry. While during 1966–1973 there was developed in the Institute a set of methods capable of isolating individual chemicals from a complex mixture of substances and of determining the amounts present, the task in the present third stage is to master the coupling of these methods with the most important methods that will permit the determination of the structure of an individual chemical individuum and the characterization of its transformations. This implies particularly the development of methods such as mass spectrometry, functional and elemental analysis, the application of computer-aided methods in chemical analysis, etc.

An integral part of the scientific activity of the Institute is the work of the documentation staff, who have provided, with high-level computer and information techniques, a bank of comprehensive information on gas chromatography and who now also follow the literature on high-efficiency liquid chromatography and analytical isotachophoresis. The material in this information bank has become sought-after material for study and, since 1963, it has also served as the basis for the bibliography that is published regularly in the *Journal of Chromatography*[37].

EDUCATIONAL AND ORGANIZATIONAL ACTIVITIES

The Institute has been contributing to postgraduate education in analytical chemistry, cooperating on a national scale with the Czechoslovak Chemical Society and the J. E. Purkyně University in Brno and, on an international scale, with UNESCO and the University of 17th November in Prague. In addition, the Institute

has been cooperating as a training establishment with the international foundation, The Scientific Exchange Agreement, with the aim of supporting the development of European research on chromatography.

Every year, the Institute has organized basic courses in chromatography for graduate students who have used analytical separation methods in their work and need to obtain an integrated and deeper view of the subject. The courses are intensive, last a week, and comprise 14 h of lectures on the theory, methods and instrumentation of gas and liquid chromatography, and 36 h of practical work. Up to now, 17 courses have been held, attended by more than 500 postgraduates. In addition, summer schools have been organized on topics concerning the modern development and utilization of chromatography, intended for advanced specialists. The summer schools are of 3 days in duration and have so far been attended by 160 participants. Up to the present time, three international courses have been arranged under the auspices of UNESCO, aimed at the long-term postgraduate education of specialists coming particularly from developing countries, and these have been attended by 36 persons.

As an educational establishment in analytical chemistry, the Institute has educated a number of scientists under Postgraduate Fellowships lasting 1–5 years; there have been 42 postgraduates, including 14 from abroad.

Some members of the Institute's staff participated in the setting up of international journals, such as *Journal of Chromatography* (The Netherlands), *Journal of Chromatographic Science* (Illinois, U.S.A.), and *Chromatographia* (G.F.R.). The Institute has exerted a considerable influence on the development of the first of the above journals.

The Institute has organized several national and international symposia on advances in chromatography, which took place in Czechoslovakia or elsewhere (*cf.*, *J. Chromatogr.*, Vol. 69, No. 1, 1972), the most recent of which being held in Bratislava, Czechoslovakia, in 1974 (*cf.*, *J. Chromatogr.*, Vol. 91, 1975).

The Institute plays a leading role in the Czechoslovak State Plan for basic research in analytical chemistry and also functions as a coordinating organization for chromatography within the framework of research and development plans of COMECON countries. The Institute has elaborated a prognosis of the development in the field and a project of scientific research cooperation within the Complex Programme of the Socialist Economic Integration. These documents have been accepted internationally and have become the basis of a general plan for the scientific research activity of the COMECON countries in the field of chromatographic instrumentation. The Institute also played an initiative role in the development of the international journal *Nauchnye Pribory* (U.S.S.R.).

In the near future, the Czechoslovak Academy of Sciences intends to establish an International Chromatographic Laboratory at the Institute, which would be able to meet the growing demands of countries with different social systems for the education of specialists and the aspirations of the COMECON countries for an advanced research base.

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