# The Literature of Electrochemistry in Japan and China*

By DAVID Y. P. CHOU
Lenoir Rhyne College, Hickory, North Carolina
Received January 22, 1964

The electrochemical industry has been growing rapidly both in Japan and China, and the literature in this field has been increasing accordingly. However, it is true that there are very few papers in English relating to the Japanese chemical literature and practically none on the Chinese chemical literature. To the author's knowledge, there are only two English language papers dealing with the Japanese chemical literature in general.[1,2] This paper is intended to assist in how and where to find this literature and not to discuss what is to be found, although important references on certain subjects are included.

## ELECTROCHEMICAL LITERATURE IN JAPAN

**Development of Japanese Electrochemical Industry.**—Although electroplating had been practiced in Japan in the middle of the 19th century, it was not on an industrial scale. The first attempt at large-scale electrochemical processing was in the electrolytic purification of crude copper at the Ashio copper mine in 1884.[3] Thereafter, Japan's electrochemical industry developed steadily under the influence of Western technology. Progress was particularly stimulated by the establishment of the "Deutsche Bunsengesellshaft für Physikalishe Chemie" in 1894 and the "American Electrochemical Society" in 1902 through which more information was readily available to the Japanese chemists of academic and industrial circles, and consequently research was encouraged and new techniques were adopted in the field of electrochemistry. Because of Japan's geographical characteristics and the abundance of rainfall, she produces a large amount of hydroelectric surplus power during the summer months. This surplus power has contributed an important factor to the development of Japan's electrochemical industry in treating raw materials.[4] During the first decade of this century the electrochemical production of the following materials was started: calcium carbide (1902), nitrogen fertilizer (1910), potassium chloride (1909), caustic soda, chlorine, and aluminum (1902). By World War I, sixteen companies were engaged in the electrolysis of salt solution. In 1936, power consumption by the electrochemical industry was 6.4 billion kw.-hr. and was used in 54 electrochemical processes. During World War II, three-quarters of the total consumption of electric power was in the production of aluminum, calcium carbide, zinc, and sodium. Since the war, greater attention has been given to the electrometallurgy of light metals and some rare earth metals and and to the production of inorganic chemicals. Detailed descriptions of the growth and development of Japan's electrochemical industry can be found in two books published by the Electrochemical Society of Japan at the time of its 25th anniversary in 1958; one is in English[4] and one in Japanese.[5] Material on this subject is also found in the official journal of the Society.[6,7]

The growth of the Electrochemical Society of Japan is another indicative sign of expansion of Japan's electrochemical industry. For the last 30 years, its membership has increased from about 100 to the present number of above 2000 with an additional 150 electrochemical manufacturing companies as supporting members.[4] The founding of this Society is somewhat interesting; in the mid-1920's there were about 80 members of the American Electrochemical Society in Japan, and a movement was started to form a branch of this Society.[5] After many meetings and conferences, a decision was finally made in 1933 to form a Japanese Electrochemical Society instead. Now, not only has the society grown in number, it has become a powerful organization in influencing and guiding the future of Japan's electrochemical industry.

**Searching Japanese Electrochemical Literature through English Language Publications.**—Even without an understanding of the language, the Japanese literature can be searched through many English language publications. In addition, most Japanese scientific journals have included English titles and abstracts since about 1948. Specific information on this can be found in the description of the Japanese language journals.

**A. Guides, Abstracts, and Indexes**

1. *Japanese Scientific and Technical Serial Publications.*—This guide was published by the Science and Technology Division of the Library of Congress in 1962. While concerned with the general holdings of Japanese serial publications in the Library of Congress, those related to electrochemistry can be found in the physical sciences and in the chemical and industrial engineering sections. The title of the publication, and the language are given.

2. *Chemical Abstracts.*—The Electrochemistry Section has abstracts of Japanese original papers and some patents.

3. *Japanese Periodicals Index, Natural Science Edition.*—This is a monthly compilation prepared by the Indexing Section of the National Diet Library of Japan. It has been published since September, 1960, and includes many subjects related to electrochemistry such as electrodes, electroluminescence, and electrolysis.

4. *Reports of the Institute of Physical and Chemical Research.*—This is published annually by the institute in Tokyo since 1928. Prior to 1950, it was titled *Abstracts from Kagaku Kenkyujo Hokoku.*

5. *Review of Physical Chemistry of Japan.*—This has been published semi-annually by the Physico-chemical Society of Japan at Kyoto beginning in 1926.

* Presented before the Division of Chemical Literature, 143rd National Meeting of the American Chemical Society, Cincinnati, Ohio, Jan. 15, 1963.

**B. Journals and Reports**

1. *Journal of the Electrochemical Society of Japan, Overseas Edition.*—This publication, monthly since 1958, contains the original papers which are published in the Japanese edition, *Denki Kagaku*. The papers are larger than abstracts but shorter than the Japanese originals, but include the charts, tables, graphs, and references cited.

2. *Bulletin of the Chemical Society of Japan.*—This is a monthly English publication started in 1926. Many reports of a fundamental nature but related to electrochemistry, such as electrode processes, electrode kinetics, alternating current polarograph, etc., are found in this journal. Each issue also includes the English tables of contents of the Pure Chemistry Section and the Industrial Chemistry Section of the *Journal of the Chemical Society of Japan* which are published monthly in Japanese.

3. *Chemical and Pharmaceutical Bulletin.*—This bulletin has been published monthly by the Pharmaceutical Society of Japan since 1953. Electrochemical papers found here are usually on polarographic and other electroanalytical methods.

**C. Patents**

1. *Chemical Abstracts, Electrochemistry Section.*—Japanese chemical patents have been abstracted by the *Chemical Abstracts* since 1948 and can be found toward the end of said section.

2. *Japanese Patent Abstracts.*—These abstracts are prepared by the Derwent Information Service, London, England, beginning in 1961. These abstracts also can be obtained through the International Patent Service, The Netherlands.

3. *Japanese Patent News.*—Edition II carried information on patents in mining, metals, and chemistry. It has been published monthly by the International Patent Service since 1960.

**D. Bulletins, Reports, Memoirs, or Collected Papers of Institutes of Higher Learning or of Research Institutions**

These may be published annually, semi-annually, quarterly, or monthly. The exact titles of various publications of this type may be found in Japanese Scientific and Technical Serial Publications (see above). One of the most important publications in this category is the *Scientific Papers of the Institute of Physical and Chemical Research* in Tokyo which has been published monthly since 1922.

**Searching Japanese Electrochemical Literature through Japanese Language Publications.**—Although there are a large number of Japanese publications in which electrochemical papers may be found, the following list includes those of greatest importance.

**A. Abstracts, Bibliographies, and Guides**

1. *Nippon Kagaku Soren* (Complete Chemical Abstracts of Japan).—This publication has been issued monthly by the Japanese Chemical Research Association since 1927. It covers all chemical literature published in Japanese journals. Abstracts of articles on electrochemistry are found in the sections on physical and analytical chemistry and under the subtitle of electrochemical industry in the applied chemistry section. Two subject indexes have been issued in connection with this journal, No. 1 covering the years 1927–1940 and No. 2 the period from 1941 to 1955.

2. *Zasshi Kiji Sakuin, Shizen Kagakuhen* (Japanese Periodical Index, Natural Science Section).—This index has been published monthly since 1950 by the National Diet Library of Japan. Although the coverage of biological material is emphasized, subjects of interest in electrochemistry such as ions, ion exchange, hydrogen ion concentration, electrolytes, and electromobility are included.

3. *Kagaku Gijutsu Bunken Sohoku* (Current Bibliography on Science and Technology).—The Japan Information Center of Science and Technology has published this biweekly journal since 1958. Bibliographies of articles relating to electrochemistry are found in the Chemistry and Chemical Engineering Edition. The coverage includes not only Japanese papers but also those of foreign origin.

4. *Nippon Kogyo Gijutsu Soren* (Japan Engineering Abstracts).—This has been published by the Engineering Society of Japan each month since 1949 and includes literature pertaining to electrochemical engineering.

5. *Daigaku Kenkyusha Kenkyu Daimoku Sorem, Shizen Kagakuhen* (Directory of Researchers and Research Topics in Japanese University and Research Institutions, Natural Science Edition).—This was published by the Japan Society for the Promotion of Science and Technology in 1961 and provides names, positions, and fields of research as of 1959. It is similar to the Directory of Graduate Research prepared by the American Chemical Society.

**B. Journals**

1. *Denki Kagaku* (Journal of the Electrochemical Society of Japan).—This is the official journal of the Electrochemical Society of Japan and has been published monthly since the Society was founded in 1933. Since the June issue of 1961, the title has been *Denki Kagaku Oyubi Kogyobutsuri Kagaku* (Electrochemistry and Industrial Physical Chemistry). It contains original articles, reviews, general discussions, abstracts of important foreign papers, and indexes of Japanese patents. It formerly included English titles and abstracts of the original papers but these were discontinued with Vol. 25, No. 5 (1957). The number and the subject matter of the original articles appearing in this journal provide indicators of the direction and rate of growth of the Japanese electrochemical industry. Before World War II the emphasis was on applied problems especially in electrolysis and batteries. During the war, the number of papers dropped to as low as two per issue and frequently related to electrochemical studies on aluminum or magnesium. For example, about 20% of the papers in 1943 dealt with the problems in the production of magnesium by reduction with calcium carbide. Since 1948, the number of papers has increased and more attention has been given to theoretical studies.

2. *Denki Kagaku no Shimpo* (The Progress of Electrochemistry).—Each year since 1933, a special edition of *Denki Kagaku* has reviewed in 26 categories the progress and development of electrochemistry. Extensive lists of references to the Japanese and foreign literature are given. The materials section includes a list of electrochemical companies and their principal products.

3. *Porarogurafii* (Review of Polarography).—The Polarographic Society of Japan is a daughter of the Electrochemical Society and since 1953 has issued this bimonthly journal. It contains original papers and reviews. Many of the original papers are written in English or have extensive English abstracts.

4. *Kogyo Kagaku Zasshi* (Journal of the Chemical Society of Japan, Industrial Chemistry Section).—This journal has been published monthly since 1898. Until

1948 when it assumed its present English title, it was called *The Journal of the Society of Chemical Industry, Japan*. Many electrochemical papers appear in this journal, and prior to 1933, it was the most important source. English titles and abstracts and patent abstracts are included. Since 1950, the December issue has included author and subject indexes in English.

5. *Nippon Kagaku Zasshi* (Journal of the Chemical Society of Japan, Pure Chemistry Section).—This journal has been published monthly since 1880 and contains papers in all branches of chemistry. Until 1920, it was called *Tokyo Kagaku Kaishi* and from then until 1947, *Nippon Kagaku Kaishi*. Papers relating to electrochemistry may be found in the physical and analytical sections. It includes English titles and abstracts.

6. *Boshoku Gijutsu* (Corrosion Engineering).—This has been published monthly since 1952 by the Japanese Society for Preventing Corrosion. It has original papers, reviews, and bibliographies of foreign papers.

7. *Kinzoku Hyomen Gijutsu* (Journal of the Metal Finishing Society of Japan).—This has been issued monthly since 1950 and contains many articles relating to electropolishing and electrofinishing. It does not have English titles or abstracts but does include abstracts of Japanese patents in each issue.

8. *Bunseki Kagaku* (Japan Analyst).—Beginning in 1952, the Japan Society for Analytical Chemistry has published this journal of original papers and reviews with English titles and abstracts. It includes papers on electroanalytical methods.

9. *Nippon Kinzoku Gakkaishi* (Journal of the Japan Institute of Metals).—This is a monthly publication established in 1937. It contains technical papers, discussions, and abstracts of patents with English abstracts and titles. Such subjects as electroplating, electrolytic separation, corrosion, and electric furnaces are included.

10. *Keikinzoku* (Light Metals).—This is a bimonthly publication issued by the Japan Institute of Light Metals since 1951. It has English tables of contents and abstracts. The research reported may concern electropolishing, electrolysis, and problems of corrosion.

11. *Nippon Kogyo Kaishi* (Journal of the Mining and Metallurgical Institute of Japan).—Monthly since 1885, the Institute has published this journal which includes papers related to electrorefining and the electric properties of the molten state. It has English titles.

12. There are a few articles scattered in other journals and in special numbers of *Denki Kagaku* which are worthy of special mention. These include studies on theoretical and applied polarography,[9-20] fused salts,[21-24] corrosion,[25-32] the carbide industry,[33-36] and batteries.[37-38] These selected articles may assist the searcher in gaining rapid entry into the literature on these subjects.

**C. Reports**

1. *Kyoto Daigaku Kagaku Kenkyujo Hokoku* (Bulletin of the Institute for Chemical Research, Kyoto University).—This has been published bimonthly under various titles. The first 19 volumes appeared under the title *Kyoto Daigaku Kagaku Kenkyujo Koenshu*. For Vol. 20–30, the Japanese title above was used, but beginning with Vol. 31, the English title in parentheses above has been used.

2. *Tokyo Kogyo Shikenjo Hokoku* (Report of the Government Chemical Industrial Research Institute).—This has been published monthly since 1903 and with English abstracts since 1945. The annual report of the Institute appears as a special number and summarizes the year's work. Information such as the research worker and the problem studied or under study, indexes of published work appearing either in the monthly reports or in other journals, and patents obtained and the grantee company is included.

**D. Patents**

*Tokkyo Koho* is the official report of the Patent Office in Tokyo and appears irregularly.[39] Abstracts of patents may be found in each issue of several journals such as, *Denki Kagaku*, *Kogyo Kagaku Zasshi*, *Kinzoku Hyomen Gijutsu*, and *Tokyo Kogyo Shikenjo Nianbbo*. The book "Tokkyoho Kaisetsu"[40] would be very helpful concerning patent questions.

**E. Handbooks and Dictionaries**

A few handbooks and dictionaries which are very important in the field of electrochemistry are listed in the bibliography.[41-46]

## ELECTROCHEMICAL LITERATURE IN CHINA

The electrochemical industry and research in China prior to World War II was primarily concerned with the areas of electrolysis, electroplating, and batteries.[47] Since 1950, the Peking government has increased research, and substantial gains have been made in improving techniques in several electrochemical processes.[48-51] Some of the areas that have been emphasized are electrogalvanizing brass, bronze, and other copper alloys; the preparation of pure rare metals by the electrolysis of fused salts; improvements in lead batteries; the manufacture of Ni–Cd, Ag–Zn, Fe–C batteries and Zn–Hg dry batteries; and the modification of the cell for the electrolysis of NaCl. For the latter process, the Tienyuan Electrochemical Works in Shanghai developed its own diaphragm cell rated at 6000 amp.[52] and also built a new type of evaporator for the caustic solution.[53] Other new areas which have been studied extensively are electroanalytical methods especially polarographic analysis and fuel cells.[54] In addition, theoretical and experimental research has been conducted on potentiometric, conductometric, and amperometric titration of biological, pharmaceutical, and metallurgical materials.

In spite of the progress that has been made in electrochemistry, there is no professional organization for electrochemists. In August, 1958, at a conference of representatives of electrolytic industries held in Peking, papers on nine technical subjects were presented and discussed.[55] More detailed information on the state of China's chemical industry may be found in the recent book, "Sciences in Communist China."[56]

On the island of Taiwan, studies in electrochemistry have been associated with the mining and metallurgical industries developed during the Japanese occupation.[57] At present, one governmental agency and two major companies use electrochemical processes: the Bureau of Gold and Copper Mining, the Taiwan Aluminum Company, and the Taiwan Fertilizer Company which produces cyanamide and superphosphate.[58] There is no professional society of electrochemists, but the Institute of Mining and

Metallurgy has been active in substituting for such a society.

**Sources for Searching Electrochemical Literature from the Mainland**

**A. Guides, Abstracts, and Indexes**

1. *Chinese Scientific and Technical Serial Publications, Revised Edition.*—Prepared by the Library of Congress in 1961, this publication lists all the Chinese serial titles, both from the mainland and Taiwan, held by the Library.

2. *Mainland China Organizations of Higher Learning in Science and Technology and Their Publications.*—This is a guide also prepared by the Library of Congress in 1961. Learned societies of interest to electrochemists are the Chemical Society of China founded in 1932, the Chinese Society of Chemical Engineering, and the Metallurgical Society of China. The publications of these societies are listed.

3. *Science Abstracts of China, Chemistry and Chemical Technology.*—This is issued bimonthly in English by the Institute of Scientific Information of China, Academica Sinica, Peking, and contains abstracts of all papers appearing in Chinese periodicals on chemistry and chemical engineering. A large number of these are not original papers.

4. *KWIC Index to the Scientific Abstracts of China.*—This was compiled by the MIT Library in 1960 in preparation for the Symposium on the Sciences of Communist China sponsored by the AAAS. All issues of the *Science Abstracts of China* available in the U. S. through 1959 were indexed. About 3300 papers were included.

5. *Index to the Most Important Periodicals of China, Natural and Technical Sciences Section.*—This has been published monthly by the Shanghai Library since 1955.

6. *Index to Current Papers in Chemistry.*—This is published monthly by the Science Press, Peking.

**B. Journals**

1. *Hua Hsueh Hsueh Pao*(Acta Chimica Sinica).—This is the official journal of the Chinese Chemical Society. It was published quarterly from 1953 to 1956 and monthly since that year. It is the continuation of the former *Chung-Kuo Hua Hsueh Huei Chih* (Journal of the Chinese Chemical Society) which was published semi-annually from 1933 to 1951 (Vol. 1–18). Starting in 1953 (Vol. 19), the papers have either English or Russian abstracts. Papers on electroanalysis and the properties of electrolytic solutions are published.

2. *Hua Hsueh Tung Pao* (Chemical Bulletin).—This has been issued monthly by the Chinese Chemical Society since 1953. It has many discussions and reviews but very few original papers. It is prepared for readers in the educational field and is similar to the *Journal of Chemical Education.*

3. *Hua Hsueh Shih Chieh* (Chemical World).—This has been issued monthly by the Chinese Society of Chemical Engineering since 1946. Many short articles related to electrochemical engineering are found in this journal but it has no English titles or abstracts. Since 1953, the number of original papers has gradually increased and from this journal a large amount of information on the progress of chemical technology on the mainland can be obtained.

4. *Hua Kung Hsueh Pao* (Journal of Chemical Engineering).—This is the official journal of the Chinese Society of Chemical Engineering and has been published quarterly since 1950. An English table of contents is available.

5. *Chin Shu Hsueh Pao* (Acta Metallurgica Sinica).—This journal is edited by the Metallurgical Society of China and has been published quarterly since 1956 by the Science Press, Peking. It includes English and Russian tables of contents.

6. *Yao Hsueh Hsueh Pao* (Acta Pharmaceutica Sinica).—This has been issued bimonthly since 1953 by the Pharmaceutical Society of China. Some articles on electrochemical analysis, especially polarographic methods, are included. It has English and Russian tables of contents.

**Sources for Searching Electrochemical Literature from Taiwan**

**A. Indexes**

1. *Periodical Index.*—This is compiled by the Library of the National Defense Academy, Taipei, and has been published monthly since 1960. The Chinese title is *Ch'i K'an Lun Wen So Yin.*

**B. Journals**

1. *Journal of the Chinese Chemical Society.*—This is a semiannual publication in English prepared by the Chinese Chemical Society at Taipei since 1954. Electrochemical papers have appeared on the subjects of the behavior of electrolytic solutions, electrodes, and polarography.

2. *Hua Hsueh* (Chemistry).—This is published in Chinese by the Chinese Chemical Society in Taiwan and has appeared quarterly since 1954. The nature of the papers in electrochemistry is similar to those appearing in the journal of the society.

3. *K'uang Yeh* (Mining and Metallurgy).—This is the official journal of the Chinese Institute of Mining and Metallurgy in Taipai. It appeared quarterly during the period 1952–1954 and became a semiannual in 1955. Since most of the electrochemical industry in Taiwan is closely related to mining and metallurgy, much information on the state and progress of electrochemical technology in Taiwan can be found in this journal.

4. *Hsien Lu T'ung Hsun* (Chlorine and Alkali News).—This has been published by the Taiwan Alkali Company in Taiwan since 1952. It supplies information on the electrolysis of salt solutions.

5. *Kung Yeh Yeh Chiu Yueh K'an* (Industrial Research Monthly).—This journal has been published by the Taiwan Industrial Research Institute at Taipei since 1947.

**C. Patents**

There is no independent patent office in Taiwan. The administration of patents is handled by the Central Bureau of Standards, Department of Economics, of the national government. Patents are usually published in the "Standardization Monthly," Tainan, Taiwan.[59]

## ACKNOWLEDGMENT

The author wishes to express his sincere appreciation to Drs. J. F. Smith and Dean Gamble for their helpful advice; to Prof. T. Kubo of Tokyo Institute of Technology for the informative materials he supplied; and to the Chinese and Japanese Sections of the Division of Orientalia, Library of Congress, for their fine cooperation.

## REFERENCES

(1) L. J. Stevens, Advances in Chemistry Series No. 10, American Chemical Society, Washington, D. C., 1954, pp. 494–499.
(2) L. J. Stevens, *J. Chem. Educ.*, **31**, 471 (1954).
(3) Electrochemical Society of Japan, "Denki Kagaku Benran," Maruzen Ltd., Tokyo, 1954, p. 5.
(4) M. Anzai, Ed. "Japan's Electrochemical Industry," Tokyo, 1958, p. 1 (in English).
(5) T. Aono, Ed. "Nippon no Denki Kagaku Kogyo no Hatten," Electrochemical Society of Japan, Tokyo, 1959.
(6) Group Discussion, *Denki Kagaku*, **21** (7), 327 (1953).
(7) S. Oka, *ibid.*, **22**, 50 (1954).
(8) E. Takagi, *ibid.*, **21** (7), 305 (1953).
(9) S. Godo, *ibid.*, **18** (7), 207 (1950).
(10) T. Kambara, *et al.*, *ibid.*, **20** (4), 602 (1952).
(11) M. Suzuki, *et al.*, *ibid.*, **21**, 164, 212, 264 (1953).
(12) Electrochemical Society of Japan, *ibid.*, **27** (2) (1959) (a special issue of 12 papers).
(13) T. Kambara, *Bull. Chem. Soc. Japan*, **27** (8), 523 (1954).
(14) Y. Yasumori, *ibid.*, **27** (8), 554 (1954).
(15) H. Shirai, *Nippon Kagaku Zasshi*, **81**, 1248, 1578 (1960).
(16) H. Shirai, *ibid.*, **82**, 339 (1961).
(17) A. Saito, *ibid.*, **82**, 212, 214, 715, 718 (1961).
(18) M. Suzuki, *Denki Kagaku*, **22**, 23, 112, 162, 220 (1954).
(19) T. Takahashi, *Kogyo Kagaku Zasshi*, **64**, 515 (1961).
(20) A. Tateisa, *Bunseki Kagaku*, **11** (1), 32 (1962).
(21) M. Saito, *Nippon Kagaku Zasshi*, **83**, 883 (1962).
(22) H. Hayagawa, *Denki Kagaku*, **19** (12), 374 (1951).
(23) S. Nagai, *ibid.*, **20** (4), 150 (1952).
(24) W. Sakai, *ibid.*, **21** 376, 442, 516 (1953).
(25) K. Anazawa, *ibid.*, **19** (11), 338 (1951).
(26) C. Okamoto, *et al.*, *ibid.*, **22**, 8, 56, 213 (1954).
(27) T. Mukaibo, *et al.*, *ibid.*, **22**, 11, 59, 516, (1954).
(28) T. Ishiyam, *ibid.*, **22**, 150 (1954).
(29) G. Okamoto, *ibid.*, **24**, 69 (1956); **25**, 166, 175 (1957).
(30) Corrosion Committee, *ibid.*, **25**, 218 (1957) (in English, 7 papers).
(31) Electrochemical Society of Japan, *ibid.*, **26** (12) (1958) (11 papers).
(32) G. Okamoto, *Chem. Chem. Ind.* (Japan), **14**, 648 (1961).
(33) T. Aono, *Denki Kagaku*, **11** (7), 16 (1943).
(34) Y. Nomura, *ibid.*, **21**, 389 (1953).
(35) T. Ishishiro, *ibid.*, **22**, 78 (1954).
(36) Electrochemical Society of Japan, "Special Issue for Carbide," *ibid.*, **26** (10) (1958).
(37) Electrochemical Society of Japan, "Special Issue for Primary Battery," *ibid.*, **22** (11) (1954) (14 papers).
(38) Electrochemical Society of Japan, "Special Issue for Batteries," *ibid.*, **26** (2) (1958).
(39) Chemical Abstracts Service, "Chemical Abstracts List of Periodicals," Columbus, Ohio, 1961, p. 20J.
(40) H. Kataoka, "Tokkyo Ho Kaisetsu" (Interpretation of Patent Laws), Nankodo, Tokyo, 1961.
(41) Electrochemical Society of Japan, "Denki Kagaku Benran" (Handbook of Electrochemisty), Maruzen Ltd., Tokyo, 1954.
(42) Chemical Society of Japan, "Kagaku Benran" (Handbook of Chemistry), Maruzen Ltd., Tokyo, 1952.
(43) Japan Institute of Metals, "Kinzoku Benran" (Handbook of Metals), Maruzen Ltd., Tokyo, 1952.
(44) H. Inouye and W. Nakajima, "Denki Kagaku Kogyo Taikei" (Outlines of Electrochemical Industry), Tokyodo, Tokyo, 1947.
(45) S. Oka and Y. Nagai, "Kagaku Kogyo Jiten" (Dictionary of Chemical Industry), Tokyodo, Tokyo, 1959.
(46) T. Inouye, *et al.*, "Rikagaku Jiten" (Dictionary of Physics and Chemistry), Enlarged Ed., Iwanami Shoden, Tokyo, 1958.
(47) L. C. Ku, *Hua Hsueh Shih Chieh*, **11**, 382 (1956).
(48) Anon., *ibid.*, **14**, 454 (1959).
(49) Y. C., T'ong, *Hua Hsueh Tung Pao*, (5) 41 (1959).
(50) J. Y. Yen, *ibid.*, (11) 495 (1959).
(51) T. C. Yuen, *Hua Hsueh Hsueh Pao*, **25** (5), 1 (1959).
(52) Anon., *Hua Hsueh Kung Yeh* (Chemical Industry), 11 (1959).
(53) Anon., *Hua Hsueh Shih Chieh* (Chemical World), **14**, 85 (1959).
(54) R. S. Du, *Chung-kuo K'o-hsueh* (Scientia Sinica), 8 (11), 1196 (1959).
(55) L. C. Yu, and C. C. Shih, *J. Peking Pedagogical Inst.*, (1) 29 (1959).
(56) S. H. Gould, Ed. "Sciences in Communist China," AAAS, Washington, D. C., 1961.
(57) K. Hibi, *Denki Kagaku*, **21**, 396 (1953).
(58) Anon., *Hua Hsueh Shih Chieh*, (2) 9 (1948).
(59) Ta-Hsung T'ung, private communication, July 10, 1963.


# An Analysis of the Designing, Installation, and Operation of a Coordinate Indexing System Using Links and Roles for the Plastics Department of the Du Pont Company*


By BARBARA A. MONTAGUE

Research and Development Division, Plastics Department, E. I. du Pont de Nemours and Company, Inc., Wilmington, Delaware


Received December 9, 1963

This paper discusses the decisions involved in the planning and operation of a technical information system incorporating internal research reports, patents, and sales reports dealing with polymers and polymer intermediates. References to pertinent documents are located by a manual inverted coordinate index or by an IBM 650 computer.

**The Need for an Information System.**—Several years ago the development of one of our new plastics was nearing completion and plant start-up was in process. The research technology which led to the development of this plastic had been documented in some 200 internal research reports

* Presented before the Division of Chemical Literature, 145th National Meeting of the American Chemical Society, New York, N. Y., Sept. 10, 1963.