



October 1979 Vol. 43 No. 5

Chemistry

in new zealand

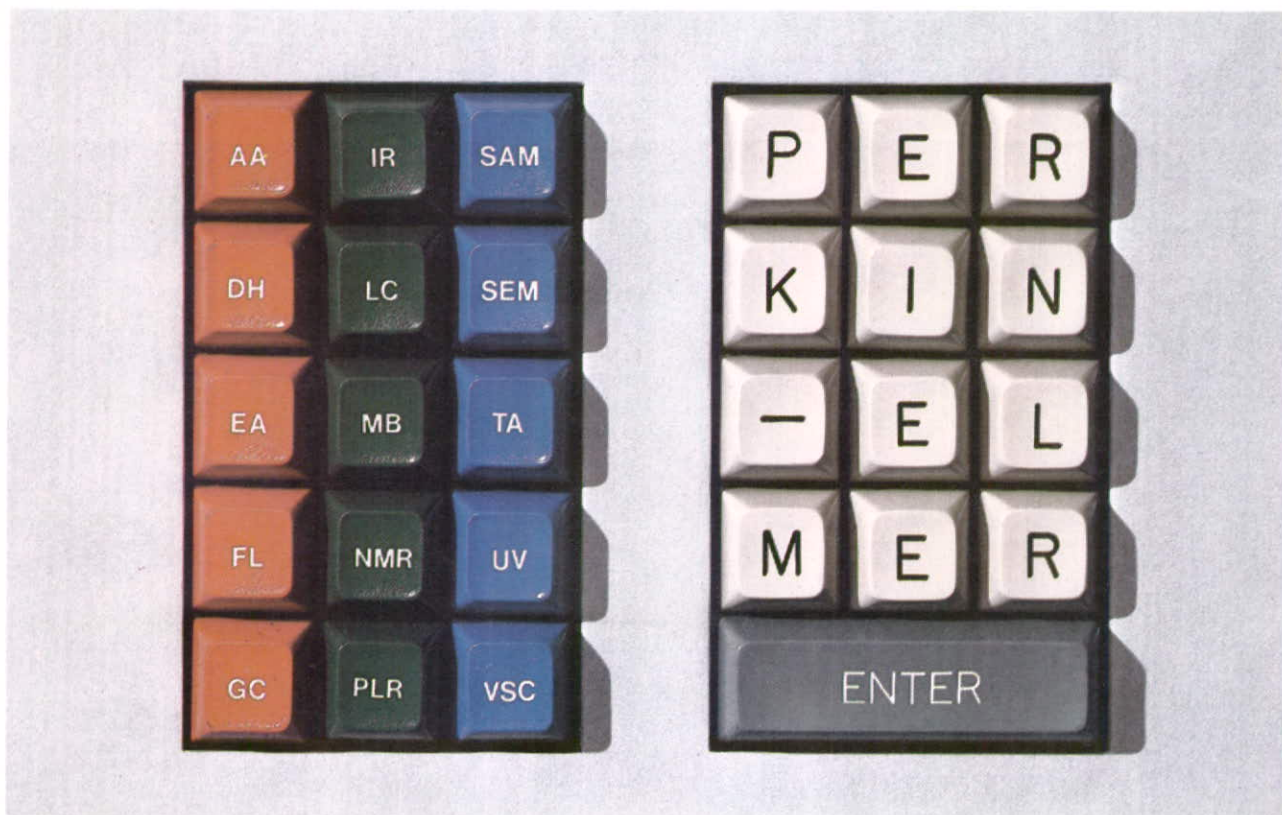
Official Journal of the New Zealand Institute of Chemistry

INSIDE: ENERGY SOLUTIONS FOR NZ



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Chemistry

in new zealand

Official Journal of the New Zealand Institute of Chemistry

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Cover: Digital's new fully mobile
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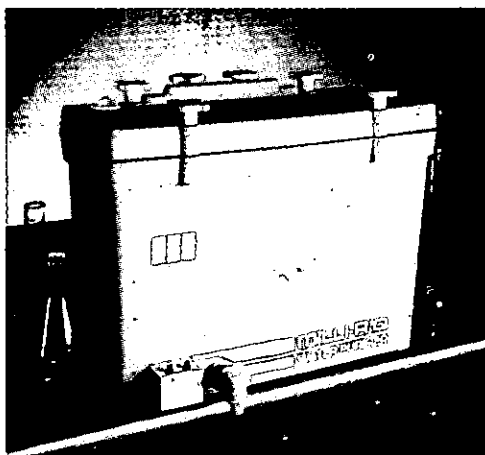
As an additional service to readers — and for the NZ chemical industry as a whole — the publishers of "Chemistry in NZ" plan to release the first NZ Chemistry Yearbook in December.

Essentially a guide to the industry's suppliers and services, the Yearbook has been planned to be of daily use throughout the industry during 1980. It will be fully cross-indexed and will contain information on products, materials and services currently being sought from local and overseas organisations through distributed questionnaires.

As a day-to-day reference to "Who, What, Where", the Yearbook will be invaluable to manufacturers, suppliers and others.

Advertising details will be readily supplied on request to Advertising Manager Carl Roze (Ph: Auckland 589-034) or Managing Editor Peter Reaves (Ph: Auckland 694-115).

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Guest Editorial

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The Energy Solution: "Show Me!"

When Mr Rowling opened the 2nd NZ Energy Conference in May 1975, he noted that its subject matter had "come to the forefront of public consciousness only comparatively recently, but we have rapidly acquired many experts on it. Everyone is particularly ready to state our problems. The provision of solutions is less noticeable". That the Prime Minister thought the conference important enough for him to fly to Christchurch on Budget day to open it attracted only a sentence or two in the local newspapers.

Times have changed. Every day we are confronted with newspaper, radio and television new items on energy matters. As I write this, my morning newspaper carries an editorial-page article on how our natural gas reserves might best be used for the manufacture of liquid fuels — a report that stems directly out of the detailed investigations conducted by the Liquid Fuels Trust Board over the past 12 months. On another page, there is an analysis of the 18-month long study of energy farming carried out by the NZ Energy Research and Development Committee, with its recommendations concerning ethanol production from fodder beet and synthesis gas from waste wood. We still have a superabundance of experts, but now we perceive solutions as well.

That machinery now exists to help the Government take informed decisions in the energy fields is in no doubt. We now have a Ministry of Energy, some 15 years after J. S. Pollard, in writing on energy planning in this Journal, said "it is time this vast and unco-ordinated cacophony was silenced under the firm legislative chairmanship of a vigorous Ministry of Fuel and Power". The Liquid Fuels Trust Board and the NZ Energy Research and Development Committee and have been able to draw widely from resources within the public and private sectors in their liquid fuel investigations. This Institute, like kindred learned bodies, as established a Committee on Materials and Energy to provide professional comment on important energy issues. And countless numbers of New Zealanders have been able to take part in conferences, workshops, debates and seminars on energy matters.

Yet the manner in which recent decisions have been made and announced, such as that to increase the bulk electricity tariff by 60% or that to implement carless days, has done little to inspire confidence in the expressed hope of successive Ministers of the Crown "to find a way in which planners and people might join forces to achieve a clearer public appreciation of, and involvement in, the direction of the nation's energy future" to quote from the Foreword to Goals & Guidelines. One is reminded of Eliza Doolittle's anguished cry in the musical version of Shaw's Pygmalion —

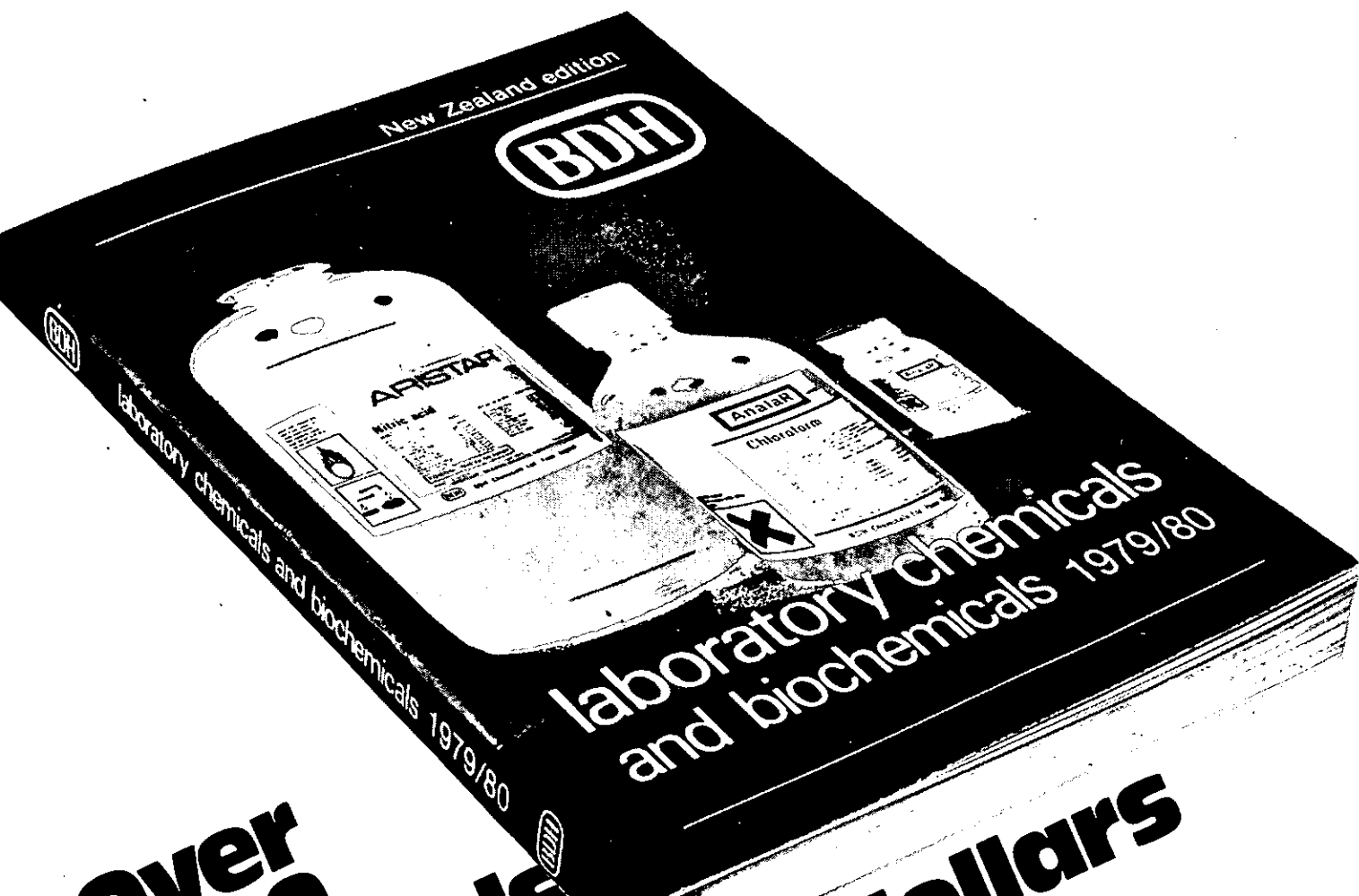
"words, words, words,
I'm so sick of words ...
Show me!"

Miles Kennedy

In our next issue . . .

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Polemics From the Pulpit

NZIC Annual General Meeting 1979

The Annual General Meeting was held during the Conference in Wellington, presided over by the President, **Dr W. E. Harvey**.

The Annual Report, as published in the August issue, was approved with the following corrections: The third member of the Hazardous Chemicals Committee should be **D. J. Ogilvie**; the ICI Prize was won by **Dr G. B. Russell**, not **Dr R. P. Garland**, who in fact won the Industrial Chemical Essay Prize; **Mr Bob Schoenfeld** is Editor, Australian Journal A Chemistry, not the RACI journal, Chemistry in Australia.

The financial statement was approved. The General Secretary, **Gavin Fletcher**, announced that he would recommend to the November Council meeting that subscriptions be increased by \$3; anyone with strong views on this should write to the Registrar.

The President announced that in accordance with the rules **Prof. Arthur Campbell** of Otago would become President from September 1, and **Dr A. J. Ellis**, DSIR, Wellington, First Vice-President, **Dr. Stan Simpson**, Director, Wool Research Organization (WRONZ), Lincoln, is the new Second Vice-President.

The ICI prize for Excellence in Research was awarded to **Dr B. K. G. Theng**, Soil Bureau, Wellington, and the Industrial Chemistry Prize donated by ICI/Tasman Vaccine Ltd., to **Mr Max Rands**,* AFFCO, Auckland. **Mr S. L. Marshall**, Auckland University, was awarded the Chemical Essay Prize.

Three remits were discussed. It was decided to make no change in the requirement that candidates for all grades of membership be interviewed, while the proposal that the Institute seek a Royal Charter was resoundingly defeated. A motion urging pharmacists to use that term for themselves, rather than chemist was carried, and is to be passed on to the Pharmaceutical Society.

Dr G. Gainsford announced that another salary survey would be commenced in April, and invited members to submit suggestions on the form it should take, particularly to assist the Industrial Chemistry Group to set a salary scale for younger industrial chemists.

We enjoyed the Synod in the Archdiocese, though we did not receive the liturgical mass we expected, perhaps because there is no Cardinal at present in Wellington to receive us at the level we should be welcomed after hearing the plaudits from various less inspired sources at the Conference.

Every ecclesiastical gathering has a different direction of prolation; our opinion is that Wellington excelled in the merit of its programme which was worth several Hallelujahs! If we have any other observation to make is that there was so much on in the way of concurrent sessions that citizens like ourselves in the autumn of life grew a little weary, but we revived for the official dinner at Weir Pro-Cathedral, which capped an excellent four days. The programme seemed to succeed in drawing more of our fellow worker-priests; comparative figures with other Synods could be interesting. We rejoiced to see our old friend Brother Bill, whose fertilising power we acknowledge, also Father Don from Dunedin who made a useful contribution with the sacred oil with which he anointed us and other dignitaries. We thought the complaints of the southerners about the weather were unworthy of them; one should accept what the Lord sends and thank Him for it, even if it forms a symbiotic alliance with man's poor design.

One feature of Conferences that we continue to deplore is poor presentation both with visual aids and voice — illegible ideographs illustrating inaudible interlocution — to coin a phrase. In this respect we sinned as much as any of our brethren (or sistern) in relying on the blackboard and speaking downwind in the draught of LB3. We do not blame this on any fault of the higher powers, though we may have overtaxed our ageing strength with our efforts on the Ecclesiastical Times. We celebrate the Einstein centenary this year (Watch out for the enthralling story by Dave Fenby in our next issue — order your copy in advance to avoid disappointment!). Like Einstein, our laboratory these days is our fountain pen, and our best tool is the w.p.b., neither of which help in making good slides and transparencies.

We admit that we have sinned, and we repent, but will we be saved from this at future conferences? Speaking of sin, we read that President Carter is eager to press forward with a "synfuels program". We forgive Jimmy for his quaint spelling, but his fundamentalism seems to have led him astray. Surely it is the leaded petroleum fuels that syn?

(P.S. We regret the failure of communications with St Peter in our August issue. The Acts of Wattie appear in this issue.)

MEMBERSHIP OF THE NEW ZEALAND INSTITUTE OF CHEMISTRY

Membership of the Institute enables you to attend meetings of the Branches, receive the Journal, newsletters, salary surveys, attend the Annual Conference and to keep in touch generally with the activities of Chemists in New Zealand.

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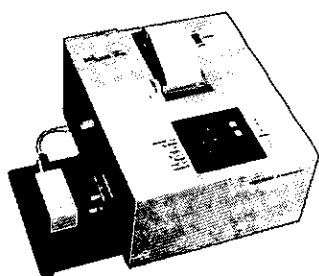
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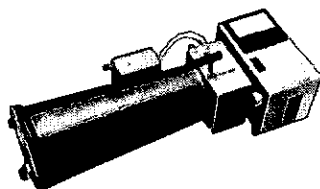
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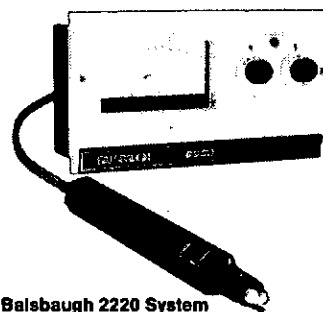


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What's Happening

Maria de Lurdes Pintassilgo, variously reported as "an industrial chemist" and "a chemical engineer like Mrs Thatcher" has become the second woman to lead her country. She has become Prime Minister of the provisional government of Portugal, charged with organising elections to be held at year's end. Her life could be difficult; she is supported by the left and by the church, but the right boycotted her swearing-in ceremony.

It will cost Metropolitan Edison and the Public Utilities Corp. \$US24M a month to buy power to replace that lost by the closure of the Three Mile Island plant and these companies face bankruptcy. **President Carter** has set up a commission of enquiry with a \$US1.6M budget, while the Electric Power Research Institute is prepared to spend \$US6M on a similar project. The Nuclear Regulatory Commission is setting up two enquiries, while sub-committees of both the Senate and the House of Representatives are also looking into the matter. A case of crowding the stable door after the horse has bolted?

The US Court of Customs and Patent Appeals has decided by a 4-1 majority that new forms of life created by genetic engineering can be patented. (New Scientist)

Prof. A. J. P. Martin, awarded the Nobel Prize with **R. L. M. Synge** in 1952 for his work on chromatography, has been dismissed from his chair at the University of Texas, Houston, for "inadequate productivity". Martin also holds a chair at the University of Sussex, where he claimed he was doing most of his research because of inadequate facilities and assistance at Houston.

It was mentioned at the Conference that Waitaki-NZR propose to set up a plant at Nelson to produce viscose resins and that fractionation of tall oil to produce resin acids, fatty acids and possibly sterols would be undertaken by a joint venture between Tasman P. & P. and NZFP.

The General Secretary has prepared a leaflet with advance publicity for the Institute's golden jubilee conference in Auckland in August 1981, on which the Committee, chaired by **Mr Alan Mackney**, and with **Assoc. Prof. Duncan McLennan** as secretary has had 3 meetings already and an outline programme has been prepared. The Committee would be pleased to hear of any leading chemists who may be in NZ at that time. All enquiries to Prof. McLennan.

J. Mercer & Sons Ltd, Christchurch, has won a \$35,000 order for 15 bench-mounted steam sterilisers from the Government of Papua New Guinea. The sterilisers, to be manufactured in Christchurch, are automatic-cycle units which can be used for sterilising a wide variety of items, including wrapped and unwrapped loads of instruments, utensils, glassware and medical dressings.

Our energy expertise is being offered on the world market.

The applied research office at Auckland University is coordinating a team of 50 energy experts from Auckland, Massey, Victoria, Canterbury and Lincoln Universities and contracting their services to developing countries.

The applied research officer, **Mr J. G. Fletcher** (also NZIC general secretary), said the scheme was part of the export campaign.

"Because of NZ's isolation and dependence on imported oil," he said, "the issue of finding alternative energy sources has been more acute here than in larger industrial countries.

"The result is that NZ has built up a repertoire of energy expertise of world standard."

The office had recently put in its first tender for a contract to assess the energy of Portugal and Argentina, he said.

"Chemistry in NZ" further enhances its international status with the recent request from Biosources Digest, Santa Monica, California (a publication subsidised by the National Science Foundation, USA) to reprint the paper on "Energy Farming in NZ" by Garth Harris, which appeared in our June issue. Naturally, we were happy to accede. Also this issue features original papers from Australian authors on alternative fuels and prospects for new batteries for electric vehicles.

A magazine aimed at chemists worldwide in all fields of specialisation is to be launched by IUPAC. Entitled "Chemistry International", the magazine discusses and summarises recent advances in all fields of chemical research and technology with an easy-to-read style understandable to any person trained in science. The focus is research and development directed at solving worldwide problems. Topics to be covered include chemical processes for conversion and storage of energy, recognising and solving pollution problems, advances in chemical insect control and chemistry of the atmosphere. Also contained in the magazine is a comprehensive listing of international conferences in chemistry and related subject areas.

Sample copies are available from the publisher, Pergamon Press Ltd (Headington Hill Hall, Oxford OX3 0BW, UK).

The Cancer Research Laboratory has now moved from the DSIR campus at Mt Albert to the new Pathology Building of the Auckland University School of Medicine. The new address of **Dr B. F. Cain**, Director, and **Dr Bill Denny**, Assistant Director (and Associate Editor, Chemistry in NZ) is now: Cancer Research Laboratory, School of Medicine, University of Auckland, Private Bag, Auckland, 1.

The Lead Development Association announces that the next Hofmann Memorial Awards will be made in 1980. The Hofmann Prizes were first awarded in 1968 to commemorate the work of Prof. Wilhelm Hofmann and to encourage research on lead, a field to which he devoted so much of his life. The awards are given to authors of papers describing original work which, in the opinion of an international consortium of experts in metallurgy and lead technology, adds significantly to existing knowledge of lead.

There are two Groups for entries, each with an award of 1,000 sterling, as follows: Group A — Extractive Metallurgy of Lead; Group B — Physical and Mechanical Metallurgy of Lead. Paper published since the last awards were made in 1977 are eligible. For further information write to: Australian Lead Development Association, 95 Collins St. Melbourne, Victoria 3000, Australia.

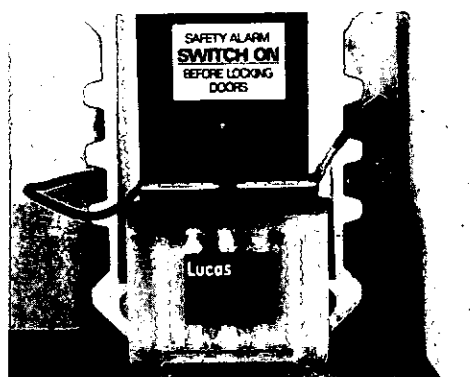
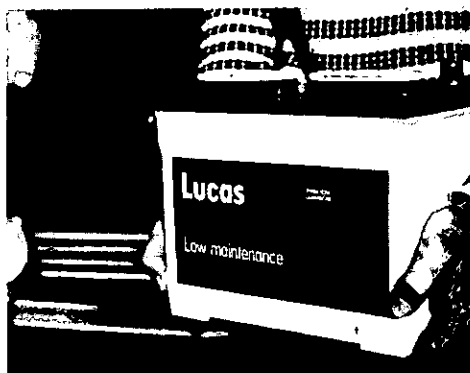
The 5th IUPAC conference on physical organic chemistry will be held at the University of California, Santa Cruz, August 17-22, 1980. It will be sponsored by IUPAC, the organic chemistry division, American Chemical Society and the University of California. The 2nd Chemical Congress of the North American Continent and the 188th national meeting of the American Chemical Society will be held in San Francisco the week following the conference.

Further IUPAC conference information is available from Prof. C F Mernasconi, Thimann Laboratories, University of California, Santa Cruz, California, 95064, USA.

"Progress with Electrochemistry" will be the theme of the 5th Australian Electrochemistry Conference at the University of Western Australia, Perth, August 18-22, 1980. Organised by the electrochemistry division, Royal Australian Chemical Institute, and sponsored by the Australian Academy of Science, it will feature lectures on energy conversion and storage, solar energy, theoretical electrochemistry, mineral processing, electrochemical engineering, waste water treatment, metal conservation and solution electrochemistry.

For details are available from Assoc. Prof. I M Ritchie, Dept. of Physical & Organic Chemistry, University of Western Australia, Nedlands, W. Australia 6009.

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What is new however, is that Lucas have come to grips with your handling problems. The next time you buy your boat's batteries you'll find it complete with a new polypropylene carry handle.

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power and fire or burglar alarms, specially developed to give a low rate of self discharge.

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PROSPECTS FOR NEW BATTERIES FOR ELECTRIC VEHICLES

Part 1. Aqueous Electrolyte Systems

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ABSTRACT

The threat of serious world shortages of crude oil within the next decade and increasing concern over urban pollution from automotive exhausts has persuaded governmental, civic and industrial leaders throughout the world to examine electric traction as a more acceptable alternative to the conventional internal combustion engine. Electric vehicles will be powered by electrochemical systems, i.e. secondary batteries, or fuel cells, or battery-fuel cell hybrids.

The purpose of this review is to outline the current world effort being directed towards developing advanced battery systems for electric power source applications. The relative merits of the various battery types under examination will be discussed in terms of their efficiency, performance, convenience and cost. These factors are important in deciding whether a particular system will be suitable for use in electric vehicles.

Present transportation systems are almost all based on petroleum fuels. Difficulties in guaranteeing continuous oil supplies, recognition that reserves are

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indeed finite and problems in meeting exhaust emission controls have led to renewed interest in vehicles powered by electrochemical systems. These electric vehicles can derive their power from primary energy sources other than oil, e.g. coal, gas, nuclear or perhaps, eventually, solar energy. Future energy scenarios indicate that an increasing share of energy will be supplied as electricity and electric vehicles offer a practical and convenient means of utilizing such energy in the transport sector — thus conserving scarce fossil fuels for other more essential tasks.

Types Of Electrochemical Power Source

Two types of electrochemical power source are available for vehicle propulsion namely, the secondary (or rechargeable) storage battery and the fuel cell. A storage battery consists of an assemblage of secondary cells which are chemically reversible to a degree that permits electrical recharging. A fuel cell consists of two electrodes which can catalyze the conversion of a particular fuel (e.g. hydrogen, methanol, hydrazine) and an oxidant (e.g. air) to electricity. Power can be drawn from the cell as long as the fuels are supplied and the reaction products are removed. Thus, *batteries store electricity* and require a plentiful supply of outside electricity to function, whereas *fuel cells make electricity* and require a plentiful supply of cheap fuel.

Although fuel cells have a considerable advantage over storage batteries in that they can be refuelled as quickly as the petrol tank of an internal combustion-engined (i.c.e.) vehicle, fuel cell systems are not suitable for the high-rate, short-duration discharges needed to start and accelerate vehicles. There are also problems in finding cheap organic fuels and more especially in discovering inexpensive and more efficient catalysts to replace noble metals for the oxidation of low-grade hydrocarbon fuels and the reduction of oxygen. The power density provided by batteries is better than that of fuel cells (although still inferior to that of the i.c.e.) but the typically low energy densities of battery systems prevent electric vehicles from having ranges commensurate with petrol-driven vehicles.

There is some world-wide effort to develop vehicles powered by a hybrid combination of fuel cell and battery. In these systems, range is provided by a high-energy-density fuel cell whereas the starting, acceleration and hill-climbing modes are powered by a high-power-density secondary battery. Other hybrid concepts include coupling different battery systems to give an all-electric-driver vehicle, or combining battery power for low-speed intracity running with gasoline, or diesel, power for intercity cruising and battery recharging. The purpose of this review is to discuss only current research on storage batteries for traction applications.

Need For A Better Battery

The only battery system presently available for motive-power application is the lead-acid battery. This battery has seen long and honourable service in a wide variety of applications but for traction purpose it suffers the major drawbacks of not producing much electrical energy per unit weight or volume and also wearing out too quickly. Thus, the lead-acid battery is barely capable of meeting the needs for on-the-road vehicle propulsion and only provides an economic and effective means of transport for semi-flexible daily use in urban environments, e.g. short-trip delivery vans, city commuter cars and second family cars. At present, most

Battery Prospects (Cont)

electric cars and vans are capable of 50-80 km/h and have ranges between 80-130 km before battery recharging is needed.

Although electric transport is unable to offer the same flexibility of use and performance as provided by today's gasoline — or diesel — fuelled vehicles (especially in the case of the private automobile), it appears that battery-powered cars can satisfy the daily driving requirements of most owners. For example, analysis has shown (1) that a car with a practical daily range of 132 km can meet the needs of the US owner on 95% of the days of the year. For this purpose, batteries with energy densities of 60 to 110 W h/kg (2-hr rate), power densities of 30 W/kg (sustained) and 100 W/kg (peak), service lives in excess of 1000 deep discharge/charge cycles, and cost of \$US25-35/kWh will be required. The current optimum achievements of the lead-acid battery, viz. 29 W h/kg (2-hr rate), 50 W/kg (peak), 700 cycles, \$US90/kWh, fall well below the combined performance and cost goals. The future of the electric vehicle as a viable transport alternative to the i.c.e. depends, therefore, upon the development and commercial availability of an economical, high energy- and power-density, long-lived, low-maintenance battery.

Searching For A Better Battery

The total amount of energy delivered by a given battery depends on how quickly it is extracted, i.e. the energy density decreases as the power required is increased. This is particularly important in the case of the

TABLE X

Battery Systems under Investigation

Acid	Aqueous	Molten Salt	Organic	Solid-State
	Alkaline			
Pb-PbO ₂	Ni-Zn	Na-S	Li-TiS ₂	Li-TiS ₂
Zn-Cl ₂	Ni-Fe	Li/Al-FeS ₂	Li-S	Cu-TiS ₂
Zn-Br ₂	Ni-Cd	Na-SbCl ₃	Li-V(Fe)S ₂	Ca-NiF ₂
	Ni-H ₂	Li-Cl ₂	Li-NbSe ₃	
	Al-Air		Li-TiO ₂	
	Li-Air		Li-Br ₂	
	Fe-Air			
	Zn-Air			

lead-acid system, which shows a marked rate dependency. If a lead-acid battery is discharged in 5 hours it will return up to 34 W h/kg, but at the 1-hr rate — which is a typical period in electric car operation — the figure drops significantly to about 22 W h/kg.

Many other battery types offer considerable improvement in energy and power density over the conventional lead-acid system (Table I). More than 30 different battery systems have received attention from research bodies in a great many countries. They can be classified by the nature of the electrolyte used, i.e. aqueous solution (acid or alkali), molten salt, organic liquid or solid compound (Table II). This review considers only those

CANDIDATE BATTERIES FOR ELECTRIC CARS

Battery		Cell Reaction		Theoretical Energy Density (Wh/kg)	O.C.P. (v)	Current Performance				Initial Cost (\$US/KWh)	Projected Cost (\$US/KWh)	
+	-	Charge	Discharge			Energy Density (Wh/kg)	Power (peak) (W/kg)	Cycle Life	Depth of Discharge (%)			Efficiency (%)
<i>Aqueous-Acid</i>												
PbO ₂	Pb	PbO ₂ +2H ₂ SO ₄ +Pb	⇌ 2PbSO ₄ +2H ₂ O	171	2.05	30 (1-h)	50-100	500+	90	60-65	~ 90	50
Cl ₂	Zn	Zn+Cl ₂ .6H ₂ O	⇌ ZnCl ₂ +6H ₂ O	465	2.12	100 (4-h)	80	400+	96	> 50	100	30
<i>Aqueous-Alkaline</i>												
NiOOH	Zn	2NiOOH+2H ₂ O+2Zn	⇌ 2Ni(OH) ₂ +Zn(OH) ₂	321	1.71	71 (2-h)	167	500	60	60-65	180	50
NiOOH	Fe	2NiOOH+2H ₂ O+Fe	⇌ 2Ni(OH) ₂ +Fe(OH) ₂	267	1.37	55 (2-h)	50-100	1,500+	90	< 60	100-150	60
O ₂	Fe	Fe+H ₂ O+1/2O ₂	⇌ Fe(OH) ₂	764	1.28	81 (5-h)	30-40	200+	65	< 40	100	60
O ₂	Zn	Zn+1/2O ₂	⇌ ZnO	1084	1.65	110	80	600	90	~ 40	53	35
<i>Molten Salt</i>												
S	Na	xNa+v ^c	⇌ Na _x S _y	664	1.76-2.08	180 (4-h)	220	300+	60	85	50	35
FeS ₂	Li/Al	4AlLi+FeS ₂	⇌ 2Li ₂ S+4Al+Fe	625	1.5	70 (2-h)	50	250+	50	70-80	60	35
<i>Organic Electrolyte</i>												
TiS ₂	Li	xLi+TiS ₂	⇌ Li _x TiS ₂	480	1.87-2.5	132	132	120+	-	80-90	?	45

systems that are the most developed, and/or the most promising, candidates in each of these 4 categories of batteries for electric road vehicles. In Part I aqueous systems are discussed.

Aqueous Electrolyte Batteries

This group includes both acidic (e.g. lead-acid, zinc-halogen) and alkaline (e.g. nickel systems, metal-air) batteries. It appears that only PbO_2 (acid) and $NiOOH$ (alkali) positive electrodes are satisfactory from the standpoint of performance, durability and cost. Secondary oxygen electrodes require different substrates for evolution and reduction of oxygen unless expensive noble metals are used. Halogen-based positives suffer from materials and self-discharge problems. Possible negative electrode materials include Pb (acid), Fe (alkali) and Zn (alkali or buffer). Cd-based systems can be eliminated on cost grounds and hydrogen electrodes await the development of a lightweight gas storage system. Aluminium alloys and lithium metal are currently being examined (2) as negative electrode materials in mechanically rechargeable metal-air batteries but these systems have storage, handling, loading and efficiency problems. These considerations narrow the choice to 6 systems: 2 acid ($Pb-PbO_2$, $Zn-Cl_2$) and 4 alkaline (Ni-Zn, Ni-Fe, Fe-air and Zn-air).

Lead-acid: Improvements to the lead-acid battery are being sought in energy density, service life, rechargeability, maintenance needs, and manufacturing processes and costs.

Problems	Near-Term	Long-Term
	Prospects	Prospects
	(0-10 years)	(> 10 years)
Low energy life, slow recharge, electrolyte maintenance, cost	excellent	fair
Size, complexity, safety, life, electrolyte maintenance	poor	poor
Life, Zn solubility, separator stability, Ni cost, electrolyte maintenance, O_2 transport, thermal control	good	good
Low power, Ni cost, low efficiency, electrolyte maintenance, thermal control	good	good
Low efficiency, low power, life, complexity, electrolyte maintenance, thermal control, cost	poor	poor
Life, low efficiency, complexity, cost.	fair	good
Life, electrolyte stability, size, safety, charge and thermal control, manufacturing process.	fair	fair
Life, positive electrode performance, separator, charge and thermal control, manufacturing process, safety.	poor	fair
Life, low power, poor reversibility, electrolyte conductivity; requires more research.	poor	fair

Present lead-acid traction batteries produce, at the 1-to 2-hr rate, only about 1/5 of the energy of which they are theoretically capable. Improvements in energy density require a decrease in weight of support materials that do not actively help in energy storage, e.g. grids, intercell connectors, terminals, outer container etc. Modern design trends are meeting the challenge of minimizing overall weight and volume by selecting optimum packaging and structural materials. Aluminium, titanium and metal-coated plastics have been tested as lightweight grids and the weight of the battery case has been reduced by the introduction of polypropylene containers.

Factors limiting the performance and/or lifetime of the lead-acid battery are mainly associated with the positive plate and include (a) low utilization of active material, (b) poor adhesion of active material to grid and (c) corrosion of grid structure. Less than half the amount of active material actually takes part in the cell reaction during discharge at the rates required in electric vehicle applications and attempts to increase utilization have involved changes in grid design, reduction in plate thickness and increase in the porosity and total surface area of the active mass. Although these approaches have generally led to improvements in energy density, they have also often resulted in premature battery failure and there is obviously a basic compromise that must be made between capacity and service life. Shedding of positive active material during battery cycling has been reduced by the use of tubular plate structures clad in fabric gauntlets and recent attempts to improve corrosion resistance have included adding cobalt and silver inhibitors to either the active material or the electrolyte (3).

To date, the best performances are shown by batteries developed in Japan which have energy densities around 33 W h/kg (1-hr rate) and lifetimes of over 500 cycles (4). It is generally considered that eventually an "improved" lead-acid battery with an energy density of ~ 45 W h/kg at the 1-hr rate and an acceptable lifetime will become available. Companies in the forefront of lead-acid battery development include: Chloride and Lucas in UK; Varta in Germany, Eagle-Picher, ESB, Globe-Union, Gould and Westinghouse in USA; and Yuasa, Shin-Kobe and Japan Storage in Japan.

Zinc-chlorine: This battery system is a flow type using circulating $ZnCl_2$ electrolyte at 50°C from which zinc and chlorine are generated at bipolar graphite electrodes during charging (Table I). Batteries have been developed principally by Energy Development Associates, in USA (5) and boast the unique feature of storing chlorine as a solid hydrate by refrigeration at $\sim 5^\circ C$. In first-commercial traction applications, it is intended that the refrigerator will be off-board the vehicle and will be packaged with the rectifier required for battery charging. The initial performance goals for this battery are: energy density 100 W h/kg (4-hr rate), sustained power > 80 W/kg, energy efficiency 50% and cost \$30/kWh for a production volume of 1000 MW h per year. It is expected that such a power source will give a 5-passenger car a 250 km range for the SAE J227a(D) US standard driving cycle.

The main problem with Zn-Cl₂ for electric traction is the size and plumbing complexity of the system, which impose severe weight, volume and cost penalties.

Nickel-zinc: This system consists of nickel oxide ($NiOOH$) positive and zinc negative electrodes in KOH

Battery Prospects (Cont)

electrolyte. Present Ni-Zn batteries have energy densities about 2½ times that of lead-acid (Table I). The major factor restricting the commercialization of Ni-Zn batteries is the rapid loss in capacity as a function of deep discharge cycle life. This is caused by the high solubility of the reaction product at the zinc electrode. Redeposition of zinc during charging results in the growth of dendrites (which penetrate the battery separators and short through to the positive electrodes), and also in redistribution of active material (the so-called "shape change") which leads to loss in battery capacity.

Steps are being taken to overcome these problems. Detrimental dendrite formation and the rate of shape change have been reduced by the use of new separator materials with improved stability. In the Swedish "Vibrocel" system (6), dendritic growth is suppressed by vibrating (20 Hz) the zinc electrode during charging. This has led to a 3-fold increase in battery life but at the expense of energy density. Other work on the Ni-Zn is being directed towards reducing nickel costs and developing totally sealed systems.

The system developed by the Furukawa Battery Co. has provided (7) the most impressive performance to date, viz. 71 W h/kg (2-hr rate), 167 W/kg (peak) and 500 cycles (60% depth of discharge). Batteries are also being built in France (CGE), Germany (Deutsche Automobilgesellschaft), Sweden (AGA Innovation Centre), Japan (Japan Storage Battery Co.), and USA (Atomics International, Eagle-Picher, ERC, ESB, General Motors, Gould, Westinghouse and Yardney Electric Corp.).

Nickel-iron: This is the iron counterpart of the Ni-Zn system. Ni-Fe batteries are well-known for their long cycle life (Table I) and recent research in Japan (Mitsubishi Electrical Industrial Co.) and Sweden (Swedish National Development Co.) has produced improved batteries with energy densities approaching those of Ni-Zn systems, i.e. ~80 W h/kg at the 5-hr rate. Other organisations involved in Ni-Fe system development are Eagle-Picher and Westinghouse in USA, Varta in Germany and SAFT in France.

Problems with Ni-Fe include poor power density, low charging efficiency, high self-discharge (associated with the low hydrogen overvoltage of iron), high Ni costs and low cell voltage (more cells needed for a given battery voltage). Problems of heat and gas generation during charging have been reduced (8) in the Westinghouse battery by using a circulating electrolyte system, but this increases system complexity and severely reduces the energy available per unit volume. Prototype Westinghouse batteries due to become available in March 1980 will have a performance of 60 W h/kg (3-hr rate), 150 W/kg (peak) and a projected life of 2000 cycles (80% depth of discharge).

Iron-air: Metal-air systems use oxygen from the air as positive active material and suffer from the problems of limited power, carbonate formation, poor oxygen electrode efficiency and limited cycle life that are common to all batteries and fuel cells using air cathodes in alkaline electrolyte. Much effort has been directed to the development of a rechargeable, low-cost, high-rate, oxygen electrode. In particular, cheaper alternatives to the expensive noble metal electrocatalysts are being sought. Such materials must exhibit good resistance to anodic corrosion processes during charging and to



Batronic electric van being used as a test vehicle for battery research by the CSIRO Division of Mineral Chemistry Battery Group. Left to right, John Hamilton, Eric Fraser, and the author, David Rand.

mechanical attack caused by the gas generation. Promising results have been obtained on layered nickel structures by Swedish (Swedish National Development Co.) and German (Siemens AG) research groups.

Fe-air batteries have been built and tested in vehicles in Japan and Sweden and other research is being carried out in USA by Westinghouse. Energy densities up to 81 W h/kg (5-hr rate) have been obtained. As with Ni-Fe systems, the Fe-air battery suffers from high self-discharge of the iron electrode, poor charge efficiency and low cell voltage. Another drawback is the rather bulky and complex auxiliary equipment required for circulating electrolyte and air, cooling, water makeup and carbon dioxide removal from the air.

Zinc-air: This is the zinc equivalent of the Fe-air system and has recently been used in vehicles in Japan. The most promising system is that developed (9) by CGE in France which overcomes problems of zinc shape change and dendritic growth by using a circulating system of zinc powder suspended in the electrolyte. The slurry is pumped through tubular air cells during discharge, and cell lifetimes of up to 600 charge/discharge cycles have been obtained. Recently, a prototype charge unit has been developed for on-board regeneration of spent slurry. Electric vehicle batteries equipped with a built-in charger are expected to deliver 90 W h/kg.

References

- (1) H. J. Schwartz, *IEEE Trans. Vehicular Tech.*, VT-26 118. (1977).
- (2) J. F. Cooper and E. L. Littauer, *Proc. 13th Intersoc. Energy Conv. Eng. Conf.*, San Diego, 1978.
- (3) R. K. Galgali, P. V. Vasudeva Rao and H. V. K. Udupa, *J. Electrochem Soc.* 126 725. (1979).
- (4) T. Takagaki and K. Yonezu, *ACS/CSJ Chemical Congress*, Honolulu, April 1979, paper 46.
- (5) P. Carr and P. C. Symons, *ibid*, paper 71.
- (6) O. V. Krusenstierna, in D. H. Collins (ed), *Power Sources 6*, Academic Press, London, 303. (1977).
- (7) K. Shimizu, *ACS/CSJ Chemical Congress*, Honolulu, April 1979, paper 51.
- (8) R. Rosey, *ibid*, paper 47.
- (9) A. J. Appleby and M. Jacquier, *J. Power Sources*, 1 17. (1976/77).

described earlier. In this process natural gas is steam reformed to produce a mixture of carbon monoxide, carbon dioxide and hydrogen (SYNGAS). The two possible routes for producing liquid hydrocarbons from synthesis gas are Fischer-Tropsch and the Methanol-Mobil processes and both rely on catalysts that have high selectivity and activity. This paper concentrates on the catalytic processes involved in the conversion of natural gas to methanol and gasoline. The routes to gasoline from coal and natural gas are summarised in Fig. 1.

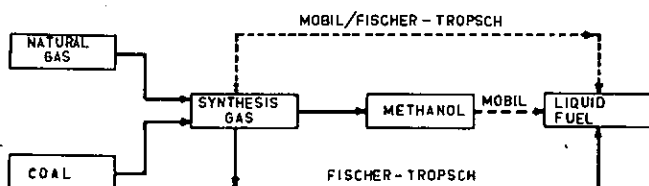
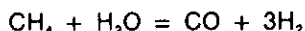


Fig. 1. Basic routes for producing liquid fuels from natural gas and coal.

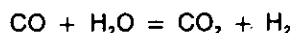
Reforming Of Natural Gas

The reforming of natural gas⁴ is simplified here by considering the reaction of methane and steam. However, it should be noted that the oxidizing agent in some continuous processes consists of a mixture of steam and air.

The reaction



is endothermic and heat must be provided to achieve adequate reaction rates. The reaction is also reversible and so high temperatures must be provided to achieve reasonable equilibrium yields. In addition, the shift reaction



can occur under reaction conditions so that the product from the reforming reactor consists of a mixture of CO, CO₂, H₂ and H₂O. This may have to be balanced by further reaction using a shift catalyst to provide the optimal CO/CO₂/H₂ ratio for methanol production.

Another reaction to be considered is that of coke formation



The reforming reaction is conducted at temperatures in the range 700 to 900°C and pressures from 5 to 40 atmospheres, the exact conditions being fixed by the ratio of steam to natural gas and the presence of O₂ in the feed.

Catalysts are packed in tubes of highly alloyed steels and are heated externally. The catalysts are invariably nickel and typically contain 25% nickel oxide supported on α-alumina. Calcium oxide is added to suppress coke formation.

Methanol

Until recently methanol has been used exclusively as an industrial chemical. The major uses have been as a feedstock for formaldehyde, dimethyl terephthalate and other methyl esters, acetic acid and for solvent purposes⁵. Possible future uses include food production via bacterial action, automotive fuel (alone or blended), utility fuel (e.g. power generation⁶) and as a building block for petrochemicals⁷ such as ethylene and propylene⁸. The major energy shortage facing NZ and Australia is transportation fuels and the following discussion concentrates on this use of methanol.

In recent months the governments of both countries have called for tenders for studies into the feasibility of the use of methanol as a gasoline extender and it appears that there will be cooperation from the oil companies. However, the debate on the relative merits of

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methanol as an automotive fuel is a continuing one. The advantages and disadvantages are summarised in Table 1.⁹

In summary, there appear to be two major drawbacks to its use as a fuel: its affinity for water (and the possibility of corrosion) and the fact that methanol on a per volume basis has only half the energy content of gasoline and thus would require twice the storage capacity for a given energy requirement if used alone.⁹ Counter to the first drawback extensive trials by Volkswagen¹⁰ in Germany have found few corrosion problems with gasoline-methanol blends and report

Table 1. Advantages and Disadvantages of Methanol for use as an Automotive Fuel⁹

ADVANTAGES	DISADVANTAGES
1. Lower noxious engine emissions.	1. Broad spectrum of phase separation resulting with water in gasoline mixtures
2. High octane rating (no additive such as lead required; methanol may serve to raise octane rating of gasoline).	2. Cold start problems for pure methanol due to a much higher heat of vaporisation than gasoline.
3. Possible smog reduction from photosynthesis.	3. Material changes required in tank linings, certain gaskets, floats and external coating.
4. No engine modifications required for blends up to 15% methanol (pure methanol requires modifications cost \$US100 (1975))	4. Requirement of separate fuel distribution systems for marketing.
5. Lower exhaust temperatures	5. Attack on certain materials in existing fuel distribution systems.
6. Motor life and life of ignition systems extended by use of pure methanol.	
7. Higher ignition temperature and flash point, plus more favourable explosive limits than gasoline.	
8. Benefits the high compression cars now being phased out.	

Liquid Fuels (Cont)

that exhaust emissions using these blends are much freer of pollution.

In contrast to the Volkswagen study which employed new vehicles, Graham and Judd¹¹ of the University of Canterbury and DSIR investigated the use of 10-15% methanol/gasoline blend in cars of various makes and ages. The conclusions of their paper which was presented at the recent Alcohol Fuels Conference are as follows.

"The main advantage of using methanol-gasoline blends in NZ would be to reduce overseas spending on petroleum by up to \$20-\$30 million. This could be done in NZ economically using natural gas which will be available in surplus over the next 15 years or more as feedstock for methanol production.

Phase separation of the blends due to the presence of water or low temperatures is not likely to be a problem in NZ once the blends have been delivered to the car fuel tank.

At the 10% level of methanol addition to NZ premium gasoline the change in drivability should be minimal for the current car fleet. Vapour lock for the blends is not likely to be a problem.

With the exception of some plastic fuel components, notably polyurethane fuel lines, there should be no compatibility problems in using the blends in existing cars in NZ. The relatively few fuel system components that would not be acceptable for use with the blends and would need to be replaced with acceptable alternatives (e.g. rubber fuel lines) would not be costly.

The level of lead compounds added to premium gasoline could be reduced with the introduction of the blends in NZ, or alternatively the methanol could be used to improve the octane rating of the fuel."

In the April, 1979, edition of **Chemistry in NZ** an NZIC commentary on the "Goals and Guidelines — An Energy Strategy for N.Z." included among its recommendations the immediate construction of a methanol plant using natural gas as a feedstock and the development of a distribution system to handle a 15% methanol blend fuel.¹²

While there exists, at least in the short term, the very real possibility that methanol will become a fuel, both automotive and utility, in its own right, the advent of the Mobil process has led to its being viewed more as an intermediate in the production of the more versatile gasoline. The Mobil process has generated such optimism that a proposal has already been made for its use in exploiting Australia's North West Shelf gas reserves¹³.

1. Production Of Methanol

Until the 1920's, methanol was obtained by the destructive distillation of wood. The first catalysts for the formation of methanol were reported by BASF in 1913 who were at that time attempting to produce liquid hydrocarbons from water gas. These catalysts were either mixtures of cobalt and osmium oxides with sodium hydroxide, or alkali treated iron oxides.

With these catalysts methanol was only a minor component, but BASF continued their research and in 1923 they found that with zinc oxide-chromic oxide catalysts methanol was the major product of the reaction between hydrogen and carbon monoxide. These zinc chromite catalysts form the basis of the current high pressure methanol process which uses typical conditions of 375°C and 330 atm.¹⁴

The other major type of catalysts used today, first reported in 1933 by Dodge, copper based and promoted with zinc and chromic oxide, were highly selective and, initially, very active but they were sensitive to overheating and poisoning by sulphur compounds present in the synthesis gas. However, with the

TABLE 2. Zeolite-catalysed Hydrocarbon Formation (Reference 25)

REACTANT	METHANOL	-BUTANOL	1-HEPTANOL	METHANETHIOL	PROPANAL	METHYLAL
Reaction Conditions						
T (°C)	371	371	371	482	371	371
LHSV (hr ⁻¹)	1.0	1.0	0.7	1.0	1.0	1.0
Conversion (%)	100.0	100.0	99.9	99.9 ^a	99.9	100.0 ^b
Hydrocarbon Distribution (wt%)						
Methane	1.0	0.1	0.0	0.0	0.8	1.5
Ethane	0.6	0.7	0.3	8.3	0.4	0.7
Ethylene	0.5	0.5	0.1	6.7	0.4	0.3
Propane	16.2	18.8	16.4	15.3	7.3	16.4
Propylene	1.0	1.1	0.2	1.3	0.6	0.9
i-Butane	18.7	18.4	19.3	9.0	4.6	15.1
n-Butane	5.6	8.6	11.0	3.1	3.0	5.8
Butenes	1.3	0.7	0.1	0.2	0.3	0.9
i-Pentane	7.8	6.2	8.7	1.2	1.8	5.8
n-Pentane	1.3	1.4	1.5	0.1	0.6	1.0
Pentenes	0.5	0.2	0.1	0.1	0.2	0.2
C ₆ ⁺ aliphatics	4.3	7.6	3.0	0.1	1.3	3.2
Benzene	1.7	3.3	3.4	0.2	4.1	1:1
Toluene	10.5	11.6	14.3	1.3	23.7	7.9
Ethylbenzene	0.8	1.3	1.2	0.1	2.6	0.7
Xylenes	17.2	12.4	11.6	8.9	26.4	20.5
C ₉ Aromatics	7.5	6.1	5.3	27.0	18.6	12.4
C ₁₀ Aromatics	3.3	0.4	2.9	9.5	3.7	5.4
C ₁₁ ⁺ Aromatics	0.2	0.6	0.6	1.3	0.6	0.2

a 27.2% C converted to (CH₃)₂S

b 11.0% C converted to CO + CO₂

production of synthesis gas by steam reforming (a process requiring quite pure feedstocks to prevent catalyst poisoning), interest was revived in copper based catalysts and in the late 1960's ICI¹⁵ introduced their low pressure methanol process using copper-oxide-zinc-oxide-alumina catalysts. This process typically uses conditions of 270°C and 50 atm.

A proliferation of patents on methanol catalysts has occurred since the 1920's, but the only significant ones industrially have been based on the above two general types.

An area of early research, which was abandoned in the desire to obtain highly selective methanol synthesis catalysts, was the formation of the dehydration product, dimethyl ether, in considerable quantities on such catalysts. The main contributors were Brown and Galloway, and Adkins and Perkins who published in the late 1920's. Some 40 years later this unwanted side reaction has become an integral part of the Mobil process.¹⁶

Recently Wainwright¹⁷ reported preliminary results on the use of Raney-copper catalysts to synthesise methanol from carbon monoxide and hydrogen. Further work carried out by Friedrich¹⁸ and Marsden and Wainwright¹⁹ has shown Raney copper-zinc catalysts to have two useful properties:

- (i) They can produce reasonably pure methanol (< 3% dimethyl ether) at rates comparable to those of commercial catalysts;
- (ii) at lower space velocities they can produce mixtures of methanol and dimethyl ether.

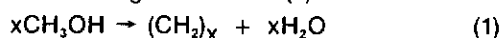
Except at very low space velocities the only products besides methanol and dimethyl ether were water and carbon dioxide. In the light of the Mobil process having an equilibrium mixture of methanol and dimethyl ether as an intermediate the results are very encouraging as Raney catalysts have a cost advantage over most other catalysts, as well as being relatively easy to prepare.

The Mobil Process

1. The Process:

The birth of the Mobil process occurred in the late 1950's with the development of the zeolite catalysts (crystalline alumina silicates) which can be tailored to meet given requirements, the term "catalyst engineering" being coined to describe this tailoring process. In 1962 Mattox²⁰ reported the formation of light olefins in the dehydration of methanol to dimethyl ether over NaX zeolite catalysts. Further work followed with the patenting of the zeolite ZSM-5²¹, a shape selective zeolite which has been found to be capable of converting methanol and other oxygenated organic compounds into high quality gasoline³. (See Table 2).

These catalysts convert crude methanol into hydrocarbons according to reaction (1)



The products are predominantly in the gasoline boiling range (C₅ - C₁₀). This gasoline is of a very high quality with an unleaded Research Octane Number (RON) of between 90 and 95 due mainly to the preferential formation of branched molecules. It also has good stability properties i.e. potential gum formation is low¹⁶.

The only undesirable product is durene (1,2,4,5-tetramethyl benzene) which boils in the gasoline range but freezes at 80°C; its maximum allowable level in gasoline being 4%. At present, depending on process variables, the Mobil process yields between 0 and 7%. Increases in temperature and space velocity reduce the amount formed while increases in pressure and catalyst ageing favour its formation¹⁶.

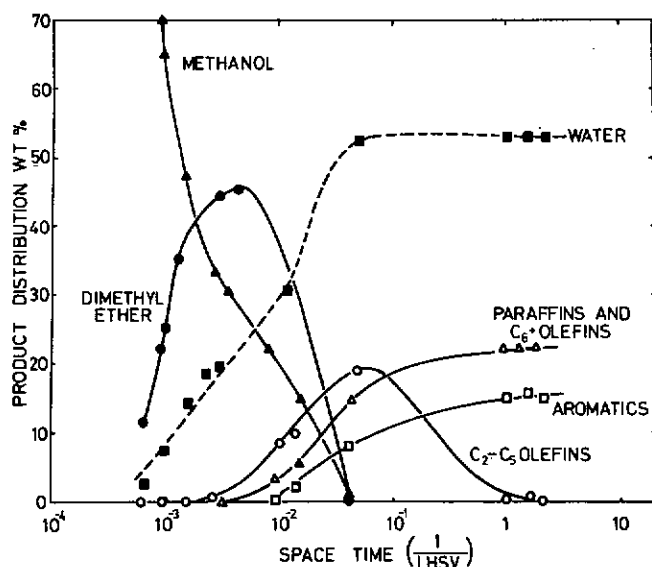


Fig. 2. Reaction path for methanol conversion to hydrocarbons (371°C) (reference 25)

2. Reactor Design

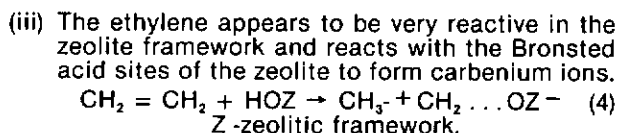
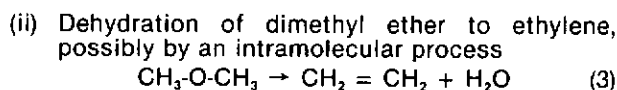
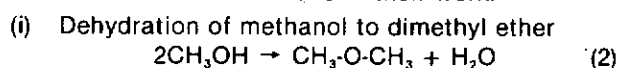
Two reactor systems have been studied²². The first was a 2-reactor design with a light gas recycle²³. In the first reactor the methanol was converted over a dehydration catalyst to an equilibrium mixture of dimethyl ether and methanol. This mixture was passed over the zeolite catalyst in the second reactor to obtain the required liquid products. Such a design allowed for removal of the considerable amount of heat produced in the dehydration reactions.

The second design was a single fluid bed reactor, and this was the design ultimately chosen for scale up²⁴. The main advantages of this design over the 2-reactor type appear to be:

- (i) The superior heat transfer characteristics of the fluid bed;
- (ii) the higher gasoline selectivity of the fluid bed when coupled with alkylation of the propylene and butene produced in larger quantities in the fluid bed; and
- (iii) better control of catalyst activity in the fluid bed. Catalyst ageing studies^{23, 24} have shown some deactivation with time. This deactivation is caused by coke formation (reversible) and steaming (irreversible).

3. Mechanism Of The Mobil Process

Equation (1) is an overall reaction for the very complex mechanism for the conversion of methanol to hydrocarbons. The first attempt at clarifying the mechanism was by Chang and Silvestri²⁵. In a follow-up to that paper Derouane and co-workers²⁶, using carbon-13 nuclear magnetic resonance and vapour phase chromatography, proposed the following mechanism to explain the reaction path shown in Fig. 2²⁵ as well as the observations in their work:



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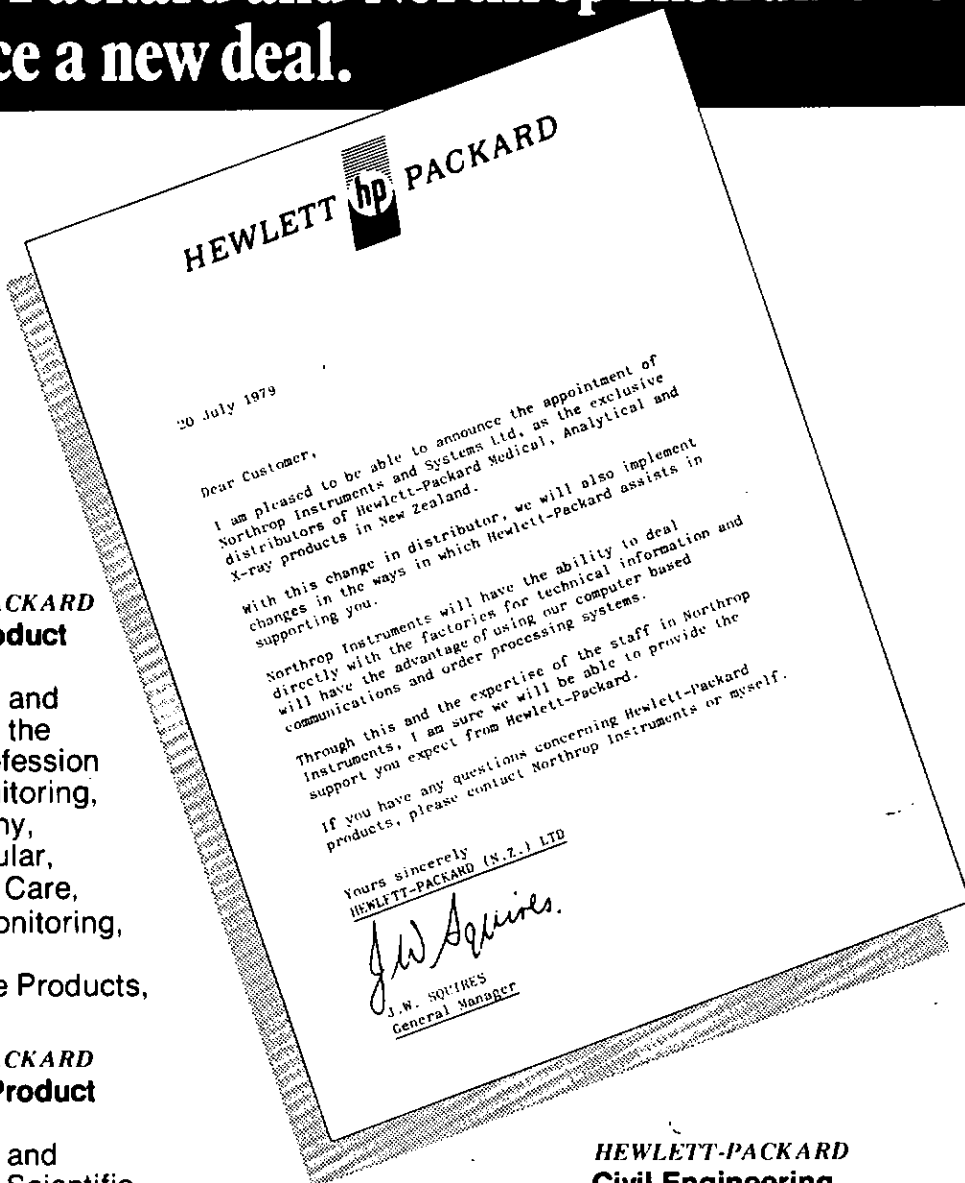
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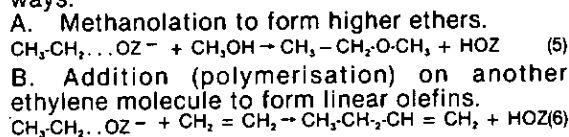
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Liquid Fuels (Cont)

- (iv) The carbenium ion then reacts in one of the two ways:



Derouane suggests that A is the most likely to occur because of the difference in basicity between alcohol and olefin. This would explain the presence of large quantities of C₂-C₅ olefins at high space velocities (low space times), with propylene being formed from the ethyl methyl ether formed in reaction (5) in a manner similar to reaction (3), i.e.



- (v) The alkenes formed in B can be hydrogenated to alkanes by hydrogen transfer from other olefins²⁷, or they can react as in (iv) by process A or B.

- A. The methanolation-dehydration process will form mostly branched molecules due to the secondary carbenium ions being more stable than the primary ones.

The existence of this mechanism is inferred from the constant observation of small amounts of methanol on the catalyst surface, probably produced by hydrolysis of the ethers.

- B. The polymerisation process will essentially yield linear olefins which can cyclise and form aromatics by hydrogen transfer to other olefins²⁷ converting them in turn to saturated aliphatics.

Derouane proposes that the dehydration-methanolation process competes with the polymerisation-cyclisation-aromatisation process to give the distribution shown in Fig. 2 at low space velocities.

Gasoline From Synthesis Gas

1. Fischer-Tropsch Process

The other major industrial process of concern here is the Fischer-Tropsch process which uses iron-based catalysts to produce a wide range of organic chemicals. Fischer-Tropsch catalysts were first reported in 1921 and since then the catalysts and process have undergone further development with the SASOL I plant being built in the 1950's and SASOL II under construction. These plants are the only truly commercial sources of gasoline from coal available at this stage. However, the Fischer-Tropsch synthesis suffers the disadvantage that it produces a wide range of oxygenated hydrocarbons as well as waxes. At this stage the gasoline fraction which is produced is most expensive and markets for the oxygenates also determine the ultimate price of the gasoline produced. The SASOL plants do provide a basic process technology that can produce increased yields and hence cheaper gasoline from synthesis gas provided improved catalysts are developed.

2. Incorporation Of The Mobil Process In The Fischer-Tropsch Synthesis

When comparing the Mobil and Fischer-Tropsch processes it is obvious that the Mobil process gives a narrower range of products with gasoline being of a higher quality. However, with the SASOL I plant in operation for over 20 years and SASOL II going into operation in the early 1980's, the Fischer-Tropsch process is a proven one on an industrial scale with established technology.

October 1979

In a recent paper Anderson²⁸, while looking at the possibility of using nitrided iron catalysts in the Fischer-Tropsch synthesis, proposed the incorporation of the Mobil process in the Fischer-Tropsch process to convert the oxygenates formed into gasoline. His scheme for the treatment of oxygenates (which are formed in larger quantities if nitrided iron catalysts are used) includes:

- (i) dehydration over alumina at 300-400°C giving olefins as well as isomerising terminal to internal olefins, which will lead to branched hydrocarbons when alkylated;
- (ii) subjecting the alcohols to the Mobil process to obtain liquid hydrocarbons;
- (iii) alkylation/polymerisation of C₃ and C₄ olefins to a C₆-C₈ fraction;
- (iv) removal of ethanol either to add to gasoline or dehydrate to ethylene for use in the chemical industry.

3. Mobil Technology

The ultimate aim of the Mobil researchers would appear to be the attainment of a process to go directly from synthesis gas to gasoline, perhaps with a single catalyst but at least without having to isolate methanol. The earliest work towards this end was reported by Chang and Silvestri²⁹ who contacted synthesis gas with a 1:1 mixture of copper (methanol synthesis) catalyst and alumina (acidic dehydration) catalyst. Subsequent to this Zahner³⁰ reported the formation of a mixture of methanol and dimethyl ether (with small amounts of other oxygenates) by passing synthesis gas stoichiometrically deficient in hydrogen over a zinc-chromium acid or copper-zinc alumina-acid modified methanol synthesis catalyst.

More recently Mobil researchers have reported³¹ gasoline production from synthesis gas over an intimate mixture of a Fischer-Tropsch catalyst with an excess of ZSM-5 class zeolite. Gasoline production in the synthesis gas conversion was increased to over 60% of total hydrocarbon and essentially 100% of the liquid product. The Fischer-Tropsch component was a commercial, potassium promoted, iron ammonia synthesis catalyst.

A further advancement³² by Mobil is the "super Fischer-Tropsch" range of catalysts that have been prepared by impregnating ZSM-5 class zeolites with nitrates of metals such as iron, zirconium and zinc-chromium. These catalysts combine the features of Fischer-Tropsch or methanol synthesis catalysts with the shape selective characteristics of the zeolites and produce high yields of aromatic hydrocarbons.

Conclusions

The progress made by Mobil researchers and South Africa Coal, Oil and Gas Co. Ltd. has led to a resurgence of interest in the possibility of obtaining liquid fuels (particularly gasoline) and other hydrocarbon feedstocks from coal and natural gas via synthesis gas. The next few years will probably see the catalysts and processes covered in this paper developed much further as well as the emergence of many more. One thing is certain, however; catalysts will continue to play an indispensable role in any processes used in the conversion of synthesis gas to liquid fuels.

Postscript

"In the Australian Financial Review (11/7/79) it was reported that Mobil proposes to establish a plant for its methanol-to-gasoline process in NZ at a site to be decided. The process would be based, at least initially, on methanol derived from natural gas, with perhaps half of NZ's daily requirements being met by the existing capacity of the Maui field. Detailed design would be

Liquid Fuels (Cont)

expected to take 1 year with 2-3 years for the construction stage.

In the address to a tripartite meeting of the Royal Australian Chemical Institute, the Australian Institute of Chemical Engineers and the Australian Institute of Engineers in Sydney on 23/7/79, Prof. D. L. Trimm, U.N.S.W., reported that this plant would be of the fixed bed design owing to design difficulties experienced in Mobil's fluid bed plant in New Jersey. It was also reported that the 1-step process from synthesis gas to gasoline was economically less viable than the 2-step conversion via methanol due to thermodynamic limitations."

REFERENCES

1. Waterman, W.W., "Clean Fuels from Coal: Symposium Papers". Institute of Gas Technology, Chicago, 1973, 673
2. Gates, B.C., Chemical Technology, February 1979, 9, 97.
3. Meisel, S.L., et alia, Chemical Technology, February 1976, 6, 86.
4. Rostrup-Nielsen, J.R., "Steam Reforming Catalysts", Danish Technical Press, Copenhagen, 1974.
5. Stiles, A.B., A.I.Ch.E. Journal, 1977, 23, 362
6. Mills, G.A., Harney, B.M., Chemical Technology, January 1974, 4, 26.
7. Paulsen, T.H., Oil and Gas Journal, October 1st 1973, 68.
8. Kaeding, W.W., U.S. Patent 4,049,573 (1977).
9. Conner, D.A., Plock, G., "Methanol Production from Coal". IMMRI-PDI-75, University of Kentucky, 1975.
10. Koenig, A., et alia, Alcohol Fuels Conference, Sydney, August 1978, 2-1.
11. Graham, E.E., Judd, B.T., Alcohol Fuels Conference, Sydney, August 1978, 2.7.
12. Watson, I.R., Williamson, A.G., Wright, G.J., Chemistry in NZ, 1979, 43, 64.
13. McWaters, D.F., Alcohol Fuels Conference, Sydney, August 1978.
14. Strelzoff, S., Chem. Eng. Progr. Symp. Ser., 1970, 66(98), 54.
15. Humphreys, G.L., et alia, C.E.E.R., November 1974, 6(11), 26.
16. Voltz, S.E., Wise, J.J., "Development Studies on Conversion of Methanol and Related Oxygenates to Gasoline", Final Report, Erda contract No. E(49-18)-1773, November 1976. (Extracts can be found in references 22, 23, and 24).
17. Wainwright, M.S., Alcohol Fuels Conference, Sydney, August 1978, 8-1.
18. Friedrich, J., Honours Thesis, Univ. of N.S.W., 1978.
19. Marsden, W.L., Wainwright, M.S., Yet to be published.
20. Mattox, W.J., U.S. Patent 3,036,134 (1962).
21. Argauer, R.J., et alia, British Patent 1,161,974 (1969).
22. Penick, J.E., et alia, Alcohol Fuels Conference, Sydney, August 1978, 5-12.
23. Chang, C.D. et alia, I. & E.C. Process Des. Dev. 1978, 17, 255.
24. Liederman, D., et alia, I. & E.C. Process Des. Dev. 1978, 17, 340.
25. Chang, C.D., Silvestri, A.J., J. Catalysis, 1977, 47, 249.
26. Derouane, E.G., et alia, J. Catalysis, 1978, 53, 40.
27. Poutsma, M.L., "Zeolite Chemistry and Catalysis", (Rabo, J.A. Ed.), ACS Monograph 171, American Chemical Society, Washington, 1976, p.487.
28. Anderson, R.B., Catal. Rev. Sci. Eng., 1979, 19, 293.
29. Chang, C.D., Silvestri, A.J., U.S. Patent 3,894,102 (1975).
30. Zahner, J.C., U.S. Patent 4,011,275 (1977).
31. Caeser, P.D., et alia, J. Catalysis, 1979, 56, 274.
32. Chang, C.D., et alia, J. Catalysis, 1979, 56, 268.

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CATALYTIC PROCESSES IN PRODUCTION OF LIQUID FUELS FROM SYNTHESIS GAS

CATALYTIC PROCESSES IN THE PRODUCTION OF LIQUID FUELS FROM SYNTHESIS GAS

W. Marsden and M. Wainwright, University of NSW

Introduction

With the oil crisis of the early '70s came the realisation that supplies of one of the world's major natural resources, crude oil, are finite. As the world economy is very dependent on liquid fuel this led to steep price rises and a resultant acceleration in the search for alternate liquid fuels, most notably those derived from coal and natural gas.

If coal is used as the feedstock there are 4 routes possible. Whether the coal is converted to a liquid or gas depends on the type of processing. The routes are¹:

1. Pyrolysis

The volatile or complex organic hydrocarbon matter is thermally decomposed. Depending on the rate of heating, the amount of gaseous and liquid products can be varied. More rapid heating tends to convert more of the coal and leave less char.

2. Solvation

By use of a hydrogen donor solvent, coal molecules can be broken down to a size which gives a product with properties of a liquid. Relatively little hydrogen addition required to convert coal to a liquid. Typical example, "Solvent Refined Coal" (SRC)

3. Hydrogenation

In this process hydrogen, coal and a catalyst are brought into contact at elevated temperatures and pressures. Typical is the H-Coal process² in which a coal/oil mixture is contacted with a hydroprocessing catalyst (typically sulphided $\text{CoO}/\text{MoO}_3/\text{Al}_2\text{O}_3$) at 450 °C and 200 atmospheres pressure.

4. Synthesis gas

This is an indirect process commonly known as the gasification route in which coal (or char) is gasified with steam and oxygen to produce carbon oxides and hydrogen. After purifying and establishing the correct CO/H_2 ratio the gas is passed over appropriate catalysts to produce the desired end product which may be methanol, gasoline or methane.

In recent years research has concentrated on the first 3 processes with little interest in the gasification route. However, renewed interest in the gasification route has been sparked off by the announcement of what has come to be known as the Mobil process³ for converting methanol to gasoline; the technology for converting synthesis gas to methanol having already been developed.

Although coal will in the long term be used as a source of liquid fuels, an immediate solution to the energy problems of NZ and Australia is provided by the conversion of natural gas to liquid fuels. The conversion processes are based on the synthesis gas route

NEW PRESIDENT



Arthur Derek Campbell was born in Waimate and educated at the local high school and Otago University, where he graduated M.Sc. in 1948, and Ph.D. in 1952. In 1954 he was at Glasgow as a Corday-Morgan Commonwealth Research Fellow and in 1961, Nuffield Commonwealth Fellow in the Analytical Laboratories of Birmingham University. At Otago, Arthur has progressed from Assistant Lecturer in 1948 to Associate Professor in 1964, and full Professor in 1971. He has served on the Otago Branch Committee in various capacities, being Chairman in 1963. He won the Morcom-Green and Edwards Prize in 1955, and the Easterfield Award in 1959.

His original interests in chemistry were in the field in the synthesis of polycyclic aromatics, but later he took over the responsibility for the micro-analytical laboratory, and he has an international reputation in this field. He is Chairman of TELARC, and a member of the management committee of the Fertiliser Manufacturers' Research Committee. He serves as an advisory member on two committees for the Dunedin Teachers' College, and is a member of Executive Committee for Dunedin Emergency Services. In addition to all these activities, he has time for some gardening and fishing.

Chemical Intrigue And Biochemical Sabotage

R. E. Mitchell.

Biology is concerned with the study of living organisms. A fundamental feature of the teeming life on Earth is the incessant interaction between various organisms. Everyday living for us all on Earth means continual interaction with various other organisms.

Plants also interact with other organisms. Often this is not so obvious to the unsuspecting eye. A plant disease in fact is the result of a specific interaction between a microorganism (or parasite) and a "host" plant. Diseases of useful plants have been known since ancient times in all parts of the world.

The interaction between plant and parasite can be viewed simply as a chemical warfare. This is a simplistic concept. In real terms the plant disease process represents a complex interaction between two organisms. An understanding of the multitude of events occurring calls, therefore, for intensive multidisciplinary investigation. It is beyond my scope at this time to focus on every detail of this complexity. Nevertheless, consideration of the "chemical warfare" theme can lead to some understanding of the mechanism of interaction between plant and parasite.

The primary event prior to a disease situation is the entry of a parasite into the plant. This is necessary for the parasite to obtain nutrients. Plants invariably have a defensive reaction to the invasion. A successful defence has the net outcome of a resistance of the plant to the parasite; this interaction won't be considered further. An unsuccessful defence would allow an ensuing disease process in the plant.

Parasites are capable of producing a wide variety of materials which play an important role in disease development.² For example, enzymes, such as pectinases and cellulases, may be involved in degradations within the host; or extracellular insoluble macromolecules, such as polysaccharides, may physically plug the host's vascular system. Smaller molecules may also be produced by the parasite in the

host plant. Often these are biologically active; we refer to such small molecules as toxins. To generalize, toxins are effective because of an interference with the normal biochemical (or physiological) function of the plant. Thus the toxin could be a hormone, an antimetabolite, or even a selective biocide. The biological activity of toxins is often responsible for some, or all, of the symptoms elaborated in the disease of the plant. This biological activity of toxins can be observed and measured. This single factor vastly facilitates and broadens both the study of toxins and the scientific utility of toxins. The chemical and biological study of toxins can help us to understand much better the interaction between plant and parasite.

Consider now a specific example, the bacterial pathogen, *Pseudomonas phaseolicola*, and a host plant, bean (*Phaseolus vulgaris*). The pathogen generally enters the leaf of the host, and primary infection-sites form where the bacterial cells proliferate. "Toxin" is produced, diffusing into the surrounding leaf tissue where it causes a metabolic disruption with a resulting yellow chlorosis, or "halo", surrounding the infection-site. Thus halo blight of beans got its name. Despite the minute size of the bacterial cell, it does have a very powerful punch with the secretion of this toxin. What is the chemical nature of the toxin, and how potent is it?

To reiterate, the overall objective is to elucidate the mechanism of the interaction between plant and pathogen. The approach adopted is to look firstly at biologically active metabolites produced by the bacterium in the absence of the plant. Then with a knowledge of the synthetic ability of the pathogen we can finally relate these findings to the real disease situation and gain some insight and illustration of the second dimension of the interaction between plant and pathogen.

Structural Elucidation Of Bean Halo Blight Toxin

1. Production, purification and bioassay of toxin: Toxin is produced in a defined liquid medium in shake culture. Depending on the strain selected, anywhere from 1 to 5 mg of toxin per litre of medium is produced. Some strains produce no more than a few μg^2 . The purification of toxin was initially very difficult; the toxin was found to be very hydrophilic, and neither soluble nor extractable into organic solvents. In addition it was unstable to even mildly acidic conditions. The toxin is purified from the medium according to Table 1⁴. The purified toxin has been given the trivial name phaseolotoxin.

Naturally to purify something it is necessary to have a chemical or biological method of detecting it. Earlier we were totally dependent on a bioassay — chlorosis of bean leaves; this had the disadvantage of being a 2-day assay, but the advantage of being extremely sensitive; 5-10 ng of phaseolotoxin is sufficient to cause leaf chlorosis. Now phaseolotoxin is routinely detected on cellulose thin layer plates, using either a single dimension chromatography, or a two-dimensional electrophoresis/chromatography (TLE/TLC) system; visualization is with ninhydrin. The most recently developed bioassay system now available is a microbiological one — phaseolotoxin inhibits the growth of *Escherichia coli* on a minimal salts agar medium⁵; this is the quickest and most sensitive method of detection. A comparison of these 3 detection methods is made in Table 2. To keep things in perspective it suffices to say that for a chemical purification, a chemical assay remains highly desirable, despite its much lower sensitivity.

Robin Mitchell was born in Auckland in 1943 and was educated at Mahurangi College, Auckland Grammar School and the University of Otago where he completed B.Sc. (Hons) in 1965. He joined the Plant Diseases Division, DSIR, Mt Albert, Auckland, the following year in which he also moved to the University of Calgary where he spent 3 years working on his Ph.D. thesis on natural products. In 1970 he worked on a post-doctoral fellowship with the late Prof T. A. Geissman at Los Angeles, and in 1970 returned to the DSIR, where he is currently employed. In 1977-78 he was on study leave at the University of Wisconsin, Madison.



Dr Mitchell is married and has 3 children, with whom he enjoys camping out; his other hobbies are bridge and fishing. His address for communications is Plant Diseases Division, DSIR, Private Bag, Auckland.

PURIFICATION OF PHASELOTOXIN FROM LIQUID CULTURE MEDIUM

Purification step	Initial wt (g)	Final wt (g)	Purification factor	Yield %
Charcoal adsorption	98			87
Recovery from charcoal		0.9-1.3	~100	67
QAE Sephadex chromatography	2.5*	0.10-0.13	~20	66
LH20 Sephadex chromatography	0.12	0.012-0.015	~10	65

* combined charcoal extracts from two 9 l batches

Table 1. Purification of phaseolotoxin from liquid culture medium.

2. Structural studies: Once pure toxin was obtained, structural studies commenced. Reactivity of the toxin to ninhydrin suggested that a peptide might be involved: strong acid hydrolysis liberated three amino acids, alanine (3a), ornithine (3b), and homoarginine (3c). Amino acid analysis showed a 1:1:1 molar ratio.

We shall pause at this point to mention the significance of early observations. The toxin migrated electrophoretically at pH 2 rather like an acidic amino acid, certainly not like a peptide containing two basic amino acids. This anomaly disappeared when the toxin was hydrolyzed with dilute acid. No single amino acids were released, but a single new tripeptide product was obtained, which now had the expected electrophoretic properties: it migrated very much like lysylalanine. This tripeptide product from the toxin was sequenced by standard chemical and enzymological techniques. It was found to be ornithylalanylhomoarginine (4). Furthermore, facile enzymatic hydrolyses of the tripeptide (referred to in detail later) were a good indication that the amino acid residues were all of the L-configuration.

Because peptide bonds are stable under the dilute acid hydrolyzing conditions used to liberate ornithylalanylhomoarginine from the toxin, the same structural unit with the same amino acid sequence must be present in the intact toxin. So how then does the toxin differ from ornithylalanylhomoarginine? The comparative electrophoretic behaviour of phaseolotoxin and ornithylalanylhomoarginine shows that an anionic component of the toxin is lost on exposure to dilute acid conditions. Where is this group bonded in the toxin? Free amino group analysis of the toxin utilizing the facile reaction of free amino functionalities with 2,4-dinitrofluorobenzene led to the finding that the ornithyl residue of the toxin has a bonded δ-NH₂ grouping. Thus the toxin at this point is depicted by the structural representation 5. That the C-terminal carboxyl group was indeed unbonded (hence eliminating the possibility of a cyclic peptide structure) was confirmed from an ex-

Table 2. Comparison of detection methods for phaseolotoxin.

COMPARISON OF DETECTION METHODS FOR PHASELOTOXIN

Method	Optimal detection range (ng)	Time for detection (hr)
Leaf chlorosis	5+20	24-48
TLE and/or TLC	5+10 x 10 ³	2-8
Inhibition of <i>E. coli</i>	0.2 + 1.0	3-5

amination of the reaction of Carboxypeptidase on the toxin. This enzymatic hydrolysis sequentially liberated homoarginine and alanine from the C-terminus of the peptide chain, yielding the isolateable compounds 6 and 7 (Figs 1 and 8). Both compounds 6 and 7 retained the ornithyl δ-N substituent. The end-product of this peptidase reaction, 7, which contained ornithine as the sole amino acid residue, was very different from ornithine in its electrophoretic mobility: it was anionic whereas ornithine is strongly cationic at pH 2. This difference paralleled the difference between phaseolotoxin and its free tripeptide, but in fact was more pronounced. Thinking about this anomalous difference between electrophoretic mobilities led to our first confident proposal as to the nature of the A-substituent group: it must contain a phosphate, or sulphate, or sulphonic acid type of function, since a carboxylic acid function would be protonated at pH 2 and hence not ionic.

CARBOXYPEPTIDASE HYDROLYSIS SEQUENCE

Fig. 1. Sequence of Carboxypeptidase hydrolysis of phaseolotoxin at pH 7.9 in 0.2 M NH₄HCO₃.

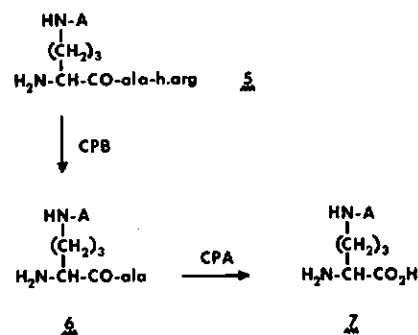


fig.1

TIME COURSE OF DILUTE ACID HYDROLYSIS

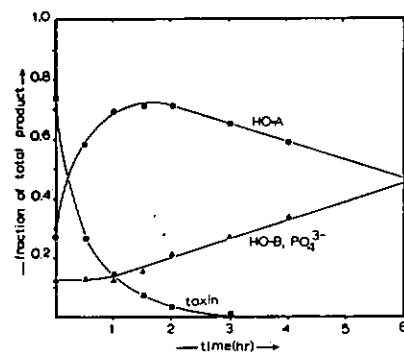


Fig. 2 a

Fig. 2: Acid hydrolysis of phaseolotoxin in 0.025 M HCl at 40°C. (a) Time course of hydrolysis; (b) Sequence of acid hydrolysis.

ACID HYDROLYSIS SEQUENCE

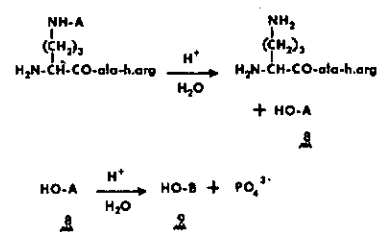
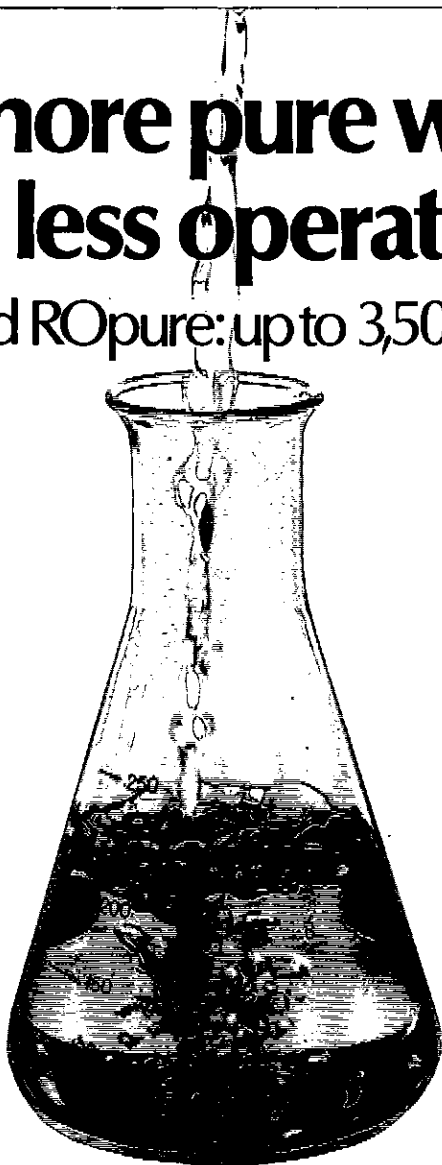


fig.2 b

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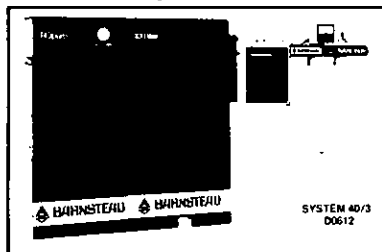
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membrane replacement.

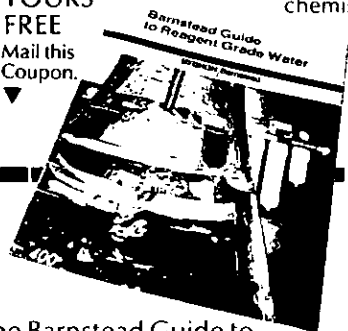
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Presence of P in the toxin was proven when *Ps. phaseolicola* was grown in a $^{32}\text{PO}_4^{3-}$ radioactively-labelled medium; the purified phaseolotoxin on a two dimensional TLE/TLC plate had a radioactive spot exactly coincident with the ninhydrin spot. Furthermore the toxin gave a blue/grey colouration after spraying with molybdate (similar to phosphate esters). Preparation of toxin from a $^{35}\text{SO}_4^{2-}$ radioactively-labelled medium showed that the toxin also contained S. The nature of the P and S functionalities were shown to be phosphate and sulphate after TLE/TLC studies of strong acid hydrolysis products from the toxin. However, the A-substituent-group was not simply a phosphate or sulphate group as might occur in a mixture of two analogues. The P and S were shown to be an integral part of the one molecule from a study of the time-course of dilute acid hydrolysis of ^{32}P -radioactively labelled toxin (Fig. 2a) and of ^{35}S -radioactively labelled toxin. Thus, the initial cleavage liberated ornithylalanylhomocysteine and a phosphate and sulphate containing intermediate (A-OH compound **8**) which underwent further hydrolysis, by cleavage of inorganic phosphate (Pi), liberating a new product (B-OH, compound **9**) which contained sulphur, but not phosphorus (Fig. 2b). A separate study showed that there was one mole of Pi liberated per mole of toxin.

This end-product (compound **9**) of the dilute acid hydrolysis of the toxin was the final key to the toxin's structure. It was chromatographically and electrophoretically distinct from sulphate, but very similar to sulphate esters of simple hydroxyacids, such as glycolic acid O-sulphate and lactic acid O-sulphate. However, a negative proton NMR spectrum clearly excluded these possibilities. Compound **9** finally was found to be sulphamic acid, HOSO_2NH_2 .

With the structural components of the toxin now known, the final task was to find some evidence on how sulphamate and phosphate were linked to the $\delta\text{-NH}_2$ of the tripeptide. Firstly, the high acid-lability of the toxin could be ascribed to an N-P linkage; this is rare in

Fig. 3: Alternative structural representations for phaseolotoxin.

Alternative structural representations for phaseolotoxin

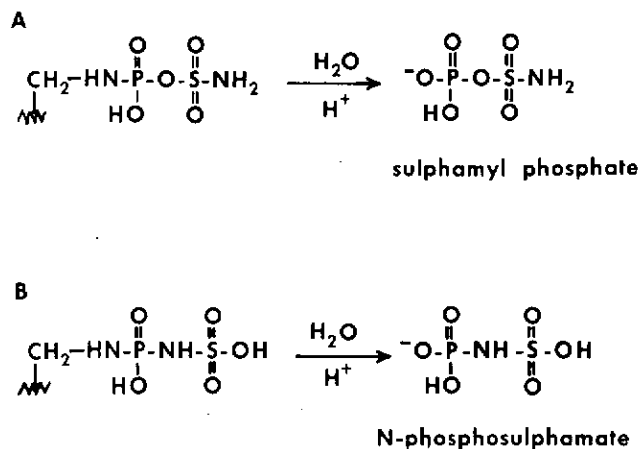


fig. 3

^{13}C NMR DATA FOR PHASEOLOTOXIN

δ^*	assignment
179.5	} carbonyl
174.2	
172	
157.5	guanidino >C=NH
55.8	} α -CH-
53.8	
50.6	
41.7	-CH ₂ NH- of h. arg and orn;
40.6	
32.1	} h. arg β and δ -CH ₂ -, orn β -CH ₂ -
29.7	
28.3	
27.1(d.)	
23.0	
17.3	h. arg γ -CH ₂ - ala CH ₃ -

* δ relative to 67.4 for dioxane

Table 3. ^{13}C -NMR data for phaseolotoxin.

nature, and notoriously acid-labile. If this were the case, only two structures were possible for the toxin (Fig. 3). These final two alternatives were distinguished when a study was made of the reaction of nitrous acid on the intermediate acid reaction product, HO-A (compound **8**). Sulphamic acid reacts with cold nitrous acid liberating sulphate and nitrogen. Compound **8** also reacted with cold nitrous acid generated in aqueous acetic acid, liberating a new P and S containing compound (**10**, Fig. 4); this product was detected on TLE, but was unstable and readily cleaved to form phosphate and sulphate. These observations are consistent with compound **10** being phosphosulphate, and compound **8** being sulphamyl phosphate, both hitherto unreported inorganic species which will be discussed further later on. There is precedence for a phosphate sulphate anhydride in the naturally occurring compound adenosine 5-phosphosulphate.

The toxin structure is now complete: the tripeptide is linked through an N-P bond to sulphamyl phosphate. Thus the toxin has structure **1**. It has been given the trivial name phaseolotoxin. This structure is fully consistent with ^{13}C and ^{31}P NMR spectra recently recorded for phaseolotoxin (Table 3 and Fig. 5 respectively).

Phaseolotoxin Analogue

A later study⁶ has revealed the presence of an analogue of phaseolotoxin in quantity amounting to about 5-10% of the phaseolotoxin. It has been separately purified and identified as [2-serine] phaseolotoxin (**2**) (1 with serine in place of alanine).

Fig. 4: Reaction of sulphamyl phosphate with nitrous acid.

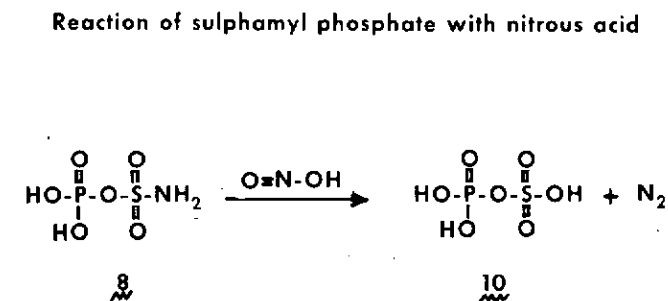


fig. 4

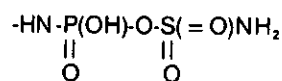
Summary Of The Chemistry Of Phaseolotoxin

The important features characterizing the structural elucidation of phaseolotoxin warrant summarizing; these features also apply to [2-serine] phaseolotoxin:

- (1) Facile acid hydrolysis reactions are illustrated in Fig. 6.
- (2) The susceptibility of phaseolotoxin to various enzymic hydrolyses (Fig. 7).
- (3) The utility of the two dimensional TLE/TLC separation system is illustrated by the composite map (Fig. 8) of all the phaseolotoxin-related compounds.

I will make brief comment on a major fascination of phaseolotoxin: as a naturally occurring precursor of two new inorganic species, sulphamyl phosphate and phosphosulphate. In particular, it should be noted that sulphamyl phosphate can be regarded as a sulphur analogue of the biologically important compound carbamoyl phosphate. Sulphamyl phosphate is potentially a very useful compound in its own right as a moderately stable precursor of phosphosulphate.

Perhaps the most remarkable feature of phaseolotoxin is how it all hangs together: I refer specifically to the inherently labile high energy bonding system



This stability has surely been achieved by the terminal sulphamino group. I wonder whether this was coincidental? Or was it clever architecture by Nature? The key to this sort of speculation is contained in the biological function and properties of phaseolotoxin.

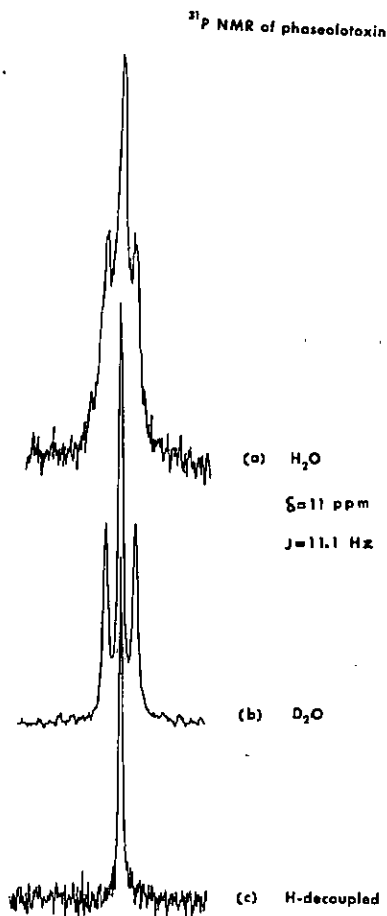
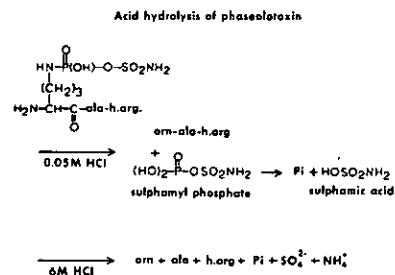


Fig. 5: ³¹P NMR spectrum of phaseolotoxin. (a) in H₂O; (b) in D₂O — NH coupling removed; (c) Proton decoupled.

Fig. 6: Acid hydrolysis reactions of phaseolotoxin.



Structure/Activity Implications From Phaseolotoxin-Derived Compounds

It was clear at the conclusion of the structural determination of phaseolotoxin that the essential feature required to produce chlorosis was an intact N-P bond in the N-phosphosulphamyl group. Thus neither the tripeptide orn-ala-h.arg nor sulphamyl phosphate apparently had this biological activity. In contrast [2-serine] phaseolotoxin, phosphosulphamylornithine (7),

Fig. 7: Action of peptidase enzymes on phaseolotoxin.

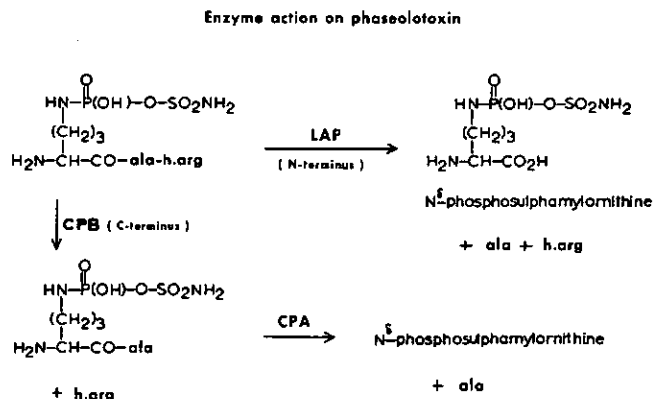
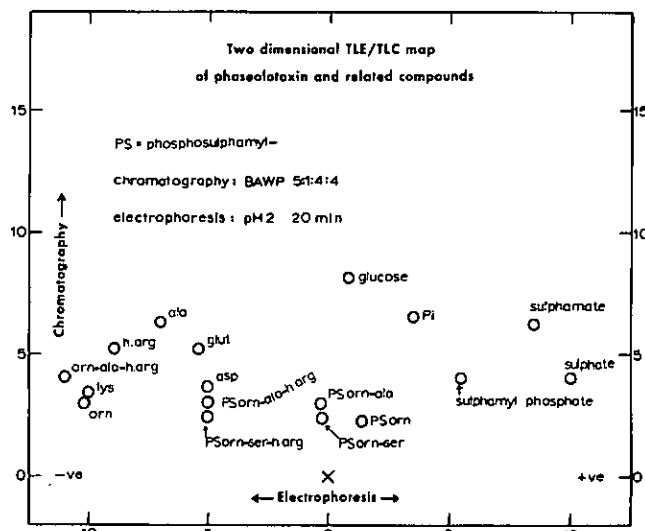


fig.7

Fig. 8: Two dimensional TLE/TLC map of phaseolotoxin and its related compounds.



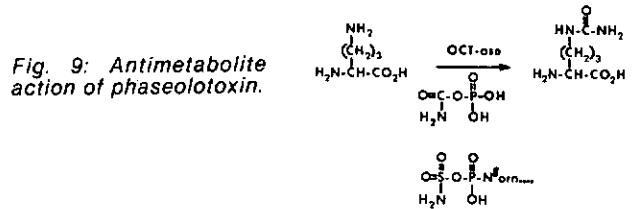
phosphosulphamylornithylalanine (6) and its serine analogue, all were capable of causing chlorosis at comparable concentrations.

Toxins In Bean Infected With *Ps. Phaseolicola*

The major toxin produced by *Ps. phaseolicola* in liquid culture is phaseolotoxin³. However, this does not validate the assumption that the effective chemical species causing the visible symptoms of bean halo blight is also phaseolotoxin. In order to investigate the nature of the *in vivo* toxin we sought initially to find what the chemical fate of phaseolotoxin was after its application to, and passage into, bean leaves. With the utility of high specific activity ³⁵S radioactively labelled phaseolotoxin we found that as soon as phaseolotoxin was applied to a wounded site on a bean leaf, a rapid peptidase cleavage of the peptide chain occurred. The stable end product persisting in the leaf was found to be N-phosphosulphamylornithine, although some phaseolotoxin (24% of the isolated ³⁵S) was found in locations some distance from the site of application. This result immediately suggests that in the disease situation we may not find much phaseolotoxin as such.

In an experiment using ³⁵S-labelled beans infected with *Ps. phaseolicola*, leaves were extracted as soon as chlorosis symptoms were observed. There was sufficient quantity of N-phosphosulphamylornithine found in the leaf extract to account for the chlorosis symptoms observed, whereas the amount of phaseolotoxin found was not significant¹.

Thus, although phaseolotoxin is very likely the primary metabolic toxic product *in vivo* from *Ps. phaseolicola*, a secondary effect of the host plant causes the functional toxin in fact to be a different form, N-phosphosulphamylornithine.



Mode Of Action Of Phaseolotoxin

For many years it has been known that the chlorotic leaf tissue from application of crude toxin preparations contained a greatly elevated concentration of ornithine⁷. Subsequently, it was shown that partly purified toxin did indeed cause a metabolic block of arginine biosynthesis by blocking the conversion of ornithine to citrulline; thus the toxin preparation inhibited the enzyme ornithine carbamoyltransferase (OCT-ase) which catalyzes this conversion⁸. Recent studies show that phaseolotoxin is indeed a potent inhibitor of OCT-ase⁹; it probably achieves this inhibition by acting as an analogue of carbamoyl phosphate, one of the substrates for the reaction (Fig. 9). Thus, it is probably this primary function of phaseolotoxin that leads to leaf chlorosis, and inhibition of microorganisms such as *E. coli*. The reversal of these biological effects by a supply of arginine points to an arginine deficiency as being the important factor leading to chlorosis and *E. coli* inhibition.

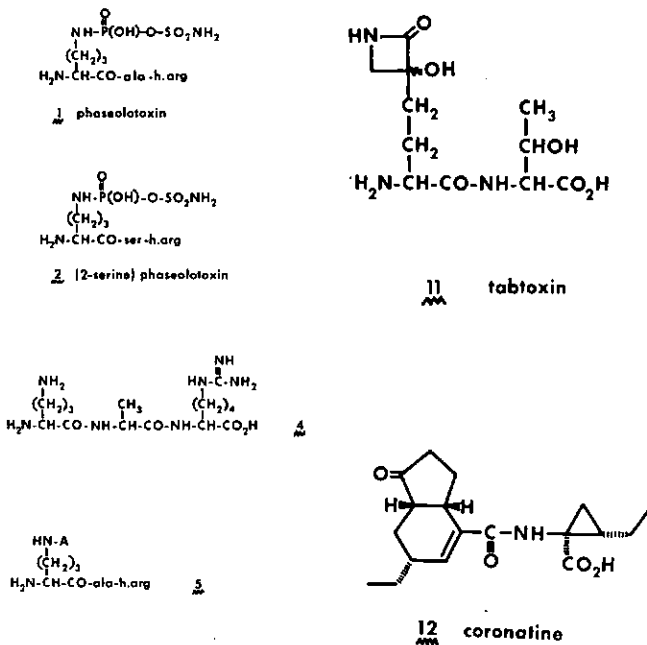
Concluding Thoughts

Although the N-phosphosulphamyl functionality is the major chemical curiosity of the phaseolotoxin molecule, recent biological data points to the speculation that other facets may be significant in several other ways. I put forward just a few of these thoughts: what is the significance of the tripeptide "backbone" of phaseolotoxin when phosphosulphamylornithine, with a single amino acid unit, seems to be equally effective as a toxin? What is the significance of homoarginine and the basic guanidino functionality?

There have been numerous fascinations with this study, yet still more are crystallizing. One recently discovered phenomenon which serves to illustrate this is initiated by posing the fundamental question: how can the bacterium *Ps. phaseolicola* produce a potent toxin which disrupts the metabolism of its host, bean, and also other microorganisms (thus totally inhibiting their growth) without itself being apparently affected? This in fact typifies the sabotage, for the bacterium appears to have evolved for itself rather special circumstances to withstand high concentrations of phaseolotoxin. Recently it has been found by Dr A. R. Ferguson and Mrs J. Johnston¹⁰ that *Ps. phaseolicola* has an OCT-ase which is able to function appreciably even in the presence of significantly high levels of phaseolotoxin. During the evolution of the phaseolotoxin story I have found it increasingly rewarding to watch the blossoming biological research growing from the solid chemical foundation that I have endeavoured to present in this lecture.

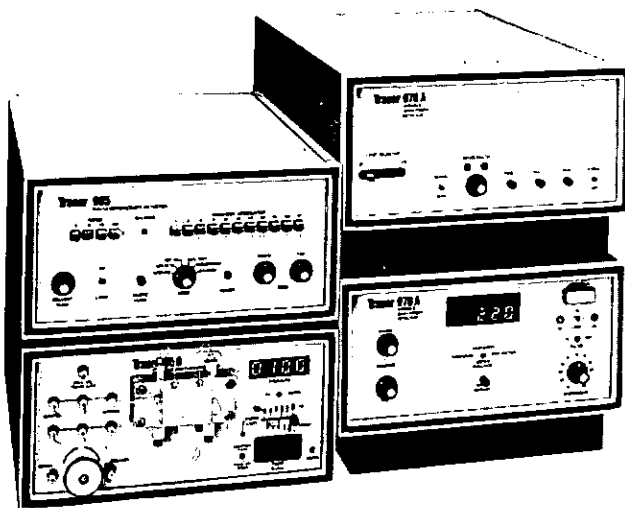
An Overview Of Toxins Of Plant Pathogenic Pseudomonads

It is appropriate that I conclude this Easterfield address with some brief mention on where our research on



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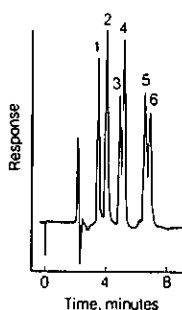
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Nitrogen Nitrosamines

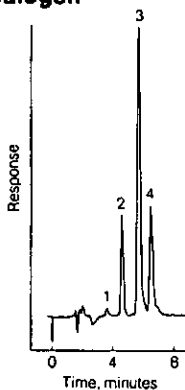


Instrument: Tracor 950/965
Separation: Normal Phase

Peak	Identity
1	N-Nitrosodimethylamine
2	N-Nitrosodiethylamine
3	N-Nitrosodipropylamine
4	N-Nitrosodibutylamine
5	N-Nitrosopiperidine
6	N-Nitrosopyrrolidine

8 ng each

Halogen

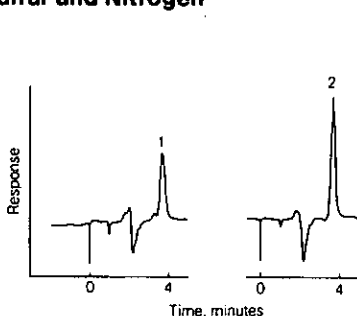


Instrument: Tracor 950/965
Separation: Reverse Phase

Peak	Identity
1	Fluorobenzene 550 ng
2	Chlorobenzene 550 ng
3	Iodobenzene 400 ng
4	4-Bromotoluene 300 ng

Relative response to halogenated benzenes. All halogens are detected with fluorine being the least sensitive in this case.

Sulfur and Nitrogen



Instrument: Tracor 950/965
Separation: Reverse Phase

Peak	Identity
1	5 µg Spectracide
2	1 µg Diazinon

On the left, a direct injection of spectracide run on the Tracor 950/965 after a simple 1/100x1/100 dilution with methanol. The component of interest diazinon is selectively detected with the Photo-conductivity Detector—here at a level of 0.5 µg. On the right, a 1.0 µg standard of diazinon.

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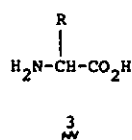
the chemistry of bacterial toxins is currently heading, for hopefully it will be apparent by now that the potential utility of toxins of plant pathogenic organisms is far-reaching. My own research is at present restricted to the *Pseudomonas* genus which has numerous species pathogenic to a wide range of host plants. Many of these species produce toxins giving chlorosis symptoms on their host plants. A classical example is tabtoxin (11), produced by *Ps. tabaci* in the wildlife disease of tobacco¹¹. Many *Pseudomonas* species produce antimetabolites which are inhibitory to other microorganisms; one produces a biocidal metabolite, syringomycin, which can kill a wide range of fungi and bacteria, but curiously not itself¹². We are only on the very beginning stages of learning what some of these chemical species are. Accordingly we don't yet know what the overlying significance of this fascinating array of products is.

An overview of the array of active bacterial products does already bring home one important fact: chemically the various compounds are extremely diverse. Examples of this diversity have already been illustrated with tabtoxin, the β -lactam containing dipeptide toxin, and phaseolotoxin. Another more recently isolated toxin from various *Pseudomonas* species is coronatine¹³, which causes chlorosis on soybean and bean, and which has the structure 12. Yet another is tagetitoxin, which causes an apical chlorosis in marigolds (*Tagetes* species) and zinnia. The structure of tagetitoxin, designated by the molecular formulation $C_{11}H_{18}NO_{13}SP$, is still being elucidated, but clearly it is an extremely unusual compound with an extremely unusual function even at very low concentrations¹⁴.

Acknowledgements

The success of the research described herein has been vastly facilitated through the input and toils of many staff of Plant Diseases Division, past and present. In particular, the excellent technical assistance provided by Mrs E. A. Dye and Mrs J. S. Johnston is very gratefully acknowledged.

STRUCTURES OF AMINO ACID RESIDUES OF PHASEOLOTOXIN



a: R = $-\text{CH}_3$, alanine

b: R = $-(\text{CH}_2)_3\text{NH}_2$, ornithine

c: R = $-(\text{CH}_2)_4\text{NH}-\text{C}-\text{NH}_2$, homoarginine
 \parallel
 NH

References

- (1) R. E. Mitchell and R. L. Bielecki, *Plant Physiology*, 1977, **60**, 723-729.
- (2) R. P. Scheffer, *Encyclopedia of Plant Physiology*, 1976, Vol. 4, Ed. by R. Heitefuss and P. H. Williams, pp 247-265; K. Rudolph, *Ibid*, pp. 270-301.
- (3) R. E. Mitchell, *Physiological Plant Pathology*, 1978, **13**, 37-49.
- (4) R. E. Mitchell, *Phytochemistry*, 1976, **15**, 1941-47.
- (5) B. Staskawicz and N. Panopoulos, *Phytopathology*, 1979, in press.
- (6) R. E. Mitchell and E. A. Parsons, *Phytochemistry*, 1977, **16**, 280-281.
- (7) K. Rudolph and M. A. Stahmann, *Phytopathologische Zeitschrift*, 1966, **57**, 29-46.
- (8) S. S. Patil, P. E. Kolattukudy and A. E. Dimond, *Plant Physiology*, 1970, **46**, 752-753.
- (9) R. E. Mitchell, *Physiological Plant Pathology*, 1979, **14**, 119-128.
- (10) A. R. Ferguson, J. S. Johnston and R. E. Mitchell, unpublished results.
- (11) W. W. Stewart, *Nature*, 1971, **229**, 172; P. A. Taylor, H. K. Schnoes and R. D. Durbin, *Biochimica et Biophysica Acta*, 1972, **286**, 107-117.
- (12) D. C. Gross, J. E. DeVay and F. H. Stadtman, *J. Applied Bacteriology*, 1977, **43**, 453-463.
- (13) A. Ichihara, K. Shiraishi, H. Sato and S. Sakamura, *J. American Chemical Society*, 1977, **99**, 636; R. E. Mitchell and H. Young, *Phytochemistry*, 1978, **17**, 2028-2029.
- (14) R. E. Mitchell, unpublished results.

Elsa Beatrice Kidson 1905-1979

With the death of Dr Elsa Kidson, NZ loses one of its pioneer women chemists. Born in Christchurch, she was educated at Nelson Girls' College and Canterbury College, where she gained



Honours in chemistry in 1927, and is believed to be the first woman to do so. After holding appointments in the University and at NZ Refrigerating Co., she joined the Soil Survey (later the Soil Bureau) of the DSIR, and was seconded to the Cawthron Institute, where she spent most of her working life, apart from visits overseas, when she spent most of her time at the Rothamsted Agricultural Station in England. Her research interests at Cawthron were wide: trace elements, bush sickness, "cloud" or "blotchy ripening" in tomatoes, vitamin C in fruits and analytical methods.

Dr Kidson took a keen interest in the NZ Section of the RIC becoming the first woman FRIC in 1944. As Chairman of the NZ Branch, she presented an excellent address on "Woman in Chemistry in NZ" which was published in this Journal in February 1958, having been delivered at the Conference in 1957. For her researches, Dr Kidson was awarded the D.Sc. of the University of NZ in 1952, and was elected FRSNZ in 1963.

Elsa Kidson was a great lover of the arts, and after she retired in 1965, she spent two terms at the sculpture division of the Wimbledon School of Art, London; in this field she followed her father, whose sculptured head of Elsa at 3 years of age, entitled "Daughter of Eve" still occupies a prominent position in the Christchurch Art Gallery. Other interests included ceramics, photography, Federation of University Women, the Chamber Music Society, the Royal Society, and the Suter Art Gallery where some of her sculptures and ceramics are displayed. In her younger days she was keen on tennis and excelled at fencing. She was a great friend of the noted Hungarian pianist, Lili Kraus, who stayed with Dr Kidson for 2 years when she first came to NZ. Dr Kidson leaves a great number of friends and admirers, who while mourning her loss, will be pleased to know that her passing was peaceful and typical; she was found dead in bed at home with a book in her hand.

Wattie Whittlestone As I Know Him

by Alan Twomey
National Dairy Laboratory
Ruakura Research Centre
Hamilton.



Wattie Whittlestone: somehow a mixture of Einstein and Schweitzer.

It is now 20 years since I first met him. I was an undergraduate. Into our class came this mild mannered, apparently meek professor from a neighbouring university, who spoke so quickly and issued us with so much information on milking machines, dairy hygiene, physiology of milking, animal behaviour, etc, that there was no way we could keep pace with either his ideas or the notes he was trying to give us. He thinks this way about so many subjects out of sheer enthusiasm and not just a desire to expose you to all of the vast reservoirs of information in his mind.

Since being asked to prepare this article, I have wondered what somebody would have written about Einstein or Schweitzer, or even a mixture of the two, for somehow, Wattie Whittlestone just fits that picture. At work he was a dedicated man, for when one area of work was over, or he was tiring of it, he gained new vigour by changing to another or just by sitting back and reading the latest edition of some scientific journal. His incredible feature was the extraordinarily ability of his retentive memory to hold the important points and discard the unimportant, all without making any notes. His remarkable reference library and card index system was probably almost unnecessary for himself, with so much of the information stored in his head.

His imagination and his ability in lateral thinking and technology transfer in science from one area into another were extraordinary. On many occasions the results of this effort were so far in advance of the technological needs of the particular industry that their importance was little realised. Probably the inputs into animal behaviour today which he started some 10 years ago are just being realised as important parts of animal production, yet Wattie saw the need for this work, understood many of the physiological mechanisms involved and set out, in a novel approach, the application of the new animal behaviour science to large animals.

It was probably the first time that this was done on such a large scale.

Wattie Whittlestone graduated from Otago University in 1936 with First Class Honours in Chemistry, winning the Sir George Grey Scholarship and the Duffus Lebecki Scholarship. He was a pure chemist but soon realised his lack of knowledge when he joined the NZ Rennet Co. where he became a research chemist looking at cheesemaking and, in particular, at improving methods of rennet manufacture. In fact he doubled the rate of rennet production and simultaneously doubled his salary.

It was at this time that he met up with a rough, tough veterinarian called Lesley who had set up the first veterinary club in the country. Whittlestone and Lesley worked together through accident and at this time Whittlestone became interested in milking, particularly the disease mastitis resulting from machine action on the cow. He and Lesley were some of the first authors to publish in this area.

Later he was to continue this work by joining the Wallaceville Animal Research Centre in 1939, working with the then famous Dr Hopkirk. This was an unusual marriage of minds which led to some very original, if stormy, thinking in the area of milking machines and mastitis. As fate would have it, he drifted into the milk ejection field where the fledgling work was being done on hormones associated with the release of milk into the udder from the alveola area. His constantly searching mind asked all the necessary questions and research began which was to last nearly 20 years in the area of animal physiology.

By 1945 he had transferred to the Ruakura Animal Research Station and was given a rundown, broken down dairy shed to build up and it was here that some of his best work was done, resulting in his DSc award in 1954. During this time he studied with Dr Charlie Turner the actual mechanisms of oxytocin and vasopressin on milk let down and

the inhibitory effects of various animal patterns causing stress. It was his unique ability to develop equipment to allow scientific measurement to be made that led him to carry out this work on the sow. There are many stories of a small and trembling Whittlestone scrambling over high fences in front of an irate sow with piglets. His devotion to science never let such matters get in his way.

The Australian scene attracted him in 1958 when he took up the position of Reader in Dairy Husbandry at the University of Sydney. This was one of the most productive periods of his life during which he was involved in introducing existing and new technology to the Australian dairy industry. It is difficult to describe to New Zealanders the tremendous mana this man holds within the Australian dairy industry. Within 4 years he had established a new dairy research centre at Camden which was the envy of Australia and which gained international recognition. At this time many papers on various aspects of dairy technology were published. Recognition for his contribution to dairy technology was made in 1963 when he received the Australian Society of Dairy Technology Gold Medal Award.

He was widely travelled and many requests were made for him on aid projects. In 1956 he began the first part of his long humanitarian programme, when he was on a Colombo Plan project at the Aarey Milk Colony in Bombay assisting in the development of lactation and local methods of milk production. In 1970 he went to Sri Lanka, again on a Colombo Plan project, to investigate the problem of low milk yields in

Cont. on P.211



New Technology

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The recent H.P.L.C. workshop held in Dunedin, represented an excellent opportunity for discussion between manufacturers and those currently using, or considering the application of Liquid Chromatography to their individual separation problems.

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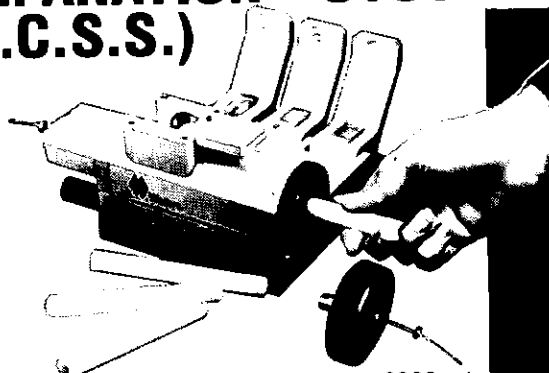
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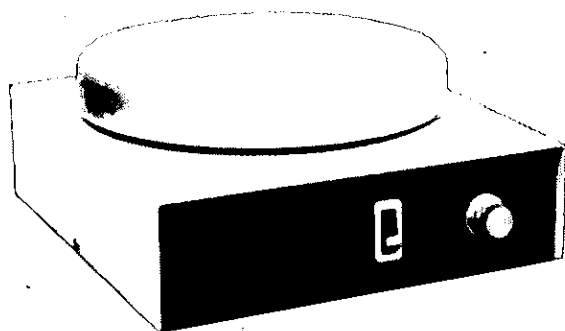
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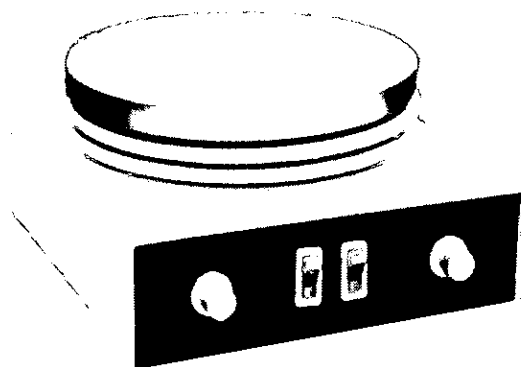
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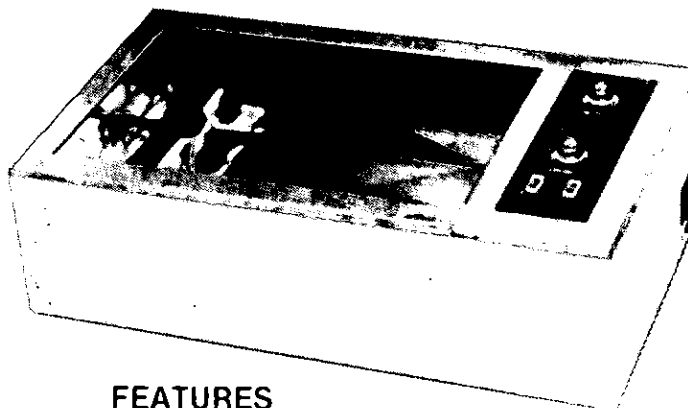


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Whittlestone (Cont. from P.208)

water buffaloes. This work resulted in the foundation of a long term research programme which is continuing today. His work in humanitarian grounds arose from his interest in dairy science and technology and the development of the NZ milk biscuit as a means of supplementing the diets of under nourished persons.

This eventually led to his very sincere involvement with the CORSO movement.

He is a true scholar, as is evidenced by the award of his DSc in 1954 and the Research Medal of the NZ Association of Scientists in 1955. In 1966 he was made a Fellow of the NZIC and in 1969 he was elected to the Presidency of the NZ Society of Animal Production and to the Fellowship of the NZ Institute of Agricultural Science. He was for many years a board member of the Dairy Research Institute, influencing many of the policies they were to derive.

While he maintained his academic role, he always kept close contact with the people on whom his work was to have the most influence. During his lecture tour of

Australia in the late sixties he spoke in a period of just over a week with over half the dairy farmers in the State of Victoria. Dairy farmers in many countries of the world treat him with considerable reverence. In the seventies this acclaim extended to France, Germany and USA. He could present complicated physiological and physical aspects of milking to the lay people in simple and meaningful terms.

His international fame is indicated by the many conferences at which he was guest speaker. These included the Americal National Mastitis Council meetings 1969 and 1978; International Dairy Congress 1970, 1974, 1978; International Stockmens School 1977; International Dairy Federation Mastitis Committee Seminar 1975; World Association of Veterinary Food Hygiene 1975; Danish Dairy Federation 1978 etc.

Most people are remembered for their work in just one particular field of endeavour in science. This man will be remembered for his contributions to animal physiology, to the construction, design, operation and mechanical functions of milking machines, the physiology of lactation, the chemistry of detergents and sanitisers used both in the dairy

and other food industries, the animal behaviour patterns of large and small animals, the development of specialised scientific equipment to measure various physiological and mechanical responses of animals and machines; for his contribution in the human field to the milking of humans, and the animal behaviour aspects of the interactions of mother and child and their associated physiological and sociological responses in latter life.

If they portray Wattie Whittlestone as a working machine, then that is wrong. He has a tremendous sense of history and a great feeling for the finer points of life. He is very interested in art, and in particular, through his family background, in the great churches of Europe. He can keep you entertained for several hours about Gothic church structures throughout Europe. He has an avid interest in music and continues to participate in music schools. His recorder can be heard to spread its melodic tones across the Waikato River on some Sunday afternoons.

While he has now left the direct confines of the Ruakura Animal Research Centre, he continues his interests at the University of Waikato, investigating aspects of milking physiology and animal behaviour as they apply to humans.

Mr S. M. Boniface, junior lecturer, University of Auckland, has been awarded the Ph.D. degree, and has taken up a position with the Port Moresby International High School, Papua New Guinea.

Ms K. J. Lewis is now with the Dept. of Medicine, University of Newcastle-upon-Tyne, England.

Mr R. K. Richardson, St Paul's College, Ponsonby, Auckland, is now with DRI, Palmerston North.

Mr R. A. Dennis, formerly managing director, Rangitaiki Plains Co-op Dairy Co., Edgecumbe, is now working as a consultant under the name Agrodennis, Orewa, Auckland.

Dr A. T. Johns, Past President NZIC, and former Director-General, M.A.F. has had an Hon. D.Sc. conferred on him by the University of Canterbury.

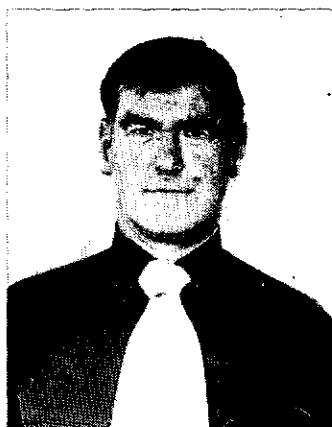
Mr R. L. Hutchinson has retired from being chief chemist, Lane Walker Rudkin Ltd., Christchurch.

Mr H. A. L. Morris is now with the UN Development Programme, Mogadisco, Somali Democratic Republic.

Mr Y. S. Ng, having gained his Ph.D. at the University of Canterbury, has taken a position with Berger Paints, Sydney.

Dr J. M. Erskine, previously with Stauffer Chemical, Sandton, Transvaal, has joined the Kwazulu Development Corp., Durban.

This year **Denis Hogan** completes 20 years of conscientious and efficient service to the Institute as Registrar, and we raise our hats to him. For those who do not know Denis, he was born at Methven in mid-Canterbury and educated at Christchurch West (now Hagley) High School and University of Canterbury, where he graduated B.Sc. in chemistry in 1948. The following year he joined the Christchurch Branch, Dominion Laboratory, DSIR, and has been there ever since. He now has the rank of Deputy Government Analyst. In 1952 he took a course in Dairy Bacteriology at Massey University. He is severely handicapped physically as a result of an attack of infantile paralysis when he was 10 years old, but he has compensated for this with increased intellectual work which has benefitted both the Department and the Institute. His wife



Helen is a lecturer at Christchurch Teachers' College; his elder son Timothy is a trainee cellist with the NZSO, while Seamus is in his U.E. year at high school. We hope that he may long continue to serve the NZIC.

New Fellows of the Institute

Mr J. B. Butchers, now retired; previously Head of Science, Hutt Valley High School.
Mr D. V. Madie, Technical Manager, ICI, Wellington
Dr. G. B. Russell, Applied Biochemistry Division, DSIR, Palmerston North.

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8.9

Waikato

The July meeting was a combined one with the Institute of Food Science and Technology. **Mr. A. J. Pollock**, Assistant General Manager (Marketing), NZ Dairy Board, spoke about "The Political and International Marketing of NZ Dairy Products". This provided an interesting change from the chemically orientated nature of most branch meetings.

Manawatu

The Branch 1979 lectures for 6th and 7th form students in Palmerston North and Hawke's Bay were presented by **Dr Rex Gallagher**, Applied Biochemistry Division, on the subject. "Mould, Mycotoxins and Man". They were warmly appreciated.

Dr John S. Ayres, of Massey, addressed a meeting of the New Plymouth Section of the Manawatu Branch at Ivon Watkins-Dow Ltd. on Developments in NZ Cellulose Ion Exchangers.

The programme reported in our June issue (p. 124) on polymers held at Massey University for 6th and 7th form students in the Manawatu area, was repeated for students from Hawke's Bay. About 120 made the trip, transport being organised by **Mr Ted Fletcher**, of Woodford House, and the programme arranged by **Dr Andrew Brodie**, Branch Chairman. Because of the enthusiasm shown by both groups of students, it is hoped that similar courses can be arranged in future as a useful link between high schools, the University and the NZIC. Congratulations to the Manawatu!

Mr Godfrey Husheer, Scientific Service Laboratories, Napier, is anxious to arrange informal meetings with any chemists who are passing through Hawke's Bay. We saw him at the Conference as usual, and anyone who takes up his offer will be assured of a welcome (Ph. Napier 439-218).

Wellington

The July meeting was addressed by **Mr G. G. Page** on "Why Corrosion Costs Millions" and attracted a good audience and press coverage. The Victoria University biochemistry dept. is co-operating with botany and zoology in a new interdisciplinary course in cell biology. It has attracted 150 students.

The improved facilities in the new lecture block at Victoria proved excellent for the Conference, although the internal temperatures could have been higher. This coolness was felt more by the weaker souls from Otago than the tougher types from the north. The Conference Committee wishes to thank all those who helped to make the Conference such a success.

As part of the celebrations for the Golden Jubilee of the Institute, a book is being prepared in association with the Royal Society on the history of chemistry in NZ. It is being edited by **Dr**



BRANCH NEWS

Peter Williams, Chemistry Division, DSIR, Wellington, who is gathering a team of writers who will deal with chemistry in various fields. **Chemistry in NZ** will have a special issue in 1981 featuring the history of the Institute. Anyone who can help with information, photos, etc. on either of these projects please write to **Dr Williams** or the Institute Editor.



University News

WAIKATO

Prof. Alex Wilson has relinquished the Chair in Chemistry and remains with the Duval Corporation, Tucson, Dural USA. The great value of Alex's contributions to the School of Science (he was Dean for the first 4 critical years) and to the Chemistry Department is well known. His isotope-based research in applied chemistry is internationally recognised. He leaves behind a Department without a Head (hopefully remedied by the beginning of the next academic year), a School of Science already missing his drive and his foresight in planning for the future, many individuals who miss his boundless energy and enthusiasm and his own special brand of humour.

Recent visitors to the Department include **Dr D Nelson**, Government Analyst, DSIR, Auckland who gave an entertaining seminar on "Chemistry in Forensic Science", and **Dr Roger Read**, Postdoctoral Fellow at Auckland University, who lectured on the structural determination of the natural product "Eupodienone" with such clarity as to bring much favourable comment even from hardened theoretical chemists. Roger was accompanied on his visit by **Prof. Con Cambie**, **Dr Bernie Swedlund** and another Auckland postdoctoral fellow, **Dr Manabu ("Slasher") Hikichi**, whose nickname apparently relates to his prowess on the soccer pitch rather than at the laboratory bench.

Dr Ken Mackay left late in July for a short period of leave during which he will visit universities in UK and attend the 9th International Conference on Organometallic Chemistry at Dijon, France.

Otago Chemistry Department

Prof. J. W. Garnett, University of NSW, visited the department and spoke

In view of the present interest in the energy situation, an intriguing development is the paper by **Ladisch, Ladisch and Tsao** which describes how cellulose can be dissolved out of natural products such as agricultural residues with "cadoxen" and then saccharified with enzymes. Cadoxen is a colourless, odourless solvent made by dissolving 5% CdO in 28% aqueous ethylenediamine. (Science 25.8.78)

Otago

In July **Graeme Dyer**, Technical Services Manager, BP (NZ) Ltd., gave an address on-methanol extension in petrol. This was a combined meeting with the NZIE. In August an address was given by **Don Nelson** on Forensic Science.

on Deuterium NMR.

Dr M. Carr has returned from sabbatical leave spent at the Materials Research Laboratory and the School of Geoscience, Pennsylvania State University.

Dr K. A. Hunter has recently joined the staff. An M.Sc from Auckland University, he did his Ph.D. in Marine Chemistry at the School of Environmental Sciences, University of East Anglia. He also had post doctoral experience at Centre des Faibles Radioactives, Gif-sur-Yvette, France, and at East Anglia.

Biochemistry Department

Dr Philip Tubbs, Department of Biochemistry, Cambridge University, will be the visiting lecturer in the department for the period August 1979 — August 1980.

Dr Kevin Farnden attended the 6th Australian Legume Nodulation Conference in Perth in August.

Dr Murray Grigor has been awarded a Heart Foundation grant and will be on leave at Duke University, North Carolina, August 1979 — August 1980.

Dr Clive Trotman the 1978/79 visiting lecturer in biochemistry will remain in Dunedin. He has been appointed to a full time research position in the Department of Microbiology.

An HPLC workshop organized by **Milton Hearn** under the the auspices of the MRC and Medical School was held in the Biochemistry Department in August. There were 70 participants. The workshop was financed in part by several business houses.

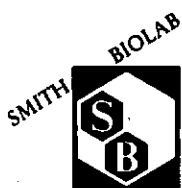
Industrial News

Mr Seow Tan has recently been appointed as a chemist at NZ Aluminium Smelters.

What's missing from this picture?

Color! We left it out on purpose to make a point. All of these products, indeed all food products, are inseparably bound in the consumer's mind with their appearance — primarily their color. This attribute — color — is probably the single most important factor in

judging the quality of agricultural products. Don't shortchange yourselves or your customers with guesswork. Call or write us now for a demonstration in your plant of one of the proven Gardner colorimeters. We'll work with you to help you get your products to market.



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Cover Story

NEW PORTABLE MODULAR LABORATORY SYSTEM.

A compact, low-cost computer system with modular design permitting engineering and scientific computation, laboratory data acquisition and general purpose computation, was announced recently by Digital Equipment NZ Ltd. Designated MINC, the new computer system is supplied with hardware and software enhancements that make laboratory interfacing and application development easy for researchers who are not computer experts. Mounted into a scope-cart-style portable cabinet, the MINC system is easily transportable between different locations in a laboratory and to general administrative offices.

There are 7 different MINC functional module types, which can be used in various combinations, to a maximum of 8, for "customizing" a laboratory system. The module types are analog-to-digital converter (ADC), digital-to-analog converter (DAC), digital input, digital output, multiplexer, preamplifier and programmable clock. The input-output modules have multiple channels, ranging from 4 - 64 depending on module type and use. MINC connector blocks can be detached from the MINC system and remain connected to instrumentations: when the MINC system is wheeled up to the instruments, the connector blocks can be plugged directly into the MINC module. Such an arrangement permits minimum connection time of instruments to the MINC system.

In additions to functional modules, MINC employs the RX02 double-density dual diskette unit for program and data storage, and a new video graphic terminal, the VT105. The terminal has full alphanumeric capabilities, plus a graphics facility of 512 horizontal by 190 vertical positions. Data can be presented graphically in point or histogram mode and alphanumerics are presented in upper and lower case, underlined, bold face, flashing, and video reverse. Characters can also be presented double-height, -width, or both.

Standard for all MINC configurations is a PDP-11/03 processor with 30K-work memory capacity and extended and floating-point instruction sets, 3 serial-line channels, and IEEE-488 standard interface. As many as 14 laboratory instruments and testing devices with IEEE-488 interface capability thus can be supported by the MINC system.

Software for the system is MINC BASIC, an extension of PDP-11 BASIC. MINC BASIC permits the user to directly

issue commands to mass-storage devices, such as transferring files between disks. This arrangement makes it unnecessary for the user to learn an operating system, making system operation easier for the researcher who is not a computer expert. Other MINC BASIC commands permit the user to control data transfer through analog and digital interfaces. Specialized commands permit the user to have the system average signals, develop histograms and present graphical displays.

According to a company spokesman, the new system has been designed for

use by a broad range of people, from technicians to laboratory directors. It can be used for laboratory data acquisition and instrument control, for graphics, for engineering and scientific computation, and for general data processing. He added that MINC can run RT-11 FORTRAN IV, an implementation of ANSI-1966 standard FORTRAN IV, for those desiring to process FORTRAN IV programs.

C026 For further details, use Reader Service Card

Thomas Hill Easterfield

Thomas Hill Easterfield was born in 1866 in Doncaster, England. Educated first at Cambridge, he later gained his Ph.D. at Wurtzburg under **Emil Fischer**. After a number of teaching and demonstrating positions back in Cambridge, he was appointed, at the age of 32, the first Professor of Chemistry and Physics at the newly established Victoria University College. When he arrived, the college was no more than a council which met periodically in a house in Tinakori Rd. Despite its humble beginnings, Easterfield managed to establish, over the next 20 years, a reputation for the young school of science, and his ex-students, such as **B. C. Aston** and **P. W. Robertson**, dominated many facets of chemistry in NZ during the first half of this century.

In 1916 Easterfield was a member of the commission set up to meet the wishes of **Thomas Cawthron** who had left a bequest of about \$500,000 to the city of Nelson for the benefit of local industry. The establishment of an agricultural research institute was decided upon and Easterfield was appointed its first Director in 1919. The Cawthron Institute under Easterfield succeeded admirably in improving the agriculture of the Nelson district

and he gained the respect of the farming community and the people of Nelson. His own main research themes at the Cawthron were the salvaging of the West Coast pakih lands and the problem of kidney stones in sheep.

In 1933 — the year he became President, NZIC — he retired as the Cawthron's Director but retained his interests in geology and local industry until his death, at 82, in 1949.

The Easterfield Award was instituted in 1952 and took the form of a medal and monetary award presented by the Royal Institute of Chemistry its NZ section to be awarded every alternative year to a chemist under 35 for his published work. After the NZ section disbanded, the monetary award was dropped by the RIC (now the Royal Society of Chemistry) but the presentation of the medal has continued.

It is made of pure silver and has a figure of Joseph Priestly on the obverse. Its estimated value is \$500.

(The above notes are based on 2 sources: a talk by the late Elsa B. Kidson to the P. W. Robertson Club in 1974 and a booklet by D. R. MacFarlane, Victoria University, Wellington, entitled "T. H. Easterfield, Science in Colonial NZ.")



The late Sir Thomas Easterfield, shown here in retirement encouraging a young Harry Atkinson who, after studying at Canterbury, Yale and Oxford, became head of the UK Science Research Council's Astronomy, Space and Radio Division. In this issue we feature the Easterfield address, given this year by Dr Robin Mitchell, to the annual NZIC conference.

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People

Dr A. J. (Jim) Ellis, First Vice-President, has been promoted to Assistant Director-General, DSIR. Miss Joan Mattingley, long time Editor, has been awarded the Ph. D by Victoria University

--Dr F. R. Grasse has transferred from the Oceanographic Institute to the Water Section, Chemistry Division, DSIR. --Mr A. Mahon, DSIR, Wairakei is lecturing in Japan on a Japan Science Council Fellowship. Dr Robin Speedy, Chemistry Dept., Victoria is spending a sabbatical year at Southampton University --Emeritus Prof. G. M. Badger of Adelaide has been knighted for his services to science and education --Mr Warren Holloway has left the Auckland Hospital Board and joined Applied Biochemistry, Palmerston North, to work on animal digestion --Dr Robert Brooks, Massey, has received a grant from the NZERDC to assist in a study of the environmental impact of geothermal power upon agriculture in the central volcanic plateau of the North Island. In this he is being assisted by Mr John Liddle, a Ph.D. student --Dr Steve Kent, a Massey graduate now at the Rockefeller Institute, New York, recently returned to his alma mater to give lectures on protein research... Dr R. Clarke of Applied Biochemistry Division, is on study leave visiting Canada, the Netherlands and France where he will attend the 5th International Symposium on Ruminant Physiology at Clermont-Ferrand ... Dr John Richardson has resigned as Chief Chemist, Christchurch Drainage Board, to join the Ministry of Energy.

Dr Bill Denny, Associate Editor, left last month on an extended trip overseas, and Dr Tony Herd, Auckland Technical Institute, will deputise for him. Dr Laurence Eyres is at present overseas, but will return next month.

Prof. Matthew Meerkin, Assoc. Prof. of Chemical Pathology, Auckland University School of Medicine and Head, Dept. of Clinical Chemistry, Auckland Hospital, has been named to head the divisions of clinical chemistry, Prince of Wales Hospital and the Prince Henry group of hospitals in Sydney.



Mr Rands

Winner of ICI/Tasman Prize

Mr M. B. Rands has retired after 31 years as chief chemist, Auckland Farmers' Freezing Co. Ltd. (AFFCO). Max did his degree work at Victoria College, Wellington, and was appointed to the old Dominion Laboratory in 1935, where he worked on lubricating oils and fuels, including pioneer investigations on the analysis of tetraethyl lead. At AFFCO he gained an international reputation for his work on meat industry effluents, and he served as Chairman of

MIRINZ Pollution Research Committee. His hobby is sailing and he has built his own trimaran. His only son, Dr David Rands, is technical manager for Taubmans International Ltd., Wellington.

Edward Dunnage recently joined Stauffer Chemical Co (NZ) Ltd as sales representative, specialising in industrial and food chemicals. Since studying metallurgy at the University of Concepcion, Chile, he has worked in a number of industrial sales management positions both here and overseas. He will be based in Auckland.

Assoc. Prof. Joyce Waters, Chemistry Dept., Auckland University, and Dr Peter Nelson, Chemistry Division, DSIR, Auckland, have joined the Editorial Committee.



Joyce Waters and Peter Nelson

Educated at Diocesan High School and Auckland University, Joyce spend a period in the Akers Research Laboratory of ICI, Welwyn, England, and at the Atomic Energy Research Establishment. Her particular interests are structural chemistry and crystallography. She is married to Prof. Neil Waters, also in the Chemistry Dept. at Auckland and will be handling the book reviews for the Journal.

Peter Nelson was educated at Otago Boys' High School and the University of Otago before he joined the DSIR in Auckland in 1970, where he has been involved in microanalytical work, HPLC and amino acid assay techniques with particular reference to forensic science, illicit drugs and the detection of drugs in biological fluids. His hobby is sailing and he is married with no children.

N. B. Will readers please note that because of the change in publishing arrangements for the Journal, the address of the Institute Editor for all correspondence is 6 Koraha St., Remuera, Auckland 5.

We regret to announce the death of Mr George ("Joe") Chamberlain who joined the Auckland Branch, Dominion Laboratory, in 1935, where he was particularly involved with food and waters, especially their fluoride levels. During the war he led a group of Auckland chemists who trained as gas identification officers. He transferred to Wellington later in the 40's and was particularly involved in paint testing and research. In 1954 he became information officer, which included the running of the library, where he had the temerity of change the book classification to conform with the logic of the chemist rather than the librarian. He retired in 1975.

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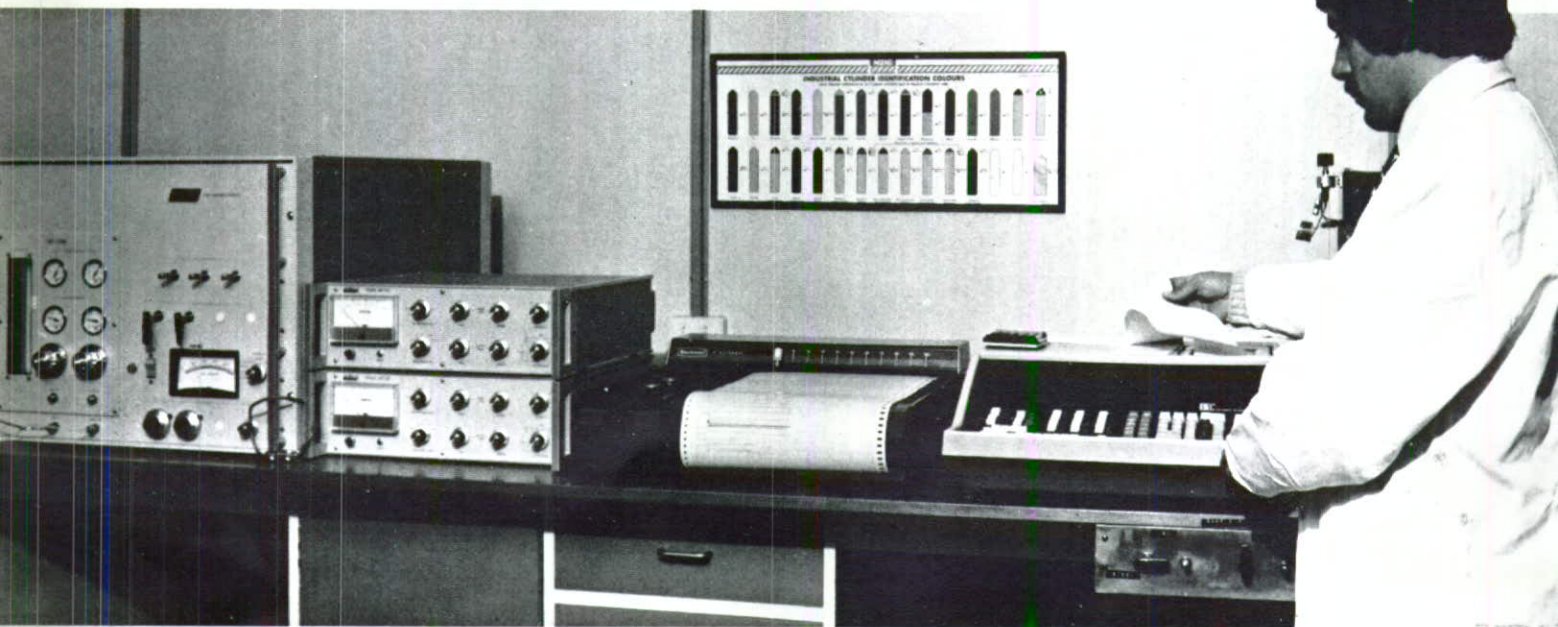
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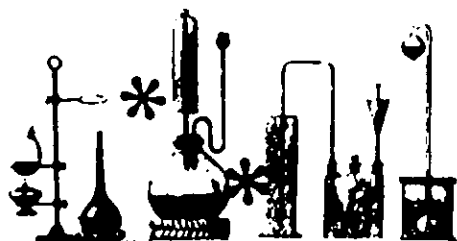


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Data General NZ Ltd. has announced the introduction of a new, more powerful line of NOVA computers, the NOVA 4 series. The new models are the NOVA 4/X, which can store up to 256,000 characters of information in its main memory, the NOVA 4/C and the 4/S, which can each hold up to 64,000 characters.

Compatible with all NOVA systems, NOVA 4 models can be used with a variety of computer languages, including FORTRAN and Business BASIC.

The two-board design the NOVA 4 computer (illustrated) incorporates CPU, MPMU, async interface, real-time clock, automatic program load, and power fail/auto restart of the CPU board, and up to 256 K-bytes of memory on a single memory board.

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It is a complete analytical system that incorporates a research type gas chromatograph with all-glass GC/MS interface, a proven magnetic mass analyser with rapid scan and versatile selected ion monitoring capability; and a high speed computer fully programmed for instrument control, system management and data handling. It is distinguished above all by the integration of its components into an effective analytical system that is controlled from a single friendly keyboard ... and is said to produce more useful analytical results, more easily.

Seldom do today's claims for MS sensitivity measure up to that demonstrated by the DP 102, say the distributors. Nor are all analysers equally effective for detecting trace components. To perform well in this demanding task, the MS must also be routinely capable of providing good resolution at high mass as well as low mass to facilitate measurement of relative abundances reliably in every part of the mass spectrum. It must also exhibit good stability to consistently generate the reproducible mass spectral patterns that assure accurate component identification, especially when performing computer-conducted library searches.

Stability is also an important factor in selected ion monitoring (SIM); only a stable analyser can remain tuned to the maximum ion signal and thus provide the highest achievable sensitivity. Once its magnetic analyser is tuned, the unit simultaneously provides good sensitivity, resolution and stability over the entire mass range for both electron and chemical ionisation, without further operator adjustments.

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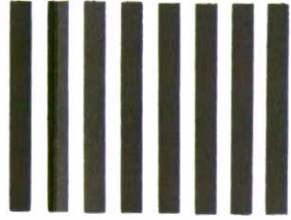
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