

# Literature Review Issue

*Journal WPCF* Vol. 48 No. 6

# water pollution control

FEDERATION

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## Meetings

### WPCF Member Associations \*

**Michigan:** June 13-16, Boyne Mountain, Boyne Falls.

**New York:** June 13-16, Niagara Hilton, Niagara Falls.

**Ohio:** June 16-18, Columbus Sheraton, Columbus.

**Puerto Rico:** July 24-25, Dorado Beach, San Juan.

**Pennsylvania:** August 4-6, Pa. State University.

**Alabama:** August 3-September 1, Auburn University, Auburn.

**Georgia:** September 12-15, Holiday Inn, Jekyll Island.

**Kentucky-Tennessee:** September 12-15, Read House, Chattanooga, Tenn.

**Rocky Mountain:** September 12-15, The Mark-Lionsquare, Vail, Colo.

**South Dakota:** September 14-16, Holiday Inn, Rapid City.

**Alaska:** September 16-17, Mt. McKinley Park, Fairbanks.

**North Dakota:** October 13-15, Ramada Inn, Minot.

**Florida:** October 24-27, Holiday Inn, Tampa.

**Oklahoma:** October 26-29, Lincoln Plaza, Oklahoma City.

**Nebraska:** October 27-29, Villa Inn, Norfolk.

**Pacific Northwest:** October 27-30, Olympia Hotel, Seattle, Wash.

**South Carolina:** November 4-5, Carolina Inn, Columbia.

**Indiana:** November 8-10, Stouffers Inn, Indianapolis.

**North Carolina:** November 14-17, Great Smokies Hilton, Asheville.

### Other Meetings

#### June 23-25

The Canadian Water Resources Association will hold its 28th annual conference at the Constellation Hotel, Toronto, Ont. The theme of this year's conference is **A Focus on the Great Lakes**. For additional details, contact Canadian Water Resources Association, 986 Grain Exchange Bldg., 167 Lombard Ave., Winnipeg, Man. R3B 0V3, Can.

#### July 14-16

"Blue-Green Algal Ecology and Management" will be the subject of a 3-day intensive **short course** that will be given at the University of California, Berkeley, under the joint sponsorship of the College of Engineering and Continuing Education in Engineering. The course is designed for water managers, government agency personnel, biologists, environmentalists, and others concerned with finding long-term solutions to the problems posed by aquatic blue-green algae. The course will be divided into three sections: factors controlling seasonal and daily cycles of planktonic freshwater blue-green algae; the control and practical uses of blue-green algae; and ecology and management of blue-green algae in restricted environments. The course registration fee is \$150; advance enrollment is necessary. For a descriptive brochure and a registration form, contact Continuing Education in Engineering, University of California Extension, 2223 Fulton St., Berkeley, Calif. 94720; (415) 642-4151.

#### July 19-23

The University of Wisconsin-Extension, Madison, will present an engineering **short course**, **Water Distribution Plant Design**, at the Wisconsin Center. The purpose of the week-long course is to provide in-depth training for engineers involved in water distribution system design and performance. The course should also be of interest to

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\* See the two preceding left-hand pages for full names and addresses.

## 49th ANNUAL CONFERENCE

### Water Pollution Control Federation

Minneapolis Convention Center

Minneapolis, Minnesota, October 3-8, 1976

Host—Central States Water Pollution Control Association

## Meetings

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engineers working in industries in which the design and performance of pipe flow networks are major concerns. The course fee is \$350. Contact John T. Quigley, Program Director, Dept. of Engineering, University of Wisconsin-Extension, 432 N. Lake St., Madison, Wis. 53706; (608) 262-2061.

### July 26-29

The third **National Symposium on Urban Hydrology, Hydraulics, and Sediment Control** will take place at the University of Kentucky, Lexington. Topics to be discussed include quantifying rainfall, runoff, and/or sediment production in urban areas; economic and legal problems associated with runoff and sediment control; techniques for managing urban runoff and/or sediment; and case studies of innovative systems for controlling urban runoff and sediment. Address all inquiries to B. J. Barfield, Agricultural Engineering Dept., University of Kentucky, Lexington, Ky. 40506; (606) 257-1383.

### August 1-6

The Engineering Foundation of the United Engineering Trustees, Inc., will sponsor the 10th conference on **Particle Science and Engineering in the Process Industries** at Franklin Pierce College, Rindge, N. H. The conference, previously called **Particulate Matter Systems**, is designed for mineral engineers, chemical engineers, and others interested in the characterization and treatment of particles. The six conference sessions will deal with the following topics: Characterization of Particles, Rheology of Particle Suspensions, Process Modeling of Particle Systems, Heterogeneous Reactor Systems, Solids-Fluids Separation, and Solids-Solids Separation. Attendance will be limited to 100 participants. The conference fee is \$195, which covers registration, double occupancy accommodations, and meals. Additional information and registration materials are available from the Engineering Foundation Conferences, United Engineering Center, 345 E. 47 St., New York, N. Y. 10017; (212) 644-7835.

### August 23-28

The 1976 International Advanced Course and Workshop, **Thermal Effluent Disposal from Power Generation**, will be held in Dubrovnik, Yugoslavia. The faculty will include lecturers from several renowned international institutions. Topics to be considered are waste heat management and biological effects, heat exchange at the water surface, physical concepts and models of turbulence and stratified flows, and several others dealing with analytical techniques. For additional information, contact either Z. Zarić, International Centre for Heat and Mass Transfer,

Box 522, 11000 Belgrade, Yugoslavia; or Keith D. Stolzenbach, Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, Dept. of Civil Engineering, Bldg. 48, Massachusetts Institute of Technology, Cambridge, Mass. 02139.

### September 1-3

The 1976 **Wood Chemistry Symposium** will be held at Mont Gabriel, P. Q., Can., under the joint sponsorship of the Technical Section of the Canadian Pulp and Paper Association and the Chemical Institute of Canada. The symposium program will emphasize new developments in the chemistry of pulping and bleaching, chemical aspects of pollution control and the environment, the influence of chemical modifications on fiber properties, new developments in the structure and use of cellulose and lignin, and other aspects of the latest technological advances in wood chemistry. Additional information may be obtained from David H. Paterson, Manager, Technical Section, Canadian Pulp and Paper Association, 2300 Sun Life Bldg., Montreal, P. Q. H3B 2X9, Can.

### September 7-10

A joint meeting of the U. S. **Water Resources Council** and the **Interstate Conference on Water Problems** will be held at the Buena Vista Hotel, Biloxi, Miss. The meeting will be attended by many federal, state, local, regional, Congressional, and private interest group officials and members interested in water and land resources planning and management. Contact Jim Fish, Assistant Secretary-Treasurer, Interstate Conference on Water Problems, c/o F. Robert Edman and Associates, W-3173 First National Bank Bldg., St. Paul, Minn. 55101; (612) 224-5705.

### Call for Papers

The International Conference on **Advanced Treatment and Reclamation of Wastewater** will take place in Johannesburg, S. Africa, on June 13-17, 1977. The meeting will be sponsored by the International Association on Water Pollution Research. Papers are being solicited in the following areas: Basic Studies (physical, chemical, and biological processes; mass transfer studies; integrated systems; and quality aspects); Technology (case studies, design, operation and training, control, and costs); and Socioeconomic and Environmental Aspects (public acceptance, regional water management, systems analysis, legislation, and pollution control). Authors wishing to present papers should submit 1-page abstracts in English before September 30, 1976. To obtain additional details and submit abstracts, write to the Technical Secretary, Reclamation Conference, National Institute for Water Research, Box 395, Pretoria 0001, Republic of S. Africa.

## Recent Books

**By the Magic of Chemistry: Pipelines for Progress.** Morris M. Cohn, Certain-tyed Products Corp., Pipe & Plastics Group, Valley Forge, Pa. (1975), 241 pp.

This book gives new and revealing insights into the contributions of chemistry to man's progress. It traces the history of plastic and its unique role as a man-made commodity and gives information on the formulation, manufacture, and use of plastic sewer pipe.

**Economic Analysis of Interim Final Effluent Guidelines for the Organic Chemicals Industry (Phase II).** U.S. Environmental Protection Agency, Office of Planning and Evaluation, Washington, D. C. 20460 (1975), 309 pp.

The purpose of the study is to analyze the economic impact that could result from the application of alternative effluent limitation guidelines and standards of performance to be established under sections 304(b) and 306 of PL 92-500.

**Alaska Natural Gas Transportation Systems: Draft Environmental Impact Statement.** Vols. I-III, U.S. Federal Power Commission, Washington, D.C. 20426 (1975).

The draft discusses the effects on man, wildlife, vegetation, soil, water and air quality, and noise levels arising from bringing gas from the Prudhoe Bay Field in Alaska and from the MacKenzie Delta region of Canada to the lower 48 states.

**Proceedings of the First International Symposium on Ozone for Water and Wastewater Treatment.** The International Ozone Institute, 24 Central Ave., Waterbury, Conn. 06702 (1975), 910 pp., \$40.00.

Technical information, graphics, analytical data, and discussions cover ozone chemistry, generating/contacting equipment developments, monitoring/analysis, engineering aspects, and applications.

**Energy, Agriculture and Waste Management.** William J. Jewell [Ed.], Ann Arbor Science Publishers Inc., Box 1425, Ann Arbor, Mich. 48106 (1975), 540 pp., \$22.50.

This volume contains the proceedings of the 1975 Cornell Agricultural Waste Management Conference. Three topics are discussed in detail: energy consumed in food production, technology and energy costs of pollution control, and potential for producing energy from agricultural wastes.

**Introduction to Ocean Engineering.** Hilbert Schenck, Jr. [Ed.], McGraw-Hill Book Co., 1221 Ave. of the Americas, New York, N. Y. 10020 (1975), 351 pp.

This text is the first basic book in the field of ocean engineering. Written by nine experts in the field, the book covers the integration of oceanographic theory, especially in the chapters on waves, soil mechanics, underwater acoustics, and water quality. A special feature of this text is its inclusion of over 150 problems.

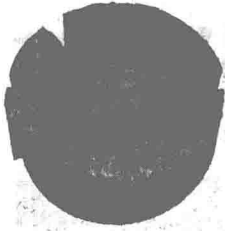
**Agricultural Waste Management: Problems, Processes, and Approaches.** Raymond C. Loehr, Academic Press, Inc., 111 Fifth Ave., New York, N. Y. 10003 (1974), 576 pp.

This book places agricultural waste management in its proper perspective, underscoring the magnitude of the problem and developing workable strategies for agricultural waste management from the basic principles of sanitary engineering, soil science, agricultural engineering, agricultural economics, poultry and animal sciences, and food and crop sciences.

**Stevens Water Resources Data Book,** 2nd Ed., Leupold & Stevens, Inc., Box 688, Beaverton, Ore. 97005 (1975), 158 pp., \$4.00.

This edition replaces the Stevens Hydrographic Data Book, which was last issued in 1970.

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Our wide experience in dewatering many different municipal and industrial sludges with Sharples centrifuges has taught us these important facts:

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**Recent Books**

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**Federalism and Clean Waters: The 1972 Water Pollution Control Act.** Harvey Lieber, Lexington Books, D. C. Heath and Co., Lexington, Mass. (1975), 288 pp.

This volume traces the legislative history of the 1972 Water Pollution Control Act Amendments, their initial implementation by the Environmental Protection Agency, and the changing responsibilities of state water pollution control programs. Case histories of five states are presented.

**Water Treatment: Industrial and Municipal.** D. C. Brandvold, Vantage Press, Inc., 516 W. 34th St., New York, N. Y. 10001 (1975), 120 pp., \$7.95.

This book is a practical manual concerning municipal and industrial water treatment intended to inform water plant personnel about a wide variety of technical systems, problems, and remedies related to water treatment.

**Science & Engineering for Pollution-Free Systems.** David Krofchak and J. Neil Stone, Ann Arbor Science Publishers Inc., Box 1425, Ann Arbor, Mich. 48106 (1975), 332 pp., \$16.95.

The authors propose that the efficient approach to fighting pollution is to "design the problems out, either directly or by recycling." By using case studies as illustrations, the authors show how costly abatement programs may sometimes be replaced by process improvements.

**Environmental Phosphorus Handbook.** Edward J. Griffith *et al.* [Eds.], Wiley-Interscience, 605 Third Ave., New York, N. Y. 10016 (1973), 718 pp.

This handbook has been compiled by four experts, each of whom selected papers pertaining to his or her special area. The book covers a wide range of topics, including the geochemistry of

(Continued on page 364a)

## New equipment and literature

**Glassware.** A 16-page catalog supplement that pictures and prices over 250 items of Pyrex laboratory glassware is now available. Several assortments of labware are featured at special prices. Case prices for larger users are included. Items covered include beakers, bottles, disposable glass, flasks, graduated cylinders, jars, microscope slides, pipets, and tubes. All glassware is cross-referenced both by Corning and Markson numbers. **Markson Science, Inc., Box 767, Del Mar, Calif. 92014.**

**Data table.** The F. P. Smith Wire Cloth Co. has a new fold-open data table for designers, engineers, and purchasing agents requiring wire cloth, mesh, screen, and filtering media. The table shows, by openings per inch, 4 in. openings (coarse) to 250 (fine) mesh, with both the percentage of open area relationship and wire diameters. **The F. P. Smith Wire Cloth Co., 10114 Pacific Ave., Franklin Park, Ill. 60131.**

**Scale remover.** A new liquid scale remover formulated for personnel safety has been announced by Nalco Chemical Co.'s process chemicals group. The product is designed to remove hardness, scale, rust, and other mineral deposits with minimum hazard to personnel. The new cleaner is Nalclean 8930; it allows preparation of cleaning solutions from the concentrated product and is non-flammable. It protects bare metal and contains a wetting agent to increase deposit penetration. **Nalco Chemical Co., 2901 Butterfield Rd., Oak Brook, Ill. 60521.**

**Brochure.** A new 4-page brochure is now available on conditioning sludge, including raw wastewater, rags, paper, chunks of wood, plastics, petrochemicals, and chemical wastes. Drawings and illustrations are included that show how the various size Dynamic Sludge Conditioners from 3 to 12 in. are used. The brochure shows how the DSC makes

wastewater and sludge more free-flowing without the need for an open pit in a compact, low headroom, pressure-rated, liquid-tight package. **Franklin Miller, Inc., 235 Watchung Ave., West Orange, N.J. 07052.**

**Bulletin.** A new bulletin from Zimpro, Inc., shows how the combination of powdered activated carbon regeneration by wet air oxidation and biophysical wastewater reclamation can be adapted to an existing sludge plant. The combination is capable of producing a high quality product water and can nitrify and partially denitrify within a single-stage system. The system can be installed without multistage construction. **Zimpro, Inc., Military Rd., Rothschild, Wis. 54474.**

**Water quality analyzer.** Martek Instruments offers the Mark V Water Quality Analyzer, which is a system for recording multiparameter data—temperature, conductivity, DO, and pH—in either fresh or salt water. It features digital readout, AC/DC operation, and internal recharging unit, and is accurate to within  $\pm 1.0$  percent. The recorder signal output can be recorded on the Model EDP Environmental Data Printer, which can record, accumulate, and subsequently process data through computers or other external data processors. **O. P. Zabarsky, Martek Instruments, Inc., 879 W. 16th St., Newport Beach, Calif. 92663.**

**Sludge press.** The MRP-36, an advanced design multiroll sludge press, is now available from The Permutit Co. It is a secondary dewatering device designed to produce a concentrated sludge ranging from 15 to 50 percent dry solids. It can dewater both wastewater and industrial waste sludges and features a stainless steel frame and corrosion-resistant construction. **The Permutit Co., E49 Midland Ave., Paramus, N.J. 07652.**

*(Continued on page 358a)*

## New equipment and literature

(Continued from page 356a)

**Thermocouple alarm.** Moore Industries, Inc., announces a dual trip version of its Model TCA Thermocouple Alarm Trip, which will accept inputs from any standard ISA T.C. type. This is a temperature-stable unit (less than  $\pm 0.01$  percent/ $^{\circ}$ F), which includes light-emitting diode indicators, 22 turn adjustments, and automatic reference junction compensation. **Moore Industries, Inc., 16650 Schoenborn St., Sepulveda, Calif. 91343.**

**Fiber glass pumps.** Fybroc, Inc., has just published Bulletin 10B1/20B1 on its Series 1000 and 2000 Fiber Glass Horizontal Pumps. These pumps are designed for continuous performance in corrosive service. Capacities are available to 4,000 gpm. The bulletin describes the features of the Fybroc series, including a pump cross section, specifications, and coverage charts for both series. **Fybroc, Inc., 235 Township Line Rd., Hatfield, Pa. 19440.**

**Literature portfolio.** EcoSciences, Inc., has issued a new portfolio describing the firm's specialized services and disciplines, as well as its major projects. It discusses preparation of impact statements, assessments, and special studies. Also described are engineering support services to other firms involved in infiltration-inflow analysis and operation-maintenance activities. Complete biographical data on EcoScience's executive, management, and project staff are included. **EcoSciences, Inc., Corporate Office, 129 Park St., N.E., Vienna, Va. 22180.**

**Report, coastal zones.** This report is sponsored by the Office of Coastal Zone Management of the National Oceanic and Atmospheric Administration; it is intended to serve as a technical guide and reference document for a wide audience. It deals at length with the requirements of the Coastal Zone Management Act of

1972 and offers a substantial analysis of the key factors involved in coastal zone management programs. Also included is a bibliography of information on coastal zone affairs and copies of the federal rules and regulations under the Act. **Coastal Zone Management Institute, Box 221, Sandwich, Mass. 02563.**

**Level monitor.** The ST-11A Sensitek is a noncontact level-measurement instrument developed by Sensor Technology Co. It is connected with an alarm or proximity switch and controls the levels of liquids, slurries, and granular materials when they reach a predetermined level. The instrument operates effectively in measuring coal, ore, and sand, and monitoring wastewater treatment settling tanks. The ST-11A has a maximum range of 4 ft and a minimum of 4 in. **Sensor Technology Co., 905 Dexter Ave. N., Seattle, Wash. 98109.**

**Sludge and slurry transmitter.** National Sonics Division of Envirotech Corp. has added the Sensall Model 4940 Sludge Density Transmitter to its line of products designed for sludge and slurry density measurement and control. The ultrasonic instrument provides a linear readout of the percentage of solids displayed directly on a meter. The unit starts and stops pumps when sludge reaches a preset density. It eliminates costly pumping and processing of excess water. **National Sonics Div., Envirotech Corp., 250 Marcus Blvd., Hauppauge, N.Y. 11787.**

**Wastewater pipe.** A new line of extruded ABS wastewater pipe from National Drain Supplies, Inc., is available in 3, 4, and 6 in. diam, standard or perforated. The ABS pipe is lighter, stronger, less expensive, and easier to install than conventional pipe. Belled ends on 10-ft lengths permit the use of simple slip joints with solvent cement.

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## New equipment and literature

(Continued from page 358a)

The ABS pipe is IAPMO and UPC approved for sewer and drain applications. The pipe is extruded from virgin acrylonitrile butadiene styrene and has a crush rating of 2,000 lb for both standard and perforated versions. **National Drain Supplies, Inc., 12243 Branford St., Sun Valley, Calif. 91352.**

**Automatic sampling systems.** A new 20 page catalog details Sigmamotor's selection of automatic sampling systems. The introduction outlines the criteria for selecting such systems. The catalog describes sampling systems which draw samples of an adjustable pre-set size at programmed intervals, which are controlled by a flowmeter, or which deposit each sample in a separate bottle, as well as many other types of systems. Also included are some examples of specially-designed units to meet unusual customer requirements. The catalog includes the LMS-400 flowmeter which is portable and battery-operated, as well as a complete line of accessories. Finally, the new line of Vacuum Pump sampling systems which samples liquids containing SS up to  $\frac{3}{8}$  in. diam with fluid velocities up to 1.91 m/sec (6.25 ft/sec) is presented. High fluid velocity prevents loss of SS from the sample, and automatic pumps prevent clogging. Over a dozen different Vacuum Pump sampling systems are available. **Sigmamotor, Inc., 14 Elizabeth St., Middleport, N. Y. 14105.**

**Filter.** The new Star filter removes solids in single-stage operation or commercially sterilizes water in a two-stage operation, both of which can be operated by one man. The filter is a 34-sheet, 24-sq in. machine with 120 sq ft of filtering area. It delivers over four times the flow rates of cast waffle-grid construction filters. These filters obtain pure drinking water without chlorination at \$0.01 for 300 gal. Using a divider plate for two-stage operation, the ma-

chine removes bacteria and solid contaminants down to 0.1 micron. Featuring basket strainer and hydraulic closure, precision-machined plates and frames to assure a pressure-tight seal, and fabrication to insure greater corrosion resistance and low contamination levels, the filter is also fabricated in 30, 36, 48, and 60 sq in. sizes. **Star Tank & Filter Corp., 875 Edgewater Rd., Bronx, N.Y. 10474.**

**Oily wastes.** A brochure released by the Allied Chemical Corp. discusses the sources and treatment procedures of various oily waste products. Industrial applications and case histories for the various techniques are included, as are details on how to get aid for specific treatment problems. **Allied Chemical Corp., Industrial Chemicals Div., P.O. Box 1139R, Morristown, N.J. 07960.**

**Technical data.** FMC's Pollution Control Release No. 11 deals with the treatment of photographic wastes with hydrogen peroxide. The bulletin summarizes the chemistry involved in oxidizing the wastes, and gives examples of the use of hydrogen peroxide in reducing the BOD of these wastes. The compounds dealt with are silver, sodium thiosulfate, sodium sulfite, formaldehyde, and hydroquinone. **FMC Corp., Box 8, U.S. Hwy. 1, Princeton, N.J. 08540.**

**Precipitants and coagulants.** Factors involved in choosing the correct precipitant or coagulant in a specific wastewater treatment situation are discussed in an Allied Chemical Corp. brochure. The various chemical salts that are acceptable for precipitants/coagulants are listed and described. Methods for storing, handling, judging, and effectively using these salts are then presented, as are details on how to obtain technical service. **Allied Chemical Corp., Industrial Chemicals Div., P.O. Box 1139R, Morristown, N.J. 07960.**

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## Recent Books

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minerals containing phosphorus, the origin and fate of organic phosphorus compounds in aquatic systems, and gas chromatography detectors for phosphorus and its compounds. Because of its wide scope, the handbook should prove useful to research scientists, oceanographers, limnologists, geologists, and sanitary engineers.

**Concise Chemical and Technical Dictionary.** H. Bennett [Ed.], Chemical Publishing Co., 200 Park Ave. S., New York, N. Y. 10003 (1974), 1175 pp., \$35.00.

About 75,000 definitions are included in this dictionary, which covers every field of scientific and technical development. Written for both scientists and laymen, this volume features an up-to-date compilation of trade name or proprietary products in the synthetic resin, plastics, metal, rubber, textile, food, pharmaceutical, paint, and varnish industries.

**Recycling and Disposal of Solid Wastes: Industrial, Agricultural, Domestic.** T. F. Yen [Ed.], Ann Arbor Science Publishers Inc., Box 1425, Ann Arbor, Mich. 48106 (1974), 372 pp.

This sourcebook contains chapters by experts in the energy, chemical, and biological aspects of solid wastes, polymer-gas reactions, ionene polymers to flocculate colloids, glass and metal container recycling, protein production from cellulosic wastes, polymers for stabilizing mineral wastes, leachate formation in sanitary landfills, and animal, farm, and field wastes.

**Wastewater Management: A Guide to Information Sources.** George Tchobanoglous, Robert Smith, Ronald Crites, Gale Research Co., Book Tower, Detroit, Mich. 48226 (1976), 202 pp., \$18.00.

This selected, annotated bibliography consolidates literature in the field of wastewater management into a useful information source. It fills the need for an authoritative guide to the rapidly expanding scope and sophistication of literature in this area of environmental study. The areas covered are: engineering of wastewater collection, treatment, disposal, and re-use systems; the economic analysis of planning of such systems; and the legislation affecting the implementation of these systems. Specialized topics are covered within each of the major subject areas.

**Managing the Water Environment.** Neil A. Swainson (Ed.), University of British Columbia Press, Vancouver 8, Can. (1976), 266 pp., \$15.50.

The six essays in this volume examine the problems behind the failure to effectively implement regulations to manage the environment. The first two essays discuss the political and legal framework of environmental management. The second two discuss the fair representation of those affected by environmental decisions. The strategic options of the water quality manager are the subject of the final two essays.

**Polluted Groundwater: A Review of the Significant Literature.** David Keith Todd and Daniel E. Orren McNulty, Water Information Center, Dept. 26, 14 Vanderventer Ave., Port Washington, N.Y. 11050 (1976), 178 pp., \$16.00.

This book is an updated report originally prepared for the EPA as part of a contractual study by TEMPO, the Center for Advanced Studies of GE. It reviews literature on man-made groundwater pollution, including causes, occurrences, procedures for control, and methods for monitoring. Thirty specific topics are covered under the headings of urban pollution, industrial pollution, agricultural, wells, salt water and surface water pollution. Current knowledge in the field is effectively summarized.

# water pollution control

FEDERATION

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Peter J. Picuch

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## The Literature Review, as readers see it

This month the *Journal* again presents its annual feature, the Literature Review issue—a comprehensive guide to significant developments in the water pollution control field as reflected in the world's technical literature. The acceptance that the Literature Review has attained in the past should speak for itself. However, there are two points relating to its popularity and usefulness that deserve amplification.

The first point relates to the growth of the Review. Since 1968, the first year in which these literature surveys were consolidated in the June issue, the growth in pages devoted to the Review has averaged over 12 percent per year. Part of the growth resulted from the increasing scope of the Review—new sections added and old ones expanded—but there is no doubt that much of the growth has been because of the increased amount of technical information being published about the extent of water pollution and the means for its control. Thus, in one sense, the growth of the Literature Review can be seen as a rough index of the worldwide concern about environmental problems and the technical approaches to their solutions.

The second point relates to the value that individual readers place on the Review. In a readership survey conducted last September among *Journal* recipients, 79.7 percent of the respondents indicated that they found the Literature Review directly useful to them. In addition, another 12.8 percent felt that although it was not of direct use to them, the Literature Review was a worthwhile service that should be continued as a regular *Journal* issue.

This 92 percent vote of confidence should serve as a tribute to the efforts of the WPCF Research Committee, one of the largest and most active groups within the Federation. For the past twelve months or more, this Committee, under the co-chairmanship of Prof. R. S. Engelbrecht and Prof. F. G. Pohland, has devoted a considerable amount of its time on a volunteer basis to compiling and referencing the literature citations and preparing the text of the Review itself. We trust that all users of this year's Review appreciate such dedication, and join us in a vote of thanks to the Committee.

Peter J. Piecuch

# Nature and analysis of chemical species

## Inorganics

M. S. SHUMAN and W. W. FOGLEMAN, Department of Environmental Sciences and Engineering, School of Public Health, University of North Carolina, Chapel Hill, N. C.

Two books on water analysis have appeared, one in English by Rodier,<sup>1</sup> another in German by Frier.<sup>2</sup> Selected methods for the analysis of first row transition elements in natural water appeared in a monograph by Whitney and Risby.<sup>3</sup> Corrill *et al.*<sup>4</sup> reviewed heavy metals and other trace metals in the environment. Filby<sup>5</sup> discussed general problems in the analysis of trace metals in the environment. A review of water analysis by Lienig<sup>6</sup> covered dissolved gases, pesticides, humic acids, polyacrylamide and other organics. Methods for chemical analysis of fresh water were described by Stainton and Armstrong<sup>7</sup> with emphasis on C, N, P, and Si, and with recommendations for sampling techniques and sample storage. The first volume in a new series on water resources instrumentation edited by Krizek and Mosonyi<sup>8</sup> discussed measuring and sensing methods. Analysis of industrial wastewaters was the subject of a French book by Bormans.<sup>9</sup> A handbook by Sittig<sup>10</sup> covers detection and monitoring of potential pollutants in industrial air and water effluents and has over 1,600 references on standards, toxicities and methods. Boltz<sup>11</sup> reviewed recent methods for determination of the anions of As, B, halogens, N, P, Se, Te, Si, and also CN<sup>-</sup>, SCN<sup>-</sup>, organic anions, anionic detergents, CO<sub>3</sub><sup>2-</sup>, EDTA, and NTA.

The contamination and loss of material accompanying analytical procedures were discussed by several authors. Lo and Wai<sup>12</sup> noted that loss of Hg at 5 µg/l occurred by reduction of Hg(II) to elemental Hg and volatilization through poly-

ethylene containers. Preserving with a dilute nitric acid-dichromate mixture prevented loss up to 21 days. Marine water spiked by Dokiya *et al.*<sup>13</sup> with inorganic <sup>203</sup>Hg showed loss of Hg, but addition of an acidic cysteine solution preserved the sample up to 15 days. Sampling procedures and storage of open ocean waters for Hg analysis were discussed by Fitzgerald and Lyons.<sup>14</sup> A polyvinyl chloride sampler was found suitable for collecting samples. Acidified sea water and also distilled water samples of Hg stored in polyethylene containers were found by Bothner and Robertson<sup>15</sup> to increase in Hg content whereas samples stored in Pyrex showed no change. The gain was attributed to leaching. Litman *et al.*<sup>16</sup> found high rates of adsorption of Hg onto polyethylene, glass, and Teflon surfaces at concentrations less than 1 µg/l, as well as significant loss during digestion, combustion and lyophilization. Instrumental neutron activation analysis was suggested to minimize sample handling and loss. Randa *et al.*<sup>17</sup> suggested a multielement standard on filter paper to prevent loss of Hg during irradiation from aqueous standards placed in plastic containers.

Selenium at 1 µg/l concentration was found to be adsorbed on Pyrex, flint and polyethylene by Shendrickar and West.<sup>18</sup> Benes and Steinnes<sup>19</sup> followed the concentrations and physicochemical state of 18 trace and major elements in river and lake water stored in polyethylene bottles. A considerable fraction of the elements was lost to container walls over a 30-day period and the chemical forms of Co, Mn, Fe, and Cr changed substantially after one wk of storage. Commonly used and commercially available disposable pipette tips were shown by Sommerfeld *et al.*<sup>20</sup> to leach Zn and Fe. Johnson *et al.*<sup>21</sup> found short term changes in measured concentrations of inorganic phosphorus in both frozen and refrigerated stream samples and recommended isobutanol extraction to minimize

these storage problems. Loss of  $^{32}\text{P}$  and  $^{14}\text{C}$  activity during scintillation counting of aqueous samples was attributed by Weimer *et al.*<sup>22</sup> to precipitation of phosphate and both precipitation and volatilization of carbonate.

An intercalibration study by Warner *et al.*<sup>23</sup> for fluoride in sea water using electro-metric and spectrophotometric methods indicated that the F:Cl ratio for samples at four locations was  $6.71 \times 10^{-5} \pm 0.07 \times 10^{-5}$  based on 99 percent confidence limits. Another interlaboratory calibration by Ekedahl *et al.*<sup>24</sup> for phosphorus and nitrogen nutrients resulted in most of the 75 participating laboratories performing with a 20 percent coefficient of variation. Koroleff *et al.*<sup>25</sup> reported that Scandanavian labs carried out parallel analyses on natural water samples containing Fe, Cu, Mn, and Zn by atomic absorption with a relative standard deviation of 5 to 9 percent and a relative accuracy of one percent. Ward<sup>26</sup> discussed problems related to EPA guidelines that list several standard methods manuals as acceptable for water quality analysis. It was argued that it is important to know if a method is standard or not.

#### ISOLATION AND PRECONCENTRATION

Traces of U, Co, and Cd in natural waters were concentrated by Korkisch and Goedl<sup>27</sup> with an anion exchange resin after addition of ascorbic acid and KCN to form their thiocyanates. Fluorimetry or spectrophotometry was used for the determination. In a series of papers, Korkisch *et al.*<sup>28</sup> used this same principle for analysis of Cu, Zn, Pb, and Mo in natural waters, forming chlorocomplexes for Cu, thiocyanate complexes for Zn and Mo, and bromo-complexes for Pb. Leyden<sup>29</sup> used an ion exchange resin prepared from tetraethylene-pentamine and toluene diisocyanate to preconcentrate Cu, Ni, and Zn from about 500 ml of sea water. The small amount of resin employed was compressed into a tablet for determination by x-ray fluorescence. A similar method by Leyden<sup>30</sup> employed Chelex 100 for concentrating Co, Au, Ni, Bi, and Cr. Florence and Batley<sup>31</sup> discussed the use of Chelex-100 for quantitative

determination of chelated Zn, Cd, Pb, and Cu in sea water. With synthetic sea water and various chelating agents, it was concluded that the fraction normally reported as chelated metal by this technique must in fact be metal adsorbed or occluded on particulates. An anion exchange procedure was used by Korkisch and Sorio<sup>32</sup> to preconcentrate metals in natural water after forming their diethylthiocarbamate complexes. Czuhra and Riggs<sup>33</sup> collected trace metals on a film of acrylic acid-grafted polypropylene by a 5-min immersion in the sample. A linear relationship between concentration and x-ray photoelectron intensity was obtained with this method for mg/l levels of Pb and Ag. Ramseyer and Janauer<sup>34</sup> used a cation exchange resin in the copper form to preconcentrate complex Fe cyanides in water. Elution was with HCl followed by  $\text{NH}_3$  which released the complexes and separated them from other Fe species.

Orthophosphate in waters at levels of 0.5–100  $\mu\text{g P/l}$  was quantitatively absorbed by anion exchange resins in a method by Blanchard and Riego<sup>35</sup>. Pyrophosphate and triphosphate interfered. Mixed ion exchange columns and elution with organic hydroxy acids at various pH and  $\text{Cl}^-$  concentrations were used by Miwa *et al.*<sup>36</sup> and Yamabe and Hayashi<sup>37</sup> to separate Mn, Co, Cu, Zn, Cd, and Pb. Chelating groups such as ethylenediamine and dithiocarbamate immobilized on silica gel were used by Leyden *et al.*<sup>38, 39</sup> to batch-extract trace metals from solution for subsequent direct determination by x-ray fluorescence. Sinibaldi and Lederer<sup>40</sup> investigated the use of Sephadex gels for separating the anions,  $\text{I}^-$ ,  $\text{SCN}^-$ ,  $\text{Cr}_2\text{O}_7^{2-}$ , and  $\text{AuCl}_4^-$ . The preparation and use of thorium phosphate as an ion exchanger for metal cations was reported by De and Chowdhury<sup>41</sup>. A procedure for simultaneous preconcentration, separation, and determination of permanganate, chromate, and vanadate at  $\mu\text{g/l}$  levels in aqueous solutions was developed by Lin and Janauer<sup>42</sup> using an Fe(II)-treated ion exchange resin and spectrophotometry. Uranium in groundwater was determined to 2  $\mu\text{g/l}$  concentration by

## LITERATURE REVIEW

Hathaway and James<sup>43</sup> after extracting with Chelex 100 and pelletization of the resin for x-ray fluorescence. The strongly basic anion-exchange resin, Varion AT-6, was used by Balint-Ambro<sup>44</sup> to isolate As from alkaline solutions. Cr(VI) in wastewater containing Fe(III), Zn, Cr, Cd, and 50 mg/l BOD was separated from interfering ions with Dowex 1-8 by Yamashige *et al.*<sup>45</sup> using sodium sulfite to reduce Cr(VI) to Cr(III) for elution. A review by Yoshida and Ueno<sup>46</sup> discussed separation of metal ions by chelating resins. Savvin *et al.*<sup>47</sup> investigated chelate sorbents based on aminopolystyrene and chloromethylated and amino derivatives of styrenedivinylbenzene copolymers to selectively concentrate Pt-group elements. Metal ions were extracted from aqueous perchlorate solutions into liquid N,N-disubstituted amides by Fritz and Orf<sup>48</sup>. The extraction of a large number of metal ions as amide complexes was shown to be practical. Extraction of Hg from sediments was studied by Agemian *et al.*<sup>49</sup> using three acid mixtures. A HF-aqua regia mixture gave highest Hg values. A tri-n-octylamine-cyclohexane mixture was coated on an XAD-2 macroreticular resin by Topping and MacCrehan<sup>50</sup> and used to concentrate Cd from 3000 ml of fresh water to 10 ml for atomic adsorption.

Froth flotation was used by Sekine<sup>51</sup> to separate traces of U in sea water for analysis by neutron activation. Tsai *et al.*<sup>52</sup> separated <sup>137</sup>Cs from sea water by precipitation with Na tetrakis-(p-fluorophenyl) borate following scavenging with ammonium molybdophosphate. The <sup>137</sup>Cs activity in surface sea water was found to be 0.35 pCi/l. Warshawsky<sup>53</sup> used ethylene diglycol dibutyl ether to coat XAD-2 resin and form a Au-selective reagent. Harrison *et al.*<sup>54</sup> found that natural waters preconcentrated by lyophilization lost Hg and I, but other elements tested were retained. Livingston *et al.*<sup>55</sup> reviewed procedures for extracting and concentrating transuranium elements in sea water and sediments. Silver filters were employed by Gordon and Sutcliffe<sup>56</sup> for particulate nitrogen and carbon analysis of sea water. The effects of water volume and volume filtered on observed

concentrations were investigated. Supatashvili *et al.*<sup>57</sup> concentrated Cu from natural water in the range 1.5 to 50 µg/l by coprecipitation with aluminum hydroxide. Sodium, Cl<sub>2</sub> and SO<sub>4</sub><sup>2-</sup> had no effect on the method, but 200 mg/l of K decreased coprecipitation by 10 percent. The use of poly-5-vinyl-8-hydroxyquinoline for trace metal precipitation was described by Buono *et al.*<sup>58</sup> This reagent precipitated Al, Co, Cu, Fe, Pb, Mn, Ni, V, and Zn in less than two min, and did not precipitate alkali metals. Hayes<sup>59</sup> concentrated tritium in environmental samples by electrolysis for subsequent counting. Electrolysis was also used by Hiiron *et al.*<sup>60</sup> to concentrate µg/l Hg in sea water and by Katalevskii and Eremenko<sup>61</sup> to deposit heavy metals from natural waters onto a graphite electrode for subsequent spectrographic determination.

## ELECTROCHEMICAL METHODS

The use of square wave polarography to detect heavy metal pollutants in water was discussed by Sturrock and Carter.<sup>62, 63</sup> Hanging Hg drop and Hg film disk electrodes were employed and 10<sup>-9</sup> F metal was determined in less than 15 min. Piccardi and Legittimo Cellini<sup>64</sup> determined 13 metals in wastewater after acid digestion with d-c polarography. Whitnack<sup>65</sup> described the use of linear scan voltammetry to analyze a number of metallic and organic micropollutants in natural waters, domestic water supplies and wastewaters. Bond<sup>66</sup> compared linear sweep, stripping a-c and pulse voltammetric methods with a variety of electrodes and electrode processes. Allen<sup>67</sup> used voltammetric techniques, principally anodic stripping, to characterize trace metal species in aqueous solutions and to measure metal complex stability constants. Heinemann *et al.*<sup>68</sup> used a mercury film electrode and differential pulse anodic stripping voltammetry with a thin layer electrochemical cell for analyzing 50 µl samples. An intermetallic compound between Li and Cd was studied by Kaplin *et al.*<sup>69</sup> For stripping voltammetry of Li in excess Cd, it was suggested that Cd:Li ratio never exceed 45:1 to avoid interferences. A computerized electroanalysis system was



discussed in a series of papers by Kryger *et al.*<sup>70</sup> Automated anodic stripping with background correction was used to determine Cu, Pb, Zn, Cd, and Bi in standard sea water. A manual of controlled-potential coulometric methods was prepared by Harrar<sup>71</sup> and contained most of the published methods for analysis of inorganic substances together with procedural details and interferences. Sensors based on controlled potential coulometry or amperometry for Cl<sub>2</sub> residual were discussed by Morrow and Roop<sup>72</sup> and by Nakagawa<sup>73</sup> Sensors for DO in water and wastewater were given by Agranov *et al.*,<sup>74</sup> by Kitchen,<sup>75</sup> and by Pijanowski.<sup>76</sup> A comparison of a-c polarographic methods with atomic absorption spectroscopy for determination of Cd, Cu, Pb, and Zn was made by Beyer and Bond.<sup>77</sup> Polarography was judged competitive with atomic absorption because it can determine the four metals simultaneously over a wide concentration range. Additional applications of voltammetric techniques are listed in Table I.

#### ION SELECTIVE ELECTRODES

A book by Koryta<sup>112</sup> presented fundamentals and applications of ion-selective electrodes. Membrane potentials and interfacial phenomena were discussed. A monograph by Covington<sup>113</sup> reviewed the history, theory, and construction, and application of ion-selective electrodes. Frant<sup>114</sup> reviewed the procedures for making low level measurements and discussed detection limits and the problems and techniques applicable to working at low concentrations. Manahan *et al.*<sup>115</sup> used the F-selective electrode as an example of an ion-selective electrode used in environmental research and discussed other solid membrane and liquid ion-exchange electrodes and their uses. Electrodes for continuous measurement of water quality in water treatment and water distribution facilities were discussed by Babcock.<sup>116</sup> Selectivity, grounding, mechanical configurations and limits of detection were included. New instrumentation for auto-

matic determination of metals, H<sup>+</sup> and F<sup>-</sup> in rivers, oceans, and wastewaters was described by Hirata *et al.*<sup>117</sup> A new F<sup>-</sup> electrode and a device that keeps the membrane surfaces of metal electrodes reproducible, smooth, and continually renewed was presented. Feher *et al.*<sup>118</sup> reviewed the use of precipitate-based silicone rubber ion-selective electrodes and silicone rubber based graphite voltammetric electrodes for continuous analysis. Attention was given to Cl<sup>-</sup> monitoring in natural waters and to CN<sup>-</sup> monitoring in industrial effluents. The construction, suitability, stability, reproducibility and selectivity of ion-selective electrodes used in continuous measuring were discussed by Oehme.<sup>119</sup> The electrodes were compared with photometric methods for important ions present in waters and effluents. Rechnitz<sup>120</sup> constructed and evaluated a liquid membrane electrode for CO<sub>3</sub><sup>2-</sup> and a solid membrane electrode for SO<sub>4</sub><sup>2-</sup>. Micro and flow-through electrodes for a number of ions were also constructed and tested. Measurements of NTA in waters and studies of ion association were carried out. Divalent ion:chloride ratios in sea water were determined by Srna<sup>121</sup> in a procedure that involved dilution of the sample. Artificial sea water dilutions were used as reference standards. Zirino<sup>122</sup> measured apparent pH of sea water with a microelectrode and specially designed cell. The cell was jacketed for temperature control and had a precision for routine use at sea of ±0.0026 pH units. Additional applications of ion-selective electrodes are listed in Table II.

#### ATOMIC ABSORPTION SPECTROSCOPY

The subject of atomic spectrometric analysis of heavy metal pollutants in water is addressed in a book by Burrell.<sup>103</sup> Both fresh and marine waters are discussed. Winefordner<sup>104</sup> reviewed multielement atomic spectroscopic methods. Comparison of methods with respect to inherent advantages and disadvantages were discussed. Mercury determination by non-flame atomic absorption and atomic fluorescence spectrometry was reviewed by