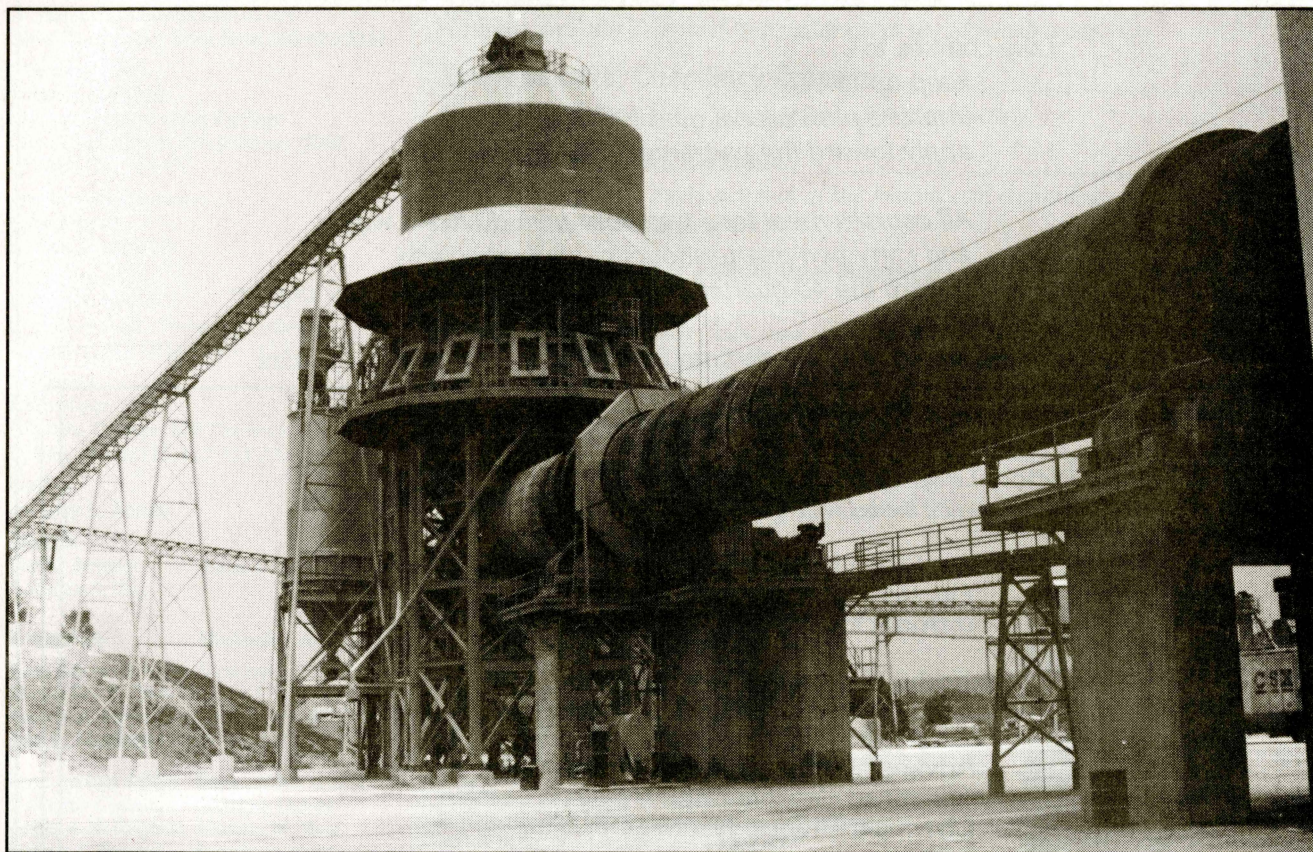


# THE NUCLEUS

December 1993

Of the Northeastern Section of the American Chemical Society

Vol. LXXII, No. 4



## Monthly Meeting

*Protein Kinase C Symposium Jointly with the Medicinal Chemistry Group*

## Chemistry and Art

*Report on John Tramondozzi's address at the September Meeting of the Section*

## Environmental Chemistry Column

*Destroying waste using liquid metal*

## Lime and Portland Cement

*James Thompson on these important construction materials*

The Longest Established Part-Time Graduate Program in  
New England



## EVENING GRADUATE PROGRAM in CHEMISTRY at NORTHEASTERN UNIVERSITY

Take courses to -  
*keep up-to-date*  
*improve professional qualifications*  
*apply toward the part-time Master's program.*

*All courses meet for a two-hour period once a week  
and carry two quarter-hours of graduate credit  
toward the 40 quarter-hour requirement for an M.S. degree*

Courses are taught by Full-time Faculty in their area of expertise

OFFERED THIS WINTER QUARTER (Classes begin January 3, 1994)

### Introductory Level Graduate Courses:

*(Prerequisite: the equivalent of a Bachelor's degree in Chemistry)*

Analytical Separations 1  
Electroanalytical Chemistry 1  
Introductory Quantum Chemistry 1

### Continuing Introductory Level Graduate Courses:

*(Prerequisite: Completion of the previous Quarter course or its equivalent)*

Advanced Inorganic Chemistry 2  
Advanced Organic Chemistry 2  
Chemical Thermodynamics 2

### Advanced Level Graduate Courses:

*(Prerequisite: Completion of a first-year graduate course in Organic Chemistry)*

Organic Reaction Mechanisms and Organic Synthesis 1

*(Additional Courses will be offered in the Spring Quarter)*

For additional information contact:

Prof. John L. Roebber, Executive Officer  
Department of Chemistry, 4HT  
Northeastern University  
Boston, MA 02115  
Tel: (617) 373-2383

Northeastern University is an equal opportunity/affirmative action educational institution and employer.

### The Northeastern Section of the American Chemical Society, Inc.

Office: Marilou Cashman, 23 Cottage St.,  
Natick, MA 01760. 1-800-872-2054  
(Voice or FAX) or (508) 653-6329.  
Any Section business may be conducted  
via the business office above.  
Washington, D.C. ACS Hotline:  
1-800-227-5558

#### Officers 1993

**Chairman**  
Dorothy J. Phillips  
Waters Division of Millipore Corp.  
34 Maple St., Milford, MA 01757  
508-478-2000 ext. 2860 FAX 508-473-5514

**Chairman-Elect**  
James A. Kaufman  
Science Division, Curry College  
Milton, MA 02186, 333-0500 ext. 2220  
FAX 617-239-1457

**Immed. Past Chairman**  
Katie Stygall  
U.Mass. Dartmouth

**Secretary**  
Michael J. Hearn  
Chemistry Dept., Wellesley College  
Wellesley, MA 02181, 283-3127

**Treasurer**  
James Piper  
Simmons College, 300 The Fenway  
Boston, MA 02115, 617-521-2730

**Auditor**  
Anthony L. Rosner

**Trustees**  
Phyllis Brauner Richard Handrick  
Adrienne S. Dey

Councilors	Alternate Councilors
<i>Term expires 1/1/94</i>	<i>Term expires 1/1/94</i>
Michaeline F. Chen	Ernest I. Becker
Arno H.A. Heyn	Doris I. Lewis
John L. Neumeyer	Myron S. Simon

<i>Term expires 1/1/95</i>	<i>Term expires 1/1/95</i>
Catherine Costello	Geoffrey Davies
Esther A.H. Hopkins	Norman W. Rice
Patricia L. Samuel	Donald O. Rickter
Valerie A. Wilcox	Alfred Viola

<i>Term expires 1/1/96</i>	<i>Term expires 1/1/96</i>
Mary T. Burgess	E. Joseph Billo
Thomas R. Gilbert	Wallace J. Gleekman
Truman S. Light	Margaret V. Merritt
Katie Stygall	Frank S. Wagner

All Chairmen of standing  
Committees, the editor of  
**THE NUCLEUS**, and the  
Trustees of Section Funds  
are members of the Board  
of Directors. Any Coun-  
cilor of the American  
Chemical Society residing within the section  
area is an ex officio member of the Board of  
Directors.



# Contents

<b>NESACS Elective Positions</b> _____	<b>4</b>
<i>Want to become an officer or elected committee member of the Section?</i>	
<b>Board of Directors</b> _____	<b>4</b>
<i>Condensed Minutes of the Sept. 23, 1993 Board Meeting</i>	
<b>Monthly Meeting</b> _____	<b>5</b>
<i>Joint Meeting with the Medicinal Chemistry Group on Protein Kinase C</i>	
<b>Chemistry and Art</b> _____	<b>7</b>
<i>A report on John Tramondozzi's address at the September meeting</i>	
<b>Environmental Chemistry Column</b> _____	<b>8</b>
<i>D. Ham on Molten Metal catalysis of waste destruction</i>	
<b>Lime and Portland Cement</b> _____	<b>10</b>
<i>James Thompson's lively account of the history and technology of these important building materials</i>	
<b>ACS Congressional Fellowship Nominations</b> _____	<b>13</b>

**Cover:** *A modern rotary kiln lime plant with stone preheater (left) operating on kiln discharge gases, and combustion air preheater (right) operating on air that cools the finished lime discharge. (see story page 10) (Courtesy: Kennedy Van Saun Corp., Danville, PA)*

**Deadlines:** *February issue: December 17, 1993.*

## THE NUCLEUS

Dedicated to the Memory of James Flack Norris  
Published monthly from October to May by the Northeastern  
Section of the American Chemical Society, Inc.



*The Nucleus is distributed to the members of the Northeastern Section of the American Chemical Society, to the secretaries of the Local Sections, and to editors of all local publications. Forms close for advertising on the 1st of the month of the preceding issue. Text must be received by the editor six weeks before the date of issue.*

**Editor:** Arno Heyn, 21 Alexander Rd., Newton, MA 02161,  
Tel: 969-5712, FAX: 527-2032

**Associate Editor:** Myron S. Simon, 20 Somerset Rd., W. Newton, MA 02165, Tel: 332-5273

**Board of Publications:** Catherine E. Costello (Chair), Michael E. Strem, Joseph A. Lima

**Business Manager:** Karen Piper, 19 Mill Rd., Harvard, MA 01451, Tel: (508) 456-8622

**Advertising Manager:** Vincent J. Gale, 56 Bartlett Island Way, Marshfield, MA 02050,  
Tel: (617) 837-0424

**Contributing Editors:** Edward Atkinson, History of Chemistry, Book Reviews; Maryann Solstad, Health; Chris Arumainayagam, Calendar.

**Proofreaders:** Ernest I. Becker, Donald Rickter, M.S. Simon

Copyright 1993, Northeastern Section of the American Chemical Society, Inc.

## NESACS Elective Positions

Any member interested in holding an elective office or an elective committee position in the Section is asked to contact the Chairman of the Nominating Committee for 1994, Dr. Dorothy Phillips. The positions are for one to four years beginning in January 1995, the election will be in May 1994. (Terms are in parentheses).

Nominees are solicited for Chairman-Elect (1 year); Treasurer (2 years), Trustee (3 years), Councilors and Alternate Councilors (3 years). The Chairman-Elect serves as Program Chairman and succeeds to the chairmanship of the Section the following year. Chairmen-Elect have alternated between those from industry and academia; the 1995 position will be from academia. Councilors represent the Section at ACS Council meetings and are expected to attend the Fall and Spring national ACS meetings. Alternate Councilors may be called upon to represent the Section when a Councilor is unable to be present. Also elected will be members of the following committees: Nominating (1 year), James Flack Norris Award for outstanding achievements in teaching chemistry (4 years).

If you are interested, please contact Dorothy J. Phillips at (508) 478-2000 x2860. ♦

## Board of Directors

### Condensed Minutes, Meeting of September 23, 1993

#### Officer's Reports:

**Chairman's Report:** Dr. Phillips thanked board members for their good wishes during her recent medical leave of absence. Dr. Phillips introduced Ms. Marilou Cashman, the new Executive Secretary of the Section.

**Chairman-Elect Report:** Dr. Kaufman discussed the ratings of the Section's annual report by the Local Section Activities Committee. The "average" rating of award activities may be because the annual report did not emphasize our award activities adequately.

**Treasurer's Report:** Dr. Piper presented the itemization of income and expenses since the May meeting.

**Archivist's Report:** Dr. Simon mentioned the ACS program to identify Designated Chemical Landmarks.

**Trustees' Report:** Dr. Handrick reported on the performance of the Section's investments. The Board expressed its pleasure at the good performance of the Trustees in regard to the Section's investments.

**Councilors:** It was announced that Dr. Hopkins was elected to the Council Policy Committee, the steering com-

#### Corporate Patrons

DuPont Merck Pharmaceutical Co.  
Duracell, Inc.  
W. R. Grace & Company  
Hoechst Celanese Corporation  
Millipore Foundation  
Polaroid Corporation,  
Chemical Research Division

#### Corporate Sponsors

Aerodyne Research, Inc.  
AESAR/Alfa Johnson Matthey  
Arthur D. Little, Inc.  
Cambridge Isotope Labs  
Consulting Resources Corporation  
Houghton Chemical Corp.  
ICI Resins US  
Organix, Inc.  
Orion Research, Inc.  
Physical Sciences, Inc.  
Research Biochemicals, Inc.  
Strem Chemicals, Inc.  
Van Waters & Rogers, Inc. (VW&R)

mittee of the Council. Suggestions were made to improve communication with members concerning issues before the council, perhaps by having a special column in the *NUCLEUS*.

#### Committee Reports:

**Education:** Dr. Hoffman indicated the renewed enthusiasm of the committee for National Chemistry Week activities. Additionally, the Undergraduate Research Symposium will take place on Saturday, April 30, to be hosted by Boston University. Dr. Hoffman asked for a policy for meal expenses at the May Education Night.

**Hospitality:** Dr. Howell stated that more than 50 dinner reservations have been made for tonight's dinner.

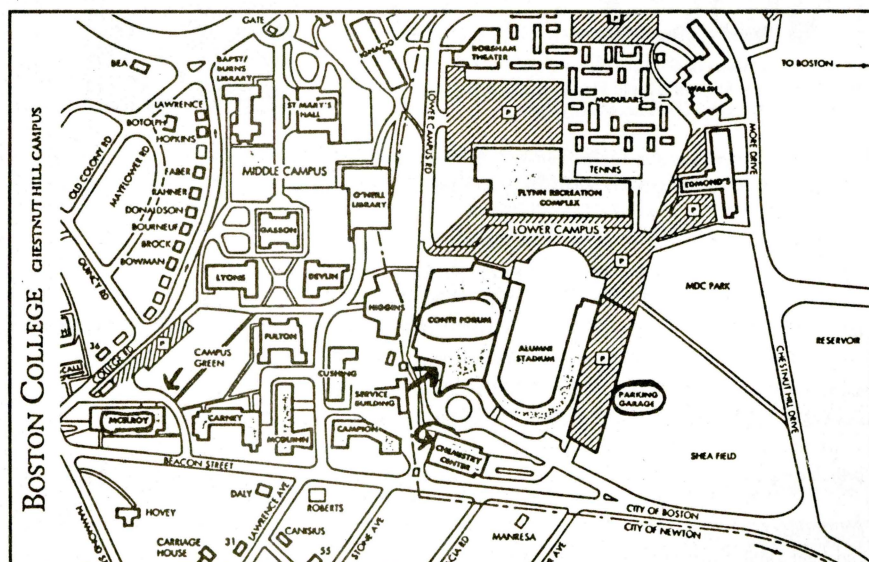
**Publications:** The *NUCLEUS* will be ending up ahead of the budget this year because of excess advertising income over the budgeted amount.

**Public Service:** Dr. Brauner stated that the Museum of Science has asked us to extend the Holiday Lecture Series through the whole holiday week in December.

#### Other Committees:

**Continuing Education:** Dr. Viola mentioned that already nine reservations have been made for the October

continued on page 6



## Monthly Meeting

The 757th Meeting of the Northeastern Section, ACS

Medicinal Chemistry Group Symposium

Medicinal Kinase C as a Target for Pharmaceutical Development

Thursday, December 9, 1993, Boston College, Chestnut Hill, MA  
Shea Room, Conte Forum

3:00 Coffee

3:30 J. Anthony Ware, Beth Israel Hospital — *Protein Kinase C Isozymes as Drug Targets*

4:30 Peter M. Blumberg, National Cancer Institute — *Protein Kinase C – Biochemical, Functional and Topological Heterogeneity Provide Opportunities for the Design of Selective Therapeutic Agents*

5:30 Social Hour

6:15 Dinner

7:30 Evening Meeting, Dr. Dorothy Phillips, chair, Northeastern Section, presiding  
Steven E. Hall, Sphinx Pharmaceutical Corp. — *Development of Selective Protein Kinase C Inhibitors*

Refreshments will be served after the program.

Dinner reservations should be made no later than December 3. Please call Marilou Cashman at (800) 872-2054. Reservations not cancelled at least 24 hours in advance must be paid. Members, \$21.00; Non-members, \$23.00; Retirees, \$12.50; Students, \$8.00. THE PUBLIC IS INVITED. Anyone who needs special services or transportation, please call Marilou Cashman a few days in advance so that suitable arrangements can be made.

Free Parking is available in the garage next to the Forum. Enter from Beacon St.

Shuttle bus from and to Reservoir Station, every 10–20 min. til midnight.

Next meeting: January 13, 1994, 8pm at Curry College, Milton, MA. Noel Plouffe, Nashoba Valley Winery, will speak on "The Biochemistry of Fruit Wines." Social hour and dinner preceding at 5:30.

## Biographies

**J. Anthony Ware** received his M.D. from Washburn University in 1977. After being an intern and a resident in Internal Medicine and a Cardiology Fellow at Baylor, he came to Boston in 1984 as a Research Fellow in the Cardiovascular Division of Beth Israel Hospital. In 1986 Dr. Ware became an Assistant Professor of Medicine at Harvard Medical School and an Associate in Medicine, Cardiovascular Division at Beth Israel. His research interests include the role of calcium and other second messengers, especially protein kinase C on the function of platelets.

**Peter M. Blumberg** received both his B.A. and Ph.D. from Harvard, the

latter in 1974 in the Department of Biochemistry and Molecular Biology under Prof. Jack Strominger. After a year of postdoctoral work at MIT, he served on the faculty of the Harvard Medical School as Assistant and Associate Professor. In 1981 Dr. Blumberg joined the National Cancer Institute where he is now Chief, Molecular Mechanisms of Tumor Promotion Section, Laboratory of Cellular Carcinogenesis and Tumor Promotion. His research interests include understanding at the cellular and molecular level the mode of action of natural products, including the phorbol esters and other tumor promoters and the resiniferatoxin class of neuromodulators.

**Steven E. Hall** received his Ph.D. in organic chemistry in 1982 working under Prof. William Roush at MIT. In 1982 he joined the Squibb Institute for

## Section News

### NESACS Wins Phoenix Award for most involvement with Student Affiliates

At the Chicago meeting in August 16 local sections were presented Phoenix Awards for different activities in which they excelled during National Chemistry Week 1992. The Northeastern Section was selected for its involvement with Student Affiliates at the First Annual Undergraduate Open House at Boston University.

### BU CHEMIA, the Student Affiliate Chapter Cited as "Outstanding"

Chemia, the undergraduate chemistry club and ACS Student Affiliate Chapter at Boston University, has been designated as "Outstanding" by the ACS Committee on Education based on its activities during the 1992-93 academic year. It is one of 31 chapters out of 850 at colleges and universities in the U.S. and Puerto Rico so designated. Chemia also had been cited as "Outstanding" for 1991-92 and "Commendable" for 1990-91.

In 1992-93, Chemia, with 74 undergraduate members, co-sponsored with the B.U. Chemistry Department an Undergraduate Seminar Series, and was co-host of the First Annual Northeast Regional Undergraduate Day, the College Research Symposium of the Northeastern Section, and a meeting of

continued on page 6

Medical Research where he was involved with the discovery of novel cardiovascular drugs. This work included the development of thromboxane A<sub>2</sub> receptor antagonists, cyclooxygenase inhibitors, leukotriene D<sub>4</sub> receptor antagonists, potassium channel activators and thrombin inhibitors. In 1993 he joined Sphinx Pharmaceuticals Corp. in Durham, NC and is currently Vice-President, Chemical Research (NC) where he is responsible for the medicinal, process and natural product chemistry groups. ♦

## Board of Directors

continued from page 4

28/29 ACS Short Course on Molecular Biology and Recombinant DNA Technology.

**Education Task Force:** Dr. Phillips stated that Duracell Co. continues its interest in the Roxbury project and that Roxbury Community College has been contacted to aid this project.

**National Chemistry Week:** Dr. Phillips introduced Bert Paul who will chair the National Chemistry Week Committee. Outreach to young people who have not yet decided on careers in science are to be the special focus this year. M. Solstad pointed out that the Speakers' Bureau is available to help during National Chemistry Week.

**Project SEED:** The program has involved seven students and their preceptors during the past summer.

**New Business:** The question of Education Night Dinner expenses will be put on the agenda for a future meeting. ◇

## Section News

continued from page 5

the New England Association of Chemistry Teachers. It published a newsletter, provided tutoring, and served as an activating force for the encouragement of students to engage in undergraduate research. Three seniors who were doing honors-level Independent Work for Distinction attended the National Meeting of the ACS in Denver last March where they presented the results of their research at the National Undergraduate Research Poster Session in the Division of Chemical Education.

Witold Hruzewicz and Alissa Rashkin served as President and Vice-President of Chemia, respectively; they are now graduate students in chemistry at the University of California-Berkeley and the University of Pennsylvania. Professors Morton Z. Hoffman and Patricia L. Samuel serve as faculty co-advisors of the group. ◇

## ACS News

### The National Historical Chemical Landmark Program

The ACS Office of Public Outreach and the Division of the History of Chemistry have initiated a program to identify chemical milestones, sites, artifacts or collections, to be designated **Historic Chemical Landmarks**. The program has the support of the Chemical Heritage Foundation.

Local sections are asked to identify and nominate potential landmarks in their area. In this area, for example, possible landmarks might be the Saugus Iron Works, the Harvard Chemical Laboratory where Theodore William Richards did his Nobel Prize winning work, sites of some of Boston's early chemical-based businesses, collections of early scientific instruments in Cambridge, and the like.

The descriptive ACS brochure states, "A designated chemical landmark submitted by your local section...can be the focus for new outreach activities and events that will promote public awareness of the positive impact of chemical science and technology in your community."

**Historic Chemical Milestones** are "key technical innovations, significant experimental or theoretical results, and new industrial processes or products". They must be of national significance, must contribute significantly to society and the chemical profession, must be unique, or distinctive.

A **Historic Chemical Site** may be "a particular locale at which some event or development occurred, or which some apparatus, instrument, building, or complex of significance occupied".

**Historic Chemical Collections** would cover museums containing "a number of objects of special significance to the historical development of chemistry and chemical engineering".

If approved by the Advisory Committee, a designation ceremony will be organized and a plaque presented.

continued on page 7

## Chemistry and Art

### Report of the address by John Tramondozzi at the September 23 Meeting of the Section.

Reported by A. Heyn.

John Tramondozzi, Professor at Curry College in Milton, MA, addressed a capacity audience in the Faculty Dining Room at Boston College. He explained that the title: *Science and Technology and Pretty Things* would more accurately describe the talk.

Why are there works of art around us? Some are there because of their beauty – they appeal to our senses, others, because of the prestige they lend to the owner: They show that the owner can afford them. Other works of art are there for devotional purposes.

Artisans practice applied technology available to them. This is true for painters, sculptors, those working in ceramics, textiles, and even photographers.

This point was illustrated by following the technology of making glass from ancient Roman glass, a rather impure soda-lime glass, to lead glass,

introduced about 1600, which is produced by adding lead oxide to the melt and results in very heavy glass with a high refractive index. Other metal oxides were added to obtain colored glasses of various tints, culminating in ruby glass, which contains gold.

Gold was used extensively from ancient times because of its resistance to corrosion, and silver was similarly used. The use of precious metals and precious stones reached their peak during the seventeenth and eighteenth century, as shown by articles for table use by the wealthy made by gold and silver smiths such as Cellini.

Similarly, artists learned the use of metal oxides and other compounds from alchemists. In modern times, starting with Perkins in 1856 when he invented the first synthetic aniline dye, synthetic dyes have been used by artists and artisans alike, not always with fortunate results since they are not

as stable as inorganic pigments.

Dr. Tramondozzi illustrated the influence of technology on art for the case of ceramics, especially porcelain which in the west was invented in the 18th century by Böttger in Saxony. Josiah Wedgwood in England used known technology extensively for his ceramic products.

The same points were illustrated for textiles and paintings. In the latter case, the nature of the pigments used help dating and authenticating pictures.

Dr. Tramondozzi spoke about the role of varnishes in helping deepen the colors of a picture and the problems encountered when varnish darkens with age and has to be removed and replaced with new varnish.

He spoke about a course in Art Conservation which introduces art students to scientific concepts. Thus students can learn about chemistry through art. ◇

## ACS News

continued from page 6

Section members interested in this program, please contact the Section's Archivist, Dr. Myron S. Simon, 20 Somerset Rd., West Newton, MA 02165-2722; Tel. (617) 332-5273. ◇

## Nominations

### Philip L. Levins Memorial Prize

Nominations for the Philip L. Levins Memorial Prize for outstanding performance by a graduate student, whose research is in the area of organic, analytical or environmental chemistry, should be sent to the Administrative Secretary, NESACS, 23 Cottage St., Natick, MA 01760 by March 1, 1994. Please include a biographical sketch, transcripts of graduate and undergraduate grades, a description of present research activity, and three references. ◇

## Complete Microanalysis Services

Analysis for all elements • Trace analyses  
Environmental Analyses • GLP • GMP



- Instrumental superiority
- Technical competence
- Guaranteed turn-arounds
- Regulatory expertise
- Quality assurance
- EPA certification
- Customized reporting

Serving over 3,500 clients worldwide,  
including 60 of the largest 100 U.S. corporations

Accuracy with speed

## GALBRAITH LABORATORIES, INC.

Fax: (615) 546-7209  
2323 Sycamore Drive  
Knoxville, TN 37921-1750

Tel: (615) 546-1335  
P.O. Box 51610  
Knoxville, TN 37950-1610

Call or write for our information packet.

Barrier & Dielectric protection that lasts

For precision electrodes, medical implants and sensors, parylene coating can provide unparalleled barrier and dielectric characteristics in an ultra-thin film.

AST's ParyLAST, plasma enhanced parylene coating process (patent pending) produces a tenacious chemical bond between the substrate and coating. As a result, ParyLAST can provide effective lifetime performances up to 150 times longer than other parylene coatings. ParyLAST is an environmentally friendly, dry process that produces no chemical waste.

Product Innovation through Advanced Coatings

**ParyLAST**<sup>TM</sup>  
PARYLENE COATING

**AST** Advanced  
Surface  
Technology, Inc.  
9 Linnell Circle  
Billerica, MA 01821  
508-663-7652

# Environmental Chemistry Column

## Molten Metal Catalyzes Waste Destruction

by David Ham, Envirochem, Inc.

Recent Environmental Chemistry Columns have featured several emerging technologies for treating a variety of liquid and solid phase waste problems. This series started with a brief discussion of photochemically enhanced oxidation catalyzed by titania which is being developed for treatment of aqueous waste streams containing less than about 1% organics. Significant local work is currently involved with developments of supercritical processes which offer attractive possibilities for treating waste solutions in the intermediate range of 1-20% organics in water as well as for treating small scale, specialized wastes. Bioremediation has considerable potential for destroying wastes in situ at dump sites. This column provides a technical background discussion of an emerging technology, being developed by a Massachusetts company, that provides an alternative to incineration for treating a wide variety of condensed wastes, solid or liquid, such as municipal refuse or industrial waste.

The public has been sensitized to many problems involved in disposal of condensed phase wastes, including very diverse materials ranging from the relatively innocuous municipal solid wastes to hazardous and toxic industrial solids or liquids. Recent news articles have warned us that landfills are full and towns cannot afford to treat them to avoid ground water contamination. Also, public protests are stalling and stopping construction of waste incinerators that could alleviate the need for landfills but will pollute our air and water unless emissions are treated with expensive emissions control processes.

Incineration is used to dispose of waste streams with relatively high concentrations of waste, typically requiring organic content greater than 25% to avoid addition of expensive additional fuels. Public resistance to the stack gas emissions, waste delivery

problems, and any landfill wastes is limiting incinerator installation. Incinerators burn refuse at temperatures in the range of 1800°–2600° F (1000°–1400° C) resulting in volume reductions of the waste of typically 85-90 percent. Additional benefits can derive from the heating value of the waste if it is used to raise steam for space heating or power generation to achieve an economic return and reduce operating costs.

An alternative to incineration is being offered by Molten Metal Technology, Inc. (MMT) of Waltham, MA for treating a wide variety of wastes. Their "Catalytic Extraction Process" (CEP) has received extensive attention recently throughout the news media, mostly covered as an exciting new business. In September, MMT dedicated a new, \$15 million commercial scale demonstration facility in Fall River, MA. The remainder of this article presents some scientific explanations of this emerging technology that has spawned excitement in the business community.

### Background

Catalytic extraction processing (CEP) has been developed rapidly by taking advantage of well developed technologies of steel furnaces and steel plant processing units from which it derives. CEP is also an extension of a gasification process, the Atgas Process, developed in the early 1970's by Applied Technology Corporation. Atgas used a molten iron plus limestone bath to react crushed coal with steam and oxygen at 2500° F. This process produces hydrogen, carbon monoxide, and methane with no sulfur contamination as the sulfur is removed in a slag layer as calcium sulfide along with other mineral matter contaminants from the coal.

Iron and iron compounds are well known to be good cracking catalysts when used under reducing conditions

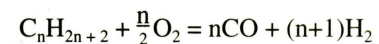
in connection with coal gasifiers. CEP takes advantage of this catalytic activity of molten iron for cracking and oxidizing any waste material as well as its ability to dissolve many substances, especially metals, to adapt these molten metal baths for treating many, diverse wastes.

### Process Description

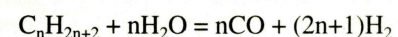
In CEP, gaseous, liquid, or solid feed streams can be injected into either the top or bottom of a preheated molten metal bath (mostly iron) in the temperature range of 2,400°–3,200° F (1315°–1760° C). One injection stream is oxygen, added at the required stoichiometric amount to react with any combustible matter in the waste feed stream. When sufficient oxidation is occurring, the oxidation will maintain the desired process temperature with no additional heat input. A flux, for example calcium oxide (lime) and/or silica, is usually added to form a melt layer on top of the metal to trap and dissolve oxidized inorganic contaminants.

The molten iron is a catalyst for cracking and oxidation of anything as well as a solvent for metals. The reactors are designed to provide residence times in the range of 0.5-6 seconds. On this time scale and at the normal operating temperatures, the chemical kinetics are instantaneous. So, with injection that provides good mixing, all substances treated in the bath will reach chemical equilibrium in the three phases, molten metal, inorganic melt, and gas phase.

Most waste materials except metals will be partially or completely oxidized in the molten metal bath. The oxygen feed is controlled to achieve partial oxidation of any organic materials to go completely to CO and H<sub>2</sub> but not to CO<sub>2</sub> and H<sub>2</sub>O. As an example, partial oxidation of a mostly saturated hydrocarbon can be represented by the reaction

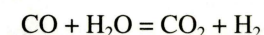


When the waste being processed contains a large amount of water or if water is added as a feed, the partial oxidation reactions will be supplemented by reforming reactions. The overall chemical reaction for reforming of a mostly saturated hydrocarbon is



Reforming, reaction of a fuel with water, has the advantage of producing more hydrogen than partial oxidation. However, reforming is an endothermic process, so that it must be accompanied by sufficient exothermic oxidation to maintain the operating temperature. When operated in a mode combining oxidation and reforming, the CEP reactor is essentially an autothermal reformer (ATR) which is a fuel processing reactor designed to balance these reactions to operate at a constant temperature. ATR's have been developed extensively using solid state catalysts for fuel conversion and hydrogen production.

The chemical composition of the gaseous products is determined by full equilibrium among all vapor phase species. Since enough O<sub>2</sub> is added to react with essentially all of the carbon and hydrogen, the composition is given simply by equilibrium of the water gas shift reaction,



If the elemental composition of the reactant waste is known, it can be used as input along with the equilibrium constant for this reaction at the operating temperature to accurately calculate the product distribution among the main species. The only other carbon or hydrogen containing species to consider is methane, CH<sub>4</sub>, which has an equilibrium concentration a couple of orders of magnitude less than the major species at CEP operating temperatures. In the reducing atmosphere nitrogen oxide will be reduced to N<sub>2</sub>, avoiding emission of NO<sub>x</sub> pollutants. Concentrations of minor species can also be determined by similar equilib-

rium calculations.

Inorganic waste materials will concentrate in the flux melt layer above the molten metal. For example, in this layer sulfur can be trapped as CaS, chlorine as CaCl<sub>2</sub>, aluminum as Al<sub>2</sub>O<sub>3</sub> or Al<sub>2</sub>SiO<sub>5</sub>. In cases where these inorganic products can be readily isolated in relatively pure states they can have commercial value, for instance as road de-icing chemicals or abrasives. For cases where the inorganic layer is too chemically complex or toxic for commercial use, it can be safely disposed of in a landfill since the volume is much smaller than that of the original waste and can be sealed in a glassy silica.

### Advantages and Limitations

CEP has several outstanding advantages for treating a variety of waste problems. This process will treat anything and produces no gas phase pollutants such as NO<sub>x</sub>, SO<sub>2</sub>, or airborne particles. The CEP reactors can be custom designed at small scale for operation on site at industrial facilities where the products can be used and transportation of hazardous or toxic wastes is avoided. For many waste streams, most of the products will have commercial value providing an operating cost advantage. For non-salable wastes, their volume will be tremendously reduced and they will be sealed in non-leaching forms for disposal.

The primary products of the organic wastes will be the synthetic gas composed primarily of CO and H<sub>2</sub>. Common commercial uses of such a medium Btu gas (MBU) (heating value from 250 to 400 Btu/scf), are either as a fuel, as a chemical feedstock, or to produce high Btu gas (synthetic natural gas) equivalent to methane. For the relatively small CEP units envisioned as a pollution control unit on-site at an industrial facility, the most economical use of this off-gas will probably be to provide process heat to other parts of the industrial process. When this synthetic gas is used to replace natural gas or oil in direct firing processes, it requires different burner designs due to the higher volumes of gas and different air fuel ratios.

Small CEP units will not provide sufficient quantities of chemical feed stock to justify the capital costs of the chemical plants required to convert CO and H<sub>2</sub> into methanol, ammonia, hydrogen or other value added chemicals. When used to process high heat content wastes, sufficient water could be added to compete with reforming of natural gas for hydrogen production, especially if H<sub>2</sub> were required on-site.

The Atgas process was abandoned in favor of other coal gasification processes because it is inefficient for energy conversion due to the very high temperature. Preheating of the inlet streams to this high temperature requires a lot of heat, and conventional heat engines do not run at such high inlet temperatures. These efficiency losses will limit CEP's use for economically treating wastes that have very low heating values, such as river sludge containing PCB's, because the low energy efficiency must be compensated by expensive added fuel. Typical heating values of municipal refuse are about half those of coal and about a third that of No. 6 fuel oil on a mass basis. Thus, lower thermal efficiencies may limit CEP in competing economically with incinerators for large scale disposal.

Watch the local media for further developments of the exciting developments of Molten Metal Technology, Inc. and their efforts to develop non-polluting waste disposal systems. ◇

### Errata

We apologize for incorrectly listing the name of the late Robert Lindbergh Cleland as "Cleveland" on page 20 of the September 1993 issue.

We also omitted crediting Dr. Robert F. O'Malley for writing the page 4 obituary of David C. O'Donnell in the October 1993 issue.

# Lime and Portland Cement<sup>1</sup>

by James V. Thompson

In Part I of this series<sup>2</sup> we discussed mud and gypsum as the source of primitive construction and artistic plastics; mud in the form of a calcined product or plaster of paris.

## Lime

Lime, calcium oxide (CaO), is made from limestone. In proper usage the word "lime" should refer to calcium oxide; however, the term has become almost generic for anything containing calcium. Limestone is essentially calcium carbonate, CaCO<sub>3</sub>. When pure, it is 56% CaO and 44% CO<sub>2</sub>. It is almost never pure and a stone containing at least 96% CaCO<sub>3</sub> is considered high grade, providing there are no unusually objectionable impurities. Sulfates and sulfur in any form are objectionable and were objectionable long before air pollution was a problem. The common impurities are MgO, SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub> and Fe<sub>2</sub>O<sub>3</sub>. Many limestones contain a trace

of strontium, manganese and sulfur in some form. When the MgO is high the stone is called dolomite, CaMg(CO<sub>3</sub>)<sub>2</sub>. Dolomite is used to make dolomitic lime which has wide use in industry, but this discussion will be held to high calcium lime.

Limestone is widely distributed all over the world. Few countries are short of limestone. Atolls in the Pacific islands are coral reefs made out of mostly calcium carbonate. In the foothills, in the Mother Lode Belt of the Sierra Nevada, there are millions of tons of high grade limestone.

Limestone is formed by three major processes. Chemically deposited limestone is believed to be the result of CaO being dissolved out of igneous rocks and precipitated as CaCO<sub>3</sub> by CO<sub>2</sub> in the atmosphere at a time in the geologic past when the earth's atmosphere was much richer in CO<sub>2</sub> than it is now. Indeed, many limestone

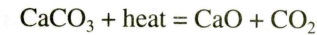
deposits date from precambrian time, over 600 million years ago. Organically formed limestone comes from the remains of animal or vegetable organisms that are capable of absorbing calcium carbonate or bicarbonate from the waters in which they live. Coral limestones are an example. Reconstituted limestones are formed when limestone is dissolved by meteoric waters containing CO<sub>2</sub>, resulting in soluble Ca(HCO<sub>3</sub>)<sub>2</sub>:



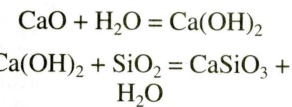
The reaction is reversible, resulting in the redeposition of CaCO<sub>3</sub>. This chemistry can be observed in limestone caves where stalactites and stalagmites are being formed.

Lime may be another campfire discovery by primitive man. Very old structures exist in the Mideast and Mediterranean area that employed lime mortars. Limestone, when heated

to around 900°C, starts to calcine as follows:



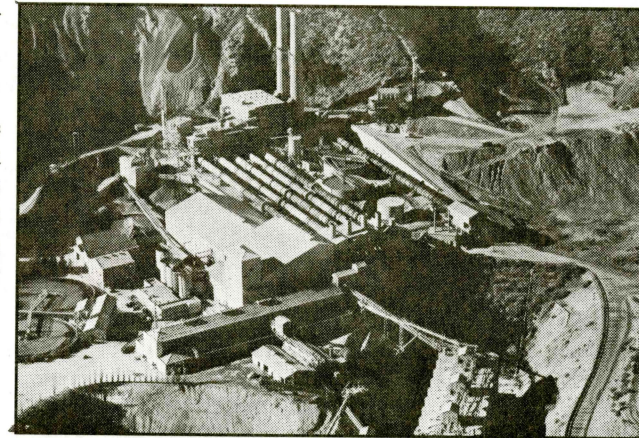
When water and sand are mixed with lime (CaO) a mortar is formed which is superior to gypsum mortars because the lime reacts with the silica in the aggregate. The reaction is as follows:



The reaction may be slow and incomplete and the water must escape before the mortar "sets". Surplus lime is eventually recarbonated by CO<sub>2</sub> in the atmosphere.

Lime-silica bricks have been used in the past and are still in use in some places. They are a simple mixture of sand and hydrated lime. Often the process is hastened by "curing" in a heated kiln. For mortars or shapes the best silica sources are those whose particles have high specific surface such as volcanic cinders, ash and pumice. However, for interior plastering fine, washed, sized silica sand is generally used. For lime mortars pozzolan, a leucitic tuff of volcanic origin, was quarried near Pozzuoli, Italy by the ancients. The name is now applied to a variety of materials that exhibit pozzolanic properties. Pozzolan is added to take up free alkali and add late age strength and resistance to saline and acidic conditions that may be encountered in modern portland cement concrete. This benefits structures, such as dams that are intended to have a long life.

Pozzolan cement is made by grinding lime with pozzolan. In the old world there are structures of great age made with this type of cement. The Romans made extensive use of pozzolanic cement. To this cement they added coarse aggregates of rock, lumps of pumice or broken bits of fired bricks from former structures. With the use of lumpy pumice we have an early day light weight concrete. The great advantage to Roman engineers was that this type of cement and the concrete



Kaiser Cement & Gypsum Corp. cement plant, Permanente, CA built near San Jose in 1938 by Kaiser, with later additions. Thickeners and slurry mixers indicate a "wet" grinding of raw material. Converted in 1980 to a dry grind of raw material. Photo: ICF Kaiser Engineers, Oakland, CA

are pure and a high quality limestone would be one that contains >95% CaCO<sub>3</sub> and containing as little as possible SiO<sub>2</sub>, Fe<sub>2</sub>O<sub>3</sub>, Al<sub>2</sub>O<sub>3</sub>, MgO and other impurities. MgO is the least objectionable; silica,

iron and alumina are the bad actors. At made therefrom would harden under water. Their skill with this cement enabled them to make stout load-bearing walls, arches and domes, and some of their structures have stood for over 2,000 years.

But Rome was also a city of much artistic and structural marble. After the fall of Rome (it fell more than once, by the Goth invasion of 410 A.D., or the Vandals in 455 and a few times thereafter), there was much damage to works of art and structures made of marble. During the Dark Ages and Middle Ages the producers of lime mined the city. Many works of art and inscriptions on marble slabs were fed to the kilns. The church survived the invasions but the Vatican made little attempt to save anything. After all, weren't these structures the work of pagans? We can say that the Vatican pontificated while Rome calcined. However, the quality of pozzolanic cement seems to have declined after the fall.

Lime calcining is simple, but it has only been understood in the last hundred years, more or less. Primitive lime was often of poor quality, due to inferior stone and underburning. It was a batch process employing some kind of primitive calcination. One method was simply to make a heap of stone mixed with wood and set it on fire. This method would result in much unburned core. Later, mud, brick or stone batch kilns were employed using charcoal.

The quality of lime is measured in terms of "available lime", i.e. its true content of free CaO. Few limestones

are pure and a high quality limestone would be one that contains >95% CaCO<sub>3</sub> and containing as little as possible SiO<sub>2</sub>, Fe<sub>2</sub>O<sub>3</sub>, Al<sub>2</sub>O<sub>3</sub>, MgO and other impurities. MgO is the least objectionable; silica, iron and alumina are the bad actors. At calcining temperatures impurities combine with lime to form compounds that reduce available lime. When "quick" lime, CaO, is hydrated with the stoichiometric amount of water it slakes to a fine, dry powder leaving the impurities and unburned core as coarse particles that can be removed by air classification.

If limestone is calcined at as low a temperature as possible and under conditions that result in low partial pressure of CO<sub>2</sub> in the calcining zone, a "soft" burned lime is produced. The lime particles are pseudomorphs of the original limestone. There is very little shrinkage and the lime particle is very porous. Soft burned lime can be explosively reactive resulting in rapid release of heat of hydration when water is added without careful control.

Well designed gas or oil fired semi-continuous shaft kilns and fluid bed kilns can produce good soft burned lime. Calcination may start at 900°C, but most kilns operate at 1200° to 1300°C. Hard burned, or overburned lime results from calcination at higher temperatures. The particles have shrunk and are no longer pseudomorphs, and thus the specific surface is reduced. Hard burned lime hydrates slowly, but is preferred for some uses.

Kilns may be classified as fixed bed, semi-moving bed, moving bed and fluid bed. The oldest, still in use today, are fixed bed and semi-moving bed shaft kilns. Few shaft kilns today use solid fuel mixed with the charge; however, the author visited a large installation of this type in India some

## Posi-Trap positive flow vacuum inlet traps



*We've got  
the perfect trap  
for your  
system!*

- Positive Flow • No "Blow-By"
- Variety of Elements
- Positive Trapping
- Easy Changing • Easy Cleaning

It's bye-bye to "blow-by" with Posi-Trap. Unlike others, our filter is sealed at both the inlet and the exhaust so that all the particles must flow through the element. We've got the perfect trap for your system, and should your application change, simply choose from our wide variety of filter elements, and you're back on-line! Protect your vacuum pump and system with Posi-Trap from MV Products.

For more information contact

**MV PRODUCTS**  
247 RANGEWAY ROAD, PO BOX 359  
NO BILLERICA, MA 01862  
TEL (508) 667-2393 Fax (508) 671-0014

A DIVISION OF MASS-VAC, INC.

years ago. Natural gas and oil are the preferred fuels for shaft kilns but some still burn coke mixed with the stone. The great drawback of shaft kilns is their inability to burn fine stone. The ideal size is 3-5" but this range can be extended downward to about 2" with some loss of kiln capacity. Well designed shaft kilns of the Azbe type can produce a good soft burned lime for about 4.5 - 5.0 million BTU per ton of lime. Rotary kilns treat finer stone of about  $2\frac{1}{4}'' \pm \frac{1}{4}''$ . Smaller sizes result in high dust loadings, but can be treated in fluid bed kilns and rotaries where the operators are willing to accept the problems. Older rotaries and those burning fines may use 8.0 to 10.0 million BTU per ton of lime. Rotary kilns tend to overburn, producing a less reactive lime but they can also produce less unburned lime core as measured by the "LOI" (loss on ignition), meaning remaining CO<sub>2</sub> in the product. A satisfactory range is 0.5 to 1.0%. Modern rotary kiln plants have combustion air preheaters (coolers on the burned lime discharge), and stone preheaters where the combustion gases pass through the incoming feed stone. Such kilns can operate on as little as 4.5 million BTU per ton of lime.

In 1946 the author was involved in research and pilot plant testing with fluid bed lime burning kilns. The process produced a very soft burned, highly reactive lime with a fuel consumption (Bunker C oil) of a little under 6.0 million BTU, which was better than most rotary kilns of the day. However, it was beset with mechanical difficulties involving plugging of the holes in the constriction plates between stages. Some commercial units were built for stone and for water treatment and paper mill lime sludges. Today, most commercial plants are rotaries with stone and air preheaters.

The use of lime in construction has declined, being replaced by gypsum wallboard for interior use and portland cement for exterior mortars and stucco formulations. By far the largest use is in the chemical and metallurgical industries. As an industrial chemical it will usually rank fifth on any list.

### Portland Cement - The Ultimate Inorganic Mineral Plastic

Portland cement seems to have been discovered almost by accident when John Smeaton built the Eddystone lighthouse in England in 1758. He used a cement of his own formulation to make a superior concrete. The lighthouse lasted over a hundred years. He calcined limestone with a high clay content (providing alumina) and mixed it with pozzolan imported from Italy. His limestone came from the Isle of Portland and portland cement derives its name from this location. Smeaton probably did not understand the chemistry involved, but the use of clay to provide alumina was the beginning of modern portland cement. In 1824 a British patent was issued to Joseph Aspdin who had done much research employing the Isle of Portland impure limestone. The basic content of the raw material to make portland cement is CaCO<sub>3</sub>, SiO<sub>2</sub> and Al<sub>2</sub>O<sub>3</sub>. Later, iron was found to be an important additive, as well as uncalcined gypsum added to the final clinker before final grinding. Whether sufficient free silica was found in the Isle of Portland limestone or whether Aspdin added it to his mix was not clear in the literature reviewed by the author. In any event, clay, providing alumina, was found in the Portland stone. Aspdin's cement did not require pozzolan; only common aggregates were required to make concrete, but pozzolan might have been beneficial.

Aspdin's first kilns were fixed bed kilns with solid fuels mixed with the charge, not unlike beehive coke ovens. It was a batch process producing un-

even results and in time it was learned that higher temperatures (unlike lime burning) made better cement. The higher temperatures forced the combination of CaO with SiO<sub>2</sub> and Al<sub>2</sub>O<sub>3</sub>. Cement kilns operate in the range of 1450° to 1600—C.

The United States started to import portland cement in 1868. The standard container was the barrel, and for many years cement plants were rated in barrels per year, but the recent trend is toward short tons. A barrel is 376 pounds; there are four 94 pound sacks to the barrel, and a sack is about one cubic foot.

In some places natural cement rock occurs containing about 50 to 65% CaCO<sub>3</sub>, 20 to 30% SiO<sub>2</sub> and 15 to 35% clay minerals. Some MgO is always present. However, much cement is made from carefully controlled mixes of several raw materials. Chief Chemist is an important job in a modern portland cement plant.

In 1871 David Saylor started to manufacture portland cement from natural cement rock at Coplay in the Lehigh Valley of Pennsylvania and this area is still an important cement making district. His batch shaft kilns were labor intensive and low capacity. In 1885 Frederick Ransome, an English engineer, patented the rotary kiln, still in use today.

Portland cement is made by fine grinding, either wet or dry (since the energy crunch most kilns are fed with dry feed), a mixture of limestone, clay or shale, and silica. Some of these may be inherent in the limestone. Iron is added from any cheap source, such as

rolling mill scale, iron ore or staurolite, a mineral which adds iron, silica and alumina and has the formula HFeAl<sub>5</sub>Si<sub>2</sub>O<sub>13</sub>. It is a byproduct of beach sand mining for titanium minerals in Florida. The mix to the kiln is controlled to give the following approximate analysis, but with variations from plant to plant and for different types of cement:

CaO	61.5%
SiO <sub>2</sub>	22.5
Al <sub>2</sub> O <sub>3</sub>	7.5
MgO	2.0
Fe <sub>2</sub> O <sub>3</sub>	2.0
SO <sub>3</sub>	1.0
Na <sub>2</sub> O, K <sub>2</sub> O	1.5
Undefined	2.0

The foregoing should be taken as only approximate, especially where minor compounds are involved.

The discharge of the kiln is a lumpy clinker which is fine ground with the addition of raw gypsum to make a fine gray-green powder. The gypsum prevents too rapid setting of the cement. The analysis of the clinker is approximately as follows:

Tricalcium silicate	3CaO.SiO <sub>2</sub>	55%
Dicalcium silicate	2CaO.SiO <sub>2</sub>	25%
Tricalcium aluminate	3CaO.Al <sub>2</sub> O <sub>3</sub>	10%
Tetracalcium Aluminoferrite	4CaO.Al <sub>2</sub> O <sub>3</sub> .Fe <sub>2</sub> O <sub>3</sub>	8%
Other minor compounds		2%

These compounds form in the intense heat of the kiln operating at 1450° to 1600°C. The fuel requirements in a well designed system are of the order of 3.0 to 6.0 million BTU per ton of cement, depending on whether the feed is a wet slurry or a dry powder.

When cement is mixed with water new compounds form due to hydration. In general, concrete (cement plus aggregate) is made with as little water as possible to provide proper hydration, but for practical reasons fluidity must be maintained to efficiently place the concrete.

Concrete must not be allowed to dry too fast or there may not be sufficient water for proper hydration. Concrete does not dry so much as it "cures". Much of the water is contained

in the concrete for ever. The compounds mentioned above have the following functions:

**Tricalcium silicate:** A cement compound that adds strength and causes rapid hardening.

**Dicalcium silicate:** Adds strength but hardens more slowly.

**Tricalcium aluminate:** Promotes fusing of hydrated crystals and liberates much heat in the first few days. This can cause problems with large masses of concrete, requiring internal cooling systems.

**Tetracalcium aluminoferrite:** Reduces heat of hydration and promotes formation of cement crystal growth.

The perfect cement should perhaps contain no free lime, but this may not be achieved. In time, free lime attacks silica aggregates and causes other problems. Good, ancient fine-ground pozzolan is often added to counteract free lime.

Like steel, the importance of portland cement in modern civilization can hardly be overstated. The buildings we live and work in, the roads we drive on, the airports we fly in and out of, the utilities that provide us with power, water and sanitary facilities, all depend on portland cement - the ultimate inorganic plastic.

### References

The following are well illustrated, historic and essentially nontechnical, easy to read discussions of lime and portland cement.

### Lime

The brochure *Lime Calcining Equipment and Systems*, published by the Kennedy Van Saun Company, Box 500, Danville, PA 17821.

### Portland Cement

The January, February and May, 1989 issues of *California Geology*, published by the Department of Conservation, Division of Mines and Geology, Box 2980, Sacramento, CA 95812. ♦

### Footnotes:

1. Reprinted by permission from the January 1992 issue of the *Vortex* of the California Section, ACS.
2. The *NUCLEUS*, LXXII, No. 1, September 1993, p. 15.

## ACS Congressional Fellowship Program

The ACS Congressional Fellowship Program places a person with a background in science and public policy in the office of a U.S. Senator, Representative, congressional committee or subcommittee. During the year-long fellowship, this person is responsible for providing that office with a sound, objective scientific basis for policy decisions, increasing ACS visibility on Capitol Hill, and providing the Society's membership with insights gained from this service.

ACS fully funds a stipend, but other sources may be acceptable (employer, private foundations, etc.). For 1994-5 the stipend is \$ 42,000. The next fellow to be selected will begin work in September 1994.

Fellows are selected competitively from among ACS members. Criteria for selection are: familiarity with a chemical science or engineering (e.g. doctorate or equivalent work experience), a working understanding of the chemical community, experience in civic activities or public affairs. Past involvement in ACS activities is taken into account.

Applicants must submit a letter of intent and a resume directly to the ACS. Two letters of recommendation are to be sent to the ACS by their authors. The ACS Committee on Chemistry and Public Affairs (CCPA) Congressional Fellowship Subcommittee and the ACS Department of Government Relations and Science Policy maintain ongoing contact with the fellow and the congressional offices. The fellow is required to report regularly to CCPA and meet with other Society groups as necessary to provide for an adequate flow of information. An orientation session will be provided by the AAAS, which has a parallel program.

Application deadline is January 1, 1994 for receipt of all materials. For information: Bill Gray, ACS Department of Government Relations and Science Policy, 1155 Sixteenth St., NW, Washington, DC 20036; Tel: (202) 872-4467. ♦

- Spectroscopy
- Chromatography
- Thermal Analysis
- Permeation Data
- Physical Testing
- Deformulation

Please send for capabilities

### PLASTICS ANALYSIS

CHEMICAL/MECHANICAL



444 W. County Rd. D  
St. Paul, MN 55112  
(612) 631-9412  
FAX (612) 631-8405

### NEW CAPABILITIES

- ASTM Injection Molding with Testing
- Dynamic Mechanical Properties

# Unilever Award

## ACS Polymer Division Invites Nominations

This award is sponsored by Unilever for Outstanding Graduate Research in Polymer Chemistry.

The \$2,000 award, to be presented at the Fall 1994 National ACS Meeting in Washington, D.C., will recognize a graduate student or recent graduate who has completed an outstanding Ph.D. thesis in research accepted by a U.S. or Canadian university between January 1, 1990 and December 31, 1993, as well as the thesis supervisor.

Nominations must be made by the thesis supervisor and/or others familiar with the nominee's work. The deadline for nominations is January 15, 1994.

A copy of the detailed announcement can be obtained from the Section office, Marilou Cashman (see p.3.).

## RECRUITING ?

The NUCLEUS readership base is New England's largest source for chemical industry personnel.

The Nucleus reaches more than 10,000 readers each month. These readers are in the following areas of activity:

Industry	Management & R&D	67%
Academe	Faculty & Admin	14%
Students	Grad & post-docs	10%
Consulting & Clinical Labs		5%
Government		4%

One company that recruited through The Nucleus said: We received more qualified resumes from our ad in The Nucleus than we did from our newspaper ad.

Call Nancy Bedell for more info:  
(617) 837-0424

## BUSINESS DIRECTORY

### PRODUCTS

#### Glass Repair & Fabrication

- ◆ Cost-Saving Repairs - Save 50% of replacement costs
- ◆ Custom and off-the-shelf fabrication
- ◆ Glassware for Perkin Elmer & others

Call (615) 546-1335

for our information packet.

**GALBRAITH SCIENTIFIC GLASS**  
a division of Galbraith Laboratories, Inc.  
2323 Sycamore Dr. • Knoxville, TN 37921

### PROTECT

Your Expensive Lab Work with Research and Development Record Books

#### STOCK RECORD BOOKS

- B50D — Fifty pages and fifty duplicates. 1/4 inch sqs. on right pages.
- B100P — 100-1/4 inch sqs. on right pages. 100-10 sqs. per inch on left pages.
- B200P — 208 1/4 inch sqs. on right and left pages.
- B200PH — 208 horizontally lined right and left pages. Books have instruction and TOC's. Page size is 11 x 8 1/2. Hard extension brown cloth covers. Pages open flat.

\$10.50 each, FOB Chicago  
CUSTOM MADE BOOKS TO ORDER

SCIENTIFIC BINDERY PRODUCTIONS  
1255 S. Wabash Ave., Chicago, IL 60605

Phone: 312-939-3449 Fax: 312-939-3787

### SERVICES

#### Laboratory Automation

Off-the-shelf & customized hardware and software

#### Direct reading simultaneous spectrometer upgrades

Apollo, our data acquisition retrofit product is designed to extend the life and functionality of your ARL, Baird, or Jarrel-Ash (ICP) spectrometer. It provides instrument control, data storage, and reporting through easy menu driven software.

**Technology Exchange Corporation**  
A Scientific Computer Applications Company  
Phone (508) 234-6655 FAX (508) 234-6859

## SATT

### Quality Custom Synthesis

Organic chemicals, biochemicals

You challenge our chemists -

We challenge any body's price

SATT Corporation  
P.O. Box 654, Woodbury, NJ 08096  
Tel: (609) 384-8822  
Fax: (609) 384-8835

### POLYMER PROBLEMS?

- Complete Polymer Deformulation
- Good vs. Bad Comparison
- DSC, TGA, IR, UV-Vis, GC, HPLC, NMR
- GPC/SEC Molecular Weights and MWD
- Additive Package Analysis

4 Mill Street  
Bellingham, MA  
02109

(508) 966-1301



### LABORATORY EQUIPMENT

Bought • Sold • Exchanged

#### December Special MICROSCOPES

Many in stock - Call for prices  
Ask for our latest equipment listing

American Instrument Exchange, Inc.  
21 Canal Street, Lawrence MA 01840  
TEL: 508-794-3496 FAX: 508-794-8431

**CUSTOM SYNTHESIS.** Lab scale synthesis (gram to several kilograms) of organic chemicals, biochemicals, metal alkoxides, metal acetylacetonates, and metal carboxylates. We have the ability to handle air and moisture sensitive compounds. Contact Dr. N. Rice, Oryza Laboratories, Inc., 112 Parker Street, Newburyport, MA 01950. Tel: (508) 463-8658 Fax: (508) 462-3048.

## Support Our Advertisers

### FREE Polymer Standards Catalog



AMERICAN POLYMER STANDARDS CORPORATION  
P. O. Box 901, Mentor, Ohio 44061-0901  
Phone: 216-255-2211 Fax: 216-255-8397

## BUSINESS DIRECTORY

### CONSULTANTS

#### Materials & Processes Contract Analyses & Engineering Services

#### Consulting:

- R&D
- Materials Selection
- Process Development
- Contamination Analysis and Control
- Mechanical/Electrical Failure Analysis
- ODC Phaseout

#### Capabilities:

- SEM/EDS, GC/MS, FTIR, ICP, DSC, UV/Vis.
- X-ray Fluorescence
- Karl Fischer
- Dilatometry
- Metallographic Preparation/Examination
- Hardness, Shear Tensile Testing
- Thin Film Coatings

Commercial Business Department  
100 Morse Street  
Norwood, MA 02062  
(617) 762-5300 (617) 769-2237 FAX

### NORTHROP

Electronics Systems Division  
Norwood Site

### CAREER OPPS.



## Validation Engineer

In microelectronics, pharmaceuticals, biotechnology, and a wide array of industries, Millipore's customized products are essential to the revolutionary progress that's being made. By designing our solutions around our customers' needs, we're able to anticipate, define and meet the need for innovation. Our rapid pace of development and pursuit of new ideas means that you'll be involved from the start. Your expertise will be fully valued and rewarded here.

Plan, schedule and organize projects both internal and within the customer base. Responsible for project management and direction of validation projects; generation of SOP's, protocols and reports for validation of new and existing areas. Prepare validation project plans, schedules; organize and identify resources for internal and customer support projects. Evaluate validation projects/proposals, and make recommendations on adequacy, direction and procedures.

Requires hands-on experience in a GMP plant (preferably pharmaceutical), good written/oral and interpersonal skills, experience writing SOP's, qualification protocols and reports, and a strong statistical background. The ideal candidate will work well under changing circumstances and pressure, is willing to travel and has strong technical knowledge of major engineering disciplines, e.g. mechanical, biochemical, electronic, computer. 20-30% travel required.

With a growing presence in markets at home and abroad, we're competitive in the products and solutions we're developing, and in the compensation package we offer our employees. Our focus is fixed on present and future opportunities — now is the time to get involved. Send your resume to Fred Mangin, Human Resources Department, Millipore Corporation, 80 Ashby Road, Bedford, MA 01730. As an equal opportunity employer, we promote quality and diversity on every level.

# MILLIPORE

### ELEMENTAL ANALYSIS

#### Your Priorities...

- 1° - Accuracy and Precision
- 2° - Turnaround (1 day for CHN, S, X)
- 3° - Value

#### Our Capabilities...

- Organic Elemental Analysis
- Inorganic Analysis - AA, ICP
- Chromatography - HPLC, IC, GC

#### Your Service Lab...

**QTI** QUANTITATIVE TECHNOLOGIES INC.

(908) 534-4445 P.O. Box 470, Rt. 22E  
Whitehouse, NJ 08888

### A CALL FOR NUCLEUS VOLUNTEERS

If you wish to help us produce and publish the Nucleus you can do so be helping in a variety of ways.

Writers, roving reporters in the academic or corporate communities, proofers, editors and assistance in other activities can help make the Nucleus more useful to our members. And, you can have fun in the process.

Call  
Arno Heyn  
Editor, The Nucleus

Tel: (617)969-5712

### Index of Advertisers

Advanced Surface Technologies, Inc.	6
Am. Instrument Exchange, Inc.	14
Am. Polymer Standard Corp.	14
Betec Laboratories	12
Galbraith Laboratories, Inc.	7
Galbraith Scientific Glass	14
Jordi Associates, Inc.	14
Mass-Vac Inc.	10
Millipore	15
Northeastern University	2
Northrop	15
Oryza Laboratories, Inc.	14
Quantitative Technology, Inc.	15
SATT Corp.	14
Scientific Bindery Productions	14
Technology Exchange Corp.	14

# Calendar

## For additional information, call:

Boston College – (617) 552-3625  
Boston University – (617) 353-2537  
Brandeis University – (617) 736-2500  
Clark University – (508) 793-7116  
Dartmouth College – (603) 646-2501  
Harvard University – (617) 495-5333  
MIT – (617) 253-4080  
St. Anselm College – (603) 641-7148  
Northeastern University – (617) 437-2822  
Tufts University (Chemistry, Medford Campus) – (617) 627-3441  
Tufts University (Chemical Eng., Medford Campus) – (617) 627-3900  
Tufts University Health Science Campus – (617) 956-6867  
UMass Dartmouth – (508) 999-8232  
University of New Hampshire – (603) 862-1550

## December 1

Dr. Don Eigler (IBM Almaden Research Center)  
“Quantum Corrals”  
Harvard University  
12 Oxford Street, Mb-23 at 4:00 pm  
Dr. Rex Pratt (Wesleyan University)  
“ $\beta$ -Lactamase Active Site Chemistry”  
UMass Dartmouth  
Rm 305 Science & Engineering Bldg. (Group II) at 4:00 pm

## December 2

Prof. Richard R. Schrock (MIT)  
“Catalytic Processes Involving Well-Defined High Oxidation State Alkylidene Complexes”  
Boston College  
Rm 127, Merkert Chem. Ctr. at 4:00 pm

Prof. M.E. Kuehne (Univ. of Vermont)  
“Total Synthesis of Strychnos Alkaloids”  
Northeastern University  
Hurtig Hall at 4:00 pm

## December 3

John Bushweller (Dartmouth College)  
“NMR Structural Studies of E. Coli Glutaredoxin in its Oxidized, Reduced and Glutathione Mixed Disulfide Forms”  
Saint Anselm College  
Perini Hall, Rm 217 at 3:30 pm

## December 6

Prof. Cynthia Burrows (SUNY at Stony Brook)  
“Oxidative Chemistry of Nickel Complexes From Hydrocarbons to DNA”  
Harvard University  
12 Oxford Street, Mb-23 at 4:15 pm

Prof. Mary Walsh (BU Sch. of Medicine)  
“Protein Folding and Structure: Application to Apolipoprotein”  
Boston University  
Science Ctr Audit., SCI 107 at 4:00 pm

## December 7

Prof. Amir Hoveyda (Boston College)  
“Catalytic and Enantioselective Addition of Alkylmagnesium Halides to Alkenes”  
Brandeis University  
Gerstenzang 122 at 4:00 pm

## December 8

Prof. Philip Anfinrud (Harvard University)  
“Ultrafast Near- and Mid-IR Spectroscopy of Photodissociated MbCO: Conformational Relaxation and Ligand Dynamics Revealed”  
Harvard University  
12 Oxford Street, Mb-23 at 4:00 pm

## December 9

Prof. Y. Ron Shen (UCal, Berkeley)  
“Vibrational Spectroscopy of Neat Liquid Interfaces”  
MIT  
77 Mass Ave., Rm 6-120 at 5:00 pm

Prof. William R. Roush (Indiana Univ.)  
“Problems in Glycoside Chemistry”  
Boston College  
Rm 127, Merkert Chem. Ctr. at 4:00 pm

## December 10

Prof. Louis A. Carino (UMass, Amherst)  
“New Methods for Peptide Bond Formation”  
Saint Anselm College  
Perini Hall – Rm 217 at 3:30 pm

## December 15

Prof. Mark Barteau (Univ. of Delaware)  
“Site Requirements for Carbon-Carbon Bond Formation and Related Reactions on Metal Oxide Surfaces”  
Harvard University  
12 Oxford Street, Mb-23 at 4:00 pm

## Notices for the Nucleus Calendar should be sent to:

Chris Arumainayagam  
Dept. of Chemistry  
Wellesley College  
Wellesley, MA 02181  
Tel: (617) 283-3326  
Fax: (617) 283-3642  
e-mail: CARUMAINAYAG@LUCY.WELLESLEY.EDU

# THE NUCLEUS

19 Mill Road  
Harvard, MA 01451

NONPROFIT ORG.  
U.S. POSTAGE PAID  
NORTHEASTERN  
SECTION  
AMERICAN CHEMICAL  
SOCIETY