



Chemistry

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THE LITERATURE OF CHEMISTRY is perhaps the best organized and documented in all the physical sciences. The many bibliographies, treatises, abstracting journals and review serials, and indexes are excellent tools for locating information in the literature. Methods for searching the chemical literature have been up-dated, expanded and accelerated by means of the current awareness or alerting services and information retrieval systems that have been developed in the last decade. Changes in the basic methods of handling scientific and technical information are providing new tools to meet information needs of chemists and chemical engineers. Materials are available in whatever form best suits the user's needs—printed pages, microfilm, notched cards, or computer-searchable tapes.

Chemistry and chemical engineering literature is growing in a steady and predictable way. The annual rate of production is doubling every 7.5 years.¹ The need for new and better communication between scientists and faster searching of the literature has resulted not only in new types of bibliographic tools but also in the establishment of information centers for the dissemination of information among scientists. Some of these are the Science Information Exchange, Smithsonian Institution; National Referral Center for Science and Technology; The National Standard Reference Data System; and the Special Libraries Association Translation Center.

The Science Information Exchange, Smithsonian Institution, is a national registry of research in progress. It will furnish reports on current research planned or in progress and is intended to bridge the gap between the start of research projects and their subsequent publi-

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Chemistry

cation. In scope, the Exchange includes all basic and applied fields of the life, social, physical and engineering sciences. All services are handled by specialists in the requestor's own area of interest.

Often the materials needed by the librarian and information scientist are not available readily or the locations are unknown. For this purpose the National Referral Center for Science and Technology was established in 1962 in the Library of Congress with the support of the National Science Foundation. The Center does not answer scientific or technical questions directly. It is designed to provide a single place to which anyone with an interest in science and technology may turn for advice on where and how to obtain information in these fields.

The National Standard Reference Data System (NSRDS) was established in 1963 by the President's Office of Science and Technology to make critically evaluated data in the physical sciences available to science and technology on a national basis. The System is administered and coordinated by the National Bureau of Standards through the NBS Office of Standard Reference Data.

The Special Libraries Association Translation Center, located at the John Crerar Library in Chicago, is a depository and information center for published translations into English from the world's literature on the sciences. Its collection totals over 100,000 translations which have been donated. All translations are listed in *Technical Translations*.² The Center is a nonprofit, cooperative organization.

Chemistry and chemical engineering literature may be broadly classified as primary and secondary source materials. No significant trends are evident in the general nature of the primary sources of information. In general, the number of periodicals, patents and other government publications, dissertations, and manufacturers' technical publications is steadily increasing, and in most cases their quality is good.

Bibliographies, reference works and treatises, together with alerting and abstract journals, review and index serials are secondary sources for scientific and technical information. As such, they serve principally to help one find the data which have appeared first in the primary sources, and to alert one to what is going on in areas of interest. The most significant current bibliographic developments in chemistry and chemical engineering literature seem to be in this secondary area. One development is the data registration of chemical compounds by the Chemical Abstracts Service of the American Chemical Society. Progress has been reported in the exploration of the development of computer-based methods for handling chemical information.³

Currently *Chemical Abstracts* is abstracting about 11,000 periodicals and serials. More and more cover-to-cover translations of Russian and other Slavic journals are being published. As the scientific technical literature increases, the need for standardized citations to the literature becomes even more important. A good citation should include the minimum data required to enable a user quickly to locate the reference. Chemical Abstracts Service has done the most in adopting standard abbreviations for titles of periodicals and serial publications, and in using the minimum data necessary to cite series, volume, issue number, page, and year of a periodical. A citation to the *Journal of the American Chemical Society* would be *J. Am. Chem. Soc.* 88, 5809 (1966). The ASTM five-letter Coden abbreviations for journal titles are being widely adopted for bibliographic references for electronic computer searches.⁴ The Coden for the *Journal of the American Chemical Society* is JACSA.

Manufacturers' technical publications are issued by many industrial concerns which deal in chemicals or equipment. Usually, if one knows what to request and whom to write, all such companies will supply the publications desired. There seems to be no general bibliography or index of titles of such publications.

In this paper we will discuss briefly some of the many bibliographic tools one might use for current awareness and retrospective searches in the areas of chemistry and chemical engineering.

Current awareness publications are relatively recent. Designed to inform chemists of new works quickly, they are not intended to replace the abstract journals. They are excellent tools for use in the interim between publication of an article and its abstract.

The first of these alerting journals to appear was *Current Chemical Papers*⁵ published by the Chemical Society, London. It began in 1954 as a classified world list of new papers in pure chemistry. These papers are listed by subject, within a month to a month and a half after the original journal has been received.

The American Chemical Society's *Chemical Titles*,⁶ starting in 1960, is a biweekly concordance to chemical research papers arranged in three parts. The first part is a keyword-in-context index; the second is a bibliographic listing of titles of current papers in the form of tables of contents of the journals; the third is an index of all authors of papers mentioned. Page proofs of many of the journals are received in advance of publication. Approximately seven hundred important

Chemistry

journals of chemistry and chemical engineering are covered. *Chemical Titles* is also available on tapes for computer searching.

Among the alerting services provided by the Institute for Scientific Information are *Current Contents; Life Sciences* which began in 1958,⁷ *Current Contents; Physical Sciences* in 1961,⁸ and *Current Contents; Chemical Sciences* in 1967.⁹ These weekly publications give reproduced tables of contents of about fifteen hundred journals. A directory of first authors included in each issue and their addresses is appended. This makes it easy for the scanner to write immediately for reprints when a particular paper may seem of interest to him.

Index Chemicus,¹⁰ which started in 1960, is a weekly source giving information about new chemical compounds and usually appears within two months of the original article's publication. Information on the synthesis, isolation or identification of, new chemical compounds, as well as structural formulas are given. Approximately one hundred and eighty journals are covered and screened for reports of new chemical compounds in addition to those covered by the *Current Contents* publications. An important inclusion is the date the paper was received by the journal publishing it. Author, subject, molecular formula and journal indexes are issued monthly and cumulated semi-annually and annually. *Index Chemicus* is cumulated yearly as the *Encyclopaedia Chimica Internationalis*.¹¹ This *Encyclopaedia* provides rapid-search indexes for retrospective searching. It is also a good supplement for *Beilsteins Handbuch der organischen Chemie*¹² (see below).

Science Citation Index,¹³ also published by the Institute for Scientific Information, is an index of current source material. Beginning in 1961, it is a useful source for identifying the papers of a specific author in the current year indexed. It lists where and by whom a specific paper has been cited since publication and furnishes scientists, working on specific subjects, with a knowledge of other work in the same area.

*Chemical-Biological Activities*¹⁴ started in 1965 by the Chemical Abstracts Service, is a biweekly current literature index to the biological activity of organic compounds. Each article is indexed by authors, molecular formulas, and keywords. Pertinent articles from approximately six hundred journals are indexed. *CBAC* tapes and search services are available.

After using the current awareness publications the searcher should

next turn to such sources as the general and specialized abstracting journals, indexes, review serials, bibliographies, and also to the great reference treatises such as *Beilsteins Handbuch der organischen Chemie*¹² and *Gmelins Handbuch der anorganischen Chemie*.¹⁵ These two well-documented and exhaustive compilations are based on the original literature.

Three current abstracting journals offering general coverage in the field of chemistry and chemical engineering are *Chemisches Zentralblatt*,¹⁶ *Chemical Abstracts*,¹⁷ and *Referativnyi Zhurnal. Khimiia*.¹⁸ The oldest of these, *Chemisches Zentralblatt*, begun in 1830, is now published weekly and has good, concise and informative abstracts. Before 1919 the main emphasis was on pure and theoretical chemistry and only German patents were abstracted. It is especially valuable for the Eastern European and the Russian literature. *Chemical Abstracts* started in 1907 and has expanded its coverage from 475 journals abstracted in 1907 to about 11,000 in 1967. Coverage is now prompt; the time from journal publication to the published abstract is approximately three months. Its coverage of world literature is comprehensive, and the abstracts are informative and accurate. Presently, *Chemical Abstracts* appears to be giving faster and more complete coverage of the patent literature than other journals. All the Belgian, British, French, German and United States patents of chemical and chemical engineering interest are covered. For literature searches after 1907, *Chemical Abstracts* is the best starting point. It is now offered on microfilm. The newest of the three, the Russian abstracting journal, *Referativnyi Zhurnal. Khimiia*, was started in 1953 and is world-wide in coverage of the chemical literature. The abstracts are in Russian, but for non-Russian publications, author, title and journal citation are in the original language. This is a good source for information on Russian dissertations.

The increase in the volume of literature has resulted in the publication of abstracting journals for the special subject areas and by types of materials abstracted. For example, *Analytical Abstracts*¹⁹ is a monthly abstracting journal covering all the branches of analytical chemistry, while *Nuclear Magnetic Resonance (NMR) Abstracts*,²⁰ on notched cards, have been issued since 1963. A computer-based retrieval system for these NMR cards has been developed at the National Institute of Health and the Food and Drug Administration.

In making an exhaustive literature search of materials published before 1907, it is necessary to also consult the early review serials and

Chemistry

some early journals that carried abstracts. From 1795 to approximately 1890, review serials were a very important source of information. Of special importance to the searcher are Berzelius' *Jahres bericht über die Fortschritte der Chemie*²¹ and Liebig and Kopp's *Jahresbericht über die Fortschritte der Chemie und verwandter Teile anderer Wissenschaften*.²² These gave excellent, but brief, critical reviews of work done in a field and noted any special advances that had been made within the year. They also provided numerous references to the literature. Journals that have good abstracts for this period are *Annales de chimie et de physique*,²³ *Journal of the Chemical Society*,²⁴ *Journal of the Society of Chemical Industry*,²⁵ *Bulletin de la Société chimique de France*²⁶ and *Zeitschrift für angewandte Chemie*.²⁷

The number of U.S. Government reports and bulletins has increased rapidly since World War II. Twelve important libraries now serve as Regional Technical Report Centers for the vast number of unclassified reports. The main bibliographic problem of a searcher in these publications is to find what has been, and is being, done. A recent study²⁸ shows that 6,100 abstracts appeared in Volumes 55-61 of *Chemical Abstracts* from the U.S. Atomic Energy Commission alone.

Two U.S. Government abstracting journals are *Nuclear Science Abstracts*²⁹ and *U.S. Government Research and Development Reports*.³⁰ *Nuclear Science Abstracts* is published by the U.S. Atomic Energy Commission. Begun in 1948 it covers the international literature on nuclear science and technology and gives a comprehensive coverage of the technical reports of the U.S. Atomic Energy Commission and its contractors and of other U.S. Government agencies. The technical reports of governments, universities, industrial and research organizations, as well as patents, books and journal literature, are covered on a world-wide basis. The *U.S. Government Research and Development Reports* is published by the Clearinghouse for Federal Scientific and Technical Information and gives a complete listing of unrestricted reports of the Atomic Energy Commission, the National Aeronautics and Space Administration, the Defense Documentation Center and the Clearinghouse for Federal Scientific and Technical Information.

The monthly *Government-Wide Index to Federal Research & Development Reports*,³¹ also published by the Clearinghouse for Federal Scientific and Technical Information began in 1965. It is an up-to-date index to these two journals and also to the *Technical Abstract Bulletin*³² and *Scientific and Technical Aerospace Reports*.³³

Current review serials differ from the earlier review serials in that the current reviews are lengthy and have excellent bibliographies. They are intended to give a survey of the work done in a given area and any special advances that have been made within the year. For the literature searcher, review serials provide numerous references to the literature. An aid to locating reviews during the period 1958-1963 is a *Bibliography of Reviews in Chemistry*,³⁴ issued by the Chemical Abstracts Service. This is an excellent source for review articles during the period covered. The work is arranged by the same bibliographic sections as used in *Chemical Abstracts*, and contains keyword and author indexes. Some current general review serials providing critical reviews and good references to the literature are *Annual Reports on the Progress of Chemistry*,³⁵ *Reports on the Progress of Applied Chemistry*,³⁶ *Chemical Reviews*,³⁷ and *Advances in Chemistry Series*.³⁸

With the increased growth of literature in the fields of chemistry and chemical engineering, emphasis is shifting from general to specialized areas. Within the last twenty years the number of specialized review serials and bibliographies has been increasing. These, like the general review serials, give critical and authoritative reviews and contain lengthy bibliographies. Some of these are *Advances in Analytical Chemistry and Instrumentation*,³⁹ *Advances in Chemical Engineering*,⁴⁰ *Advances in Organic Chemistry*,⁴¹ *Annual Review of Biochemistry*,⁴² *Annual Review of Physical Chemistry*,⁴³ and *Progress in Inorganic Chemistry*.⁴⁴

Patents are especially important sources of technical and scientific information. There are now more than 3,200,000 United States patents, and over 6,000,000 more from foreign countries. The general abstract journals give good coverage of both U.S. and foreign patents, but their abstracts often do not give the searcher sufficient information; they ordinarily contain very few details of specifications and claims. For these one must examine a copy of the patent itself. U.S. patents and photocopies of most foreign patents are available from the U.S. Patent Office. Bound volumes of printed United States patents may be consulted in many of the depository libraries. Some also have extensive collections of foreign patents; the collection of the New York Public Library nearly matches that of the Patent Office Scientific Library. Chemical patents listed in the *U.S. Patent Office Gazette* since July 1963 are available on microfiche from Microcard Editions, Inc.

Searching the patent literature is greatly facilitated by several new indexes and computer systems. The *Uniterm Index of United States*

Chemistry

*Chemical Patents*⁴⁵ beginning in 1950, is a bimonthly index by numbers to United States patents. Annual compilations from 1950 are available on magnetic tape for computer use. Documentation, Inc., has developed an *Electronic Index* to use with computers of some 150,000 chemical patents. A recent report⁴⁶ describes HAYSTAQ, a comprehensive computer system, developed by the U.S. National Bureau of Standards and the U.S. Patent Office, for the searching of chemical information. It is particularly useful for patent searching. More traditionally, the *International Index of Patents*⁴⁷ is a most extensive compilation covering the years 1790–1960. The section, "Chemical: United States," covers some 400,000 patents, listed under more than 9,500 subclasses.

Bibliographies and reference treatises, though not as current as the abstract and index journals, are valuable tools for the searchers of science literature. Bibliographies on specific subjects are increasing in number. Examples are Deitz's *Bibliography of Solid Adsorbents*⁴⁸ and Zeitlin's *Annotated Bibliography on High-Pressure Technology*.⁴⁹ Still another type of bibliography is Kharasch and Wolf's *Index to Reviews, Symposia Volumes and Monographs in Organic Chemistry*.⁵⁰ This is an excellent tool for locating major current reviews and monographs in organic chemistry and related subject areas including biochemistry and bacteriology. It covers works in the English, French and German languages, and English translations of Russian reviews.

Often references to early publications are difficult to verify and locate. Reuss' *Repertorium Commentationum a Societatibus Litterariis Editarum*, Volume 3, *Chemia et res metallica*⁵¹ is a valuable index to the publications of the learned societies of various countries before 1800. The *International Catalogue of Scientific Literature. D: Chemistry*⁵² is an annual index to books and articles in many scientific journals for the period 1901 through 1914. Another excellent source for locating early publications is Bolton's *Bibliography of Chemistry*.⁵³ This four-volume work covers the literature from 1492 through 1902. Bolton is a useful source for locating the principal books and journals on chemistry published during this period. It is also useful for locating academic dissertations, especially those from the United States, Germany, France and Russia, that have been published as books.

There are many other useful bibliographical works besides those considered here. Abstract journals and indexes in the related disciplines are also helpful in making literature searches.

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Chemistry

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