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By Yen Chen-ying

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THE DEVELOPMENT OF ANALYTICAL CHEMISTRY IN THE CHINESE PEOPLE'S REPUBLIC

[Following is a translation of an article by Yen Chen-ying in Zavodskaya Laboratoriya (Plant Laboratory), Vol. XXV, No. 9, Moscow, 1959, Pages 1023-1027.]

The creation of the Chinese People's Republic was the beginning of a new epoch in the history of Chinese science.

Under the reactionary policy of the Kuomin tang, when industry and agriculture stagnated, analytical chemistry was not developed and was almost not used in industrial control. Higher educational establishments and research institutes were very poorly equipped. Simple analytical apparatuses - the photocolorimeter, pH-meters, etc. - were very rare. All laboratory equipment, even glass tubing and stirrers, were imported. Only gravimetric, volumetric and colorimetric analyses were included in the courses of analytical chemistry taught in the universities and colleges. Original articles, based on research works conducted, were very scarce. With the exception of the very small number of investigations devoted to spectro-graphic analysis, Chinese scientists, at that time, did not conduct any scientific research whatsoever on physico-chemical and physical methods.

From the moment of the formation of the People's Republic, the Chinese Communist Party and the People's Government very seriously turned to scientific research work. In the past 10 years numerous scientific research organizations have been founded. Numerous scientific research institutes and affiliates of the Academy, situated in different provinces, cities and autonomous regions, are managed by the Academy of Sciences. Such organizations as the Academy of Agricultural Sciences, the Academy of Medical Sciences, the Institute of Ferrous Metals, the Institute of Non-ferrous Metals, the Institute of Mineral Resources, etc., are under the supervision of the various ministries. A host of local institutes have also been created, e.g., geological institutes in various cities, the Institute of Chemical Reagents in Peking, etc. The work of many of these institutes requires the application of analytical methods.

At the present time our scientific organizations are outfitted with modern laboratory equipment. Spectrographs, polarographs, photometric colorimeters, etc., are being used widely. In some laboratories

there are also spectrophotometers, infrared spectrographs, mass-spectrographs, fluorimeters, and other more complex devices.

Analytical wrights, photocolorimeters, polarographs, spectrographes, pH-meters, etc., are made in domestic factories.

Factories in various cities make chemical glassware of good quality. Chemical plants in Peking, Shanghai (Tientsin) and other cities regularly produce around 1,500 chemicals of sufficient purity. In addition more than 4,000 chemicals were prepared in individual batches for special purposes, e.g., sodium tetra-phenyl-boron, acetyl acetone, Tetraphenylarsonium choloide, etc. Various ion-exchange resins are also produced. The chemical reagents still imported amount only to an insignificant portion of the chemical production being released to the Chinese market. Nationals standards for chemical reagents and their official testing methods are being developed.

The old system of higher education in China could not satisfy all the growing requirements of science and engineering. In 1952 we became acquainted with the teaching plans of the USSR and an educational reform was undertaken in the colleges and universities. Chairs of analytical chemistry were organized. Specialties in analytical chemistry were set up in the chemical faculties of the various universities. At the present time the universities yearly release analytical chemists for work in the national construction. Having completed the course of study in analytical chemistry they serve an apprenticeship in the various universities and institutes. In addition to this, a large number of technicians are trained in technical schools and in the industrial and mining enterprises.

Under the leadership of the Communist Party, Chinese analytical chemists have performed valuable work during the past ten years. In 1955, the first national conference on analytical chemistry was held in Peking, at which 67 reports were presented. In addition, symposia, conferences, and congresses convened by various organizations have been conducted for the purpose of exchanging experience. For example, at the conference on the work of laboratories, organized in 1958 by the Ministry of Geology, more than 100 reports on analytical chemistry were presented. The number of reports, presented by the analytical chemists of China during the past ten years, is several times more than the corresponding number presented during several ten-year periods up to the liberation of China.

There is a striking difference between the articles published now and those published before the liberation. The experiments conducted are characterized by their practical value and are closely connected with the national economy. It is now absolutely clear to the scientists of China that science must serve the ends of socialistic construction, that scientific labor must proceed in close association with industry and agriculture and that both theoretical and practical work are important in equal measure. The workers of geological establishments, most certainly, were responsible for the more rapid development of analytical chemistry in the new China. The very large

quantity of tests and samples, obtained by the growing number of geological expeditions, required the improvement of existing methods of chemical analysis. New and contemporary analytical methods were continuously introduced, especially the rapid and the physicochemical methods.

In 1956 the Chinese government commissioned a group of scientists to draw up a prospective plan for the development of science in China for the period 1956-1967.

The expansion in ferrous and non-ferrous metallurgy, production of rare elements, chemical engineering, agriculture, medicine, pharmaceutics and other branches of science and industry also required the development of new, improved methods of analysis. At the present time tens of thousands of analytical chemists are working throughout the country. Rapid and express methods are being developed, especially for metallurgical analysis. For example, using recently developed express methods, one can carry out an analysis on samples of cast iron, steel or a non-ferrous alloy in 9 - 20 minutes. It has been reported that a group of experienced analysts completed the analysis of a sample of steel for silicon, manganese, sulfur, phosphorus, carbon, chromium, nickel and molybdenum in 7 minutes 49 seconds. There is a report about the installation of a unit of automatically controlled analyzers which performs determinations for manganese, phosphorus and silicon in 3.5 - 5 minutes. Colorimetric and photometric methods are widely used for rapid analyses.

In the period of the "great leap forward" in 1958 an urgent need was felt for simplified methods of analysis. A great number of members from national communes were engaged in general inspection work on soil, in the production of domestic chemical fertilizers and in the production of cast iron, steel and non-ferrous metals. As a result of the efforts by analytical chemists simplified methods were developed for analyzing fertilizers, soils, cast iron and steel, copper and sundry materials. These methods are permitting the attainment of fairly accurate results and can be easily mastered technically by very illiterate individuals.

Spectrophotometric methods are being used for determining traces of impurities in pure and extra pure metals and compounds of several rare metals. Methods have also been developed for direct and differential spectrophotometry for determining basic components of ores and alloys.

New systematic methods for analyzing minerals and ores are being developed and applied in practice. Refinements in methods for cleansing samples, for separating and determining various components, etc., have proven to be very successful. As examples one can cite the separation of minerals and ores with the aid of phosphoric acid, the determination of silica in the presence of fluorine compounds and the complex analysis of tungsten ores and magnesite. Methods are also being studied for determining the individual components of various materials. New methods have been prepared for analyzing various

industrial products and raw materials and likewise methods for check analyses in industry. Chemical methods are being widely used for analyzing rare elements.

Among the analytical methods developed lately, titration, using ethylenediaminotetraacetic acid and other complex compounds, has received very wide propagation. The complexometric methods have been accepted as the official methods for investigating chemical reagents. During investigatory labors and periodic analyses other new reagents are also used, for example, sodium tetraphenylboron, fluorobenzene, N-benzoylphenylhydroxylamine, tributylphosphate, etc.

Phase analysis is one of the methods studied by us in the USSR over the last several years. A new system for the phase analysis of copper ore has been developed.

Among separation methods, the classical precipitation methods have been refined. By using the mercury cathode at a high current, density, steel and alloys can be decomposed and the basic components separated simultaneously; the operation can be completed within several minutes.

Chromatography has been well developed as a separation method. Chromatographic methods have been used with great success during the analysis of petroleum, shale tar and gases. The problem of separating the highly complex fractions of shale tar has been partially solved. Chromatographic methods for gas analysis are displacing the classical absorption methods, especially for analogous industries. Theoretical study is also being conducted on chromatography. The possibility of chromatographic separation of inorganic components has been studied. New types of ion-exchange resins have been synthesized. Much attention has been paid to the development of polaragraphic methods. The work in this field was begun at an institute of the Chinese Academy of Sciences and has been continued by other organizations. Polarographic methods have been used for analyzing ores, minerals, metals, alloys and fine chemicals, but in the future - for determining rare elements and nonferrous metals.

Research on the polarography of organic substances has been intensified over the past years. Methods have been proposed for the polarographic determination of components in medicine, in pharmaceutical and biological products, dyestuffs, insecticides, etc. Some success is being achieved in the theory of polarography and in the construction of the usual and oscillographic polarographs. Chromatography and polarography can be considered as new disciplines in organic analysis.

Theoretical and experimental research has been conducted on potentiometric, amperometric and conductometric methods and methods of high-frequency titrations and the possibilities for their application for metallurgical and pharmaceutical analysis are being developed. Nevertheless these methods have not yet been widely used under industrial conditions.

Another, very widely distributed method is emission spectrography. In addition to analytical chemists, a number of physicists are also participating in investigations in this field. Much attention has been paid to exposing and determining rare elements and to controlling their purity. There have been reports on the success achieved during the analysis of ores, minerals, ferrous and non-ferrous metals, pure and ultrapure substances, etc. The constructions of excitation sources have been studied, in addition to methods for the preliminary.treatment of samples. X-ray spectrographs are being assembled. There exists and is used in case of necessity such equipment as interferometers, electron microscopes, mas-spectrographs, etc.

The role of other modern scientific methods of analysis is growing. Several laboratories have begun to use tagged atoms.

In the last 10 years Chinese scientists have written many books, collections and brochures. The textbooks by I. P. Alimarin and V. N. Arkhangel'skaya, V. I. Petroshen ("Qualitative Analysis"), Ye. V. Alekseyevskiy and others, books by A. K. Babko, and A. T. Pilipenko, S. Yu. Faynberg, A. I. Ponomarev and tables by Yu. Yu. Lur' have been translated into Chinese.

In the last 10 years a rapid growth has been noted in the number of personnel in the field of analytical chemistry. At the present time ters of thousands of analytical chemists are working throughout the country. For example, in 27 universities, in numerous colleges and polytechnical institutes there are a large number of professors, instructors and assistants who teach analytical chemistry. Many workers can supervise scientific research work or conduct it independently.

The scientists in China are giving a complete account of themselves, since their labor must serve the policies of the working class, and the goals of socialism. In order that their efforts might be more fruitful the senior scientist are closely associated with the youth and youth honors them for their knowledge and experience. As a result of teamwork in scientific research and educational institutes and in production enterprises, and also because of massive measures, young scientists are growing more rapidly and are becoming ever more mature. In answering the call of the Party, we have mastered the Communistic style of bold thinking, of expressing our thoughts, of acting to increase our awareness in both scientific and production fields.

The achievements of analytical chemistry in China would not have been so astonishing without the fraternal aid of the USSR. Soviet scientists have helped us to organize institutes and laboratories, have helped in the instruction of personnel. On their visit to China Academician A. P. Vinogradov and Academician I. V. Tananayev, together with our scientists, noted the paths along which analytical chemistry should be developed.

Many students after graduation have spent and are spending an apprenticeship under the tutelage of Soviet specialists in various universities and institutes in the USSR. Several have received the degree of candidate of sciences and are participating in the socialistic construction of China.

Books, periodical literature, laboratory equipment and chemical reagents from the Soviet Union have been of great help to us. Much aid has been given also by scientists from other socialistic countries, for example, by Professor Ya. Geyrovskiy from Czechoslovakia.

The development of analytical chemistry in China during the last 10 years has been astonishing. However, 10 years is too short a period for the complete development of the science. We absolutely believe that on the created foundation, under the wise leadership of the Communist Party in China, along with the fraternal aid of the USSR and other socialistic countries, as a result of the efforts of Chinese scientists after the passage of still another 10 years, our achievements will surpass many times over that which has been attained in the past. At the end of this period analytical chemistry in China will hold an honorable place in the ranks of world science.

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