

# chemistry

## in new zealand



**Life in  
Japan**

**HPLC**

**School  
Lab  
Safety**

**Nuclear  
Power  
Planning**

**Actinidin  
Structure**

**Annual  
Report**

**Presidential  
Address**



Journal of the New Zealand Institute of Chemistry

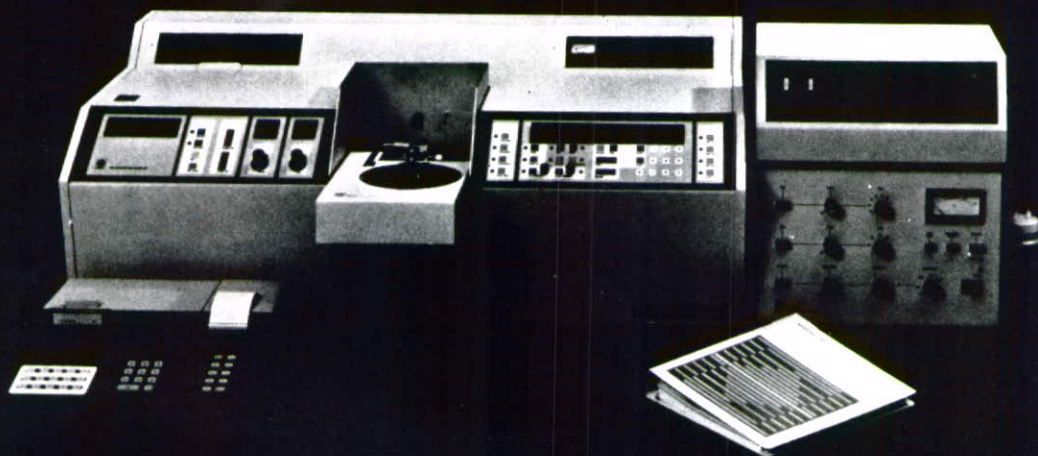
**VOLUME 41  
NUMBER 3  
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NOVEMBER 1977  
VOLUME 41  
NUMBER 3

# chemistry

## in new zealand

Journal of the New Zealand Institute of Chemistry

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## AN INSTITUTE FOR THE FUTURE

G. N. MALCOLM

The first conference of the NZIC was held in 1935 here in Hamilton. It was actually a combined conference: the 7th annual conference of the N.Z. Section of the R.I.C., and the first of the NZIC. That was a significant event for the future of the NZIC at that time. With the conference here again in Hamilton it is appropriate to give some thought to what the role of the Institute might be in the 1980's rather than the 1930's — and not only to think about it but to arouse ourselves to do something about it. I am convinced that the time has come in our affairs for reorganisation and expansion. Whether or not I can supply the necessary activation energy to enable that process to occur remains to be seen.

I would hasten to explain that I have not presumed to take on this task of my own volition. I am not by nature a reformer, or even a mild 'stirrer'. But the Conference Committee asked me if I would be willing to support the conference theme of the Future of Chemistry in N.Z. by devoting my presidential address to the topic of the Future of the Institute. I agreed to do this, and give you therefore this title: "An Institute for the Future".

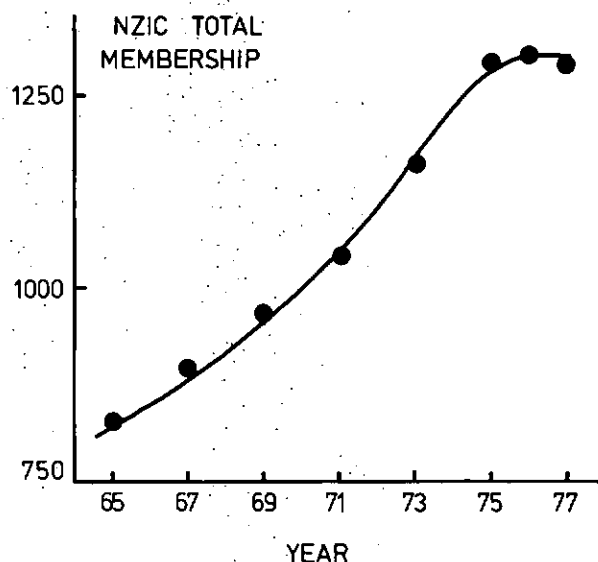
It has been wisely said by someone that before one considers where one is going to one should take note of where one has come from. That excellent advice I propose to ignore. Please don't misunderstand me. I respect our history and am grateful for it. I fully agree with the dictum that "if we now see more clearly than our fathers it is not a result of our greater wisdom but because of their efforts to find the truth." I would heartily commend to all of you this simple action: take one hour of your valuable time, — no make it two hours, — and spend them browsing through the early issues of the Journal of the NZIC, which records our various activities. I will be surprised if you are not impressed and inspired. But I am not here to review the past. That must be kept in store for 1981 when we expect to celebrate our Golden Jubilee.

Nor am I here to analyse the present situation. Analysis is a time-honoured activity of chemists. But to analyse is to take apart. I am here to try to hold things together! This much only of analysis I will permit myself, for the sake of perspective.

1. Firstly the size of the membership. With 1300 members the Institute is fairly large for a N.Z. Society. But it is small compared with the 7,000 of the RACI, or the 28,000 of the RIC at the time of its association with the Chemical Society. Don't let us be too dejected if we cannot yet do all that those groups do. Greater numbers bring greater resources, particularly financial ones. On the other hand greater

numbers do not necessarily bring greater vision.

2. Secondly the growth of the membership. The accompanying figure shows that this has reached a plateau. The big question is, does



the plateau indicate saturation or merely coverage of the more active sites? Recent economic stress has dislodged a number of our valued members, but I am confident that with clarification of purpose and some reorganisation of structure we can attract some of them back, and also others to take the remaining vacant places. It used to be said that there are always as many good fish left in the sea as ever came out of it — although that may not be as literally true now as once it was. Certainly 47 new members of various categories were elected at the last Council Meeting.

3. The distribution of membership: 28% of our members are employed in Industry, 26% in Government Departments and Research Associations, 20% in Universities and 26% in other sectors. There is evidently a wide variety in our membership and no dominance by any one group. I would add that the place of technician entrants and members is now well assured, and their presence is welcomed.
- So much for analysis. What now for the future? There is a pithy Chinese proverb which says that "to prophesy is always difficult, particularly with respect to the future" Despite this prophetic difficulty, I

believe that the future role of the NZIC will be summed up under three headings.

Concern for CHEMISTRY  
Concern for CHEMISTS  
Concern for COMMUNITY

These are not new. Institute speakers have often spoken eloquently about them under various disguises. But apart from the first one — concern for chemistry — we have paid little more than lip-service to these objectives. Even for the first our contribution in recent years may have waned, under the strain of financial problems. I believe that the future role of the NZIC lies in the active pursuit of all three of these objectives.

The first topic refers to the intellectual aspect of our activity. I have called it **Concern** for Chemistry, but I would like to be able to call it love for Chemistry. We are a company of enthusiasts for a great subject! Chemistry contains a rich blend of observation, explanation and application, which provides ample scope for a wide variety of persons to find enjoyment or satisfaction. We don't need to be all alike in intellectual attitude to count as chemists. For some, careful observation of new phenomena is a continuing source of wonder; others seek the intellectual challenge of developing explanatory theories; others again find their role in using a knowledge of chemistry for the purposes of society. Yet others again find their pleasure in teaching these things. There is no need within the Institute to put a value judgement on our various roles, and to compare a research chemist with a chemistry teacher or an industrial chemist. Frankly we can't all understand the detail of each other's work, but that doesn't matter in the slightest provided that we appreciate the worth of each others activity and give to each other encouragement and support. That is what we should join the Institute for — to give encouragement and support, not for what we get out of it! Through its branch meeting and its conferences the NZIC has done a great deal to promote the enjoyment of chemistry and to provide a meeting ground for those whose working lives are devoted to some aspect of it.

The conferences in particular are good value in this regard. I remember clearly being programme secretary for the 1959 conference in Dunedin, wondering how I could make 31 papers spin out over three days. Some few years later I recall rather worse embarrassment when a distinguished American visitor told me that the NZIC conference which he happened to attend was the poorest conference in his extensive international experience. Of course we play ourselves down very badly. University staff, for example, with some curious sense of modesty let their papers be presented by students, which is no way to build up the quality of scientific discussion. Things are somewhat different now. This week we have 131 instead of 31 papers to be presented. I wonder how many of them are of reasonable interest and significance, and are not merely ego-trips for the authors. I noticed in the Auckland Herald this morning that the President of Consolidated Edison has conceded that human error played a significant part in the recent disastrous blackout in New York. "The two operators," he said, "were talking to each other, but they weren't communic-

ating." I suggest that in the future we will need to be more selective in the papers accepted for either oral presentation or poster display. We should make more use too of single topic conferences — not just sectional conferences, but conferences devoted to a particular chemical theme. I may say however that I am opposed to conferences based on the use of a particular instrument. That seems to me to be a negation of the view that science is concerned with problems to be understood and solved, not just instrumental techniques to be used!

I applaud the association of other interested groups in our conferences, as with the Trace Element people at this conference and the Association of Clinical Biochemists. We must be grateful too for the harmonious relationship which has been preserved between the NZIC and the more recently formed N.Z. Biochemical Society. Our interests lie together, and I would like to acknowledge in public the courtesy I have received as NZIC President from the Chairman of the N.Z. Biochemical Society.

There is another matter: I know there are some people here who don't belong to any society associated with this conference, but they are here for the value of the conference itself. We welcome them, but hope that before long they will pull their **full** weight in one or other kindred society.

There are other things we might do as part of our concern for chemistry. Fostering good teaching we are already doing. But publication of papers is something we could look at more closely. The "Proceedings of the Otago Medical School" has a good citation listing. The Proceedings of the First NZIC Chemical Education Symposium, or the Massey Protein Symposium are now available in the National Library of Congress in Washington!

Concern for Chemistry . . .  
Concern for CHEMISTS

This second topic brings us to the professional aspect of our activity. There has always been a tension between the learned society and the professional aspects of our work. There are some who say that these two functions should be split apart, and I know of some colleagues who will not join the Institute because it is not purely a learned society. On the other hand others are seriously questioning whether it may be necessary for the effective support of our members for the Institute to register as a Union. I suspect that that would bring a sharp division among us.

The NZIC is in fact in a most remarkable position compared with the situation of chemists in the U.K. We already have what they are striving to achieve! In the U.K. the two tasks of learned society and professional institute have been undertaken for chemists by two separate bodies with largely different membership — the RIC and the Chemical Society.

The RIC has 28,000 members, 90% of whom are resident in the U.K., and the Chem. Soc. has 17,000 members, only 55% of whom are resident in the U.K. Only 4000 members are common to both groups. In recent years they have formed a common phase boundary, and are now trying to increase the pressure sufficiently to form a one-phase solid solution, possibly with the illustrious title of the Royal Society of Chemistry.

If they can see an advantage in coming together we do well to pause before we consider moving apart. Having said that, I now assert that the NZIC of the future must become far more active in its professional concern for chemists. We have done a little with our regular salary surveys, an attempted manpower survey some years ago, and this year some Guidelines for Professional Employment, and a submission to Government concerning the Industrial Relations Amendment bill, which has now been passed. But all of that is not enough. We are mainly responding to outside pressures, whereas we should be taking the initiative in creating policy.

The trouble as I see it is that many of our members are cared for professionally by other means: University people by the AUT, teachers by the PPTA, Government science members by the Public Service Commission, and so on. Yet the affairs of the NZIC are largely in the hands of these people, with very little contribution from the industrial members. Take our Presidents. The outstanding recent exception is John Pollard from British Pavements last year. I doubt if it is very widely known how much we owe to his wise counsel in the resolution of the technician membership business. Things would probably have been greatly different, and much worse for the professional standing of the Institute, if it had not been for John Pollard. But before him as President were Lester Davey and Peter Foster from Research Associations. Before them Ted Corbett from the University. After John Pollard is myself from the University, then we can look forward to three more university people, Professors Wright, Harvey and Campbell. How can you expect these people to understand in detail and in **strategy** the needs of the industrial chemists, even though they are sympathetic? Perhaps the Council is more representative of industrial chemists. This year we have been fortunate to have Ashley Wilson from Forest Products, but the rest of us are: 6 from universities and 3 from Research Associations. Result obvious.

What we need is a group of people whose vocation lies in the industrial field who will devote themselves to the proper work of a professional society in this one area. I will discuss the organisation of this group in a moment. But there are many matters demanding attention . . .

Conditions of employment.

Remuneration.

Safety and Health.

Initial training and in-service training.

Take just one matter of initial training. Many of you will know of, and possibly enjoy, the column in the Listener called "Life in N.Z." which collects various items from newspapers and holds them up for amusement. I have one of these items here which I thought was serious rather than amusing.

From the Christchurch Press, 21.1.75: "It is no easy task to train today's students to solve problems that have not yet been identified, using techniques not yet invented."

I think the time may well have come when we have to advise the incoming generation of students that what the chemical industry may need in the future is the graduate with the good chemistry or bio-chemistry degree who knows something of the

fundamentals of the subject. Tailor-made degrees for very specific purposes may sound attractive to some employers in specialised industries, but the future is full of change. I would like to hear our industrial chemistry members in the Institute advise those of us who are in the education and training sector about these concerns.

I turn now for a brief comment on the role of the Institute in **Concern for the Community**. Here we have a great deal to do to set things in perspective in the public mind. You have probably all heard the so-called joke that we chemists are members of the effluent rather than the affluent community. But head-lines such as this recent one — **CHEMICALS: A DANGEROUS THREAT** — are of frequent occurrence and can have an insidious influence. Too often chemistry and chemists come to prominence only when there is an explosion or a spillage or an environmental problem. The credits when they arise all go to people called agricultural scientists or medical scientists, etc. We need to take the initiative in matters affecting the community and call public attention to matters with potential for either good or ill before they occur. Our NZIC President in 1937, Professor Worley, gave this example.

"The existence of the large planted pine forests in the Rotorua district and the Waikato Valley raises the question of pulp mills inland, and it is important to consider any adverse effects to be expected from the establishment of a pulp mill, for example, in the Upper Part of the Waikato Valley.

Similar caution and investigation are necessary in the case of other industries, dairying, cheese-making, canning, meat works, fertiliser works, etc. Part of the price to be paid for development of manufacturing industries will be the damage to our streams, our clear air, our harbours and estuaries, and it is incumbent on chemists, who alone are in the position to understand and to anticipate such dangers associated with manufacturing industries, to keep the problems continually in view and possibly to . . . advise the Government on this aspect of industrial development."

Individual chemists can't do much, but I am unaware if the Institute followed up Professor Worley's suggestion.

In matters also of new product development and conservation of material resources the Institute could lend weight to the efforts of isolated people who have difficulty in promoting their ideas.

Now I must present my blue-print for the future of the Institute. I believe that what is required is a renewal of faith and commitment, and a new style of organisation. The re-organisation is set out in the diagram, which can be studied at leisure. I offer now only a few comments.

- (i) There is a proposal for a slight change of name.
- (ii) There is a proposal for three strong working groups with dignified titles. These are not to be regarded as mere sub-committees. The Governing Council could meet once per year, perhaps with representatives from other related societies and would concentrate on



New Associate Members:	5
New Graduate Members:	20
New Technician Members:	3
Resignations (includes 13 for approval at August meeting):	42
Deaths:	7
Re-instatements:	3
Deleted	35*

\*(Note: The change to computer records has given us a more accurate and up-to-date listing of operable addresses.)

Consolidated membership figures for the last four years are as follows:

	1974	1975	1976	1977
Auckland:	311	335	343	339
Waikato:	94	97	97	94
Manawatu:	133	131	128	124
Wellington:	292	299	310	306
Canterbury:	174	182	180	174
Otago:	95	105	104	105
Overseas:	139	146	140	138
	---	---	---	---
	1238	1295	1302	1280
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The distribution of Branch membership in 1977 is as follows:

Branch	Hon.F.	Fellow	Memb.	Assoc.	Grad.	Tech.	Total
Auck.	4	50	250	1	33	1	339
Wai.	2	12	75	2	3	—	94
Man.	—	21	92	—	11	—	124
Well.	6	47	239	—	13	1	306
Cant.	4	37	126	—	5	2	174
Otago	2	23	76	2	2	—	105
O'seas	—	21	114	—	3	—	138
	---	---	---	---	---	---	---
Total	18	211	972	5	70	4	1280
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#### OBITUARY:

We record with regret the deaths during the year of the following members: E.D. Andrews, G.F. Frieberg, J.T. Holloway, R.W. Olliff, L. Osgerby, M.H. Panckhurst, H. Rands, D.M. Bielschowski.

#### HONOURS:

Mr N.H. Law has been awarded the O.B.E.

Dr A.T. Johns, Dr W.A. McGillivray and Mr K.E. Seal have been awarded the C.B.E.

S.H.J. Wilson has received his D.Sc. from Manchester at eighty years of age.

#### PRIZES:

The I.C.I. Prize for 1976 was awarded to Dr H.K.J. Powell.

The R.I.C. Easterfield Medal for 1976 was awarded to Dr K.J.D. MacKenzie.

There were no entries for the Chemical Essay Prize. The Prizes in Industrial Chemistry originally offered by Tasman Vaccine Laboratory Ltd. have been renegotiated with the new company ICI-Tasman Vaccine Ltd. There is now one prize of the value of \$200 to be offered annually. Full details of the new prize have appeared in the Journal. The Institute is grateful to the company for this generous award.

Council decided to offer an annual prize to the student who gains the highest marks in the Chemistry V examination of the Technicians' Certification Authority. The prize is to consist of books

to the value of \$40, and will be awarded for the first time in 1977.

#### CONFERENCES:

The annual conference for 1976 was cancelled in favour of the IUPAC Conference on the Chemistry of Natural Products held in Dunedin during August. Many members of the Institute attended the IUPAC Conference which proved to be an outstanding success.

The World and 3rd N.Z. Energy Conference held in Wellington in May, 1977 was attended by two members of the Institute Energy and Chemical Resources Committee, Dr I.D. Watson and Professor A.C. Williamson.

#### OVERSEAS VISITORS:

Council made one grant of \$100 at the request of the Polymer Chemistry Group to support the visit of Professor M. Szwarc, F.R.S., who is Director of the Polymer Research Center at the State University of New York.

#### RELATIONSHIPS WITH OTHER BODIES:

One of the Objects of the Institute listed in Rule 3. is to co-operate with any other association, society or institute whose objects are similar to those of the Institute. To this end Council has continued its membership of the Member Bodies Committee of the Royal Society; has submitted nominations for the National Committees on Chemistry, Biochemistry, Biophysics, Crystallography, Nutritional Sciences, Environmental Problems and Pacific Science; and has submitted nominations for the ANZAAS Medal for 1977. It is pleasing to report very full co-operation has continued to be enjoyed with the N.Z. Biochemical Society, and to note the close association with the Trace Element Research Group at the 1977 Annual Conference.

The Institute was invited to send a representative to the Centenary Celebrations of the Royal Institute of Chemistry in London in March this year. It was not possible to send a representative, but a Scroll of Greeting and a gift of books published in New Zealand were sent to the R.I.C. to mark the occasion.

#### PUBLIC AFFAIRS:

- Environmental Consultants:** In response to a request from the Commissioner for the Environment, Council invited all members of the Institute to submit their names to the Administrative Secretary if they were willing to be engaged professionally by clients to prepare environmental impact reports or to carry out environmental studies.
- Nuclear Power Generation:** On behalf of Council the Energy and Materials Resources Committee submitted a nomination for membership of the Commission on Nuclear Power Generation in N.Z., and subsequently presented a submission to the Commission.
- Alcoholic Liquor Advisory Committee:** Council submitted a nomination for membership of this Committee to the Minister of Justice.
- Transport of Hazardous Chemicals:** A review of a Government report on this topic was carried out on Council's behalf by a sub-committee.
- Safety in School Laboratories:** An investigation

of this matter was undertaken by a sub-committee of the Canterbury Branch on behalf of Council.

#### PROFESSIONAL WELFARE:

Rule 3.2 states that one of the Objects of the Institute is to raise the status and to advance the interests of the profession of Chemistry and of those engaged therein. In the past year Council has prepared for members a set of Guide-lines to Professional Employment which will soon be available for distribution. The Guide-lines refer to the responsibilities of both employers and employed.

Council also noted the provision for exemption from compulsory union membership which was made for certain categories of professional persons in the amendment made this year to the Industrial Relations Act (Industrial Relations Amendment (No. 2) of the Industrial Relations Act 1973). Council made a submission to the Labour Select Committee which considered the Amendment Bill asking that Industrial Chemists who are corporate members of the N.Z.I.C. should be added to the list of exempted persons. The request was declined but the Amendment Bill was altered to enable a further request for exemption to be made to the Minister of Labour after the Amendment had been enacted. This further submission was delayed while advice was sought from the Registrar of Industrial Unions, but is now being prepared by the Institute's legal consultant.

Council has also initiated a further Salary Survey in order to assist various members in Salary negotiations.

Council decided during the year that for admission to the Institute the full interviewing and refereeing procedures permitted by the 1975 Rules would be implemented. Council is grateful to those members who have accepted responsibility on interviewing panels throughout the country.

#### PUBLICATIONS:

- (a) **Journal and Bulletin:** In the face of continually rising publication costs, Council resolved that for the 1977 calendar year there should be six issues of the Bulletin and only three issues of the Journal. The budgetted gross expenditure was \$7,000 with an expected recovery of \$3,000 from advertisements. Despite the difficulties of cost escalation Council considered that continuation of the Journal as a high quality publication was in the best interests of the Institute. A decision about Journal publication for 1978 will be made by Council when the success or otherwise of the 1977 policy has been evaluated. Members are urged to continue to discuss this matter at Branch level so that Branch delegates may properly reflect the opinions of members at Council.
- (b) The 1976 Revision of the Code of Ethics and Rules of the N.Z.I.C. was approved for publication and copies should be distributed to members before the end of 1977.
- (c) A new Members List, to replace that issued in 1973 is being prepared and should be available for distribution towards the end of 1977.
- (d) Two new publications for membership promotion and for the fostering of public relationships are being prepared on behalf of Council.

#### FINANCE:

(a) **Balance Sheet:** It is gratifying to note that the Statement of Accounts to April 30th, 1977 shows an excess of Income over Expenditure of more than \$3,000. This should provide an opportunity to replace some of the reserves which had to be sacrificed when the expenditure exceeded the income by \$2,738 for the year ending April 30th, 1975, and by \$3,071 for the year ending April 30th, 1974. The number of subscriptions in arrears continues to cause concern, but appropriate courses of action to improve the situation remain difficult to devise.

(b) **Subscriptions:** These were increased to \$14 for the financial year commencing 1st May, 1974, and to \$18 for the year commencing 1st May, 1975, but no increase was made for the year beginning 1st May, 1976. Council considered that it was prudent to adopt a policy of regular small adjustments to subscriptions rather than occasional large changes and accordingly approved increases of \$1 or \$2 for the various grades of membership for the year beginning 1st May, 1977.

Current subscriptions are:

Fellows and Members:	\$20
Associate Members:	\$13
Graduate and Technician Members:	\$5
Local Members:	\$5

#### APPRECIATION OF LONG SERVICE:

This year has been notable in that it has seen the termination of two particularly long periods of service to the Institute by two of its members. Miss Joan Mattingley served the Institute as Journal Editor for a total of twelve years, and Dr W.E. Harvey served as General Secretary for twenty years. Council wishes to place on record its deep appreciation to Joan and Ted for their long and distinguished services to the Institute, and intends to make suitable presentations to them during the Conference proceedings in August.

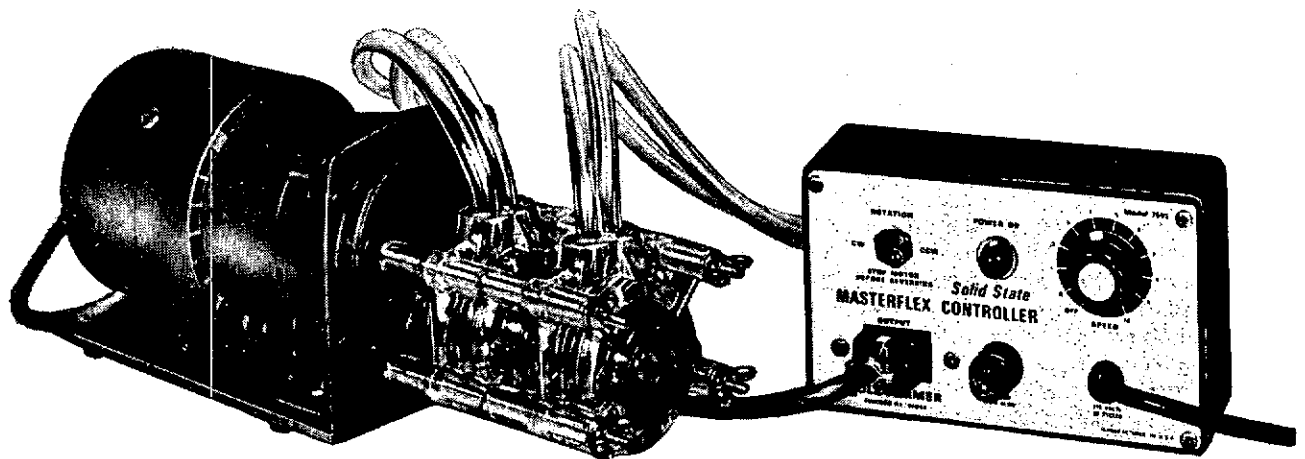
#### THANKS:

It is difficult to discern simply from reading a formal report of this kind what a large amount of work either in creative planning, or in problem solving or in formal administration is carried out by a wide range of persons on behalf of the Institute. Much of this work is done voluntarily, but even those who quite properly receive salaries or honoraria have willingly accepted financial restraint in these difficult times without any diminution in dedicated service. Thus the Statement of Accounts for the year ending April 30th, 1977 reveals that whereas the total administration expenses increased by 20% over the previous year the amount paid for salaries and honoraria increased by only 5.6%. To all those many members who have assisted in so many ways to fulfil the purposes of the Institute we offer our sincere thanks.

FOR AND ON BEHALF OF THE COUNCIL:

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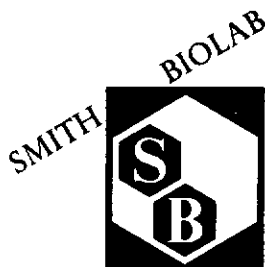
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# THE STRUCTURE OF ACTINIDIN, A PROTEOLYTIC ENZYME

E. N. BAKER

Department of Chemistry, Biochemistry and Biophysics, Massey University,  
Palmerston North.

Although the three-dimensional structures of proteins are crucial to the way in which they operate in living systems, the structures of only 30-40 proteins are, as yet, known in detail. A proper understanding of the chemical and physical properties of proteins requires detailed structural information and this has become an important area of biochemical research.

The proteolytic enzyme actinidin appeared to be an attractive subject for beginning our research in this field, and a co-ordinated research programme was begun at Massey University about six years ago. This embraced chemical and kinetic studies (M.J. Hardman and M.J. Boland), the amino acid sequence determination (C.H. Moore and A. Carne) and an X-ray crystallographic structure determination. The kinetic studies have already been described [3, 4]; the present account gives a brief description of the X-ray crystallographic results.

## INTRODUCTION

Actinidin is readily obtainable in large quantities from the fruit of the Chinese goosberry, (or Kiwifruit), *Actinidia chinensis*. (This enzyme is in fact responsible for the meat tenderising properties of the Kiwifruit.) It has a relatively low molecular weight (25,000), and can be purified easily and crystallised.

Furthermore the initial chemical and kinetic work showed that actinidin depends on a free sulphhydryl group for its biological activity, and that its mode of action is broadly similar to that of a considerable number of proteolytic enzymes [6] found widely

distributed through living systems. Similar enzymes are found, for example, in other plants, such as pineapples (the enzyme bromelain), papaya (papain) and figs (ficin), in bacteria (e.g. streptococcal proteinase) and in mammalian organs such as the kidneys and the spleen (cathepsin B). Structural studies on actinidin were expected, therefore, to be particularly relevant to this whole group of proteins, as well as to general understanding of protein structure and function.

## STRUCTURE DETERMINATION

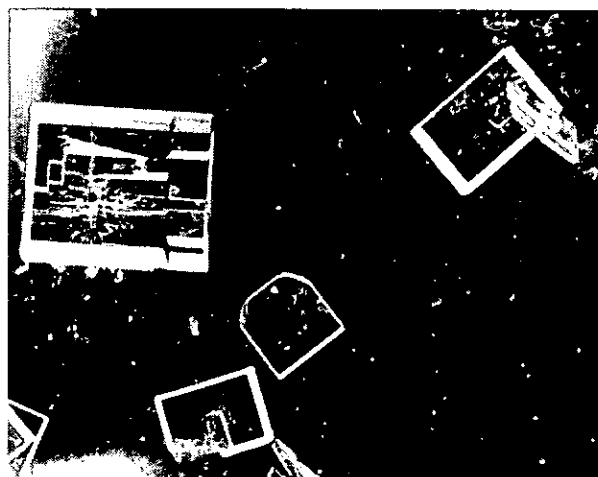
Actinidin can be crystallised by dialysis of a 10 mg/ml protein solution against 20% saturated ammonium sulphate solution, pH 6.0 [1]. The crystals grow as thin plates which tend to stack on top of each other. Although single crystals proved difficult to separate from one another, they are very well ordered and stable to X-rays. In the diffraction pattern, the spots extend strongly to high angles, giving the potential for obtaining a very detailed and accurate structure.

The structure determination requires that the amplitudes and phases of the scattered waves of X-rays be measured. Amplitudes are derived from the intensities of the waves (*i.e.* the spots on the diffraction pattern) and can be measured directly. During the course of this work about 50,000 intensity measurements were made, using computer-controlled X-ray diffractometers at the Chemistry Division, D.S.I.R., and the Chemistry Department, University of Auckland. The phases can be estimated from intensity measurements from crystals of heavy atom derivatives of the protein. One derivative was prepared by reacting the free

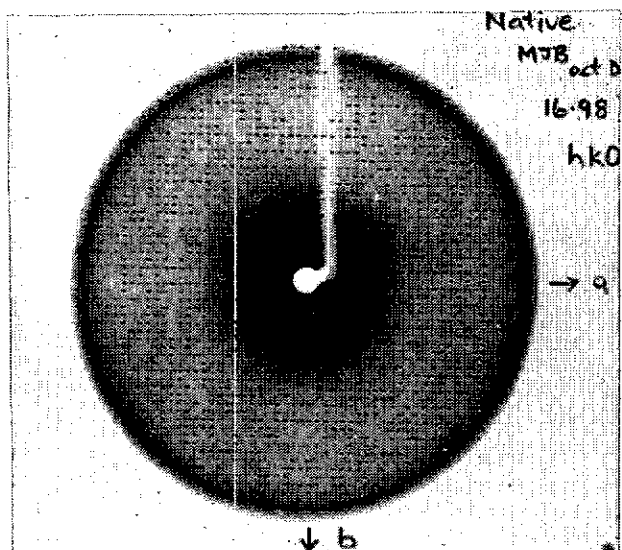


*Dr TED BAKER graduated M.Sc. (1965) and Ph.D (1968) from the University of Auckland where he worked with Professors T.N. Waters and D. Hall in X-ray crystallographic studies of co-ordination compounds. He spent the years 1968 to 1970 at the University of Oxford, working with Prof. D.C.*

*Hodgkin and Prof. D.C. Phillips on the structure of the protein hormone insulin and on myoglobin. Since November 1970 he has been in the Department of Chemistry, Biochemistry and Biophysics where he is now a senior lecturer. His main research interest is in X-ray crystallographic studies of protein molecules.*



Crystals of actinidin



Diffraction pattern from actinidin crystals

sulphydryl group with  $\text{HgCl}_2$ . Others, tabulated below, were prepared by soaking actinidin crystals in solutions of heavy-atom-containing molecules or ions, and the two best-defined derivatives used for the phase determination.

#### Table of heavy atom derivatives of actinidin

Heavy atom compound	Binding sites
*Uranyl acetate	3 sites, adjacent to $\text{COO}^1$ groups on the molecular surface
*Dichloroethylene-diamineplatinum (II)	2 sites adjacent to S of Met side chain in active site 1 site adjacent to N of His side-chain in active site
Ethylmercuric chloride ( $\text{C}_2\text{H}_5\text{HgCl}$ )	1 site, at S of Cys 25, in active site 1 site near S of Cys 25, in active site
Mercuri-iodide ion [ $\text{HgI}_4$ ]	1 site near $\text{COO}^1$ and OH groups on the molecular surface

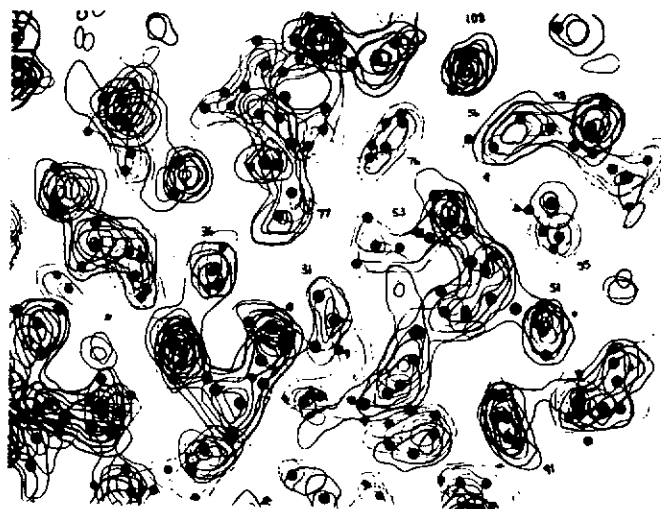
\*Derivatives used in eventual phase determination

An initial electron density map, calculated at low resolution revealed the overall molecular shape [2]. Finally an electron density map was calculated using data to a resolution of  $2.8 \text{ \AA}$  (i.e. a maximum diffraction angle  $\theta = 16$  for  $\text{Cu-K}\alpha$  X-radiation). At this resolution, individual atoms are not resolved from one another. However, the polypeptide chain is visible as an unbroken ribbon of electron density, the carbonyl groups are visible as "bumps" of density along the chain, and most of the amino acid sidechains are clearly resolved.

While the course of the polypeptide chain could be followed with ease, and the positions of the sidechains established, the full interpretation of the map has depended heavily on knowledge of the amino acid sequence [7]. This is because some sidechains (e.g. Val and Thr; Asp and Asn) cannot be differentiated by their electron density, while some sidechains on the outside of the molecule have poorly-

defined density, probably because they are free to vibrate or take up a variety of orientations. Nevertheless, a considerable number of amino acid residues (40-50%) could be identified with some certainty by the characteristic shape of their sidechains. These included most of the aromatic amino acids, Phe, Tyr, and Trp, visible as flattened discs of density of the appropriate size and shape, smaller ones such as Gly, Ala, and Ser, and some of the internal aliphatic sidechains, e.g. Leu and Ile.

Since the amino acid sequence determination was in progress when the electron density map was calculated, a considerable amount of co-operation was possible. Pieces of "X-ray sequence" could be matched with peptides which had been sequenced chemically, but not yet fitted in to the overall sequence. As more chemical information became



A section of the  $2.8 \text{ \AA}$  electron density map for actinidin. Some of the numbered amino acid residues include 31 Ile, 77 Ile, 76 Phe, 53 Leu, 51 Asn, 91 Tyr (with the aromatic ring seen end-on) and the disulphide bridge 56 to 98.

available, residues in the model were changed, where necessary, or were confirmed. For example, the "X-ray sequence" (with residues in brackets denoting a "best guess" only) for residues 169 to 177 was —



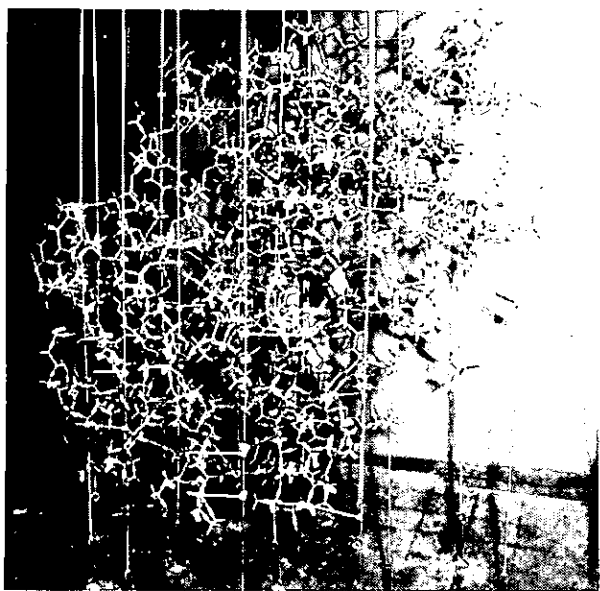
This was then readily identified with a peptide, chemically characterised as —



but not yet positioned in the overall sequence.

A second illustration is provided by the disulphide bridges. Two disulphide bridges, linking residues 22 to 65 and 156 to 206, had been well characterised chemically. The electron density map unexpectedly indicated a third disulphide bridge, 56 to 98, and subsequent successful efforts to identify this disulphide bridge chemically yielded amino acid sequences at each end of it which were quite consistent with the electron density map.

The final detailed model of actinidin, shown here, and comprising about 2000 atoms, from the 220 amino acid residues, was built by fitting model-building components to the electron density map using an optical device [8] which superimposes an image of the model, as it is built, on to the map.



*A detailed molecular model built for actinidin*

## THE STRUCTURE OF ACTINIDIN

### (i) Polypeptide chain conformation

The molecule is folded up into two distinct halves, or Domains, Domain I consisting of residues 19-115 and 214-218 (residues 219-220 are not clearly visible in the map, and are probably disordered) and Domain II residues 1-18 and 116-213. Thus Domain I consists mainly of residues from the first half of the chain, but with the N-terminal end crossing over into Domain II, while Domain II consists mainly of residues from the second half of the chain, but with the C-terminal end crossing over into Domain I. Both the N-terminal and C-terminal sections are bound in to Domains II and I respectively by hydrogen bonds, and therefore appear to act as "straps" helping to hold the two halves of the molecule together.

Domain I contains several pieces of  $\alpha$ -helix, the most striking being a five-turn  $\alpha$ -helix, 25-42, which forms part of the interface between the two domains. Domain II contains only one stretch of  $\alpha$ -helix (120-129) but is largely made up of an

extensive, if somewhat irregular, piece of  $\beta$ -sheet. This sheet, which is largely buried in the interior of the molecule, contributing many of the sidechains which make up the non-polar core of Domain II, has a marked right-handed twist to it.

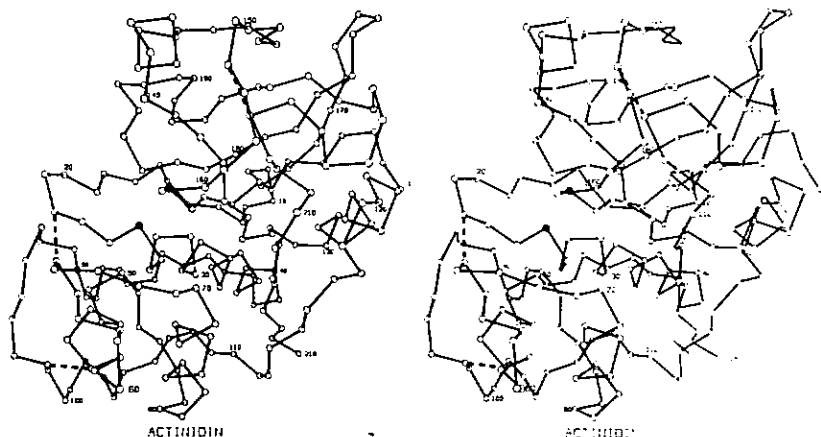
### (ii) Sidechain interactions

Each domain has a hydrophobic core consisting of about 20 non-polar sidechains tightly packed together. A number of non-polar sidechains also make Van der Waals contact at the interface between the two domains. The interior of the molecule is not entirely non-polar however, as several Ser, Thr and Tyr residues are found on the inside, hydrogen-bonded to each other or to main chain carbonyl groups. There is also a cluster of two acidic (Glu) and two basic (Lys) sidechains (which presumably means that the charges are neutralised) and there are even 3 or 4 water molecules apparent in the interior, adjacent to other polar groups. Thus while the clustering of non-polar sidechains in the interior of the molecule is no doubt the main factor in the stability of this compact, globular molecule, other interactions also make a significant contribution. There are also many hydrogen bonds and some ion-pairs formed on the molecular surface, but these are too numerous to detail.

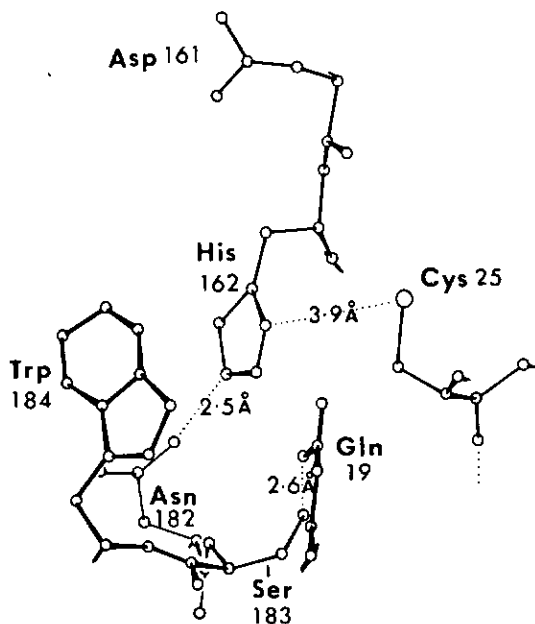
### (iii) The active site

The kinetic studies on actinidin indicated that the participation of both a sulphhydryl group and an imidazole group are required for catalysis. Both His 162, the sole histidine residue in actinidin, and Cys 25, with its free sulphhydryl group, are found in a shallow cleft between the two globular halves of the molecule, and this is clearly the active site.

The imidazole ring of His 162 is oriented such that one of its nitrogen atoms, N $\delta$ , lies 3.9 Å from the sulphur atom of Cys 25, close enough, presumably for transfer of a proton between them, while the other nitrogen atom, N $\epsilon$ 2, is hydrogen bonded to the amide group of Asn 182. There is a close resemblance between this arrangement Asn . . . His . . . Cys and the charge relay system found in serine proteases, viz. Asp . . . His . . . Ser. The hydrogen



*A stereo diagram showing the polypeptide chain of conformation of actinidin.  $\alpha$ -Carbon atom positions are plotted. The disulphide bridges are represented by more solid lines.*

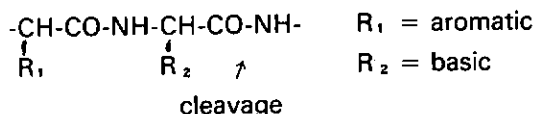


The arrangement of some of the residues in the catalytic site of actinidin

bond between His 162 and Asn 182 is covered (and probably thereby protected from the external solution) by the indole ring of Trp 184. Both Cys 25 and His 162 are firmly tied in to the rest of the structure, since Cys 25 is at the beginning of the  $\alpha$ -helix 25-42, while His 162 is involved in the  $\beta$ -structure of Domain II. This presumably helps to ensure that the groups involved in catalysis are fixed in the required orientation to one another.

The amide group of Gln 19, which has been implicated in substrate binding, is oriented so that its oxygen atom forms a hydrogen-bond with the hydroxyl group of Ser 183, while its -NH group projects up into the active site. Other groups which are directed into the active site and may be involved in substrate binding include the main-chain carbonyl groups of residues 66, 68 and 161 and the main chain NH groups of residues 25 and 68. A proper understanding of exactly how the substrate is bound, and which groups are most important, must, however, await further chemical and crystallographic studies.

A further aspect of the function of actinidin worthy of comment is its specificity. As shown below actinidin has a strong preference for an aromatic (or generally non-polar) sidechain on the residue one removed from the peptide bond being cleaved, and a weaker preference for a basic sidechain on the adjacent residue



In the structure of actinidin there is, further along the cleft from the active site, a cavity lined with the sidechains of Tyr 69, Ile 70, Met 211, Ala 136 and Val 160, i.e. a strongly hydrophobic pocket of the right size to bind an aromatic sidechain from the substrate. Furthermore, above the catalytic site is the carboxyl group of Asp 161, in a position where it

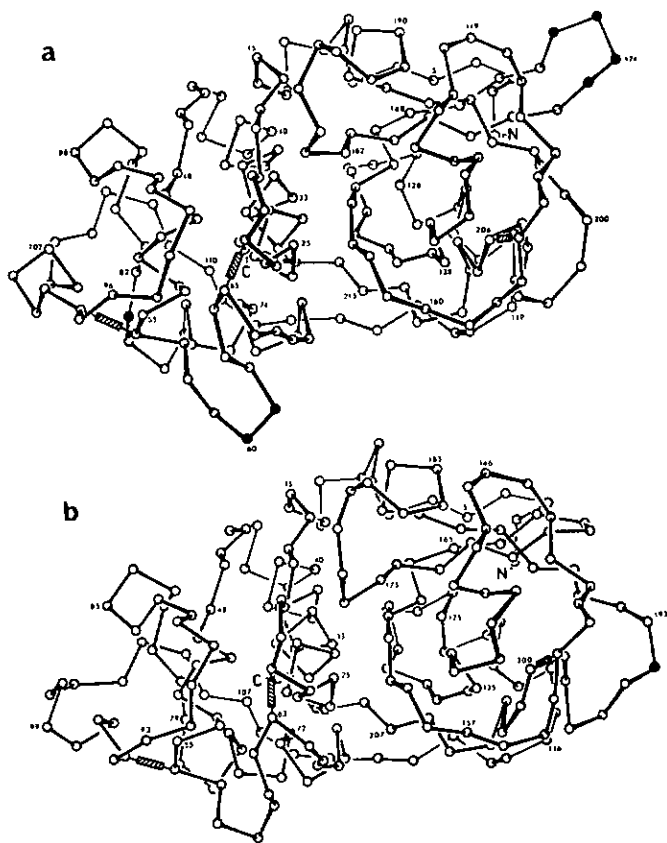
could interact with a basic side chain on the substrate.

#### (iv) Comparison with papain

One of the most striking features of the structure of actinidin is the remarkable similarity between its overall conformation and that of papain, the only other sulphhydryl protease whose structure has been determined [5]. This is in spite of the fact that about 50% of the individual amino acid residues are different.

Actinidin contains 8 more residues than papain. These are accommodated as an additional 2 residues between 59 and 60 (papain numbering), 1 between 78 and 79, 4 between 168 and 169, and 2 at the C-terminus, while one residue (194) is deleted from the papain structure. All the above changes (which are shown by the filled circles in the diagram) occur on the outside of the molecule, extending or contracting external loops, and none appears to significantly affect the overall conformation. One or two small local changes can be seen (notably at residues 99-104) and can probably be correlated with changes in amino acid sequence, but overall, the two molecules are very similar in their conformation.

There are few differences in individual amino acid residues in structurally or functionally important parts of the two proteins. In the hydrophobic cores 50% of the residues are identical and a further 40% remain non-polar in nature. At the interface between Domains I and II 16 out of 19 residues are the same in both proteins, and of those that change, two can be seen as compensatory changes. Residues 32 and 165 are in contact across the interface. In



The polypeptide chain conformation of (a) actinidin and (b) papain. Additional residues in either molecule are indicated by filled circles

actinidin these are Ala and Val; in papain Val and Ala. Thus the nature of the interface is conserved by two compensating changes. Residues on the outside of the molecules are much more variable. For example, in the section 80-119 a long external piece of chain, only 8 out of 39 residues remain the same.

#### CONCLUSIONS AND FURTHER WORK

The stability of actinidin can now be understood in terms of a large number of interactions (non-polar, H-bonding, electrostatic) involving groups from different parts of the molecule. The stereochemistry of the active site and the groups responsible for the specificity of actinidin can be seen, and further chemical and crystallographic binding studies, of inhibitors and substrate analogues should provide the fine details of the enzyme-substrate interaction. The similarity of the conformation to that of papain suggests that conclusions from these enzymes will probably apply to others of the same type. Furthermore, a detailed comparison of actinidin with papain should give valuable information on the effects of amino acid changes on protein conformation.


Most of all, it is hoped that the structural information we now have will form the basis of further specific chemical, kinetic and spectroscopic studies, since only by merging results from all these sources can a complete picture be gained.

#### ACKNOWLEDGEMENTS

I am very grateful to the many people who have helped with this work and made it possible; to Drs P.P. Williams and K.L. Brown of the Chemistry Division, D.S.I.R., Wellington and Prof. T.N. Waters of the Chemistry Department, University of Auckland, for help with data collection on their 4-circle diffractometers; to Dr C.E.F. Rickard of the Chemistry Department, University of Auckland, for help with stereo diagrams; to Prof. B.R. Penfold and Dr W. T. Robinson of the Chemistry Department, University of Canterbury and staff of the Massey University Computer-Unit for helping with computing; to Drs C.H. Moore, A. Carne, M.J. Hardman and M.J. Boland for their co-operation and help in our joint work on actinidin; and especially to Prof. R.D. Batt and Prof. G.N. Malcolm and colleagues in this department for their constant support.

#### REFERENCES

- 1 Baker, E.N. (1973), *J. Mol. Biol.*, 74, 411
- 2 Baker, E.N. (1976), *J. Mol. Biol.* 101, 185
- 3 Boland, M.J. and Hardman, M.J. (1972), *FEBS Letters*, 27, 282
- 4 Boland, M.J. (1973), *Chemistry in New Zealand*, 37, 83
- 5 Drenth, J., Jansonius, J.N., Koekoek, R. and Wolthers, B.G., (1971), *Adv. in Protein Chem.*, 25, 79
- 6 Glazer, A.N. and Smith, E.L. (1971), In "The Enzymes" (P.D. Boyer ed.), Vol. 3, p. 501, Academic Press, New York
- 7 Carne, A. and Moore, C.H., unpublished work
- 8 Richards, F.M. (1968), *J. Mol. Biol.* 37, 225



#### PRESENTATIONS FOR LONG SERVICE

Two presentations for exceptionally long service to the Institute were made at the Annual Conference in Hamilton in August. The presentations consisted of silver salvers as shown in the photograph. The inscriptions on the backs of the salvers read as follows:

"Joan M. Mattingley  
in appreciation for  
services to the NZIC  
as  
Journal Editor  
1964-1976"

and secondly

"Dr W. E. Harvey  
in appreciation for  
services to the NZIC  
as  
General Secretary  
1956-1976"

The presentations were made with the good wishes of the members of the Institute by the President at the start of his Presidential Address.





## Royal Institute of Chemistry

30 Russell Square, London WC1B 5DT 01-580 3482

## Centenary 1977

R E Parker, B Sc, PhD, C Chem, FRIC / Secretary & Registrar

Professor G N Malcolm  
New Zealand Institute of  
Chemistry  
C/o Massey University  
Palmerston North  
New Zealand

14 October 1977

REP/EKM

*Dear Professor Malcolm,*

I should like to express to you and to all the members of the New Zealand Institute of Chemistry the sincere gratitude of the Royal Institute of Chemistry for the three books - the New Zealand Atlas, DSIR's First Fifty Years and Science is Human - that you sent us to mark our Centenary. It is indeed generous of you to present us with these fine volumes in addition to the scroll that Professor McGlashan present on your behalf at our Centenary Ceremony earlier this year.

Unfortunately, the books did not arrive in time for them to be displayed at the last meeting of our Council on 7 October, but we shall certainly take the opportunity of putting them on display at the next meeting of the Council on 16 December. We are also planning to put all the gifts that we received on permanent display here and we hope you will take the opportunity to view the collection when you are next in London.

*Yours sincerely,*

*Eric Parker*

# HIGH PRESSURE LIQUID CHROMATOGRAPHY

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Norwalk, Connecticut 06856

## ABSTRACT

A theory for high pressure liquid chromatography is presented, including its relationship to other chromatographic techniques. The equipment is described briefly and criteria by which to choose an appropriate mode of liquid chromatography separation and how to optimize the separation are presented. The measurement of column efficiency and performance, the selection of an appropriate eluent and the relative merits of a wide range of detectors are all discussed. A series of representative applications is presented.

## INTRODUCTION

Chromatography is a separation technique based on partitioning of analytes between a mobile phase and a solid or liquid stationary phase. The mobile phase may be a gas or a liquid. In the former case the technique is called gas chromatography (GC), in the latter liquid chromatography (LC). GC requires that an analyte be thermally stable and be either volatile or able to be made so. LC requires that a compound be soluble and thus it is particularly well suited to the analysis of mixtures of a great number of chemical compounds. LC techniques may be planar or columnar and include paper chromatography, thin-layer chromatography and column chromatography.

Liquid chromatography in columns is the parent chromatographic technique [1]. However, except in amino acid analysis column chromatography has become secondary to planar and gas chromatography. In its traditional form LC is characterized by low-pressure flow of a mobile phase through large diameter columns containing large particle size packings. The column effluent is usually monitored periodically, depending upon subsequent analysis of individual eluted fractions. Column LC of this type is still used for preparative work or for pretreatment of a complex sample.

\* Mr Adams is now associated with Commonwealth Scientific and Industrial Research Organization, North Ryde, New South Wales, Australia.



DR REGINALD F. ADAMS' main area of interest has been clinical biochemistry especially in relation to nutrition. Has worked on the development and investigation of a completely chemically defined diet. Has spent the past several years with the Perkin Elmer Corporation, U.S.A., utilizing high-resolution separation

techniques for the study of metabolites and therapeutic agents in biological samples. Most recently joined C.S.I.R.O., Australia, to work on the relationship between dietary components and the gut microflora.

The development of column packings of small uniform particles (less than 40  $\mu\text{m}$ ), requires pressurized mobile phase flow, low dead volume systems and high sensitivity continuous effluent monitoring. This has resulted in the technique being described as "high-performance", "high-speed", or "high pressure". For convenience, the term "high-pressure liquid chromatography" (HPLC) is used here, and denotes an LC system incorporating some or all of the above attributes.

## PRINCIPLE

During chromatographic development, a mobile phase flows over a stationary phase. A solute introduced into the mobile phase will move along at a rate largely dependent on its distribution between the mobile and stationary phases. Components of a mixture, if their distribution co-efficients are different, move, or migrate, at different rates, the components separating to produce a characteristic pattern, the chromatogram. Several different separation mechanisms or modes may be involved in a separation of a mixture, but one mode will usually predominate in any particular analysis. Four basic separation modes are recognized, each characteristic of a specific type of stationary phase.

1. Adsorption: The stationary phase is a solid adsorbent.
2. Partition: The stationary phase is modified by a liquid physically adsorbed to a solid support.
3. Ion exchange: The stationary phase is designed to exchange ions between itself and the sample.
4. Exclusion: The stationary phase has a controlled porosity which separates compounds according to their molecular size.

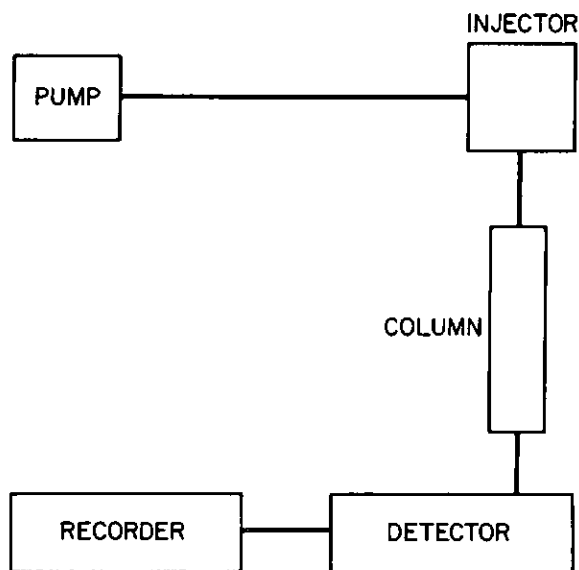


Figure 1. Schematic giving the essential components of an HPLC system.

## EQUIPMENT

The essential components of an HPLC system are shown schematically in Figure 1. Mobile phase is continuously pumped through a packed column. A sample is applied to the column head by way of an injector. As components of the sample are separated, they appear in the column effluent which is continuously monitored by a detector. The detector output is recorded versus time or flow rate, the tracing being the chromatogram.

A successful analysis depends on consideration of all components of an HPLC system. This procedure generally follows a sequence that applies to any chromatographic technique.

## SEPARATION

As indicated above there are four separation modes from which to select: adsorption, partition, ion-exchange or exclusion. Selection of the best mode to suit a specific analytical situation is largely empirical, no theory is able to give a correct prediction. It is generally true, however, that a separation may be done successfully using any one of two or three separation modes.

Some discussion of the features of the different separation modes will help in understanding the mechanisms involved.

### Adsorption

In this mode, compounds are retained by intermolecular forces between a compound and the surface groups (usually hydroxyl) of a solid adsorbent. Since a mobile phase is part of the system, the mobile phase composition is selected to interact with the adsorbent, giving rise to competition between the mobile phase and the compound for the adsorptive (active) sites of the adsorbent. The solvent used for the mobile phase is critical. Solvents are graded according to solvent strength which denotes the degree of interaction between the solvent and active sites. The strength and the polarity of a solvent are related. In an adsorption mode, nonpolar compounds will require weak (nonpolar) solvents for elution and the strong solvents for polar compounds.

Solvent strength based on their interaction with alumina has been determined for many common solvents. These data have been published [2] and the order of the solvent strength with respect to adsorptive energy applies to other adsorbents, notably silica.

The different functional groups of compounds also interact with the adsorbent depending on their adsorption energies, for example, a methylene group has an adsorption energy that is very low compared with that of a carboxyl group. Hence a carboxyl group in a compound will cause it to be retained more strongly. The energies of different groups on the same molecule are approximately additive, the most polar group predominating. The adsorption energies ( $Q$ ) on a silica surface for a range of groups is available [3]. The great range of adsorption energies is the basis for the separation of different classes of compounds, including isomers, by adsorption chromatography.

A major advantage of the adsorption mode is that correlations may be made between it and TLC separations. This is particularly true when single solvent development is used. Mixed solvent anomalies in TLC may cause difficulty in translating a TLC separation to HPLC. The most frequently used adsorbent in HPLC is silica because of its stability under most operating conditions. Other useful adsorbents include alumina and florisil.

### Partition. (Liquid-Liquid Chromatography)

Partition chromatography employs the same process as in solvent extraction, that is, partitioning of a solute between two immiscible liquids. In partition chromatography the two liquids are the mobile phase and a stationary phase, either coated on, or preferably, chemically bonded [4] to a solid support. Where the stationary phase is more polar than the mobile phase, the partitioning is called normal phase. Where the stationary phase is less polar than the mobile phase the partitioning is called reverse phase.

Coated stationary phases are associated with mechanical effects that limit their usefulness. A fast mobile phase rate may strip the coated phase from the support. Solubility, even where slight, of the coated phase in the mobile phase gives rise to instability. Temperature fluctuations must be insignificant otherwise there are temperature-related changes in solubility of the stationary phase. For maximum stability and to permit flexibility in the choice of a mobile phase, the chemically bonded phases are preferred. The partition mode separates largely on a basis of polarity. In the case of reverse phase chromatography the less polar a compound the more it will interact with the non-polar stationary phase. The converse is true of normal phase chromatography. These features make partitioning particularly pertinent for a wide variety of compound separations within a class.

### Ion Exchange

Ion exchange chromatography is based on the use of stationary phase with fixed ions and counter ions of opposite charge. An ionic solute distributes between the stationary phase and the mobile phase by an exchange of ions with the counter ions of the stationary phase. Solutes with different affinities for the counter ions will be retained differently in the column.

Ion exchange chromatography is efficient for the separation of ionic compounds. The formation of complexes often may make it possible to effect separations of normally nonionic compounds, e.g. sugars may be separated as borate complexes. In addition to direct ion exchange, sample interaction with the ion exchange matrix may contribute to the separation on an ion exchange column. Ion exchange materials with an organic polymer matrix may permit adsorption of some compounds by hydrophobic or van der Waals-London forces. Silica-based ion exchangers may display adsorption effects because of unreacted hydroxyl groups on the silica.

### Exclusion

Exclusion chromatography is based on diffusion of solute molecules into and out of the pores of a three dimensional matrix. The porosity of the matrix determines a cutoff point above which a specific size of molecule will not diffuse into the matrix and thus the smaller the molecule the more chance it has to enter the matrix. Additionally, molecular configuration is important; molecules with more complex molecular shapes being increasingly excluded from the matrix. Overall, the smaller molecules diffuse more readily than larger into the matrix, hence they will take longer to elute from the column.

The exclusion mode is used for the separation of compounds where gross differences in molecular size exist. It is especially useful for separating mixtures according to the molecular weights of the components. With suitable standardization close estimations of

molecular weights may be made. This separation mode works best for compounds with molecular weights above 500.

When the mode is used with aqueous solvents the term preferred is "Gel Filtration Chromatography"; with organic solvents the term is "Gel Permeation Chromatography".

### Affinity Chromatography

A special category of partitioning is that of affinity chromatography [5]. The mechanism is based on the fact that many biological macromolecules can bind reversibly and specifically to other molecules. An example is where the solute is an enzyme and an immobilized affinant which might be an inhibitor or cofactor of the enzyme.

### Selection of Separation Mode

For most analyses it will be feasible to utilize minor modifications of procedures reported in the literature. When it is necessary to develop a procedure from the beginning a series of decisions must be made. The first choice to be made is that of a suitable separation mode. The decision is made easily if the analyte or analytes have a wide range of molecular weights, for example from just under 1000 to over 1,000,000. Exclusion chromatography is most effective where the molecular weights of each pair of analytes to be separated differ by a ratio of 4 to 1.

Where the molecular weight of the compound of interest is 10,000 or less, one or more of the other separation modes will generally be preferable. The mode chosen will depend largely on the polarity of the sample or whether it is ionic or nonionic in nature. Theory does not give a definitive answer to the analyst and in practice a separation will not be limited to a single separation mode.

Sample solubility provides a useful guideline for selecting a separation mode. The solubility of a sample should be determined in a variety of solvents with a wide range of polarities. A suitable series might be: hexane, methylene chloride, methanol, water. It may be necessary to add acid or base to the water to dissolve some compounds. Good practice suggests the use of adsorption chromatography for those compounds soluble in the less polar solvents and partition chromatography for those soluble in the more polar solvents. Molecular structure often suggests a separation mode. Adsorption chromatography is excellent for the separation of compounds into different molecular classes and for separation of isomers. Partitioning is better for separation of homologues and for compounds with highly polar functional groups such as amines. Ionic compounds may be separated by ion exchange but partitioning is a useful alternative. A summary of some of these points is given in Table 1.

*Table 1. Separation mode selection is related to a compound characteristic in this table. In practice more than one mode may be suitable.*

Compound	Separation Mode
Low to Medium Polarity	Adsorption
Medium to High Polarity	Partition (Normal phase)
Medium to Non-polar	Partition (Reverse phase)
Ionic or highly polar	Ion-exchange
Molecular weight above 1000 (4 to 1 size difference for complete separation)	Exclusion

Often two possibilities may present themselves. Preliminary analyses using the optional modes should be made followed by choosing the mode which gives better performance.

**Reverse Phase Chromatography.** A special argument may be made for reverse phase chromatography as a generally useful separation mode. The mobile phase requirement is usually simple, viz., one solvent plus water. The column packing is a largely non-polar material bonded to silica and may be regarded as an immobilized solvent. Thus the chromatographer may use his knowledge of solvent-aqueous phase partitioning to optimize an analysis. Salt may be added to the mobile phase to "salt-out" a solute into the stationary phase. the pH may be changed to vary the distribution of a solute between mobile and stationary phases. Temperature is important and varying it will often affect distribution coefficients. Solvent added to the mobile phase will compete with the stationary phase and thus will affect retention times.

Additionally reverse phase separations are largely predictable, being generally based on the polarity of a solute. The more polar a solute, the faster it will elute from the column.

**Column efficiency.** Characteristics of column performance may be defined mathematically and determined experimentally. For a detailed discussion of this the reader is referred to a standard text [2, 6]. The following is a summary of the main points.

**Column Performance.** The efficiency of a column to separate several compounds of a mixture may be expressed mathematically. For a detailed discussion of this, the reader is best referred to a standard text [7]. A number of parameters relative to the evaluation of column performance have been defined. These permit ready comparison between columns and include elution volume, separation factor, capacity factor, and column efficiency.

**Elution Volume.** A compound injected onto a column will take a discrete time to pass through the column. This is termed the retention time, or more accurately, the elution volume of a compound because a specific volume of mobile phase must pass through the column before an injected nonretained compound appears in the column effluent. This volume is the void volume. A retained substance elutes at a volume larger than the void volume. If  $V_0$  is the void volume and  $V_1$  is the volume measured from the time of injection to the appearance of a solute, then the elution volume ( $V_E$ ) of that substance may be expressed as:

$$V_E = V_1 - V_0$$

The elution volume is constant for a compound under identical analytical conditions. Because most column effluents are monitored and the detector output recorded against time, the term **retention time** is often substituted for **elution volume**.

**Capacity Factor.** Calculation of the elution volume is required for calculation of the capacity factor of a column. This factor (also known as the retardation factor or partition ratio) describes the degree of sample retention in column volumes. It is symbolized by

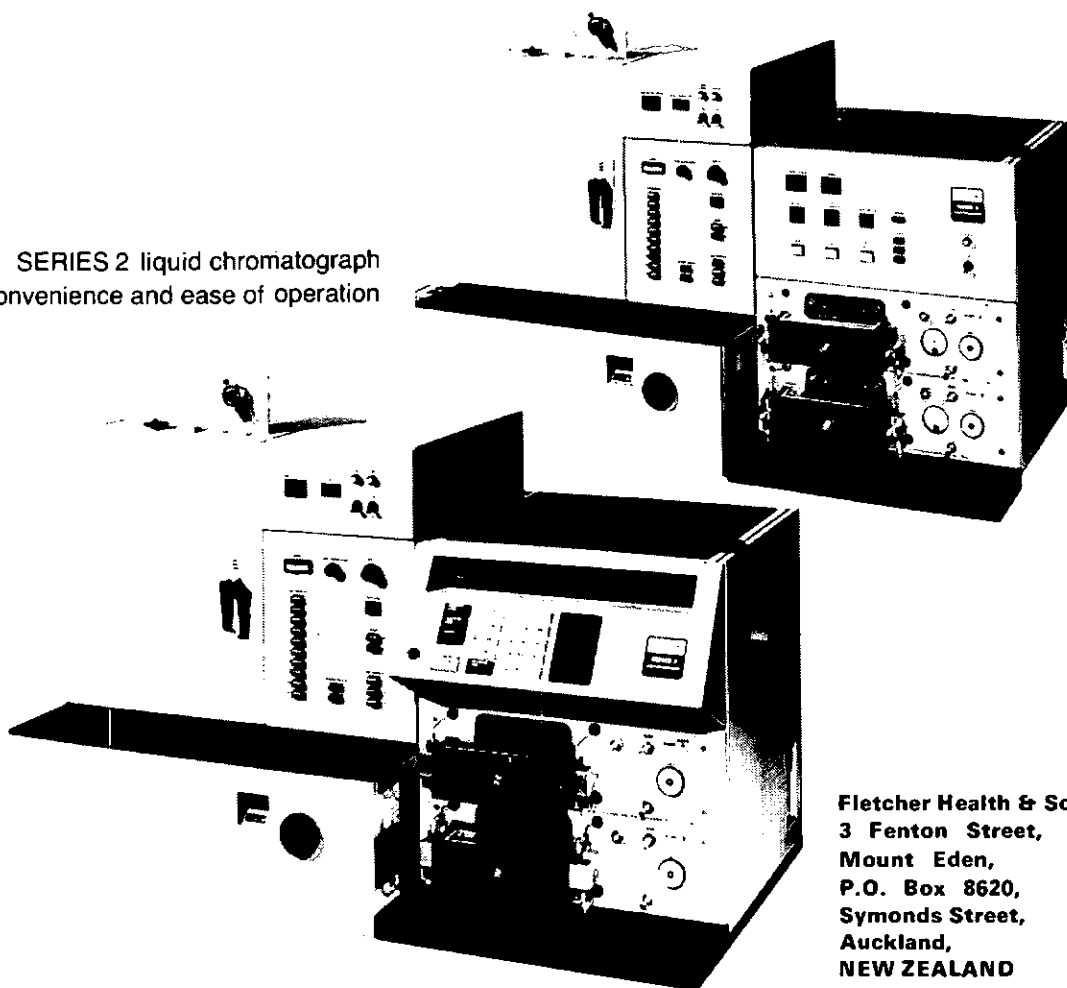
$$k' = \frac{V_E}{V_0}$$

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**Separation Factor.** The separating ability of a column is expressed as the separation factor. It describes a column's behaviour for two components. The capacity factors ( $k'$  and  $k''$ ) of two compounds are calculated. The separation (or selectivity) factor (symbolised as  $\alpha$ ) is defined as:

$$\alpha = \frac{k'_2}{k'_1}$$

The more closely the separation factor approaches unity, the more nearly components coincide until at  $\alpha = 1$ , components are not separated.

**Column Efficiency.** Column efficiency is expressed as the theoretical plate number, ( $N$ ). For calculation purposes it is convenient to measure the distance in mm that the recorder chart moves from time of injection to the time when a peak occurs (less the elution time of the void volume) as a measure of the retention time (RT) of a compound and the peak width ( $W$ ) at base line of the eluted compound. The  $N$  is defined as:

$$N = 16 \cdot \frac{(RT)^2}{W}$$

**Resolution.** The term resolution, ( $R$ ), describes the number of average peak bandwidths that may be fitted between any two peaks. It expresses the relationship between  $\alpha$ ,  $k'$  and  $N$ . It is defined by the equation:

$$R = \frac{(\alpha-1)}{4\alpha} \cdot \left( \frac{k'}{k'+1} \right) \sqrt{N}$$

but in practice it is best calculated from the contracted equation:

$$R = 2 \left( \frac{V_{E2} - V_{E1}}{W_2 + W_1} \right)$$

where  $V_{E1}$  and  $W_1$  are the elution volume and peak width at baseline of a solute and  $V_{E2}$  and  $W_2$  are the same parameters for a second solute eluting after the first.

The  $N$  value of a column is most useful. For analyses to be comparable between columns using identical procedures, the  $N$  values of columns must be closely similar.

To illustrate these concepts, the chromatogram in Figure 2 will serve as an example.

### Optimization of Separation

The above definitions are of practical consequences to the chromatographer. The resolution ( $R$ ) gives the relationship between peak bandwidths and separation, but is not in itself useful for optimizing a separation. The

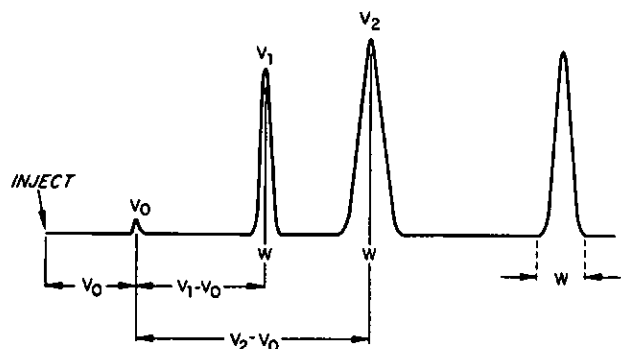


Figure 2. Chromatogram illustrating the measurements used to calculate column performance. The symbols are defined in the text.

definitions of  $R$  does give the interdependence of the three variables: capacity factor, column efficiency, and the selectivity factor.

The capacity factor affects  $R$  by the ratio:

$$\frac{k'}{k'+1}$$

For a wide range of values for  $k'$ , other parameters being held constant, a large change in  $k'$  has a relatively small effect on  $R$ . However, the elution volume (or retention time) of a peak is affected. The larger the  $k'$  value, the larger the retention time of a peak and the smaller the peak height. For  $k'$  to be optimal, with respect to maximum resolution within the required analysis time, a  $k'$  of 2 to 5 is generally required. Where  $k'$  values are large, retention times will be long and may be shortened by an increase in solvent strength with a concomitant improvement in peak height. Where  $k'$  values are extremely small (approaching zero), solvent strength should be decreased.

**Column Optimization.** Peak bandwidth is a function of a column's efficiency. Where  $k'$  is optimized to a value of 2 to 5 (by use of solvent strength) but two peaks are not adequately resolved, an improvement may be made by increasing the number of theoretical plates,  $N$ .  $N$  is related to the plate height ( $H$ ), and the length ( $L$ ) of the column thus:

$$H = \frac{L}{N}$$

An empirical relationship exists between  $H$  and the mobile phase flow rate,  $u$ , and is given by the equation:

$$H = Du^n$$

Where  $D$  and  $n$  are column constants, the usual figure for  $n$  is 0.3-0.5 and  $D$  is usually 10-50 times the particle diameter of the column-packing.

This relationship gives the most immediate way of changing column efficiency, that is, to change the flow-rate of the mobile phase. A decrease of flow-rate increases column efficiency. Other ways include lengthening the column, reducing particle size of the packing or, in the case of partitioning, a change of temperature may improve the efficiency.

**Column Dimensions.** Column size is related to the column efficiency for a particular separation. The efficiency of a column depends on the quality of the packing and the thoroughness with which it has been packed in the column. Efficient columns are difficult to produce and are best acquired from a reputable supplier. Most columns for routine use will be 0.26 or 0.46 cm I.D. and 25 to 50 cm in length. Columns may be used in series to attain higher efficiencies. Large diameter columns are useful for preparative work. Packing mesh size will generally be below 20  $\mu\text{m}$  and often 5 to 10  $\mu\text{m}$ . The longer the column or the smaller the particle size of the packing, the higher will be the column back-pressure. The tube containing the packing is generally of stainless steel and the inner surface must be polished, as irregularities increase band spreading.

### Mobile Phase

Selection of a mobile phase will primarily be on the basis of solvent strength. As discussed above (see Adsorption) solvent strength tables are available [2] permitting selection of a solvent which will serve to effect a separation which may then be further optimized by modification of solvent strength. Other considerations must be kept in mind when selecting a solvent. Where a

**Table 2. Portion of a solvent strength table with additional data for other solvent characteristics.**

Solvent	E <sub>0</sub> (Al <sub>2</sub> O <sub>3</sub> )	Visc- osity cp/20°	RI	UV Cutoff /nm
n-Pentane	0.00	0.23	1.358	210
Chloroform	0.40	0.57	1.443	245
Acetone	0.56	0.32	1.359	330
n-Propanol	0.82	2.30	1.380	210
Ethanol	0.88	1.20	1.361	210
Methanol	0.95	0.60	1.329	210

refractive index detector is used, then a solvent outside the refractive index range of the detector would be useless. Similarly for UV detection, the UV cutoff point of the solvent must be known in relation to the detection wavelength used. Additionally, the viscosity of a solvent, if above a certain value may impose too great a burden on the pumping system. The solvent strength tables [2] generally provide this necessary information. A portion of such a table is given in Table 2. The solvent strengths range from 0.00 to 0.95 and are given in the second column (E<sub>0</sub>). The viscosities have a wide range. Solvents of similar strength often have differing viscosities, for example, n-propanol and ethanol. It is good practice to use the solvent with the lower viscosity. Note that these viscosities were measured at 20°C and that higher column temperatures will probably reduce them to lower values.

The UV cutoff wavelength for the solvents must be noted when UV detection is used. One cannot, for example, detect xanthines at 273 nm using a mobile phase containing acetone (cutoff 330 nm). These points are often overlooked when optimizing a separation. For adsorption chromatography, the solvent will usually match the polarity of the sample. This will often require the use of a mixed solvent. The ionization state of the solutes may require solvent adjustment by addition of base or acid.

Special attention must be paid to the quality of the solvents that are used. The prime concern is solvent compatibility with the detector used. It is good practice to use the best grade of solvents available. For use with ultraviolet absorption detectors, it may be necessary to use an ultraviolet grade, distilled in glass product, which should be labeled with the ultraviolet cutoff wavelength. Poor quality solvents can often be purified by passage through a 2 cm x 20 cm column of anhydrous silica gel followed by passage through a similar sized column of basic alumina.

Additionally, it is necessary to avoid the introduction of artifacts onto the column which might create interferences. Solvents must be degassed to remove dissolved air (a water aspirator or other source of moderate vacuum should be used) or back-pressure applied by a valve in the effluent line. Degassing is usually mandatory if oxygen sensitive compounds are to be analyzed. Some solvents such as chloroform or ethers may contain stabilizers. Ethanol is often used to stabilize chloroform, and it will affect the solvent strength. Check the purity of your solvent — a cardinal rule which must be observed to insure good results.

**Mobile Phase Delivery.** To maintain reproducibility of the chromatographic conditions, the solvent must be applied to the column at an accurately controlled rate. It is desirable to be able to change flow rates at will and to replenish the mobile phase conveniently. A wide range of pressures (about 100 to 6000 psi) must be accommodated. Of several possibilities for mobile phase delivery, three

are commonly used; gas pressure, a reciprocating pump or syringe pump. Gas pressure systems may introduce gas into the solvent and it is difficult to obtain precise flow-rates. The pump systems are versatile giving flexibility in the selection of flow rates. Reciprocating pumps generate a pulsed flow that may be apparent on the chromatogram and limit sensitivity if the pulsations are not properly damped. The syringe pump delivers solvent smoothly and contributes little noise to the total system. Pumps readily permit the use of electronically programmed variations in flow-rate or in solvent strength allowing gradient elution where the concentration of one solvent in another is increased or decreased at a linear, logarithmic or other rate.

The choice between a reciprocating or syringe pump depends on the complexity of the analysis, that is, the number of components to be separated and the quantity of each to be detected.

**Elution mode.** Several options of elution developments are available to the chromatographer. Isocratic and gradient elution are most commonly utilized.

**Isocratic elution.** The mobile phase is delivered at a constant flow rate and composition to the column. There are two advantages to isocratic elution; convenience in mobile phase and equipment requirements and excellent reproducibility for similar samples. The disadvantages are mainly evident for multicomponent samples where long retention times result in dilution of the solutes at high *k'* values with consequent decrease of sensitivity.

**Gradient elution.** A controlled change in mobile phase composition is termed gradient elution. Many applications are for the separation of multicomponent samples, this generally being accomplished by increasing the solvent strength throughout the separation. The advantages of this mode are that it is the only elution mode that optimizes a wide range of *k'* values; it is especially useful for unknown samples, and it minimizes dilution of substances which otherwise would have late elution times. Its disadvantages are the requirement of sophisticated equipment, the extra time required to achieve equilibration at the start position and the possible need to restrict the range of solvents when the refractive index detector is used.

**Other modes.** Flow programming, where the flow rate of the mobile phase is increased at a controlled rate throughout an analysis, is attractive because it can shorten the separation time for an analysis and also improve peak bandwidths of the later eluting solutes. In practice, flow programming is an improvement over isocratic elution because it will cover a range of *k'* values. It is, however, somewhat less versatile because some detectors may be sensitive to flow rate changes.

## Detector

The chromatographic separation may be regarded as a procedure to optimize presentation of the analyte to the detector. Any technique that can be employed for measurement of some physical or chemical property of an analyte can potentially be employed as an LC detector [6]. Of all the possible systems, three are widely used. They are fixed or variable wavelength photometers, refractive index monitors and transport systems.

The refractive index detector measures a general property of the column effluent, but does not display good sensitivity for most analytical applications. The photometer detector is more selective. In its simplest

form, it operates at 254 nm with a low pressure mercury lamp. When a variable wavelength photometer is used, the detector set at short wavelengths near 200 nm comes close to being a general detector. The sensitivity of detection for many compounds approaches a few nanograms. The versatility and sensitivity capabilities of this detector have made it the most important detector in use today.

Transport detectors carry a solute, after evaporation of the solvent by means of a moving wire or band, to the detector proper. One successful detector combusts the solute to carbon dioxide and water. The carbon dioxide is reduced to methane which is detected by a flame ionization detector. The concept of the transport detector is excellent, but in practice because of the small quantity of solute sampled from the eluate, the sensitivity attainable, although better than that using refractive index, is not as good as that obtained with a photometric detector.

Other general detectors are based on thermal conductivity, density, or dielectric constant, but they are limited in sensitivity. Several selective detectors are used, including those using polarography, conductivity and fluorescence. These display adequate sensitivity comparable to photometric detection and in the case of fluorescence, pg sensitivity may be attained. With variable excitation and emission wavelength capability, the specificity of the fluorescence detector may be highly desirable for some applications.

Specificity of detection may be improved by use of post column reaction techniques, reacting the solutes with a reagent with which, in the case of amino acid analysis using ninhydrin, a high degree of specificity and sensitivity is attained. With variable wavelength detection, the adsorption of a solute may be measured at several wavelengths. The ratio of one absorption reading compared with the others is highly specific for a single compound, and serves to monitor the purity of the solute eluting from the column. This procedure requires stopping the mobile phase flow when the detector shows response for an analyte. Absorbance readings are taken at two or more wavelengths, and after correcting for background absorbance of the mobile phase, ratios are calculated. A solute with identical retention time to the standard will display identical ratios, if chemically identical. If contaminated with other material, the ratios will differ.

Where the sensitivity of a UV or fluorescence detector is limited in a particular application, it may be feasible to utilize derivatization prior to chromatography to improve detection limits [6]. For UV detection, especially where a fixed wavelength of 254 nm is used, substituent groups containing aromatic structures may be added to a suitable molecule. The latter will then embody the absorbance characteristics of the substituent group. Reagents are commercially available for use with compounds possessing any of the carboxyl, hydroxyl, amino, and carbonyl functional groups. Similarly, in many cases, fluorophores may be added to suitable compounds not naturally fluorescent. As an example, amino acids may be reacted with dansyl chloride to give fluorescence detection capability to the pg level [8].

HPLC is a nondestructive separation technique. Because of this, the capability exists to take eluted solutes and subject them to further analytical scrutiny, e.g., by IR, NMR, MS.

## Column Oven

The transfer heats in the LC are insignificant for most practical purposes. However, temperature is important from the standpoint of diffusion coefficients and viscosities of solvents; the first property increasing the second decreasing with temperature. Thus it is often advantageous to use the highest possible temperature. The use of a thermostatted oven or other means to control the column temperature is important because it permits obviating effects due to a variable ambient temperature. Temperature programming is feasible but is not used routinely as it is not much more useful than isothermic operation at an elevated temperature.

## Sample Size

Both sample volume and solute concentration must be limited to avoid excessive peak spreading and the effect of overloading the column. Skewed peaks generally indicate overloading of the stationary or mobile phases and is usually remedied by reduction of sample size. For some adsorption modes, skewing or tailing peaks may reflect nonuniformity of adsorption site activity and in these instances deactivation using water may be necessary. For partition chromatography, overloading may be avoided by using a sample quantity of about 1/1000 of the amount of stationary phase in a column. This may be approximated by using the figure of 4  $\mu\text{g}/\text{cm}$  of column. Sample volume should not be greater than about 1  $\mu\text{l}/\text{cm}$  of column. Adsorption chromatography requires similar precautions.

## Injection

Injection of a sample into the column may be by syringe through a septum or by valve with the mobile phase flowing or stopped. Syringe injection requires attention to reproducibility, enables ready change of sample volumes, but has problems related to septum leakage at high pressures and septum-solvent incompatibility. Valve injection has better reproducibility, in some configurations allows variation in sample size, and is more useful at high pressures. A potential problem with valve injection is the possibility of a carryover effect, particularly where a wide range of solute concentrations are analyzed. It is imperative to flush the valve thoroughly between injections unless the design provides for this automatically. A considerable advantage of the valve system is its capability for automation.

## Recorder

A multirange recorder (1 to 100 mV) is useful in making rapid changes in chromatogram scale.

## Solute Identification

The eluted compounds are identified by correspondence of their retention time with those of reference compounds processed in an identical manner. Additionally, it is possible to overcome the limitations of a single physical parameter, such as retention time for identification by use of dual wavelength or scanning spectrophotometers. In special instances, it may be possible to use the selectivity of a fluorimetric detector, especially where excitation and emission wavelengths may be scanned. Post-column reaction techniques where the eluate is mixed with a selective reagent may be useful. Eluted components may be collected for further analysis by GC, UV, MS, IR, NMR, or by individual chemical tests. Generally, the use of

# NZIC

# Bulletin

No. 12

27 Nov., 1977

Edited by Dr L. K. Creamer, N.Z. Dairy Research Institute, Private Bag, Palmerston North. Deadline for next issue: 2 Feb., 1978.

## EDITORIAL

After two years' operation the NZIC Bulletin, as a relatively rapid and inexpensive method of disseminating news to the NZIC members, has been a successful venture. With the combined editorship of the bulletin and the journal over the past year, it has been possible to integrate the two publications to some extent and to prevent the duplication of notices, etc.

I would like to express my gratitude to all those who have contributed to the journal or the bulletin and to those who have helped make my job easier. I am especially indebted to Dr Keith Bedford in Auckland, Dr Peter Molan in Hamilton, Dr Gavin Hedwig here in Palmerston North, Dr Brian Halton in Wellington, Dr Colin Freeman in Christchurch and Stuart Gray in Dunedin for the continuing stream of Branch news and for the instances in which they have provided the initial impetus to prospective authors of journal articles. I also acknowledge the help I have had from the Institute Office-bearers, Denis Hogan, Betty Wignall, Gavin Fletcher, Professor Geoff Malcolm, Professor Graeme Wright, Dr Rod Furkert and members of the publications committee and to Ross Turner who has, with the assistance of our advertisers, maintained sufficient advertising income to keep the net journal cost within reasonable bounds.

## N.Z. ASSOCIATION OF SCIENTISTS

Each year the Association offers two medals; first the N.Z. Association of Scientists Research Medal, and second the Sir Ernest Marsden Medal for Outstanding Service to Science.

Nominations should be in the hands of the Secretary by May 10 and the rules covering the awards can be obtained from the Secretary (C.P.O. Box 1874, Wellington).

The winner of the 1977 Research Medal was Dr G. Glasby.

## JAPANESE CHEMICAL SOCIETY CENTENNIAL

April 2, 1978

Any members attending Japan during March or April 1978 are requested to contact the General Secretary,

Mr J. G. Fletcher,  
University of Auckland,

so that arrangements can be made for them to present a suitable recognition to the Japanese Chemical Society who are celebrating their centenary on April 2, 1978.

## HAMILTON AWARD 1978

Nominations for the above award should be sent to the General Secretary, the Royal Society of New Zealand, P.O. Box 12249, Wellington, by 31 December 1977. At least two copies of the relevant publications and a supporting statement should accompany the nomination.

Rule J III 7 reads:

"The prize shall be awarded for scientific research carried out in New Zealand or in the islands of the South Pacific Ocean which has been published within 5 years preceding the last day of January prior to the Council meeting at which the award is made. Such publication may consist of one or more papers and shall include the first investigation published by the author. No candidate shall be eligible for the prize who prior to such period of 5 years has published the results of any scientific investigation in a recognised scientific journal."

For the purpose of this award, a **recognised scientific journal** will be interpreted as one for which papers are submitted to a referee prior to publication.

No award will be made unless in the opinion of Council, there is evidence of scientific work of great merit.

The 1977 prize was awarded to Dr P. N. Johnson for ecological studies of shoreline vegetation and flora of southern New Zealand lakes and of the Auckland Islands.

## 1978 MINICONFERENCE

The NZIC will hold its annual Conference in Christchurch, Monday 21st and Tuesday 22nd August.

The sections are planned to be:

- Combustion: Analytical — pollution — energy.
- Extraction and chemical conversion of natural products from primary industries.
- D.N.A.

Papers are invited, and a preliminary circular will be sent shortly to members.

Although this will be a shorter conference than usual, there will be the usual displays, social functions (other than a formal dinner), and the A.G.M. Requests for information should be sent to:

Conference Secretary,  
Dr J. Abrahamson,  
Chemical Engineering Department,  
University of Canterbury.

# BRANCH NEWS

## AUCKLAND

### Branch News:

During September the annual student lecture was given by **Dr Ian Devereux**. The title of his address was "Tycoon or Test-tube Twiddler" and he outlined the challenges involved in being self-employed in a scientific field.

The Branch held two meetings during October. **Professor K. Grjotheim** spoke on "Aspects of the Hall-Heroult Process for Aluminium Production" and **Professor M. Szwarc** spoke on "Block Polymers — their Synthesis and Properties".

Concluding events for the year will be the Food Additives Symposium and the Branch A.G.M. at which **Professor**

**Renwick** of the University of Auckland

Department of Biochemistry will speak on the growth hormone unit which is being established in the Department.

### University of Auckland— Chemistry Department:

**Ms Wendy Noall** has won a scholarship awarded by the N.Z. Federation of University Women for post-doctorial study. She hopes to take it up in the United States next year after completing her Ph.D.

contributed by  
Dr K. R. Bedford.

## WAIKATO

### Branch Meetings:

At the end of July a special meeting was arranged in conjunction with the Waikato Branch of the N.Z. Institute of Agricultural Science and the Veterinary Association. The meeting was addressed by **Prof. P. Berquist** from the Department of Cell Biology, Auckland University, on the subject of "Plasmid Genetic Engineering".

In September the branch was addressed by **Prof. R. Batt** from Massey University on the subject of "Alcohol Metabolism in Humans".

At the October branch meeting **Prof. G. Williams**, Visiting Professor of Chemistry at Auckland University, spoke on the subject of "Fluorocarbons and Free Radicals".

### Ruakura A.R.C.:

**R. Fairclough**, of the Chemical Services Section, has been awarded a Ph.D. by Auckland University.

**Dr Steve Davies** recently joined the staff of the Biochemistry Section. Dr Davies is a graduate of the University of Nottingham. He held a postdoctoral appointment at Lincoln College from 1975 to 1976. His interests are in amino acid analysis and lactation biochemistry.

**Dr D. E. Wright** will be in Sudan for 3 weeks during November as a member of the International Atomic Energy Agency technical panel on water requirements of tropical herbivores.

### Forest Research Institute:

**Dr G. M. Hill** has been awarded a David Henry Scholarship. He will use it to visit the U.S.A. in June-July 1978 and look at their research into environmental effects of forestry operations, in particular water quality and the factors affecting safe effluent dispersal

in forests. He will also attend the quinquennial conference of the N. American Forest Soils Assoc.

**Dr R. Ballard** will be leaving FRI in December 1977 to take up a permanent post as Director of the Forest Fertilisation Research Cooperative, based at North Carolina State School of Forestry Resources, Raleigh, N.C.

contributed by  
Dr P. Molan.

## MANAWATU

### Branch Meetings:

At a meeting held in New Plymouth in August, **Dr G. B. Russell** (Branch Chairman), Applied Biochemistry Division, DSIR, gave a talk on "Plant Chemicals Affecting Insect Development". This topic was also the subject of this address to the Branch A.G.M. in September.

The October meeting took the form of a Symposium on Fine Chemical Production in New Zealand. The speakers were **Dr R. M. Garland** of New Zealand Pharmaceuticals Ltd. ("Fine Chemicals from Animal By-Products — Possibles and Probables"), **Mr T. J. Miller** of Kempthorne Prosser and Co. ("Manufacture of Tranquilizers"), **Dr N. H. Clarke** of Lactose Co. of New Zealand ("Challenges in Lactose Production") and **Mr E. Beanland** of Chemistry Division, DSIR ("Extraction of Solasodine from Native Solanum").

### Massey University:

**Dr D. R. Husbands**, Department of Chemistry, Biochemistry and Biophysics, recently left for study leave to be spent in the Department of Biochemistry and Physiology, University of Southampton.

**Dr D. A. D. Parry**, Department of Chemistry, Biochemistry and Biophysics, is spending a six-week period from mid-November at the CSIRO Division of Protein Chemistry in Melbourne. Dr Parry will assist in a project concerning the matrix protein of the wool fibre.

**Dr V. L. and Dr Kathy Crow** have recently returned from 2 years post-doctoral research at the National Institutes of Dental Research and of Mental Health, Bethesda, Maryland. Dr V. L. Crow has joined the Department of Microbiology and Genetics.

Recent visitors to the Department of Chemistry, Biochemistry and Biophysics were **Dr J. Schroder**, University of Freiburg, who gave a talk on "Analyses, at the Messenger RNA Level, of Enzyme Induction in Plant Tissues", and **Professor M. Szwarc**, FRS, State University of New York, who gave a talk entitled "Block Polymers, their Synthesis and Properties". Professor Szwarc was visiting New Zealand at the invitation of the Polymer Group of the NZIC.

**Dr G. W. Butler**, Assistant Director General of DSIR, was recently elected to the Council of Massey University, by the Court of Convocation. The Court consists of graduates of the University.

### DSIR—Applied Biochemistry Division:

**Dr C. S. W. Reid** was recently awarded the Royal Society of New Zealand's Hector Medal in recognition of his contributions to animal science.

**Messrs D. Greenwood and G. Waghorn** have recently been awarded NRAC Fellowships to undertake PhD research at the University of Liverpool, England, and at the University of Davis, California, respectively.

**Dr L. P. Milligan** from the University of Alberta, Edmonton, Canada, recently joined the Division while **Dr L. P. Ruiz** left to take up a World Bank Project post at the Malaysian Agricultural Research and Development Institute in Kuala Lumpur.

**Dr N. D. Grace** recently returned from study leave at the Moredun Research Institute, Edinburgh. While at the Institute, Dr Grace studied the mechanism of the Cu x Mo x S interaction in sheep.

**Dr E. L. Hove** was recently elected a Fellow of the New Zealand Institute of Food Science and Technology.

The Animal Nutrition Building was opened by the Minister of Science and Technology, **Mr Gandar**, on 28 October. The two storey building has a complete surgical suite, post-mortem facilities, laboratories and offices. Research in this centre is concerned with studies into animal digestive processes, mineral nutrition of cattle and sheep, bloat and the cause of the deposition of excess fat in some sheep.

### Technical Institute:

A controversy developed recently over the siting of a new Technical Institute in Palmerston North. The current proposed site on Fitzherbert Avenue was opposed by various organisations including the local branch of the NZIC. Statements by the Minister of Education, **Mr Gandar**, and the Member of Parliament for Palmerston North, **Mr Lithgow**, and the Mayor and City Councillors of Palmerston North and **Mr N. W. Smith** of the Chamber of Commerce were widely reported in the local newspapers. A referendum on the actual site preference, held in conjunction with the local body elections, was inconclusive.

contributed by  
Dr Cecil B. Johnson.

## WELLINGTON

### Branch Activities:

**Dr John Featherstone** (Pharmacy School, Central Institute of Technology) addressed the September meeting on his recent work involving "Chemical Aspects of Subsurface Demineralization in Dental Decay", for which he has achieved international recognition. The October A.G.M. and dinner meeting was also the occasion for the Wellington 1977 Mellor Lecture given by **Professor J. F. Duncan** (Chemistry Department, Victoria University, and Commissioner for the Future). His topic, "Science Options for the Future", outlined the aims and objectives of the Commission for the Future as well as some of its current projects and complemented the plenary paper presented at the Hamilton Conference.

In mid-October the branch held its inaugural annual dinner, at the Catering School Restaurant in Wellington Polytechnic. Those who were lucky enough to attend were provided with an excellent meal (cooked by the 2nd year trainee chefs) and entertained by **Mr Mike Collins** (Director, Physics and Engineering Laboratory, DSIR) who gave the after-dinner address.

## Victoria University of Wellington:

Recent visitors to the Chemistry Department have included Professor Horst Prinzbach of Freiburg University, who toured the Universities as German National Fellow for 1977, and Professor Kai Grjotheim of Oslo University. Professor Prinzbach presented a series of seminars on his work involving trishomobenzenes in the Department and also at Chemistry Division, DSIR, and was guest of honour at a Departmental Dinner. Professor Grjotheim, one of the world's foremost experts on the chemistry of aluminium reduction, addressed DSIR and the Department on "Alternative Methods of Aluminium Production". As his visit coincided with the branch inaugural dinner, Professor and Mrs Grjotheim attended as guests of the local branch. Professor Robin Ferrier has returned from sabbatical leave spent in Edinburgh and Dr David Weatherburn has been appointed Chairman of the National Science Fair.

## DSIR—Chemistry Division:

Mr I. R. C. McDonald, Dominion Analyst, recently represented this country at the WHO Task Group meeting on "Environmental Health Criteria for Carbon Monoxide" in Geneva. Mr P. J. Grosvenor is completing his final year project for a degree in Chemical Engineering (from the University of Surrey, England) at the Division.

Dr V. R. Gray, who commenced his scientific work in coal research in the U.K., is leaving the Forensic Section for the post of Chief Chemist with the Coal Research Organisation; Mrs C. R. Fitchett has left the Section to raise a family. Dr R. Dolby has transferred to the Department of Agriculture and Fisheries Laboratory at Invermay and Dr D. G. Shepherd,

a recent doctoral graduate of Otago University, has joined the Geothermal Section.

Recently returned from study leave are Drs C. N. S. McLachlan and L. P. Aldridge. Dr McLachlan spent 20 months as Senior Von Humboldt Fellow in the University of Karlsruhe while Dr Aldridge had a period of post-doctoral work in Ontario.

## CIT:

Mr Chris Budgen is attending a one year course in Biopharmaceutics at Chelsea College, London, and intends following this with a three month refresher period at the State University of Washington, U.S.A.

## Wellington Polytechnic:

The Polytechnic has been awarded a Mobil Environmental Grant of \$1,000. This is to be used for research into the training of science technicians and health inspectors in environmental problems and the analytical methods necessary for measuring toxic substances.

## Wellington Hospital:

Miss J. Mattingley attended the 16th Annual Conference of the Australian Association of Clinical Chemists in Melbourne in October to present a paper "An Alternative Form of Bonding of Iron and Other Substances to Transferrin".

contributed by  
Dr B. Halton.

## OTAGO Branch News:

Two meetings were held in September, the normal monthly meeting being addressed by Prof. R. Mason who spoke on "The Structural Chemistry and Function of some Biological Membranes". Prof. P. J. Scott spoke

to a special meeting on "Connective Tissue Interactions in Artery Walls". The A.G.M. in October was followed by an illustrated talk by Prof. F. Fastier on "Poisons Good and Bad", and then a visit to and explanation of the National Poisons Centre.

## Chemistry Department:

Prof. H. Prinzbach, University of Freiberg and 1977 German National Fellow, gave a series of lectures in the Department in the course of a week's visit.

## Nutrition Department:

Dr J. McKenzie is attending the 4th Scientific Meeting of the Australian Society for Parenteral Nutrition in Adelaide, and while in Australia will be visiting the C.S.I.R.O. Department of Nutrition, Adelaide, and the Geelong University Department of Nutrition.

## Pharmacology Department:

Mr W. Schreurs, B.Sc. Hons, employed this year on a project grant to Assoc. Prof. Laverty to develop a radio enzymatic assay picogram amounts of catecholamines. He will be taking up an A.N.U. Ph.D. scholarship in 1978 to study under Dr H. Rosenberg on the isolation of membrane bound transport systems.

Mrs Rosemary Beresford will present at the January meeting in London of the British Pharmacological Society a brief account of her research which involved the technique devised by Prof. Fastier for the simultaneous measurement of the oxygen consumption and contraction of electrically stimulated muscle.

contributed by  
S. G. Gray.

## The First International Conference on Durability of Building Materials and Components

OTTAWA, CANADA  
21-23 August, 1978

This conference aims to provide a forum for the exchange of information between specialists from different areas of research who deal with the durability of building materials and components. Plenary sessions will be held to present papers on topics of general interest such as —

Economic and energy conservation aspects of durability.

General aspects of the durability of materials of various classes, i.e., inorganic, organic, porous materials, and natural products.

Environmental factors affecting durability and their measurement.

Testing.

For further information write to:

Mr K. Charbonneau,  
Executive Secretary,  
The First International Conference on Durability of  
Building Materials and Components,  
C/- National Research Council of Canada,  
Ottawa, Ontario K1A 0R6,  
CANADA.

## NATIONAL CONFERENCE CHEMICAL EDUCATION DIVISION ROYAL AUSTRALIAN CHEMICAL INSTITUTE

ADELAIDE  
Feb. 8-10, 1978

THEME: THE ROLE OF LABORATORY  
TEACHING IN CHEMISTRY

For further information contact:

Mr J. Devenport,  
Conference Chairman,  
S.A. Institute of Technology,  
P.O. Box 1,  
Ingle Farm, S.A. 5098,  
AUSTRALIA.

## Fifth International Symposium on Salt

29 May - 1 June, 1978  
Hamburg

Secretariat:

V. Internationales Salz — Symposium 1978,  
c/o Kaliverrein e.V.,  
D-300 Hannover,  
Federal Republic of Germany.

## NOTES FROM COUNCIL MEETING HELD IN AUG. 1977

### Safety in School Laboratories:

Moved — 1, that a copy of the report from the Canterbury Branch be sent to the Director-General of the Department of Education with the Institute's offer to assist in any way in these matters,

2, that Council recommend the issue of Safety Glasses to all school laboratory classes,

3, that Council recommend the construction of suitable fire-proof storage room for solvents and fuels so that school laboratories may operate within the law,

4, that this report be prepared for publication in the Journal. Carried.

It was also recommended that for the next issue of "Safety in School Laboratories" consideration should be given to other changes along the lines of the Canterbury report.

### Salary Survey:

The Registrar reported that the salary survey was already under action. The Auckland delegate pinpointed the desirability of expressing "remuneration", i.e., salary plus bonuses or allowances (e.g., house or company car), especially for industrial members. It was noted that the \$365 c.o.l. allowance would now be included. Technicians were omitted from the present survey because their numbers in the Institute were too low for statistical accuracy.

### Levich Affair:

The President agreed to prepare letters to the Royal Society, the Soviet Embassy and the Minister of Foreign Affairs expressing the Institute's concern over the treatment of Dr Levich by the Soviet authorities, and to make a Press statement on the matter.

The 1st Vice-President thanked Council for its support and action.

### Exemption from Union Membership:

Moved — that as a result of legal opinion received by Council, the resolution (M.1047, 6a1.) be rescinded, and no further action be taken. Carried.

### 2,4,5,T Debate:

Moved — that the Standing Committee prepare for publication in the Journal an account of their action in connection with the debate on 2,4,5,T.

### "A Guide to Professional Employment":

It was agreed that a copy of "A Guide to Professional Employment" should be sent to new members on election.

### Financial:

In presenting the Budget and Auditor's Report, the Registrar again drew attention to the level of subs. in arrears. Branches were asked to do what they could about the matter as the considerable portion of the membership regularly late or in arrears in payment seriously affects liquidity and hampers investment of Institute funds.

### Publications:

With one dissension, Council approved the continuation of the Publications Committee policies for the Bulletin and Journal. Moved — that the economics of registering the Bulletin and Journal as "magazines" (in view of the new postal regulations) be referred to the Publications Committee for appropriate action and report. Carried.

The Publications Committee were asked to print a "List of Members" with advertising to offset costs as soon as possible.

### Conferences:

Canterbury '78: The Canterbury delegate reported that plans were in hand for a mini-conference immediately before the N.Z. Biochemical Society's symposium on plant protein and the First Conference of the N.Z. Science Teachers' Assn. Wellington '79 would be a full conference.

### Environmental Impact Report

#### Consultants:

Moved — that the list of names of members willing to act as consultants be forwarded to the Commissioner of the Environment. Carried.

#### Membership:

Council approved the following elections:

As Honorary Fellows: Dr A. T. Johns, Dr I. H. Walker.

As Life Members: Mrs P. W. Broad, G. H. Edwards, R. Hicks, E. Hounsell, G. S. Lambert, N. H. Law, B. E. Jackson, E. Pawson.

As Fellows: D. S. Adcock, L. H. Boulton, K. R. Burnett, B. L. Cockburn, A. P. Oliver, D. C. Reaney, D. Suuring, J. M. Waters, T. M. M. Waters, P. D. Woodgate.

As Members: K. G. Allum, M. C. Cochran, R. J. Cowles, J. H. Czernohorsky, J. P. Fawcett, A. R. Furness, G. J. Gainsford, Miss C. M. Jukes, T. E. Kjellstrom, G. A. Lane, I. Scoltock, G. R. Scott, R. B. Williamson.

Graduates as Members: Miss S. H. James, K. A. Miller, R. D. Wilson.

As Graduates: W. D. Alchin, G. W. Bahlman, M. G. Banwell, P. G. Best, Miss E. A. Campbell, B. J. Farquharson, R. F. Cerlach, S. J. Hume, M. T. Lee, Mrs J. M. Jackson, J. R. Liddle, Ms W. I. Noall, S. J. Nunn, D. L. Officer, D. C. Russell, R. G. Wallace, S. P. Wong.

As Associate Members: R. N. Mumford, K. A. G. Watts.

As Technician Members: V. I. Beros, P. R. Macdonald, M. R. Steedman.

The deaths of the following were noted with regret: E. D. Andrews, M. Bielschowsky, G. S. Frieberg, J. T. Holloway, H. Rands.

Resignations were accepted from the following: M. H. Abernethy, W. F. Chadderton, R. H. Chapman, H. C. Jack, A. C. Pratt, W. S. Strang; subject to payment of subscription: J. P. Barton, A. Bonny, S. O. Brennan, G. T. Hodgson, I. C. T. Lyon, H. C. Price.

Struck Off (no address): P. H. Chew, J. E. Hayward, M. J. Nicholls, D. C. Smith, L. Sizemore, M. H. Tang, C. B. Wilks; (in arrears) R. E. Cameron, C. J. Franch.

Reinstatement: J. S. Urkuhart.

Officers elected for the coming year:

As from 1 September 1977 —

President: Associate Professor C. A. Wright.

First Vice-President: Associate Professor W. E. Harvey.

Second Vice-President: Professor A. D. Campbell.

General Secretary: Mr J. G. Fletcher.

#### Prize-winner:

The ICI Prize was awarded to Dr G. P. Glasby.

## JOURNAL MATTERS

The following articles will probably be published in the March issue of the journal, Chemistry in New Zealand.

The Easterfield address — **Feats of Clay.**

The winning student paper from the 1977 Conference.

**Ozone and the Upper Atmosphere** — a rundown on the reactions that occur in the various layers of the atmosphere.

**Carbon-13 NMR Spectroscopy.**

**The 1977 Salary Survey.**

The biochemical plenary lecture on **Histones** and the chemical plenary lecture on **Galactochemistry** and possible origins of life have both been received in the form of articles.

The following books have recently been received for review and members with an interest in any of them are requested to let the Editor know if they, or a colleague, are available to review these books.

**Trends in Electrochemistry**

#### Theoretical Rheology

The Catalytic Chemistry of Nitrogen Oxides  
Group Theoretical Techniques in Quantum Chemistry

Mossbauer Effect Methodology

Dynamics of Molecular Collisions

Resinography

Quantum Science — Methods and Structure  
Contemporary Quantum Chemistry — an introduction.

Reactivity of Solids.

Organic Chemistry of Sulphur.

Semi-empirical Methods of Electronic Structure Calculations.

Advances in X-ray Analysis — vol. 20.

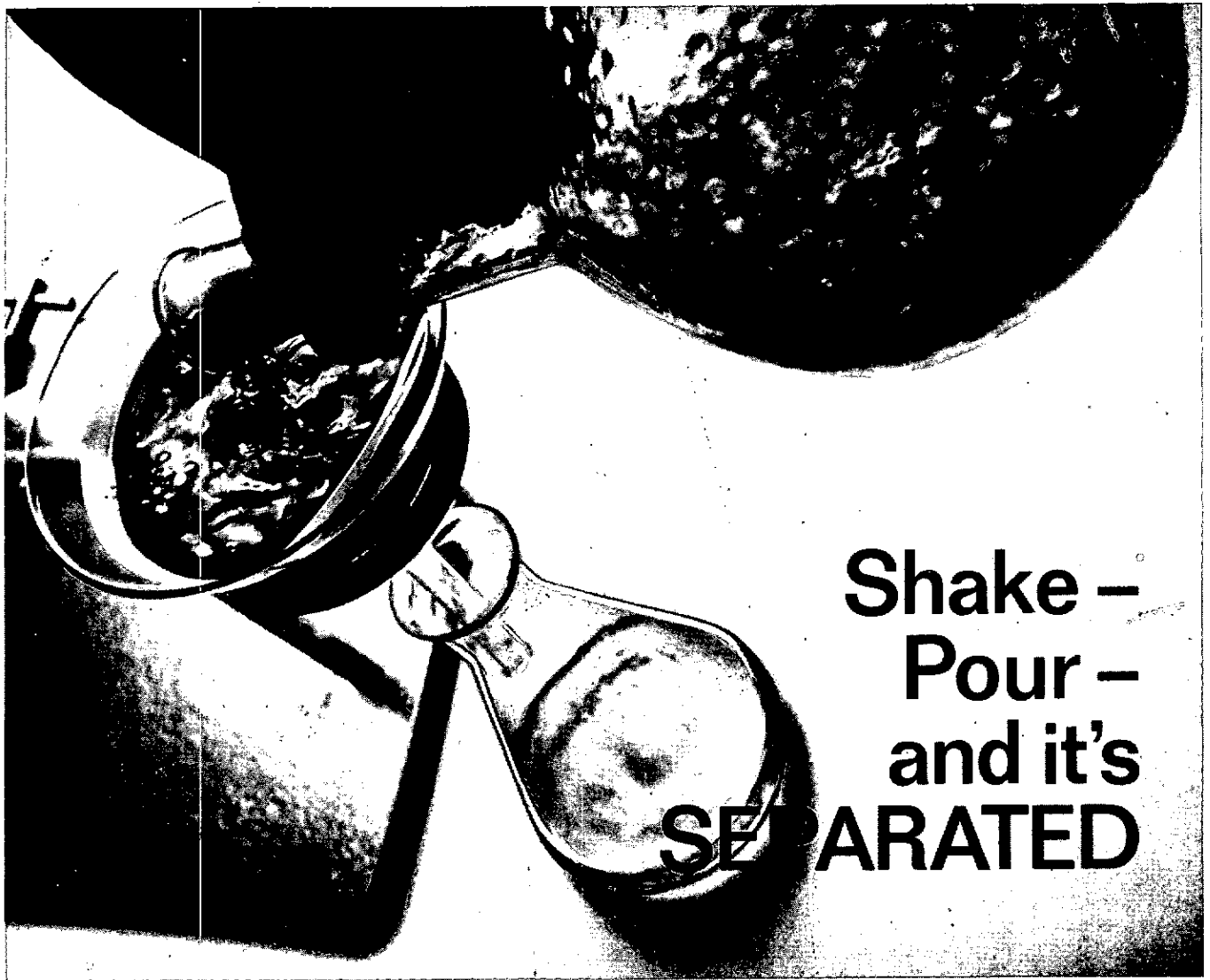
The Chemical Physics of Surfaces Treatise on Solid-State Chemistry — vol. 4.

Energetic Materials — vol. 1 and 2.

Advanced Organic Chemistry, part B (Carey and Sundberg).

Ligand Field Energy Diagrams.

The Prostaglandins.



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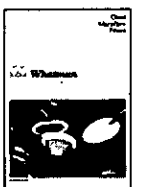
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retention time is adequate, the technique working best when the sample contains a limited number of components. The stability of the overall system must be kept within narrow limits giving, ideally, a retention time variation of less than 2%.

### Quantitation

**Without an internal standard** — Quantitation techniques based on peak height or peak area measurements are used. The former is particularly useful for narrow bandwidth peaks whilst the latter is preferable when peaks are broad and short. In addition area measurements are less subject to minor system variations and electronic integrators and computers facilitate these kind of measurements. Without an internal standard, a series of standards (extracted where this procedure is used) are chromatographed and peak heights (or areas) are plotted against concentration. Peak heights (or areas) of analytes in the test samples are related to concentration by reference to this plot. Extreme care must be given to all stages of sample manipulation.

**With an internal standard** — Calculate the ratio of peak height (or area) of each compound to that of the internal standard at a fixed concentration for a range of concentrations using standards (extracted, if the procedure involves this) and then plot the ratios against concentrations. Calculate the ratios in a test sample and determine the concentration of analytes from the standard plot.

An internal standard should be used whenever feasible to minimize system variables. It is better not to extrapolate from a single concentration of a standard. A plot covering the range required should be used for accuracy. This is especially true for peak height calculations.

### Sample Requirement

As with other chromatographic techniques, there are limitations on the complexity of the sample imposed by time and economic considerations. Where a sample consists of a solution of relatively pure components such as pharmaceutical formulations, it is necessary to ensure that insoluble particulate material, if present, is removed by filtration or centrifugation. The effect of insoluble material will be to clog the column creating intolerable backpressures in the pumping system. Other components of the sample may precipitate out on the column or the packing again giving rise to the back-pressure problem. A particular instance of this is the presence of protein in physiological samples, such as serum. It is feasible to analyze serum directly where specificity is intrinsic to the detector system used. However, protein in a sample will often precipitate out in the column or coat the packing materials and thereby limit the useful life of the column, either by clogging or by modifying the efficiency of the column. It is good practice to deproteinize samples of this type by a solvent extraction or by ultrafiltration. Solvent extractions may be less demanding than other techniques and generally, back extraction steps will not be required. Because HPLC is a microanalytical technique, it is advantageous to scale down extraction procedures.

Where a column is partially clogged by material such as protein, injection of a large volume of dimethylsulfoxide may clear the column.

## APPLICATIONS

HPLC combines the qualities of a high-resolution separation technique with the quantitative features of microanalytical techniques. The combination provides unmatched versatility for the analysis of an extensive range of compounds. In the decade or so that HPLC has undergone intensive technical development, an extensive body of literature has kept pace with both theory [2, 6, 9] and application [9, 10, 11].

Because the primary requirement of solubility for a compound is readily met, it is predictable that HPLC will become closely associated as an analytical and preparative technique with most areas of chemical analysis. The manipulation required is such that HPLC is readily adaptable to routine use. The earliest users were chemists in the pharmaceutical industry, HPLC providing basic quality control and analytical capability because many drugs are more readily and accurately analyzed by HPLC than by any other technique. The pharmaceutical chemists' pioneering working has helped promote interest in the analysis of therapeutic drugs in body fluids.

An example of a pharmaceutical sample is given in Figure 3 (a) which is a chromatogram of an analysis of an acetylsalicylic acid, phenacetin, caffeine formulation.

The ease of analysis in this application is reflected for example in the improved status of monitoring theophylline, a therapeutic agent used in the treatment for asthma. Previously techniques involved either large volumes of sample or extensive sample manipulation whereas HPLC requires microliter quantities of sample and very little manipulation of sample, the major requirement being the removal of protein which might otherwise clog or coat the column packing. An analysis for theophylline in 50-microliter of serum is given in Figure 3 (b).

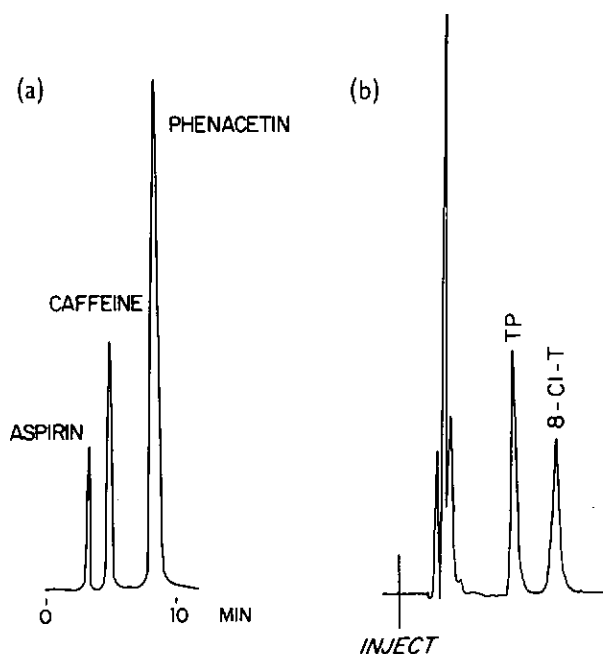


Figure 3 (a). Chromatogram of a pharmaceutical formulation containing acetylsalicylic acid, phenacetin and caffeine. The conditions were: Column: Sil-X-1 ODS at 70 C; Eluent: 30:70 MeCN:Water at 1 ml/min; Detector: UV at 254 nm, 2 AUFS. One  $\mu$ g of each compound was present in the solution.

(b). Analysis of 50  $\mu$ l serum containing ingested theophylline. The patient serum extract contained 15.1 mg/l theophylline. TP is theophylline and 8-Cl-T is 8-Chlorotheophylline (internal standard).

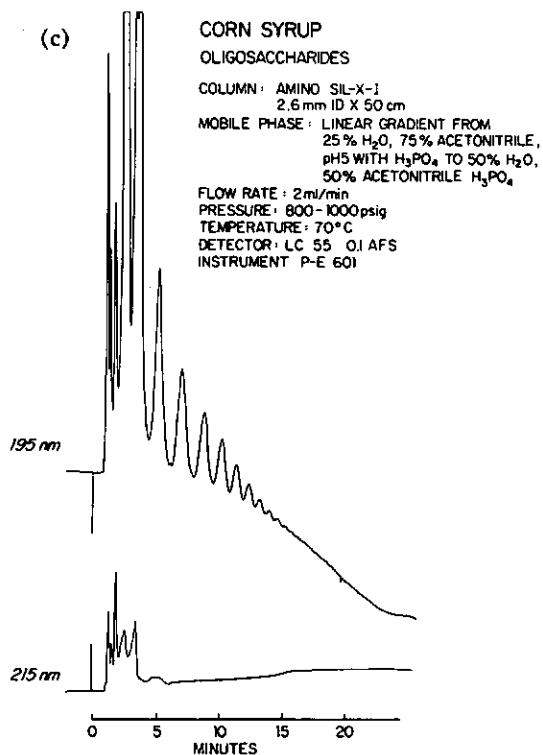
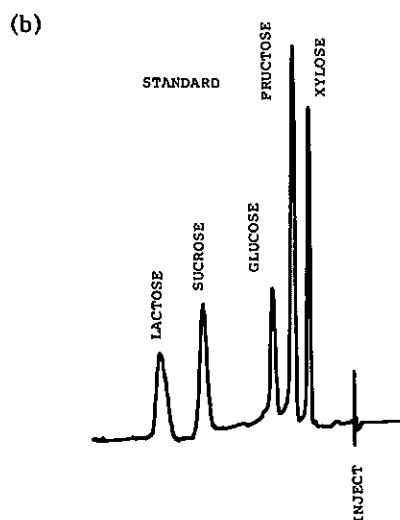
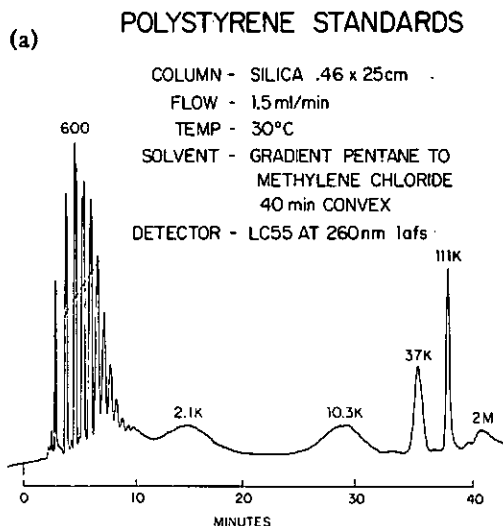


Figure 4 (a). Separation of individual polymers by molecular weight.

(b). Separation of sugars in a mixture.

(c). Separation of oligosaccharides.

In organic chemistry knowledge of the components of a reaction mixture at various stages of a reaction is often important. HPLC is suited to this type of analysis providing quantitative accuracy for the components in a very small sample. The analysis of a final polymer product is given in Figure 4 (a) and shows the wide range of molecular weights obtained.

Perhaps the major impact of HPLC will be in the area of natural products. Because of the complexity of many samples, a high resolution separation as well as quantitative technique is mandatory. The study of sugars has been difficult, with a lengthy separation time being required for separation of their borate complexes, or extensive manipulation being required prior to the gas chromatography analysis. A rapid separation of twenty mono- and disaccharides is possible by HPLC, some of which are shown in the chromatogram of a standard mixture (Figure 4 b). It is possible to extend this type of analysis to oligosaccharides present in, for example, hydrolysed corn starches. Figure 4 (c) is a chromatogram of oligosaccharides obtained from just such a sample.

Natural oils, such as vegetable or fish oils, are successfully analyzed by HPLC. The type of separation obtained is illustrated in Figure 5, a fish oil.

The examples may be extended almost ad infinitum. They represent work that is recent. The history of the new technology of HPLC is short, consequently the technique is in a state of rapid flux with new applications reported almost at an exponential rate.

It is to be anticipated that column and detector technology will provide the interesting developments of the future. Affinity chromatography will be of growing importance to the biological sciences and in applications of the mechanism for industrial requirements in large-scale isolation of specific macromolecules. In the

#### FISH OIL

COLUMN AMINO-Sil X-1 50 cm x 2.6mm PLUS  
 CYANO-Sil X-1 50 cm x 2.6mm  
 MOBILE PHASE 1.25% ISOPROPANOL IN HEXANE  
 FLOW RATE 2 ml/min  
 PRESSURE 800 PSIG  
 SAMPLE 2µl FISH OIL  
 TEMP 65°C  
 DETECTOR LC 55 298nm@ .2AFS  
 INSTRUMENT MODEL 601

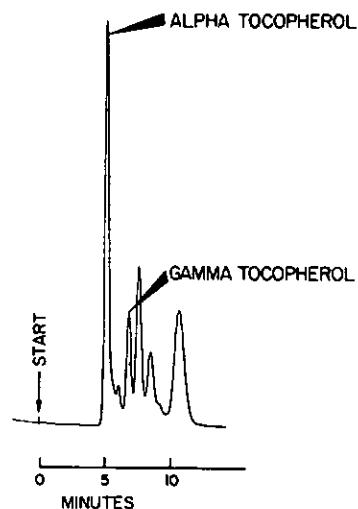


Figure 5. Separation of fish oil.

context of regarding the HPLC system as a refined means to pretreat the sample it is apparent that the only detector that combines near universality with specificity, the mass-spectrometer, must be joined with HPLC. To make an analogy with GC-MS-COM we may predict confidently that the LC-MS and LC-MS-COM will be systems of choice as development continues. Additionally, as HPLC uses continuous flow, complete automation including sample handling will be a readily attainable goal.

#### REFERENCES

- 1 Tswett, M., Kromofilly, V., Rastitel, non, Zhivotnon Mire, p. 233, Warsaw University (1910).
- 2 Snyder, L.R. and Kirkland, J.J., "Introduction to Modern Liquid Chromatography", New York: Wiley Interscience (1974), pp. 194-195.
- 3 Ibid., p. 200.
- 4 Grushka, Ed., "Bonded Stationary Phases in Chromatography", Ann Arbor Science Publications: Ann Arbor, Michigan (1974).
- 5 Dunlap, R.B., Ed., "Immobilized Enzymes and Affinity Chromatography", Vol. 42, "Advances in Experimental Medicine and Biology", Plenum Press: New York (1974).
- 6 Scott, R.P.W., "Contemporary Liquid Chromatography", "Techniques of Chemistry, Vol. XI", John Wiley and Sons: New York (1976).
- 7 Lawrence, J.F., Frei, R.W., "Chemical Derivatization in Liquid Chromatography", J. of Chromatog. Library, Vol. 7, Elsevier Scientific Publishing Co.: Amsterdam (1976).
- 8 Bayer, E., Grom, E., Kaltenecker, B., Uhmman, R., Anal. Chem. 48, 1106 (1976). "Separation of Amino Acids by High-Performance Liquid Chromatography."
- 9 Heftmann, E., Ed., "Chromatography, 3rd Ed.", Van Nostrand-Reinhold: New York (1975).
- 10 Done, J.N., Knox, J.H. and Loheac, J., "Applications of High-Speed Liquid Chromatography", New York: Wiley Interscience (1974).
- 11 Brown, P.R., "High Pressure Liquid Chromatography: Biochemical and Biomedical Applications", New York: Academic Press (1973).



#### 1977 ICI PRIZE WINNER

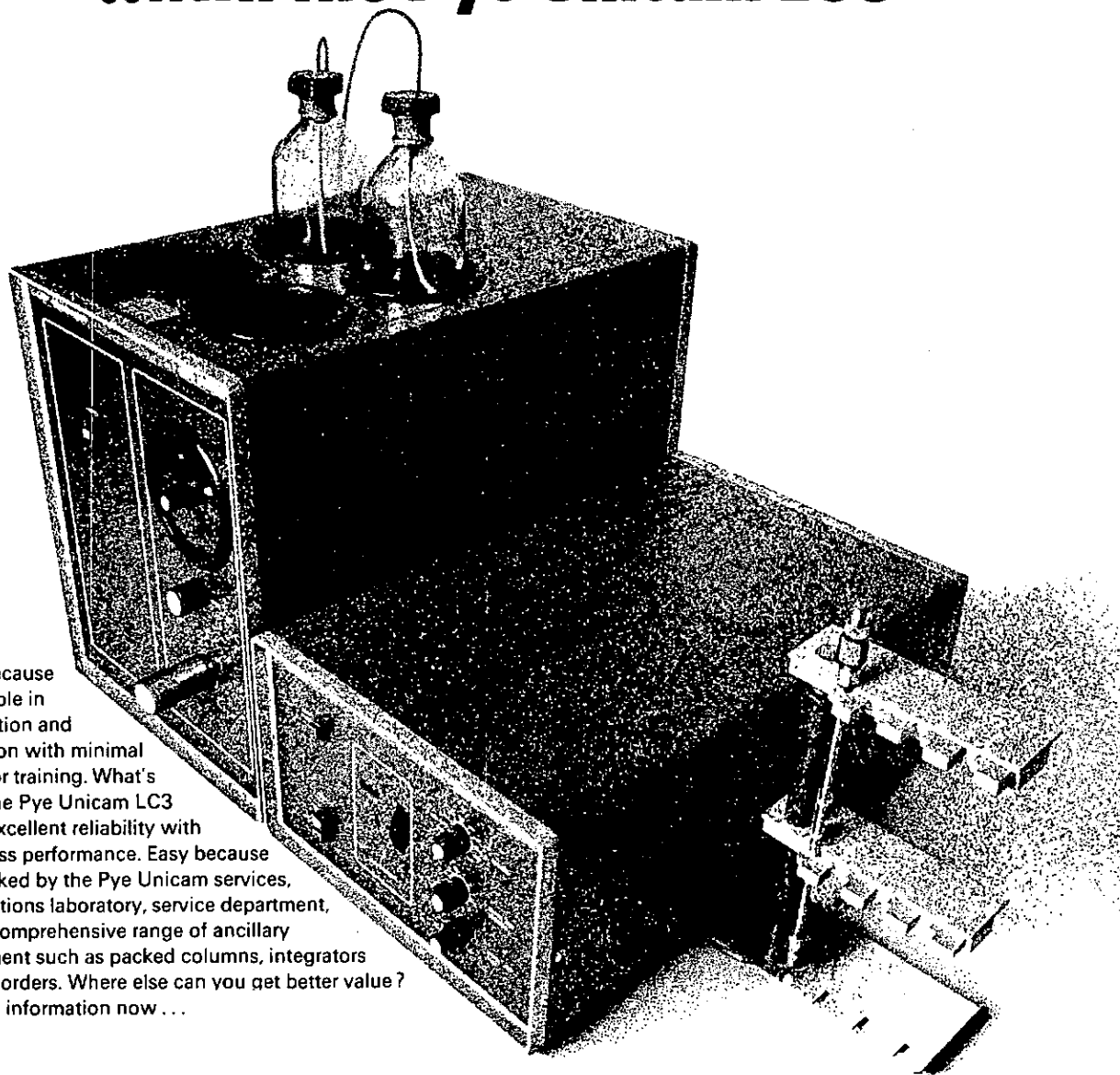


Dr Geoff Glasby (New Zealand Oceanographic Institute) has been awarded the I.C.I. Prize of the New Zealand Institute of Chemistry. The award is for his work on the geochemistry of marine sediments and particularly deep-sea manganese nodules. In the case of manganese nodules, this has involved a consideration of the optimum conditions of nodule formation and the mechanisms by which elements are incorporated into the nodule structure. To achieve this, a detailed study of nodules from a wide range of locations and environments of deposition has been undertaken using such techniques as elemental analysis, X-ray diffraction, electron microprobe analysis, scanning electron microscopy, spark source mass spectrometric analysis, Mossbauer studies and detailed statistical analysis of compositional data. The result has been to help establish the relative roles of environmental parameters such as direct deposition of elements from seawater, diagenesis, biological cycling of elements from the upper layers of seawater, sedimentation rates and others on the mode of formation of nodules under a range of environmental conditions. A number of features of nodules such as their distribution, abundance, shape, surface texture, mineralogy and chemical composition are all dependent on such external environmental conditions. The study of nodule formation is of particular interest to chemists because it involves the conglomeration of iron and manganese oxide colloids and sorption of transition elements in a medium of intermediate ionic strength (0.7M) under different fluctuating environmental conditions. Geoff has recently been concerned with manganese nodule distribution and geochemistry in the Southwestern Pacific and Samoan Basins and has just edited a book entitled 'Marine Manganese Deposits' for Elsevier.

Another aspect of his work is the geochemistry of marine sediments. This has involved studies of the mineralogy and geochemistry of sediments from three different continental shelf environments: the Bay of Plenty, Southern Fiords and Ross Sea, as well as deep-sea sediments from the Southwestern Pacific and Samoan Basins. The Bay of Plenty Study was particularly interesting because it involved a study of the effect of submarine geothermal activity on the composition of the surrounding sediments, a feature not readily studied elsewhere.

His current interests are the regional geochemistry of marine sediments around New Zealand and the mineralogy of iron in marine sediments from different environments using Mossbauer spectroscopy.

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# A GAIJIN FAMILY IN OSAKA

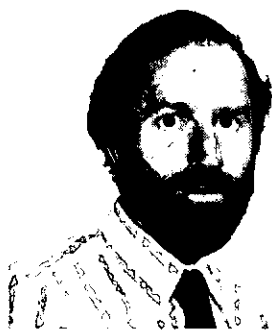
A. M. BRODIE

Department of Chemistry, Biochemistry and Biophysics,  
Massey University

Did you lecture in English? What did you eat? What sort of house did you live in? Where did your children go to school? These are typical of the questions I have been asked since returning from a year in Japan with my family.

From February 1976 to January 1977 I visited Osaka University as guest lecturer in the Chemistry Department, Faculty of Engineering Science. During this time I was involved in teaching and research in the field of bioinorganic chemistry, being associated with Professor S. Otsuka, who heads a group with an international reputation. The lectureship was newly established and funded by a grant made to the department by the Japanese Ministry of Education. I was the first recipient of the fellowship and the first foreign lecturer in the department for over eighty years.

I lectured to a graduate class (once a week for ninety minutes) over one semester. As I was lecturing in English it was not easy to get much response from the class, partly because the students' ability to comprehend oral English is generally, but understandably, not high. However, they could read English well and because I was able to make use of handouts and other visual material, the lectures appeared to be well received. About forty students completed the requirements for the course, much to the surprise of some of my Japanese colleagues, as students can choose which courses they complete for their Master degrees, although they must do a certain set number. Normally about 30 students turn up for the first lecture but the lecturer is lucky to be left with five after a few weeks.



*DR ANDREW M. BRODIE is a Senior Lecturer in the Department of Chemistry, Biochemistry and Biophysics at Massey University. He graduated B.Sc (Hons) from the University of Canterbury in 1966 and Ph.D in 1968. He spent eighteen months on a Science Research Council Fellowship at University College London before*

*taking up a lectureship at Massey University in 1970. Last year he was guest lecturer in the Chemistry Department, Faculty of Engineering Science at Osaka University. He is an Inorganic Chemist who is interested in the transition elements, especially the role they play in biological systems.*



*Third year physical chemistry students in laboratory, Faculty of Engineering Science, Osaka University.*

Although most of the academic staff in the department had lived for periods in Western countries, their students had had very little opportunity for contact with Westerners on a personal level, much of their information coming from American films, shown dubbed in Japanese, on television. Questions such as: — "What time did our children go to bed?" (Japanese children never go to bed before 9 p.m.); "Did I wash the dishes or clean my shoes?" (no Japanese male would ever confess to such things even if he actually did them); "Was my wife cross when I went out without her?" (the Japanese have an expression: "Australian husband" which means a husband who is too good and kind); and "How did I spend my two day weekend 'holiday'?" (most Japanese work six days a week) were often asked and perhaps typify some of the differences between our two cultures.

To a New Zealand family suddenly precipitated into life in Japan, so many things were different that it is difficult to describe them all. The expression, "the mind boggles" took on a new dimension. Initially, because all reference points with which we had always had contact were removed, it was almost as if we were on another planet. At first we got lost very easily as all the houses, all the shops and all the Japanese writing looked the same. It was impossible for our subconscious minds to absorb something for future reference. We missed seeing English written and hearing it spoken. We found that the everyday things which we had always done, like making a



*Fishing, Nango Fish Centre, near Kyoto. Payment is by weight of fish caught. Fish bred at the centre are sold to restaurants or released into rivers and lakes.*

telephone call, calling a doctor or enrolling our daughter at the local kindergarten became difficult or even impossible without assistance. Even though our Japanese hosts were always helpful sometimes misunderstandings arose such as the time my daughter went off to kindergarten with an empty drinking bottle instead of a full one. A recent article in the "Mainichi Daily News", which reports that the wife of a Japanese businessman, newly arrived in New York, killed her daughter and attempted to take her own life, indicates that the problem can become a serious one for those not prepared for cultural changes. I now feel that I have a much better appreciation of how Asians or Polynesians must feel when they first arrive to live in New Zealand.

When we arrived in Osaka early on a crisp Sunday morning we were met by Professor S. Otsuka and Professor A. Nakamura who was an associate professor in the group in which I was to work and who was to be our next door neighbour. Over a cup of coffee in the terminal building Professor Otsuka handed me a brown envelope full of banknotes and asked me to count them. This was our introduction to the Japanese habit of handling large amounts of cash and one to which we never could get accustomed. I was paid monthly in crisp new banknotes and my wife nervously carried them off to the bank, hoping she would not lose them. Personal cheque accounts are not common, and to withdraw money from the bank we needed our personal **hanko** (stamp) which had our name translated into Japanese **kana** engraved on it. The hanko also allowed the group's secretary to collect the salaries from the administration office and as a result everyone knew what everyone else earned.

For New Zealanders, the cost of living in Japan is undoubtedly high, our food bill for two adults and three young children, being about \$470 per month. Typical costs were milk 80 cents a litre, bread 30-90 cents a small loaf, mince meat \$1 for 100g and

cheese 90 cents for 250g. Although most Western style food was available it was sometimes difficult to know exactly what we were buying, like the time my wife bought what she thought was marmite only to find it was a black seaweed paste for putting on rice! On many occasions, due to the hospitality we received, we had the chance to eat Japanese-style food, which we learned to enjoy. Mrs Nakamura would often pop over with a sample of a tasty dish which her family was having for their own evening meal. Raw fish, squid, seaweed soup and red bean paste cakes are some of the more exotic things we tried. My wife would never have managed in the first few weeks without the help of Mrs Nakamura who introduced her to the local market. Shopping there never ceased to fascinate us, with its colourful fabric of sights, smells and sounds. We quickly learnt to say "Ikura desu ka" (how much does it cost?) and to understand the reply. Energy costs and rail fares (we did not buy a car) also consumed a considerable portion of our income but we were able to buy a second hand black and white T.V. set for \$15. Rent amounted to \$80 a month, but this was well below open market rates being subsidised by the University.

Initially we lived in a small wooden half-Japanese style house kindly let to us by Professor Nakamura. The house was spacious (about 650 square feet) by Japanese standards, consisting of two bedrooms, a dining room, kitchenette and bathroom. The Japanese features were the **tatami** (straw) matting floors in two rooms, the low dining table (with a hole underneath let into the floor, which in the winter contained a heater) and the bathroom. The latter, though traditional Japanese in style, with its deep bath and adjacent soaping area, was constructed of fibreglass and attached to the house before our arrival as a complete unit — a typical example of Japanese ingenuity where a traditional idea is adapted to modern methods. The toilet was designed so that the cistern lid doubled as a handbasin. Water used for hand washing was not wasted but flowed into the cistern below. We had to remember to remove our shoes on entering the house, a habit which many New Zealand mothers would agree is a good one when trying to keep



*Our Moriguchi house, front entrance. The "shoe off" place, not visible, but behind the sliding glass door, and the bars over the windows are typical features of Japanese houses.*



*Kindergarten children, at desks, practising patterns to be transferred to an apron later. Uniform hats and bags hang at the rear.*

winter mud outside. The house had its low doorways which would strike at unsuspecting moments and the sink bench was not built for tall Westerners either. We were lucky in that we had furniture lent to us, though we had to buy the other essential items for everyday life. Furnished accommodation for rent, and second hand furniture for purchase are both nonexistent in Japan.

Our house was situated in Moriguchi which was some distance from the University (one and a half hours by train) but generally I was able to travel with Professor Nakamura in his car. Moriguchi was a small village which has now been engulfed by the sprawling megapolis of Osaka City, however it has still retained its small village character, with its friendly people and small houses crammed together, each with pot plants along the street or balanced precariously on the fences. After six months we moved to Toyonaka and into a house that was only a few minutes walk from the campus, and one of a group just constructed by the university for foreign lecturers. It was essentially Western in style and in an area not unlike some parts of Wellington.



*First grade school children deliver lunches to classrooms.*

Compared to those in Moriguchi the houses were newer, larger and with some land around them, being mainly owned by wealthy businessmen.

My daughters attended Japanese language kindergartens and schools as English language education at this level is only found associated with the international communities of Tokyo and Kobe. Education in Japan is much more formal, especially in the kindergarten, than in New Zealand, and our girls found that it took some getting used to. We wondered if the pressure to conform would tend to restrict creativity and individuality. On the other hand Japanese work effectively in groups and have a great respect for authority and this results, for example, in Japanese cities being among the safest in the world. Our daughters were young enough to integrate into the system, although the teachers did not speak English. However for children older than about seven, attending Japanese schools would not be easy. Japanese children themselves, who have been overseas for two or so years find it difficult to step back into their own system and two special schools are now being established for them.



*First graders eating lunch, which includes a bread roll, soup and a bottle of milk.*

Living in Japan with children does have its advantages as the Japanese are child lovers and many times our children received sweets or fruit from complete strangers. It did not take us long to understand simple questions such as "What is your name" and "how old are you?" Admittedly we sometimes felt like royalty with smiling people crowding around to photograph our baby.

Although Japan is a small country in terms of area it has much to offer and interest the Western visitor — millions of people always everywhere, shrines, temples, markets, beautiful gardens, and autumn colours, contrasted against the tall buildings, immense department stores and efficient railways. We were never lacking for something to do or somewhere to go. As a family, the opportunity to live in Japan for a year gave us a unique chance to gain some understanding and appreciation of a country with which New Zealand is having increasing contact. In retrospect life had a dreamlike quality — were we really there? And yet it still seems so close that tomorrow we could walk down the street to the local shrine.

# A CHEMIST IN TOKYO

C. J. WILKINS

Department of Chemistry, University of Canterbury

In describing experiences in Japan the Western visitor often finds his material so varied that he can cover few aspects in a short space. Therefore I restrict myself mainly to something I saw of university research and to impressions gained in the course of a couple of visits, one to a chemical research centre, and the other to a steelworks. Certainly this is to the exclusion of much else because I was favoured with invitations to visit a good many homes and to attend interesting functions. I was taken on sight-seeing trips and with most considerate help from my "host scientist" arrangements were made for me to go wherever I wished in the time available.

My interest in Japan has developed slowly over a lengthy period and last year I was fortunate to gain sponsorship in the form of a Japan Society for the Promotion of Science Fellowship which enabled me to spend seven months in the country. J.S.P.S. is a government funding agency [1], and so far as the foreign recipients of its awards are concerned it operates through its host scientist system. Professor Kozo Kuchitsu who had nominated me for work in his gas electron-diffraction laboratory in the Chemistry Department, Faculty of Science, University of Tokyo, was my host scientist.

When I reached Japan I found that in general the information I had been able to gain about the way of life was to stand me in good stead, and I did not find too many surprises. However, I had much to learn about the university and educational systems, and although I knew of the particular vitality of the Japanese people, I still had to learn at first-hand of the qualities that translate into their remarkable industrial enterprise [2]. Until I saw the rate at which new buildings rise I had never quite been able to understand how so vast a city as Tokyo had twice been completely rebuilt within 50 years. With the rapid population growth of the Greater Tokyo area to about 25 million, the problems of providing modern utility services have been challenging, and to some extent, remain a challenge. Daily movement on the transport system is enormous and the smooth running of train services on the world's busiest tracks is a feat in itself.

If I had felt that I might get a little confused to start with at Tokyo's busier railway stations the misgivings were to be realised. One of my daughters had done her best to provide me with all the phrases needed to get the **gaijin** out of a spot, but with a few of the 2 million commuters who pass daily through Shinjuku milling past me (and each of them knowing exactly where to go!) I did not always find the immediate composure to use the phrases-for-foreigners approach, but fell into trial and error tactics. Yet life in Tokyo can be so full of continual interest that the Western visitor can get an 'out of this world' feeling. The subway scene never failed to fascinate me, even allowing for rush-hour close-packing and the strap-hanging trip home that could be tiring at the end of the day. It was interesting around mid-day on a Saturday when high-school pupils in student uniform seemed free and easy going home for their half-holiday at the end of the 34 hour week of classes. Later, in the evening, some would avail themselves of the supplementary English language instruction broadcast for their benefit by NHK.

## The University Scene

The University of Tokyo was the first in the country to be established (1877) and with its location in the capital, it still remains queen amongst the original seven "Imperial" Universities. It has provided many men influential in government, business and education. Even I was to feel wider benefits from associations with this particular university. When for example I wondered if I could visit a steelworks my host scientist telephoned a graduate of former years



*The author, Professor of Inorganic Chemistry, Canterbury University, together with his host scientist, Professor Kozo Kuchitsu, on Yokohama Station.*

*Cover photograph:  
The Akamon or ceremonial Red Gate of the University of Tokyo on a Sunday afternoon. The gate, built in 1828 as the entrance to an estate, is normally open to pedestrian traffic.*

and it was soon arranged that I go to the Nippon Steel Corporation's Kimitsu plant — the largest in Japan and one of the most up-to-date.

I was fortunate in other ways too [3]. Before I arrived in Japan I had expressed the hope that I might be able to work closely with research students. The hope was fulfilled beyond expectations because I found myself working with a delightful group of students in the electron diffraction laboratory, ranging from final-year undergraduate to senior doctoral. In addition, because I needed to do some preparative work, I had the opportunity to migrate from "Physical Chemistry III" into the laboratory of quite a different group, "Synthetic Inorganic Chemistry". If students were a trifle disappointed that the foreigner could not even decipher the names on solvent bottles and gas cylinders they always remained unfailingly helpful.

One or two arrangements, though not of much use to the illiterate visitor, illustrate the Japanese capacity for effective communication. With names written vertically it is easy to arrange name-tags on a peg-board in the entrance. The **kanji** were in black on one side of the wooden tag and red on the other, so that reversal showed who was in or out. Then outside each room there was a small chalk-board on which an occupant who was away wrote a character or so to indicate his whereabouts.

Statistics convey some idea of the severe examination competition for undergraduate entry to the National Universities, and especially the former Imperial institutions [4]. These Universities, where fees are low and teaching conditions generally better than at the more numerous Private Universities, provide only 80,000 places for the total of 5-600,000 students entering each year. With some 35% of the age groups continuing each year from senior high school, university resources are under strain. The Japanese people have a great desire for education, but with universities producing more than enough graduates under existing arrangements they are disinclined to divert still greater resources towards them. When the country went through its period of reconstruction and particularly rapid development during the period 1950-1970 opportunity for university education was smaller than now exists.

The structure of the whole educational system is quite uniform throughout the country. The bachelors degree is taken after a four-year course, with students majoring in chemistry being required to undertake a research project during the final year [5]. At the University of Tokyo this research is done on effectively a full-time basis during the eighth semester. Then at the Tokyo Department there is once again completely open examination competition for entry to the 40 or so places available each year for the two-year masters course. Students offering themselves for the ensuing three-year doctoral course are selected on the basis both of their masters showing and especially their ability to formulate a research proposal which has to be explained and defended before examiners. Thus every care is taken to ascertain in advance whether a candidate is really of doctoral potential.

The way in which the universities develop the research capabilities of their students has to be



*Students at the control panel of the electron diffraction camera.*

viewed against the whole academic system. The activities of a department centre on the Chairs and the size of any department is determined by the authorized number of Chairs, of which there are 12 in the Tokyo Department. Each Professor has his own research group, and so far as the research is concerned, each operates completely independently in accordance with the **Koza** or "seat of learning" system [5, 6]. Each **koza** receives a grant direct from the Ministry of Education to cover ordinary research costs. Along with the professor, the group comprises an Associate Professor or Lecturer, and two Assistants. The Assistants are concerned entirely with research matters, including seminars, but not with departmental teaching. The Professors and Associate Professors comprise the Faculty who choose one of their number as Chairman for a two-year period. Many of the Assistants are very able persons who, in the heyday of the University expansion, 1950-65, would doubtless have gained more senior appointments without having to wait so long. The precise role of Assistants would vary with the circumstances. They do whatever is needed to keep the research going forward smoothly.

A typical research group at Tokyo might contain perhaps 4 under-graduates, and half a dozen each of masters and doctoral students. Weekly seminars, usually lasting half a day but sometimes longer, play an important part in the training of the students. Because electron diffraction is the smaller part of Professor Kuchitsu's current research he was in the habit of running additional seminars on Saturday afternoons to cater for his students of this minority group. The **koza** system is particularly well suited to the natural Japanese inclination to work within a group. Final semester under-graduates are usually assigned to work on some established line. The graduate students in the group assisted their introduction to the specialities of the work. The new under-graduate researchers whom I saw threw themselves into their work with zeal and took off very quickly. Research goes forward with little support from technical staff. Some students would tend to specialise in say electronics and others in workshop practice, so that dependence on outside services is kept to a minimum. The typing of theses (which are often presented in English) affords another example of group co-operation.

At the Tokyo Department it is required that masters and doctoral theses be submitted by specified dates and an abstract of the research is required a little in advance. The abstract provides the basis of a public oral presentation when successive candidates face their grading examiners and deal with whatever questions may be raised. For doctoral candidates A and B grades mean a green light to proceed to the thesis examination; C stands for a cautionary yellow light, with the requirement of extra work; and the red light D is only in reserve.

The high polish on the final oral presentations owes much to seminar discussion and the stimulus of presenting student papers at National Meetings. In preparation for all such papers, students hold practice sessions and help one another with constructive criticism. Going on what I saw of the achievements of masters students, their research training would be close to that of our Ph.D candidates. It is an effective research system especially well suited to the Japanese predisposition to work within a group, but irrespective of this it has to be said that in terms of any value-for-money basis [6] our New Zealand system suffers badly through comparison.

### The Sagami Chemical Research Center

This center, established in 1963 for independent research, represents an interesting concept. It is supported by the Industrial Bank of Japan and 15 other Companies associated with chemical industry. Its aims embody the ideals both of contributing fundamental information that could lessen the dependence of Japan's chemical industry on imported technology, and of furthering particular areas of chemical knowledge that may bear rather directly on human welfare. Lines of research falling within the latter category include the efficient use of energy and natural resources, environmental improvement, and the synthetic approach to bio-active compounds. The Center is magnificently equipped for its work and enjoys a semi-rural setting on the south-western outskirts of Tokyo. Some examples of what the Center has been doing will indicate the scope of its activities.

Process for industrial production of oxamide as a slow-releasing fertiliser.

Process design for production of carbonyl sulphide for manufacture of a herbicide known as "Saturn".

Development of the reagent formaldehyde dimethylmercaptal S-oxide and its applications in organic synthesis.

Total synthesis of the biologically important iron-binding cyclic hexapeptide pigment, ferrichrome.

Development of a new method for analysis of NO and NO<sub>2</sub> in air by means of gas phase EPR.

Preparation and distribution of internationally accepted standard reference solutions for use in marine nutrient analysis.

New Zealand chemists concerned with water analysis will probably know of the work of Dr Mitsuko Ambe in this last field [7].

No visitor to this Institute could fail to be impressed by all aspects of its work, at present under



Students from the 'Synthetic Inorganic Chemistry' research group dine out at a special end-of-year party. Note the sake jars and the array of small dishes.

the leadership of President Yonezo Morino, an Emeritus Professor of the University of Tokyo. Within the laboratories the foreign visitor notices the dedication of staff at all levels.

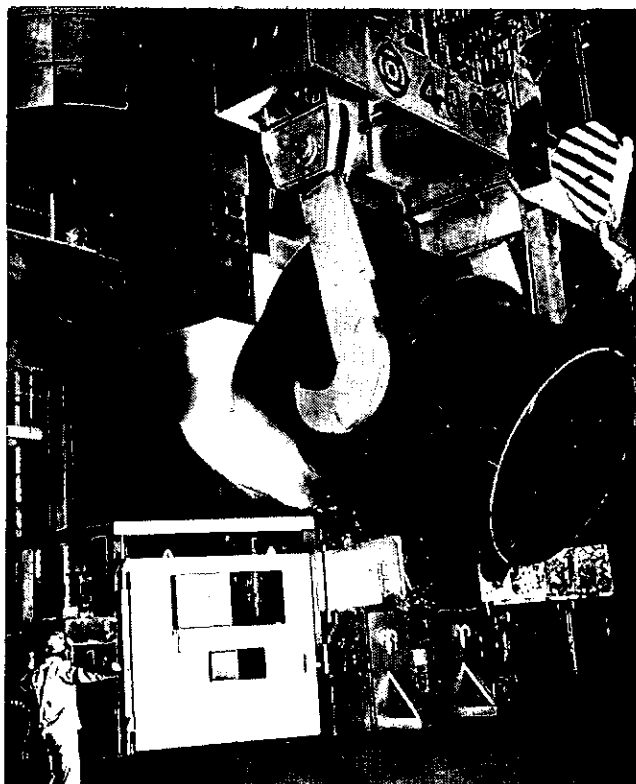
### The Nippon Steel Corporation's Kimitsu Plant

My visit to this plant was to satisfy the desire to see something of heavy industry. The Kimitsu Works, with a capacity of some 10,000,000 tons per annum is one of the world's largest and most advanced steel works. The first blast furnace was blown-in in 1968 and the last in 1975. The plant produces a wide variety of products including the largest diameter heavy steel piping used in oil fields around the world. The works are situated in reclaimed land on the eastern side of the entrance to Tokyo Bay, with wharf frontages that provide depths of 17 metres for ore-carriers. When I made my visit, there was a clear view of Mt Fuji across the bay; closer at hand scores of ships from super-tankers to fishing smacks plied the busy waters.

Ores from Brazil, Australia, India and beyond, were stacked according to their origin. I saw no one as we drove through the area, but the complex network of conveyer belts was carrying the ores in their predetermined quantities to the mixing and sintering plants where the uniform feed for the blast furnaces is made up. Calculation of the ore mix (according to composition, cost, availability, etc.) is an example of computer application within the plant. It had been explained to me before my tour commenced that the whole of the production within the integrated plant was controlled by a "total on-line real time" system, referred to as Kimitsu AOL (all-on-line).

The blast furnaces (of capacity up to 11,000 tons per day) are fitted with oil-fired burners for supplementary control of the reduction. The tapping of a furnace was a mechanical operation and apart from the initial oxygen lancing there was not a great deal to see of what was perhaps 300 tons of metal run off from each of the four tapping holes in succession, before it flowed into the torpedo car ('hot car') for transport to the converters.

I was told something about the converters as we walked past a miniature classical garden, complete with waterfall, arched bridge and stone lanterns,



*The No. 2 L.D. converter plant at the Kimitsu Works of Nippon Steel Corporation.*

wedged in somewhere between blast furnaces and converter plant. I learnt that the LD (Linz-Donawitz) converters at Kimitsu are among the world's largest [8]. Scaling to 300 tons capacity with the necessary provision for cleaning and collecting the flue gas with its useful carbon monoxide content was a major technical achievement. Even after seeing a converter in action it was not easy to grasp that the 4-5% of carbon in a 300 ton charge could be removed by oxygen lancing in only 18 minutes. To assist the converter operator in running the oxygen injection and deciding the optimum point of time for sampling, full information is displayed above his control panel. An estimate of the time as extrapolated from the analytically confirmed results of the last five charges is shown on one screen. Another screen gives an interior view of the converter with its oxygen lance and a third records a temperature plot of the metal as the oxidation proceeds.

The subsequent processes for forming the steel through ingots, slabs and blooms and on to the finished products are under similar computerised and automatic control. It was easy to appreciate the way these features contribute to high productivity; calculated on an output per annum basis the figure is about 1200 tons for each employee. It can be assumed from the readiness with which the products find export markets that prices must be rather competitive. This is more significant in the cases of an industry based on imported ore and fuel having to make unusual efforts over environmental safeguards.

I left Kimitsu feeling satisfied that I had been able to see such an enterprise. I found myself thinking again on the circumstances that carried Japan to so remarkable a resurgence after the war [9]. Japanese

industrial men commonly speak of their advantage in having an alert and well-educated work-force. Then my guide had mentioned the careful organisation behind the smooth running of the Kimitsu plant, consuming as it does some 60,000 tons of raw materials each day. Such remarks emphasise how the nation's resource lies in its people, with their capacity for planning and for co-ordinated effort. The importance of individual contributions towards the success of group-wise effort has led quite naturally to a system of bonus payments, which in turn feeds back to reinforce inherent attitudes.

There is no doubt that my stay in Japan brought unusual opportunities, including the contacts with industry and industrial research. But the traveller returning from these kinds of experiences finds the economic contrasts thrown up by some aspects of the current New Zealand scene to be sharper than make for comfort. We would all wish to eliminate ingredients for economic decline, but through historical dependence on a successful farming economy we do not offer too much else that is competitive on world markets. The urgent need to expand efficient industry is one which has to be tackled on several fronts.

At an earlier stage Japan quickly learnt from the West; perhaps we who come of the Western tradition may yet recognise a need to learn from the East. If my own experience is anything to go by, it can be helpful to be outside the Western world in order to see alternative approaches to some of our own problems. This is but one reason among a number, for my hope that through development of reciprocal arrangements, others might also be able to enjoy opportunities like my own.

#### Notes and References

1. J.S.P.S. operates both International and Domestic Programmes. In its international activities the Society often works on a reciprocal basis with corresponding scientific bodies in other nations, thus fostering two-way exchange. The Society publishes (in English) a Directory of Colleges and Universities in Japan.
2. See for example "Japan's Economy" and "The Japan of Today" distributed through Embassies by the Ministry of Foreign Affairs.
3. Like other foreign visitors to the University of Tokyo I had the benefit of inexpensive accommodation at the International Lodge maintained by the University.
4. Birnbaum, H. (1973), *Science*, 181, 1222
5. Howery, D.G. (1973), *J. Chem. Ed.*, 50, 705. This article deals quite fully with chemical education in Japan.
6. The *koza* system is probably most firmly entrenched at the Imperial Universities. These produce a high proportion of the total of masters and doctoral graduates in science (Findeis, A.H. (1972), *Science*, 177, 583). This author also indicates *koza* running costs.
7. Ambe et al. (1975), *J. Oceanogr. Soc. Japan*, 31, 33
8. The change to LD converters must have been fairly rapid; the LD output provided 74% of Japan's steel by 1968 and the last open-hearth furnace was taken out of use in 1974.
9. Ike, Nobutaka, "Japan: the New Superstate", Freeman, 1973. This is a scholarly discussion of all the circumstances underlying Japan's post-war emergence as an industrial giant.

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## BOOK REVIEWS

**Modern Fluorescence Spectroscopy, Volume I** — Edited by E.L. Wehry, Plenum Press, New York & London, 1976; 238 + xiv pp.

This is one of a two volume set, intended to survey some of the more important recent developments in instrumentation and applications of fluorescence and spectroscopy. This volume concentrates on instrumentation and technique and includes chapters on on-line computing, modulation and derivative techniques, dye lasers, internal reflection techniques and air and water pollution analysis. In many cases the techniques are still undergoing development. Each chapter has its own bibliography, typically including references published in 1974 or 1975.

Most interest in New Zealand is likely to be centred on the pollution chapters. Milton Birnbaum discusses laser techniques for air monitoring, concentrating mainly on the development of methodology for  $\text{NO}_2$  measurement. By using a 10 mW He-Cd laser at 442 nm and filtering aerosols from the air sample, as little as 0.2 ppbv could be detected using an 80 sec integration period. A postulated laser detector for  $\text{SO}_2$  has an estimated threshold of 0.1 ppbv and a system for OH radicals has a threshold  $1 \text{ in } 5 \times 10^{12}$ . A brief discussion of LIDAR techniques ("Light Detection and Ranging", analogous to RADAR) indicates insufficient sensitivity but mode-locked lasers have peak powers of gigawatts and pulse widths of picosecond duration, and offer improved range resolution and discrimination, and the possibility of double-photon excitation.

Arthur Fontiju and Rudolf Seitz review chemiluminescent techniques for air and water monitoring respectively. The reaction between NO and  $\text{O}_3$  can be used to detect either, at the ppb limit, and the

technique can be extended to measure  $\text{NO}_x$  ( $=\text{NO} + \text{NO}_2$ ) or  $\text{NH}_3$  by catalytic conversion. An enzymatic method can measure ATP in water at the 1 ppb level and thus estimate biomass. A similar approach can determine  $10^{-9}$  M ferrous iron. A variant of the phosphorus emission detector for gc can measure down to 3 mg/m<sup>3</sup> P. Glucose can be measured down to  $2 \times 10^{-6}$  M.

This book is for the specialist. It assumes a reasonable basic knowledge. For those with interests lying in its coverage, it is a useful, at times absorbing, addition to the reference library.

Michael Kingsford

**Chemistry of Organic Fluorine Compounds. A Laboratory Manual with Comprehensive Literature Coverage** — by M. Hudlicky, Ellis Horwood Ltd., England, 2nd (Revised) edition, (1976); 903 pp., \$94.50.

Replacement of hydrogen by fluorine (the most electronegative element) in many organic compounds results in products possessing unusual properties. These compounds include chemically inert fluorocarbons, stable hydrates of fluorocarbonyls and the very strong fluoroacids. Considerable development (and recent controversy) has taken place in industrial applications of fluorocarbons.

This book is an extensively revised and updated version of the first edition which was published in 1961. It aims to be both a text book (with an extensive list of references) and a laboratory manual covering the preparations and properties of fluorine-containing organic compounds. The contents include an Introduction (14 pp including a bibliography of previous books), Apparatus and Materials

(9 pp), Fluorinating Agents (12 pp), Methods for Introducing Fluorine into Organic Compounds (134 pp), Reactions of Organic Fluorine Compounds (349 pp), Fluorinated Organic Compounds as Reagents (12 pp), Properties of Organic Compounds of Fluorine (27 pp), Analysis and Structure Determination of Organic Fluorides (37 pp), Practical Applications of Organic Fluorine Compounds (20 pp), Preparation of Organic Compounds of Fluorine (57 pp of tables summarising preparative methods) and Procedures (57 pp of laboratory preparations). The contents concludes with a list of 3857 references (128 pp) and author (14 pp), and subject (33 pp) indexes.

The author has thoroughly researched the vast field of organic fluorine chemistry in this book. References surveyed include both Western and East European literature, the latter with Chemical Abstracts entries. Preparative methods described here are those used both by specialists in fluorochemistry who have facilities for the more corrosive reagents and by non-specialists who would find selective labelling with metal fluorides most useful. Properties and synthetically useful reactions are well documented (e.g. organometallic compounds) and this is required knowledge for all fluorocarbon users. Discussion of the toxic properties of a wider range of fluorine-containing compounds could have been included. Both classical and modern methods of fluorine analysis are discussed. The latter methods are important in view of the potential use of fluorine instead of deuterium as a "label" in some experiments (e.g. in mass spectrometry).

This single volume is too large as a laboratory bench manual and should have been divided into two smaller volumes. For most research workers it is very expensive (although printed in Hungary) and, because of its size and quality of binding, will tend to come apart with use. The publication date is 1976, but literature to 1971 only is cited (the manuscript was completed late in 1972),

## HONOUR FOR DR W. A. MCGILLIVRAY



Dr McGillivray was recently awarded the CBE for his services to the Dairy Industry and to science in New Zealand. After attending Mount Albert Grammar School, he took chemistry at Auckland University College gaining M.Sc.(Hons) and Ph.D. degrees. After serving in the RNZAF he was appointed Junior Lecturer in Biochemistry at Massey Agricultural College, later being promoted through to Head of Department. In 1959 he transferred to the Dairy Research Institute as Chief Bacteriologist and was successively appointed Assistant Director (1964) and Director (1965). At the end of this year he is to be seconded to the Dairy Board for two years to act as their representative in East Asia.

Dr McGillivray was elected to Associateship of the NZIC in 1944 and to Fellowship in 1952. He is a past Chairman of the Manawatu Branch, past member of the Membership Committee, past member of Council and was the Journal Editor from 1955 to 1960 and was President in 1970.

He was the foundation Editor of the N.Z. Journal of Dairy Science and Technology. He was elected to Fellowship of the Royal Society of New Zealand in 1971 and has been a Council member since 1973 and Treasurer since 1975.

His community activities have included City Councillor, Justice of Peace, member of Palmerston North High School Board of Governors, member of Massey Council and member of the Council of Palmerston North Chamber of Commerce.

so that much valuable research work in the period 1972-76 is not included. Although a list of printing errors is given with the book, other annoying misprints were observed on p 81 (gave now way = now gives way and p000 = p44), p 170 (ressists = resists), p 248 (  $(CCH_2)_2 = (CH_2)_2$ ) and p385 ( $\rightarrow F(CH_2)_{10}Cl = \rightarrow F(CH_2)_{10}Li$ ). The publishing criticisms in no way detract from the obvious scholarship of this book.

C.B. Johnson

International Review of Science; Organic Chemistry, Series Two, Vol. 1 — Structure Determination in Organic Chemistry — edited by L.M. Jackman, Butterworths, London, 1976; 172 pp., £13.45.

The basic concept of the International Review of Science, as stated in the Publisher's Note, is "to provide regular authoritative reviews of entire disciplines". Organic, Inorganic and Physical Chemistry, Biochemistry and Physiology are the disciplines so far reviewed and, at the time of writing, the first three of these have been covered for a second time. The reviews in the Second Series mainly cover work published in 1972 and 1973. The other Organic Chemistry volumes are: 2, Aliphatic Compounds; 3, Aromatic Compounds; 4, Heterocyclic Compounds; 5, Alicyclic Compounds; 6, Amino Acids, Peptides and Related Compounds; 7, Carbohydrates; 8, Steroids; 9, Alkaloids and 10, Free Radical Reactions.

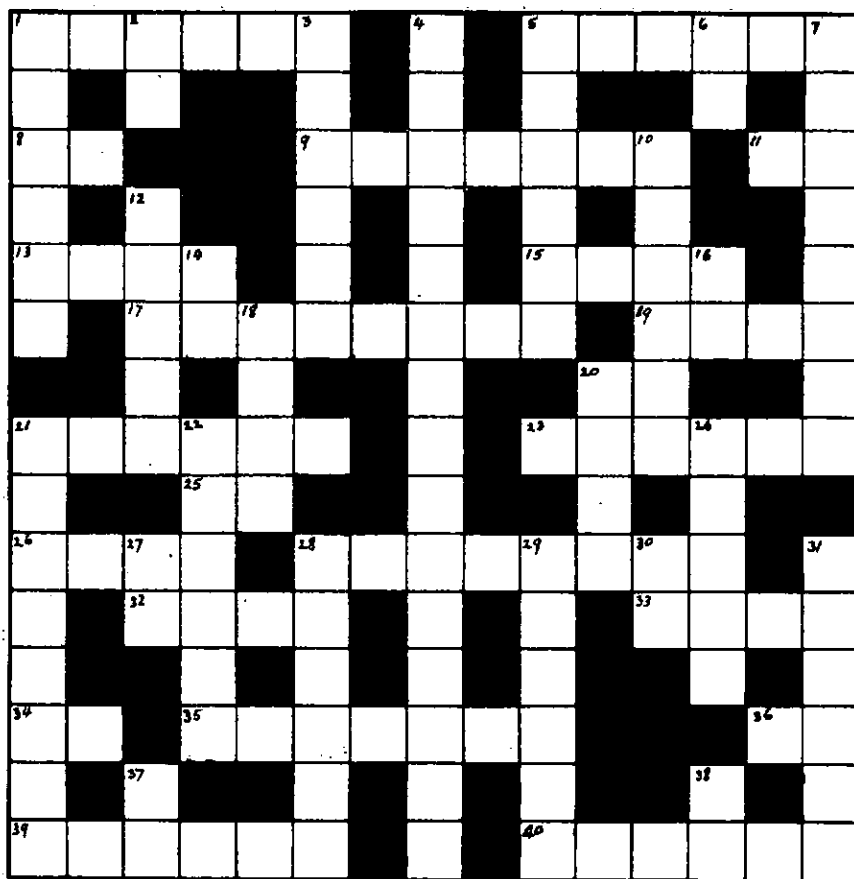
Volume 1, Structure Determination in Organic Chemistry, covers the use of mass spectroscopy, ultraviolet and visible spectroscopy, nuclear magnetic resonance spectroscopy and X-ray crystallography, with a different chapter and different author for each technique. Consideration of the theoretical basis and practical details of these techniques is minimal; each chapter is primarily concerned with cataloguing the problems which are currently being attacked and solved by means of the various methods mentioned above. For this reason, the book is obviously most suitable for the chemist actively involved in structure determination. For the specialist in a particular technique, the book would be a useful resume of the literature of 1972-73, whilst for the researcher with a particular structure to elucidate, the book provides information on which techniques have been most profitably used in solving similar problems.

For the non-specialist, the book is heavy-going; perhaps the most interesting chapter is the last, which deals with the recently-elucidated structures of some natural products — structures which range from that of the first known naturally occurring organovanadium compound, to that of a substance (found in the digestive glands of the sea hare) with the molecular formula  $C_{10}H_{12}Br_3Cl_3$ !

This book is printed on good quality paper. The diagrams are a model of clarity.

Trevor M. Kitson

## ELEMENTARY CROSSWORD — by Mike



The names of elements or the symbols for elements appear as the answers to the following clues. They are in order of increasing atomic number: 4 (first word only), 31, 36, 1 (across), 7, 5 (across), 21 (across), 35, 3 and 16, 6, 2, 8, 9, 37, 1 (down), 20 (across), 39, 11, 34, 38, 40, 30, 27.

### Other Clues

#### Across

- 13 Excreted organic acid
- 15 Dash
- 17 Small town of evil gals?
- 19 May do this in arising
- 23 Not rhyme but so near!
- 25 Street? No, further out!
- 26 Nothing from no oil! This will floor you
- 28 Truth
- 32 In on certain days, never again
- 33 Blood cell (contains atoms of 1 across, 4 — part 1, and 7)

#### Down

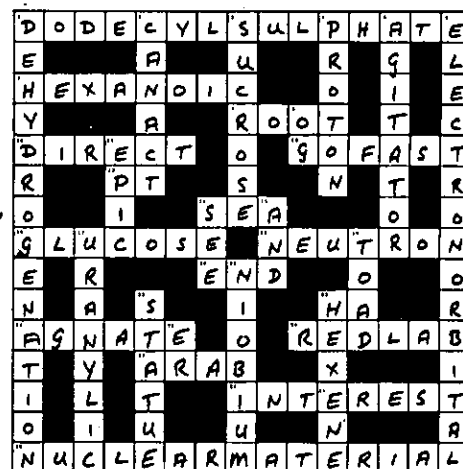
- 4 Red gaseous acid (8,7)
- 5 Compounds of 5
- 10 Thai degree maybe, for evil spirit
- 12 Brilliant
- 14 Unit named after discoverer of 40
- 18 Noisy
- 20 Half

- 21 Divalent anion
- 22 Possible salt of Fe? Perverse
- 24 Speaker
- 28 Calf skin
- 29 Miracle less 1 for soothed?

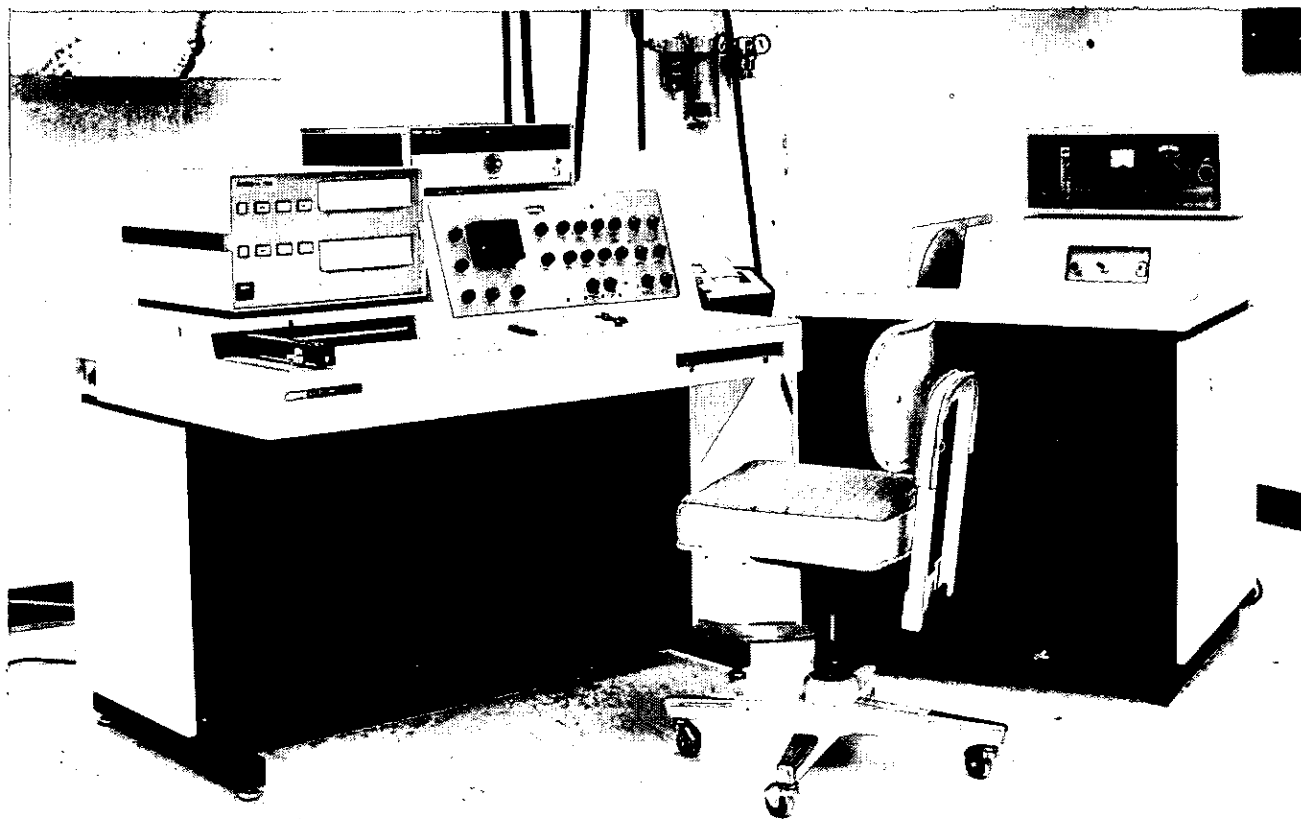
### Sundry

- 4, 5, 7 and 31 are gases
- 6 is used in transistors

### Answer to the last Crossword

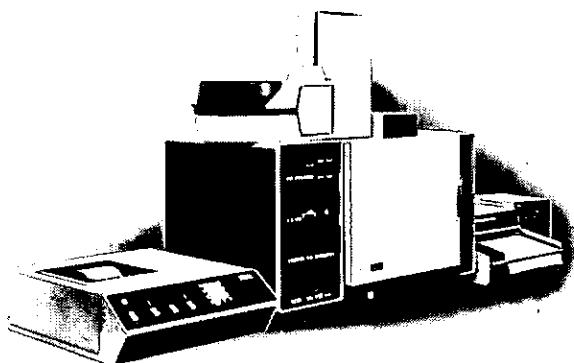


# NEW PRODUCTS



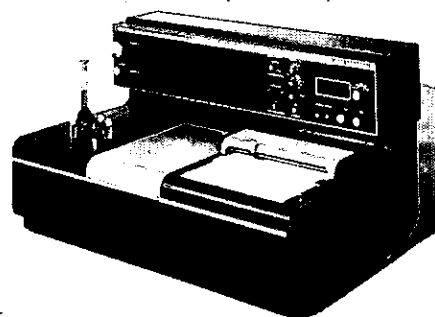
Varian recently announced the introduction of the FT-80 Multinuclear Broadband Fourier Transform NMR system. The instrument features a frequency range from 5.7 to 80 MHz with  $^{13}\text{C}$  observation at 20 MHz and  $^1\text{H}$  at 80 MHz. Comprehensive software is provided and the data processor includes a 16K non-volatile memory.

Beckman have released details of three new Liquid Scintillation Systems, LS 8000, LS 8100 and LS 9000. The basic system (LS 8000) is a computer-controlled instrument with a library of ten programmes. The insertion of a command tower in the conveyer chain implements one of the programmes which continues in use until stopped. The programmes can be altered by the individual and can be printed out. The LS 8100 includes a random coincidence counter to detect chemiluminescence, whilst the LS 9000 incorporates an on-line computer for automatic data reduction, dual label DPM quench correction, etc.



The new Varian Model 3711 Automatic Gas Chromatograph automates the chromatography process from injection and separation through peak measurement, calculations and final report.

Diamond Shamrock have recently published a brochure describing the wide range of specialty manganese and copper halide compounds now available. The brochure is available from: Diamond Shamrock, Chemetals Div., 1100 Superior Ave., Cleveland, Ohio.



Pye have introduced a new scanning UV-visible spectrophotometer, the SP8-100. The instrument contains a double beam scanning system and an attractive feature is the instrument's ability to start the spectrum on a major grid line of the paper. The system 2 instrument includes a wavelength programmer for automatic scanning between selected wavelengths whilst the reaction rate version includes automatic print-out and sample cycling.

# SAFETY IN SCHOOL LABORATORIES

The following report prepared by a sub-committee of the Canterbury Branch was received by Council at its meeting on August 21st. Members of the sub-committee were T. Hitchings, D. Hogan, D. A. House, D. Howarth, R. Rendle and A. Wooff. The report is reproduced here for the benefit of the membership of the Institute.

## Safety Information

The basis for our discussion has been the Department of Education publication, "Safety in School Laboratories", produced by the Curriculum Development Unit, 1976. The preface states,

"This booklet for teachers gives a few rules and some general guidance for those who work in the field of school science."

Later in the section on **Responsibility** there is the statement,

"Boards may use these guidelines as the basis for their own by-laws. The principal or head of department may well issue more specific instructions."

In the absence of any directives from school boards, principals or heads of departments, the average teacher will use this guide in his everyday classroom activity.

An additional source of safety information is the **Education Gazette**. This is the official circular of the Department of Education and teachers are expected to have read its contents. In 1977, recommendations such as:—

- (i) Handling of Swimming Pool Water Treatment — Chemicals p.21
- (ii) Expired Air Method of Resuscitation p.72
- (iii) Fire Safety in Schools p.98
  - (a) Smoke stop doors
  - (b) Fire egress doors
  - (c) Storage of Flammable Goods
  - (d) Heating Paraffin Wax or Flammable Material

have been published. A more comprehensive list is attached as an Appendix.

These appear to be the major ways that the Education Department provides information on safety where science is learnt.

## The "Safety in School Laboratories" Booklet (SISL)

While the guidelines contained in this booklet are regarded as a considerable improvement on those previously available, there are still areas of concern. **In particular we feel that the emphasis on safety could be more positive.** For example, the statements in 10.2 on **Protective Clothing**:

"It is a good idea to limit the compulsory use of protective clothing to those operations where it is absolutely essential. Its use is not always popular because it is always somewhat restrictive and hampers freedom of movement."

"Safety spectacles and or face shields should be provided in each laboratory."

"They must be worn for any operation which is hazardous or even potentially hazardous. This is especially important for people who wear contact lenses."

(Appendix I — Student Checklist) "**Emergency Equipment** — 26. Some form of eye protection (e.g. safety goggles) for student use."

(Appendix II — Student Safety Officers) "See that safety glasses are available whenever students are going to heat or mix chemicals."

Gloves are only mentioned for use in handling chlorides of non-metals (6.2) and there is no mention of suitable footwear for the laboratory. If the Department of Education is prepared to provide free text books, it should also be prepared to provide free safety glasses. In addition, suitable footwear, as opposed to bare feet or jandals, should be worn in all school science laboratories.

The statements quoted above should be contrasted with statements from the U.K. Department of Education and Science publication, "Safety in Science Laboratories" DES Safety Series, No. 2, 1976, p.12, Section 52 states that

"goggles **must** be worn whenever there is risk to the eyes. This means that whenever any operation with chemicals is performed, goggles must be worn, whether in chemistry lessons, biology lessons, physics lessons, geology lessons or indeed in home economics or craft."

Section 78 says that

"some form of protective clothing, a laboratory coat or a simple apron made from non-flammable material, is always advisable. A supply of protective gloves should be available in all laboratories."

The following is a list of more specific points. The wording in SISL will be quoted, followed by our comments.

I "4.4. Labels carrying suitable warnings can be placed on the worst hazards, but these should be used with some restraint."

All chemical containers should be carefully labelled and the storage of liquids in bottles labelled for other purposes should be forbidden (e.g. beer or gin bottles).

II "5.1. Pipettes. When pipetting caustic, volatile or irritant liquids, use a pipette bulb."

Commercial bulbs are expensive and easily damaged but large syringes or inverted plastic squeeze bottles are just as effective.

- III "5.3. Plastics. The use of plastic squeeze bottles is now common, but the potential hazard should be emphasised. At no time should reagents of concentration greater than 1 mol l<sup>-1</sup> be stored in these bottles."

The hazard is not made clear. Thermal degradation (bottles placed near bunsens) is probably more of a hazard than chemical degradation. It may be better to replace the last sentence with "A good rule is that reagents of concentration greater than 1 mol l<sup>-1</sup> should not be stored in these bottles."

- IV "5.4. Problems of disposal. Toxicants. Highly toxic or noxious materials, solid or liquids, should be tipped into large quantities of water, burned or neutralised with dilute acidic or alkaline solution as appropriate. Alternatively they may be buried to a safe depth."

This last statement is irresponsible and the procedure is illegal in many parts of New Zealand. Professional help (e.g. Fire Brigade) is almost certainly necessary when faced with the problem of disposal of toxic materials. All reference to the burial of toxic chemicals should be deleted.

- V "5.4. Corroding cylinders. If in doubt about the safety of a cylinder or its valve mechanism consult an industrial gas company for advice on disposal."

This is the only mention of gas cylinders in SISL. Gas cylinders are in use in a variety of science laboratories and a section on the mounting of cylinders, valve care and maintenance is most desirable. Letters to "New Scientist", 9 Dec. 1976 and 23/30 Dec. 1976 highlight the danger of lubricating valves on O<sub>2</sub> cylinders with oil rather than graphite. Cylinders containing reducing gases (e.g. H<sub>2</sub>, C<sub>2</sub>H<sub>2</sub>, CO) have left handed screw thread for the valve.

- VI "5.6. Anyone heating paraffin wax is warned that under no circumstances is it to be left unattended during the heating process."

Silicone oil is a recommended replacement for paraffin wax.

- VII "5.7. Safety Equipment."

Screens and fume cupboards mentioned but we are not clear who is responsible for their provision. Glass fronted fume cupboards are a hazard and a water outlet should be available in a fume cupboard.

- VIII "5.8. Some Hazardous Reactions. Hydrogen Sulphide. Treat with respect — it is highly toxic. A strong odour of hydrogen sulphide indicates bad laboratory management."

We suggest that the preparation and use of hydrogen sulphide be abandoned.

**"Diluting concentrated acids.** Always add acid to water and stir. ('A' precedes 'W')."

'A' precedes 'W' is misleading and should be omitted.

**"Flammables.** (With particular reference to ether, carbon disulphide, alcohol)."

The use of carbon disulphide should be discontinued.

- IX "6. Chemical Hazards" Chlorates and perchlorates: Sodium and potassium chlorates and perchlorates are stable, as is ammonium perchlorate, if they are kept in clean conditions. Other chlorates and perchlorates have dangerous instability, and can explode on heating."

We suggest that the use of all perchlorates (including HClO<sub>4</sub>) in school laboratories be discontinued.

- X "6.3 Flammable chemicals. Safety measures. The following precautions are necessary for work with highly flammable chemicals. They must be applied to the whole working bench and not just to one person's work space. No flames: no electric hot plates. Heat only by steam or water bath."

OR heating mantle.

- XI "6.7. Organic Solvents."

It is illegal to have more than 15 litres (total) organic solvents in a school laboratory unless stored in a suitably fire-proof building. This quantity of solvent is too small for the routine operation of normal school laboratories and we suspect that the law is being ignored in many cases. Who has the responsibility for the provision of a fire-proof building?

- XII "What are the faults shown in these pictures and on the following pages?"

Some "correct" answers would be desirable.

- XIII "9. Fire Hazard. 9.2. Choice of extinguisher."

When a fire extinguisher has been used, this should be reported to the principal, head of department or school safety officer.

### General

Classes in many schools must operate in old, poorly designed and crowded laboratories. In these older schools, ventilation and fume cupboard provision is often inadequate. Teachers working in such situations must restrict the type of experiment they conduct to cope with these potentially hazardous conditions.

However, it is of more concern to this committee that new school laboratories (expected to last 100+ years?) are being built without adequate recognition of safety design. We ask the question "How can the NZIC use its influence to ensure that a new school laboratory is built to legal and reasonable standards of safety and comfort?"

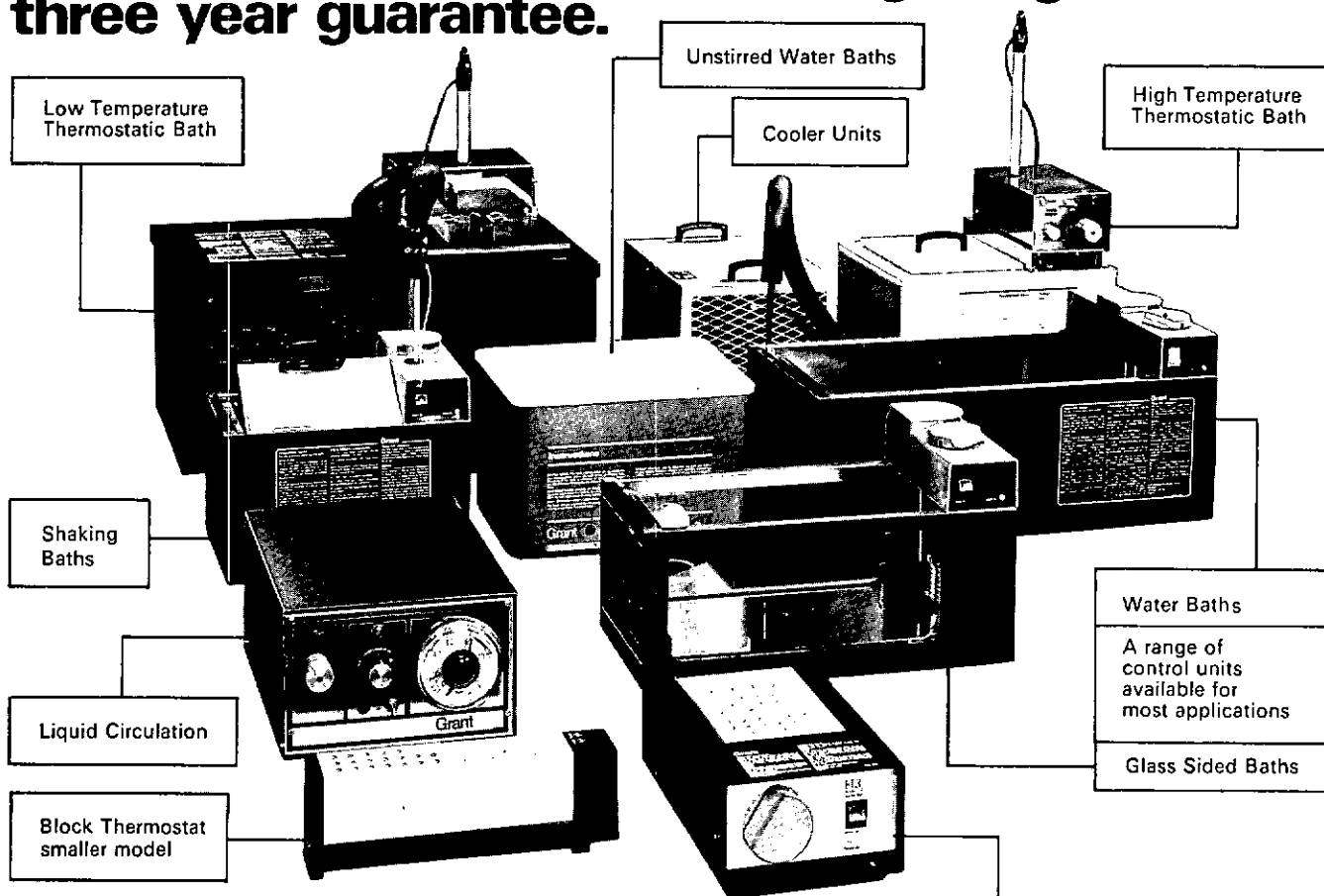
In this report we have discussed in detail the SISL Booklet and also raised some wider issues regarding safety in school laboratories.

We recommend that the NZIC press the Department of Education for

- (i) **the issue of safety glasses to all school classes**
- (ii) **the construction of suitable fire-proof storage rooms for solvents and fuels so that school laboratories may operate within the law**
- (iii) **the consideration of the changes recom-**

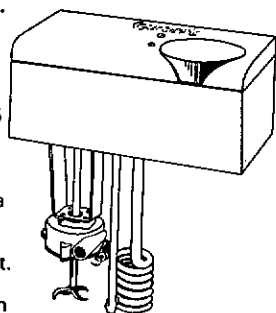
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mended in I-XIII for the next edition of SISL.

Recommendations (i) and (ii) above were adopted by Council as Institute policy.

### APPENDIX

Articles that have appeared in the *Education Gazette*.

- 1952 — p. 17 — Danger from chemicals in laboratories  
p. 76 — Safety in the School Laboratory
- 1954 — p.145 — Teachers in Science Laboratories
- 1957 — p.169 — X-ray Equipment in schools
- 1958 — p.215 — Purchase of explosive chemicals
- 1959 — p.279 — Precautions in the use of gas in laboratories
- 1960 — p.157 — Potassium Chlorate
- 1964 — p.238 — Benzoyl Peroxide
- 1965 — p.406 — PSSC Science Equipment; safety precautions
- 1966 — p.416 — Study of rabbits in Biology classes
- 1967 — p.169 — Storage of concentrated Nitric Acid
- 1968 — p.177 — Safety in schools:— Coroner's remarks (Death from exposure)  
p.413 — Control and prevention of Hydatids disease
- 1969 — p.137 — Safety in school laboratories:— Plastic squeeze bottles

*Note added in Proof*

Readers interested in this subject are also referred to articles in *N.Z. Science Teacher*.

- (a) Hazards in School Science, *N.Z. Sci. Teacher*, 15, 23 (1977)  
(b) News — Laboratory Design, *N.Z. Sci. Teacher*, 14, 27 (1977)

- p.341 — Hypothermia  
p.463 — Carcinogenic chemicals  
p.629 — Mountain safety
- 1970 — p.221 — Poisons Safety Week — June 70.  
P.669 — Conducting tramping parties
- 1971 — p.238 — Use of E coli in Senior Biology Courses  
p.359 — Conducting tramping parties
- 1972 — p. 26 — Use of gas:— Precautions in laboratories and Home Science rooms
- 1973 — p.198 — Bush and Mountain Safety  
p.500 — Bush and Mountain Safety
- 1974 — p.448 — Bush and Mountain Safety
- 1975 — p. 23 — Care with Mercury in school laboratories  
p.140 — Fire Safety in schools:— Heating Paraffin Wax, Smoke stop doors, Fire egress door  
p.304 — Safety of children on school camps and day trips  
p.391 — Classroom Dissection of Animals  
p.500 — Combustion Tests on Plastics
- 1976 — p.118 — Fire Safety in Schools (Repeat of 1975)  
Storage of Flammable Goods  
p.309 — Safety of Children on School Camps and Day Trips  
p.391 — Fire Safety in Schools

A copy of the N.Z.I.C. Submission to the Commission for Nuclear Power Generation

## NUCLEAR POWER PLANNING IN NEW ZEALAND

### GENERAL

In considering the possible use of nuclear power in New Zealand a number of factors are of prime importance. These are:

- (i) Nuclear power can at present be used only for electricity generation.
- (ii) The technology for the handling and use of nuclear fuel and the production of power is relatively recent and capable of considerable refinement.
- (iii) The technology presently employed (simple fission) makes poor use of a limited resource.
- (iv) The cost of construction of nuclear reactors is high.
- (v) The problems associated with waste handling and waste disposal have not yet been solved satisfactorily.
- (vi) The problems associated with decommissioning have not yet been fully examined.
- (vii) The cost of decommissioning of plant (after ca. 30 years use) although high is not known accurately.
- (viii) New Zealand will almost certainly be dependent on imported technology both for the reactor construction and for the re-processing of spent fuel.

### 2. UTILIZATION OF ENERGY IN NEW ZEALAND

The current sources of supply of energy to New Zealand are oil (62% of total), coal (17%), Hydro/Geothermal electricity (18%), and natural gas (3%).

They are distributed as follows:

Utilization	Oil	Coal	Gas	Elect.	Total
Domestic	1	2.5	0.5	11	15
Industry & Commerce	12	11	—	13	37
Transport	47	—	—	—	47
Electricity Generation	2.5	2.5	2.5	—	—

2.2 These figures show that almost half of our energy use (47%) is involved in transportation. At present this is virtually totally supplied by oil. This is unlikely to change in the near future. It is possible that electrification of railways and incentives to increase rail haulage may, in the long term, cause some change, but this would have little effect on the total percentage.

2.3 A possible cause for an increase in electrical demands might be a shift from oil and coal in the energy required for steam generators, the so-called "static" load in industry. The rapid increase in the price of oil may be of importance. Nuclear power is, however, only one alternative. We should consider more efficient utilization of the steam generated. It has been estimated that up to 20% of the present electricity could be produced from the steam generators already in operation in industry.

2.4 Much of the energy in the domestic sector is used to supply "low grade heat" for heating, and cooking. About 30% of the present electrical load is used (both in the domestic and industrial sector) for heating purposes. It is possible that some of this low grade heat could be supplied from the waste heat produced from steam generators (or from geothermal sources). Alternatively, natural gas could be used as a premium thermal fuel.

2.5 If nuclear power is to be used to increase the electrical supply, (and this is its only use), then it should be compared with alternative indigenous sources. Our current coal and natural gas reserves, for instance, are capable of meeting demand up to eighty years hence, and there are smaller hydro and geothermal schemes which, in view of the current oil price, have become economically viable.

2.6 The current campaign on energy conservation appears to have contributed to a drop in electricity consumption. Prior to 1972 both electricity and oil tended to be marketed as competitive rivals in energy supply. Now that oil is not as cheap, this is no longer the case.

2.7 The estimated growth in demand for electricity of 7% per annum, given by the N.Z.E.D., which was so accurate over the past twelve years now appears, in view of the lower demand, to be too great. Even without this drop however, the figure of 7% appeared generous. The projected population increase of 2.5% per annum, implies a 4% growth per head of population per annum. Since the domestic sector is already heavily committed to electricity (79% of all households use electricity for cooking, and 73% for water heating), it is difficult to see how this would increase without making excessive demands.

2.8 In view of the present conservation of energy, the potential for more efficient useage of energy already produced, and the availability of indigenous sources for electrical power, we believe that the estimate for nuclear power generation requirement of the "late 1980's", to be in error. We believe that at the present rate of consumption we have at least fifteen years before there is a likelihood of a shortfall. Consequently a commitment to a nuclear power plant in the immediate future is premature and any consideration of nuclear power plant in the

medium range must be compared with equivalent cost developments related to indigenous energy sources.

### 3. RADIATION AND OTHER HAZARDS IN NUCLEAR POWER PRODUCTION

3.1 The safety record of nuclear power reactors has, to date, been excellent. They have been designed with numerous safety features intended to prevent any major release of radio activity, and are required to meet very stringent requirements involving licensing, quality assurance, and inspection. In addition to national requirements, most reactors must also adhere to the standards of the International Atomic Energy Agency.

3.2 Nevertheless each reactor does pose a finite hazard, and with the increase in the number of reactors, the chance of a serious accident increases. There is an awareness that "there should be a continuing major effort to improve (light water) reactor safety, as well as to understand and mitigate the consequence of possible accidents" — quote the American Physical Society.

3.3 In an attempt to meet such needs the United States Energy Commission recently commissioned and published a report "Reactor Safety Study" known as the Rasmussen or WASH 1400 Report. It has attempted to assess the probability of accident risk in light water generators in the United States. Their method of analysis, the "fault tree method", gives results which are most reassuring. For instance, it estimates that the likelihood of a nuclear accident is extremely low (1 in five thousand million), as opposed to 1 chance in 4000 for a motor accident, or 1 chance in two billion of being struck by lightning. Not unnaturally, their figures are widely used, and the report has become quite authoritative.

3.4 However, these conclusions are not shared by some scientific groups. The American Physical Society, for instance, states that though the "fault tree approach has merit in high-lighting relative strengths and weaknesses of various parts of the reactor system, based on our experience with problems of this nature, we do not now have any confidence in the presently calculated absolute values of the probabilities of the various branches."

This point is rather more forcefully made by the Energy Committee of the Sierra Club of the United States of America. They point out that the Aerospace industry have now abandoned this method of fault analysis because it underestimated the likelihood of accidents by several orders of magnitude. A major problem is that the analysis input requires a decision as to what is a "credible" accident, and what is not. The aerospace industry found that up to 35% of in flight malfunctions had been deemed "incredible" prior to their occurrence.

3.5 In September 1975 a Royal Commission, set up in Britain to report on "Nuclear Power and the Environment", under the chairmanship of Sir Brian Flowers FRS published their findings. Like New Zealand, Britain was said to be facing an energy crisis in the 1990's and had been considering increasing its nuclear power by building a number of fast breeder reactors. These involve using plutonium instead of uranium as a fuel. As reported in the

Observer of the 26th of September, the commission recommended extreme caution and to delay this event as long as possible. Whilst acknowledging the high standard of safety and the excellent safety record of reactors to date, they expressed concern for the handling of waste material stating that, "there should be no commitment to a large programme of nuclear fission power until it has been established beyond reasonable doubt that a method exists to ensure the safe containment of long lived, highly radioactive waste for the indefinite future". They were also concerned "that the spread of nuclear power, will inevitably facilitate the ability of terrorist groups to make nuclear weapons."

3.6 The two major hazards of nuclear power are the likelihood of damage by radioactivity, and the likelihood of sabotage, the aim of the saboteurs being to acquire nuclear explosive material either in the form of uranium or plutonium. The latter possibility means that strict surveillance and supervision, possibly under armed guard, is required.

3.7 Radiation hazards occur when the fuel and wastes are being transported to and from the nuclear reactor, and when the reactor is operating. The most likely cause of an accident in the latter is failure in the cooling circuit, and the melting of the core as a result. It is possible that some types of reactors may be safer than others in this regard. In 1974, for instance, the British government opted for a steam generating heavy water reactor system instead of the light water reactor system (on which the Rasmussen study was carried out). Recent indications are that this decision may now be altered.

3.8 In addition to the usual operation hazards, there is the likelihood of earthquake disruption in New Zealand. Some studies of this nature have been carried out in the United States, but the situation here may be different.

3.9 The major problem with nuclear reactors is the disposal and containment of waste products. This has still not been solved satisfactorily. Several highly radioactive species, whose activity lasts for hundreds of years, (and which combine to dissipate heat for the same length of time), have to be contained and stored.

#### **4. NUCLEAR REACTORS AND THE ENVIRONMENT**

4.1 In common with other steam generating devices, there will be an amount of thermal pollution caused by the discharge of coolant water. Whilst this is not an unfamiliar problem due regard will need to be given when considering the siting of the reactor.

4.2 At nuclear plants, provision has to be made for storage of the waste materials for up to 10 years, prior to their ultimate disposal. This is usually done in deep water-covered canals, which may cause a certain amount of visual (as well as thermal) pollution.

4.3 The life expectancy of a nuclear reactor is 30 years. Once this is over, the reactor has to be decommissioned. This involves removing part of the equipment, and burying, or otherwise sealing off, the rest of the reactor for up to 1000 years. The end product, therefore may be one or more mounds of concrete and rubble, moulded over with earth and planted or built over in a permanent manner.

Little information is available on decommissionings, because to date so few have occurred. It is, however, very expensive (a partial decommissioning at Elk Creek U.S.A. cost US\$6.5 million).

#### **5. COST OF NUCLEAR POWER PRODUCTION**

5.1 Nuclear power relies on uranium for its fuel. None is available in New Zealand, though there is a substantial amount available in Australia. The amount of uranium in the world has been estimated at  $2 \times 10^6$  tons. At current rates of expansion, the United States will consume about half that amount in 1985. Thus an acute shortage of uranium (like oil) is likely by the turn of the century. This will be reflected in its price.

5.2 Nuclear power technology is highly specialized. In the construction of nuclear power stations, both the equipment and the technological expertise will need to be imported.

Some training perhaps might be done in New Zealand for those professionally involved in the running of the reactors. If a decision to develop nuclear power production over the next few years is made, then one of the tertiary educational institutions should be encouraged to provide facilities for training in nuclear technology.

#### **CONCLUSIONS**

(i) That any consideration of nuclear power technology for New Zealand should be part of an overall planning exercise for the energy development of the country and that this planning must take into account present and possible future energy usage patterns, possible costs of various forms of energy and the degree to which we wish to attempt to maintain our independence of imported energy sources.

(ii) Within the continuous planning envisaged in (i) there should be technical groups with specific watching briefs for various energy developments including one for nuclear power.



# Carl Wilhelm Scheele

a sad tale if ever there was one



CARL WILHELM SCHEELÉ:  
1742-1786

It is said of Scheele that his record as a discoverer of new chemical substances is probably unequalled. Besides discovering chlorine and ten important acids including citric, he prepared oxygen a couple of years before Priestley.

Unfortunately for Scheele, he forgot to tell anyone about the oxygen and must have got quite inflamed when Priestley took all the limelight. Therein lies a moral: if you come across something big, don't let the news hang fire—tell as many people about it as you can. Which is why we're now going to say that 'Pronalys' analytical reagents are exceptionally pure chemicals ideal for use in the most exacting analytical procedures.

No wonder they say Scheele's green!

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