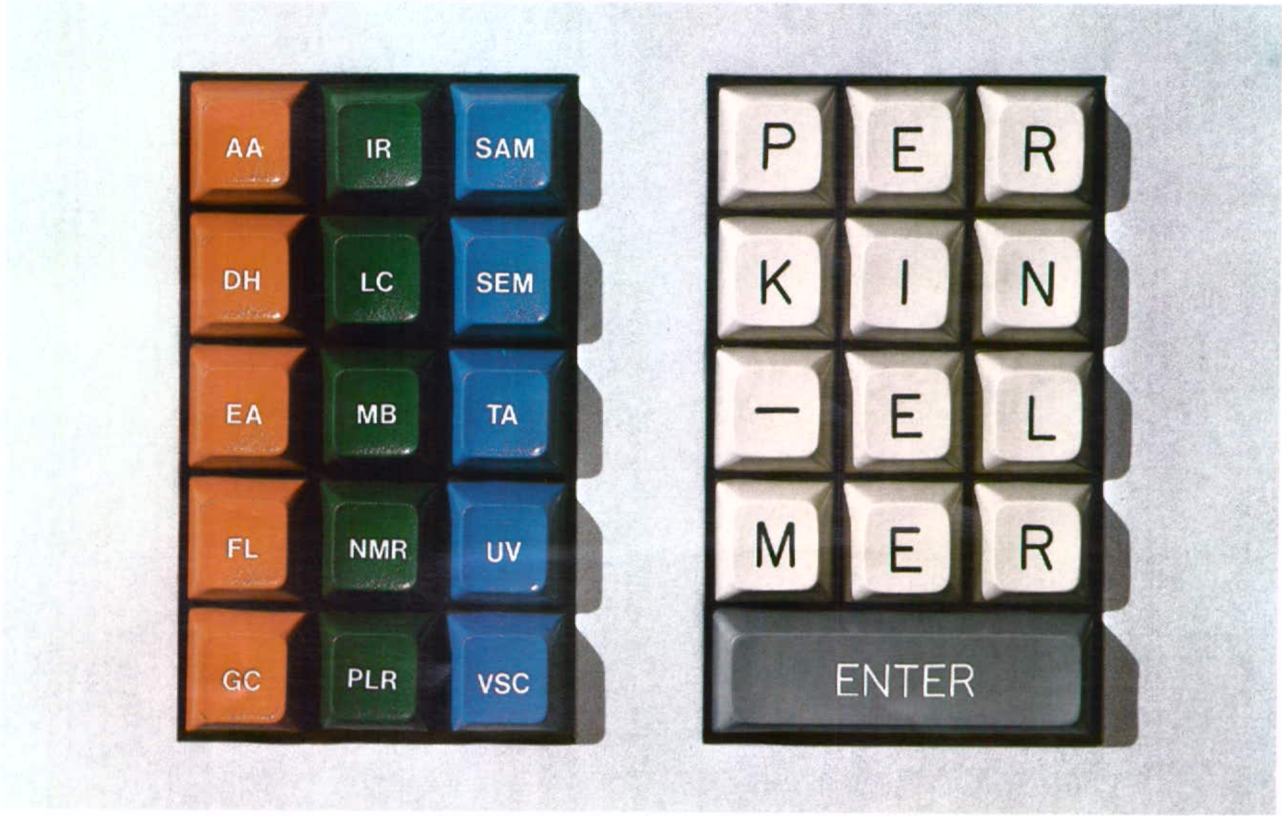
December 1979 Vol. 43 No. 6

Chemistry in new zealand

Official Journal of the New Zealand Institute of Chemistry

INSIDE: PRESENT & FUTURE OF HAZARDOUS CHEMICALS IN NZ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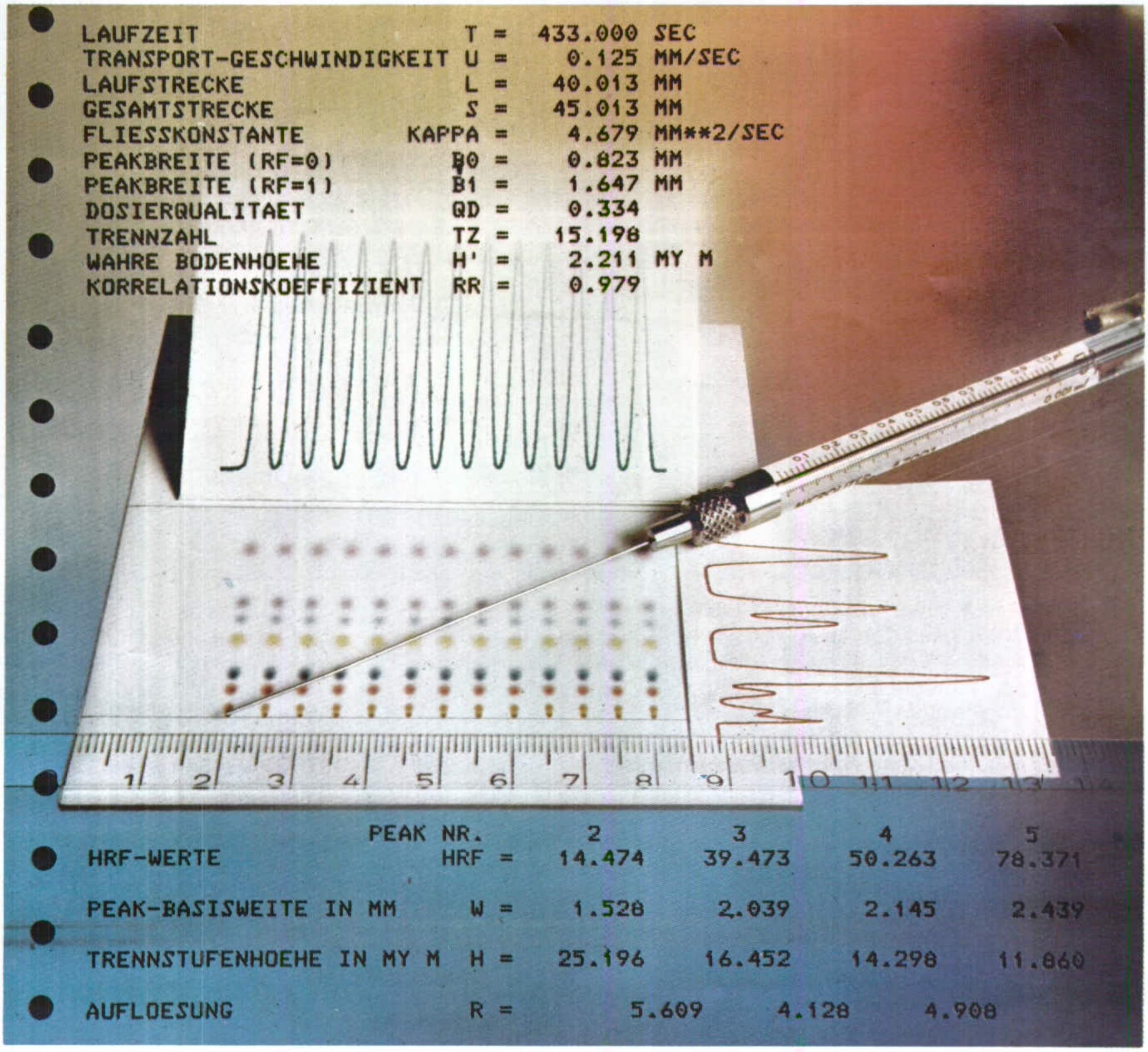

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GESAMTSTRECKE                     S =   45.013 MM
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PEAKBREITE (RF=0)                B0 =    0.823 MM
PEAKBREITE (RF=1)                B1 =    1.647 MM
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                        PEAK NR.       2          3          4          5
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Chemistry in new zealand

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Vol. 43 No. 6

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CONTENTS

Cover: A specially designed Freightways Bulk Services Ltd oleum tanker and trailer incorporating safety placards and meeting US Department of Transport Specification MC312. Operated by a specially trained driver, it features a safe dischage system to prevent accidental spillage. Inset is the emergency contact telephone number panel on the cab door.

STOP PRESS

Gas Chromatography Course — Waikato Technical Institute, October 30 — November 1: The course was run over 3 days, each day being split into two sessions consisting of a lecture followed by a practical on the material covered. All the basic theory and techniques were dealt with, plus some general aspects on advanced techniques including capillary column, GC — TLC, GC — IR and GC — MS. One limitation, however, was the class size which hindered the practical sessions in that free access to the chromatographs was not always possible. All in all the course was well run giving a sound background knowledge which will certainly help in furthering one's capabilities in GC work.

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Guest Editorial

Hazards With Chemicals

Almost every day we are confronted with newspaper, radio and television items calling the attention of the public to a real or possible hazard. Of concern is the purpose of the publicity which often seems to indicate a thirst for sensation as a news item rather than concern for the public interest. The uninformed and technically untrained public can seldom identify what is a scientifically proven fact, or just an opinion. The real danger in the interpretation of such news stems from the camouflage of so called "expert opinion" which more often than not has received scrutiny from scientific circles by previous publication in a professional journal. The problem of correct interpretation is further hindered if the author or publisher is guilty of selecting only those facts supporting their opinion or motive.

Chemicals, manmade or otherwise, seem to be in the forefront of adverse publicity. In fact the public is being indoctrinated to accept them as hazardous unless proven otherwise. What's more the establishment of proof itself is often hindered by political pressures based on public opinion which, in ignorance and as a "vote catching" force, prescribes "banning" regardless of facts as the most expedient solution.

It is obvious that many hazards could be eliminated by a complete halt in the use of the potentially hazardous element. For example the staggering annual mortality from automobile accidents could be reduced to a vanishing point by the simple procedure of stopping automotive traffic. But the many and obvious advantages of this mode of transport are such that this suggestion is ludicrous. On the other hand, the suggestion that all real or imagined hazards from synthetic chemicals should be eliminated by prohibiting their use has been advanced by the more emotional environmentalists in recent years.

Pharmaceuticals are, in my opinion, the best example of proving that toxic properties and obvious hazard associated with improper use can be turned to a real benefit by proper application. It can also be stated without fear of contradiction that our standard of "better living" in quality and longevity has been brought about by improved knowledge and technology, particularly in the field of chemistry.

A more reasonable approach therefore, as in the case of automobile accidents, would appear to involve careful appraisal of those "use habits" which contribute to those accidents. It is pleasing that the Institute has recognised this need and is participating in the development of standards, codes of practice and appraisal of redundant or proposed legislation aimed at ensuring reasonable methods of control.

In support of the environmentalists it can be stated that they hastened the appraisal of the either legal or tolerated habits. These included the obvious inadequacies and insufficient responsibilities demonstrated by some manufacturers and transport agencies.

The current close co-operation of professional staff of Government departments, manufacturing and transport industries in the definition of potential hazards, clear and internationally understood labelling and containment of potentially hazardous chemicals will go a long way towards a more rational judgement of chemicals by the public, particularly if these efforts go hand in hand with a careful establishment of judicious balance between the hazards of use and the benefits to be gained thereby.

Finally, I should like to applaud NZ scientists and professional people in not bowing to pressures for control in the absence of facts so evident in some overseas countries.

Arnost ("Ernie") Wratislav
Operations Services Manager,
Ivon Watkins Dow Ltd.
Member, NZIC Hazardous Chemicals
Committee.

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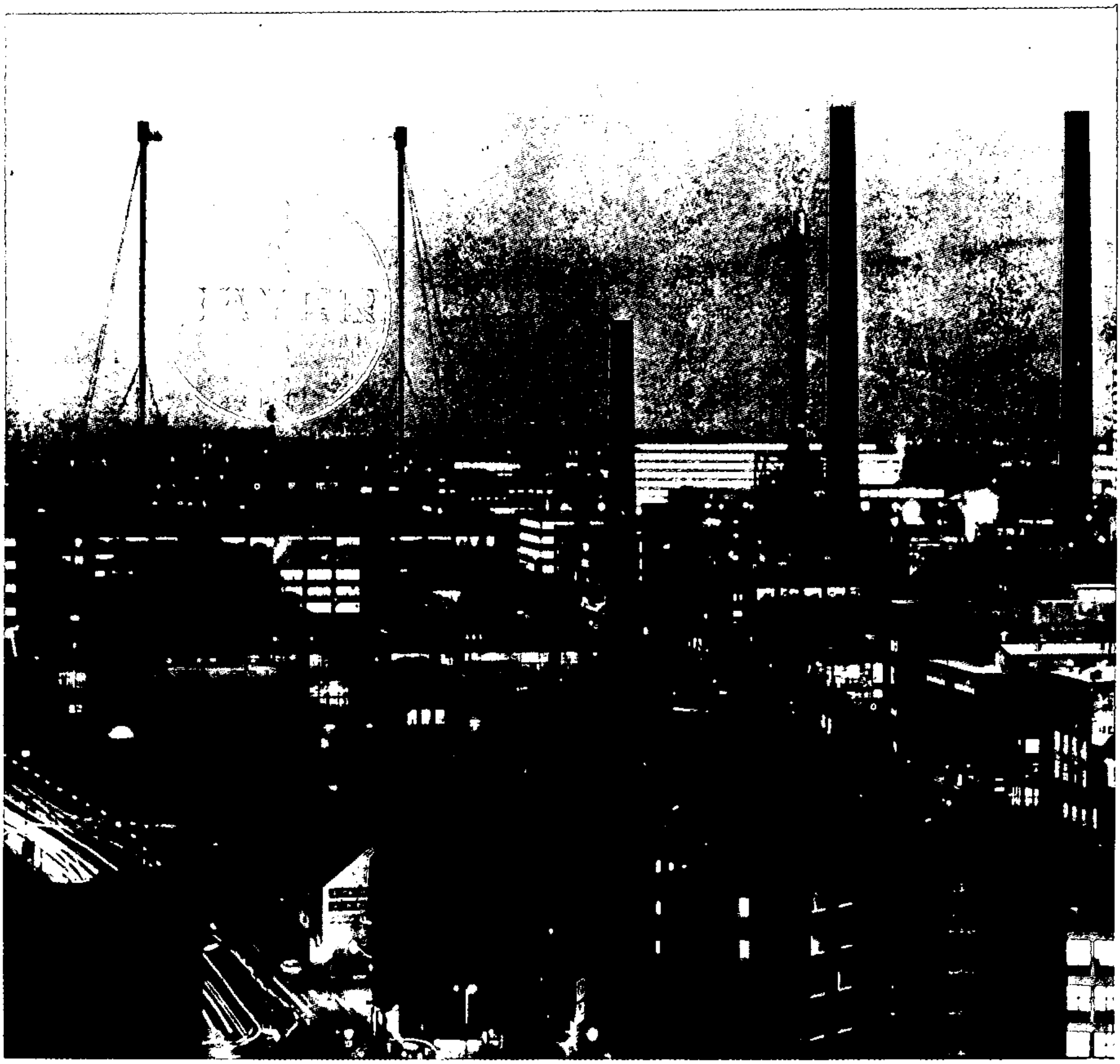
For further details write to:

The Registrar, N.Z.I.C P.O. Box 1926, CHRISTCHURCH.



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Comment

Polemics From The Pulpit

Since our last epistle we have been on a pastoral excursion, bestowing our benediction on the faithful in the Manawatu Diocese. We sojourned at New Plymouth, Kapuni, Wanganui, Palmerston North, Longburn, Napier, Hastings finishing with high mass at Forest Research Institute, celebrated with Father George, the Polisn-Scot-Kiwi who inspires our brethren who worship at the shrine of St. Chromatograph.

In this journeying we benefitted from the company of our brother in the faith Sancho Panza (ICI) Rands who looked after our 90 horses. Both Sancho and I were cheered by our welcome and felt that these visits were definitely a good thing; in fact we Czeched with Ernie Wratislaw in New Plymouth and found that this was the first visit by an NZIC executive since we visited the city as high priest in 1964. Perhaps our Presidents don't serve long enough to visit all these far flung brethren and the Holy Synod should be looking at a 2-year term.

At Hastings we donned (as we are well entitled to having beeb canonized in that communion) the clerical vestments of our separated brethren of the NZIFST and addressed a joint meeting in Watties sumptous conference room. We also much admired Frank Crotly's fertilising power (and are considering an encyclical on it), were interested in the Leather & Shoe (& Boot) Research Association, saw the Food Technology and Biotechnology extensions at Massey, bestowed the Kiss of Peace on Sylvia (who is she?), say the great light at FRI, Rotorua, but Sancho thought the highlight of our visit was Graham Midwinter's plum pudding which we consumed with lashings of cream at the well-run Manawatu annual meeting held at DRI (other branches please note!)

We and Sancho thank all those who provided such plendid hospitality (started off by Bro. & Sister Sewell at New Plymouth); if kindness could kill we would both be dead by now.

Which reminds us that the Dead Sea has been in the news which intrigues us both chemically and ecclesiastically. When we immersed our semi-sacred person in its waters in 1969, but found a cool layer of fresh water at the surface, we found it hard to get our feet down into the denser (and warmer) layer below, which contains a high concentration of NaCl and other salts. The cooler fresh layer was supplied by the River Jordan, but its waters have since been largely diverted to irrigation, so with the loss of water by evaporation and the low rainfall of 60mm/year, the Sea has reached an uniform concentration. Since it is nearly 400m below sea level, the Israelis are planning to circumcise the Mediterranean so that some of it will flow through a canal down to the Dead Sea, generating electric power on the way. The waters from one sea could invigorate the other and could do the same for your Editor in the autumn of life — is there a charitable doctor (or chemist) in the house?

S.G. Brooker.

NZIC ANNUAL BALANCE SHEET 1978-79

1978 $			
	CURRENT LIABILITIES:		
3,141	Sundry Creditors	1,413.60	
	Subscription in Advance		
52	- Insitute	70.00	
22	- Publications		
(3,215)	**TOTAL CURRENT LIABILITIES:**		1,483.80
	SPECIAL FUNDS:		
1,183	Overseas & Visitors Travelling Fund	649.47	
635	Easterfield Fund	634.86	
(1,818)	**TOTAL SPECIAL FUNDS:**		1,284.33
	ACCUMULATED FUNDS:		
7,416	Balance, 1.5.78	13,528.53	
2,608	**Add** "Trust Fund" Balances 1.5.78		
—	Legacy ex Est. C.G.W. Mason	400.00	
	Excess of Income over Expenditure For Year	3,179.96	
(13,529)	Balance, 30th April, 1979		17,108.49
$18,562			$19,876.42

1978 $			
	CURRENT ASSETS:		
65	Petty Cash Funds (Net)	4.83	
4,774	Bank of New Zealand	3,720.67	
934	Air N.Z. - Deposit Account and Prepaid Travel	679.00	
3,499	Subscriptions in Arrears	4,581.92	
13	Prepayment - A.C.C. Levy		
	Sundry Debtors		
200	- Publication Subscriptions	—	
1,340	- Journal Advertisers	65.00	
(10,825)	**TOTAL CURRENT ASSETS:**		9,051.42
	INVESTMENTS — AT COST		
1,000	North Canterbury Hospital Board Stock (1.11.84) (5.25%)	1,000.00	
1,000	Lyttleton Harbour Board Loan (1.7.80) (6%)	1,000.00	
500	Lyttleton Harbour Board Loan (1.7.98) (6.25%)	500.00	
3,500	U.D.C. Group Holdings Ltd. Debenture Stock (15.12.79) (13.25%)	3,500.00	
1,500	General Finance Ltd. Debenture Stock (1.6.78) (12%)	—	
	General Finance Ltd. Debenture Stock (16.6.79) (9.5%)	1,500.00	
	General Finance Ltd. Debenture Stock (6.10.79) (10.5%)	3,000.00	
(7,500)	**TOTAL INVESTMENTS:**		10,500.00
	FIXED ASSETS (At Cost):		
	Office Equipment	834.80	
	Less Depreciation	509.80	
(237)	**TOTAL FIXED ASSETS:**		325.00
$18,562			$19,876.42

We have audited the books of the New Zealand Institute of Chemistry (Inc) for the year ended 30th April 1979, and have received all the information and explanations we have required. In our opinion, according to the best of our information and the explanations given to us as shown by the books of account, the Balance Sheet, Income and Expenditure Account, and Trust Fund Account are properly drawn up so as to give a true and fair view of the state of the Institute's affairs as the 30th April, 1979.

CHRISTCHURCH:
21st June, 1979.

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Per: ....
A. J. Tomlin

STATEMENT OF ACCOUNTING POLICIES:

General Accounting Principles:

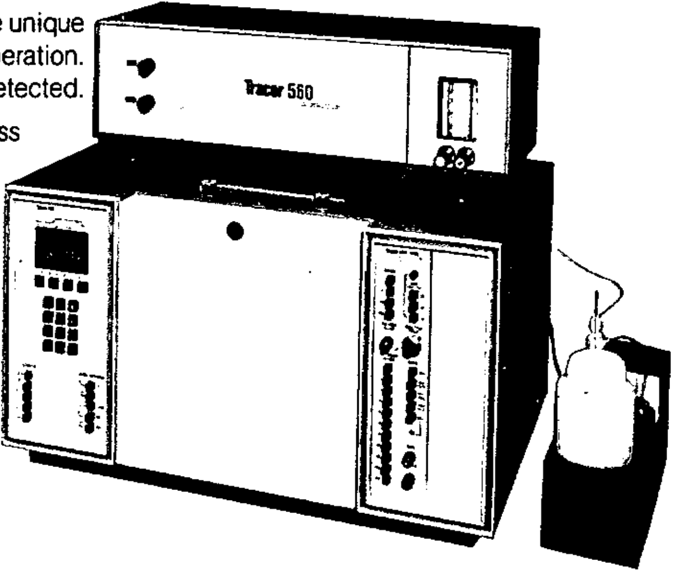
The general accounting principles appropriate for measurement and reporting of profit under the historical cost method are used by the Institute.

Particular Accounting Principles:

1. Depreciation has been charged using the straight line method based on the economic life of the assets.
   — Office Equipment and Typewriter 5 years.
2. Membership Subscriptions in Arrears —
   Subscriptions in arrears over 1 year have been written off.

Gas Chromatography

Water analysis? Sulfur analysis? Nitrosamines?



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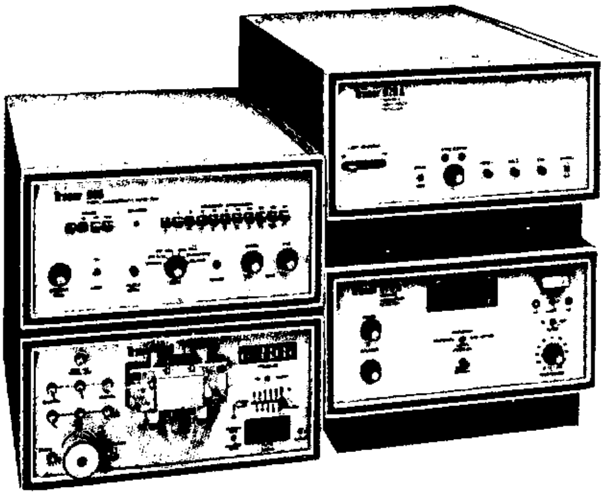
Tracor Chromatography

Liquid Chromatography

Priority pollutants? Clinical analysis? Food preservatives?



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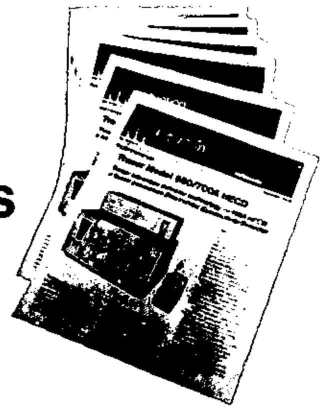

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What's Happening

Breakthrough: The international Warner-Lambert company has arranged with the Auckland Division, Cancer Society, to market the very promising anti-cancer drug mAMSA, discovered in the Society's research laboratory by a team headed by **Dr Bruce Cain** assisted by **Drs Bill Denny** (Asst. Editor, Chemistry In NZ) and **B.C. Baguley, and Mr J.G. Atwell.** The deal includes a fellowship worth $200,000 for the Society's research, and an as yet unpredictable amount of royalties. Simultaneously it has been announced that Dr Cain has been appointed to an honorary professorship in the University of Auckland.

(To the unitiated mAMSA is 4'-(9-acridinylamino) methane sulphonanisidide)

Honoured: Dr G.M. Wallace, Food Technology Dept., Massey, and a past Editor of this journal, has been made an Honorary Fellow of the NZIFST. He is only the 2nd resident New Zealander to receive this honour, which he richly deserves. He retires at the end of this year, but knowing Garth, we do not expect him to be idle!

Versatile: In addition to processing some 2.1 million sheep, lambs and cattle annually, Alliance Freezing Co. Southland Ltd. is extensively involved in the preparation of food and pharmaceutical products. As part of this latter operation, the company has recently purchased 4 large freeze dry units to manufacture 3 product ranges:

- Frozen cooked foods — beef, mutton, catering packs of goulash, stews, spiced smallgoods etc.
- Freeze dried food products — kidney powder, oysters, mussels, lamb granules, "meal in a pack" etc.
- Freeze dried pharmaceutical products — liver powder, pancreas powder, heart and brain powder.

The company also operates an active development laboratory. Two projects currently under development are the production of bovine plasma and red cell powders from blood and the preparation of pancreatin powder from raw pancreas. Its food technologist, **Elizabeth Young,** is currently in Japan promoting the company's products.

Haemoglobin Meet: A 2-day scientific meeting on "Haemoglobinopathies and Thalassaemia" is being held in Christchurch in February 1980. It is aimed primarily at haematologists and medical scientists actively involved in this field, but other biochemists or chemists with an interest in haemoglobin would be welcome to attand.

Invited speakers include **Prof. Herman Lehmann,** Biochemistry Department Cambridge University, a foremost authority on abnormal haemoglobins, and **Dr P. Wasi,** Siriraj Hospital, Bangkok, an expert on α-thalassaemia. Topics to be covered include α and β thalassaemia — diagnosis and interpretation; detection of variants by genomic mapping; haemoglobin A1 — its significance in diabetes; oxygen affinity variants; haemoglobin denaturation.

More information from **Dr Christine Winterbourn,** Clinical Biochemistry Department, Christchurch Hospital.

Survey: A questionnaire to survey the interest in solar ultravoilet radiation is being circulated at present by the Meteorological Service. Solar UV radiation contributes only a small part of the sun's radiant energy, but it is important because of its photochemical activity and, for example, is strongly implicated in the deterioration of plastics, the fading of dyes and, of course, the production of skin cancer. The questionnaire is brief and is aimed at people with any practical experience or theoretical expertise related to solar UV, be they in engineering, medicine, agriculture etc. in research or applications. The Service is evaluating the case for extending its solar radiation network to include UV sensors, and expects to co-sponsor a small seminar on solar UV radiation with CIBA—Geigy NZ Ltd in February 1980.

For questionnaires or further information please contact **Dr Reid Basher,** NZ Meteorological Service, Box 722, Wellington.

Returned: Lawrence Eyres returned last month from a trip to UK, where he visited 21 organisations, all concerned with food manufacture, particularly the field of oils and fats, and presented a paper at the SCI symposium in London on animal fats.

Among organisations he visited were the Hannah Research Institute, Scotland, Food Research Institute, Norwich, Tropical Products Institute and the Chorleywood Baking Research Institute. Scientists he met were interested in the upcoming NZIC jubilee conference in 1981 "so hopefully we may see some of them out here, particularly the lipid chemists," he commented.

"One striking piece of research I noted at the Hannah was the use of a scintillation counter to quarantine TLC plates, thus eliminating the need for densitometers which have never been reliable."

On the Institute's behalf he passed on greetings to the SCI at the symposium (the SCI celebrates its centenary in 1981). Interesting papers at the gathering included work carried on consumer preference for fatty or lean meat, how to control fat production in cattle, how to measure accurately fat in meat and the importance of animal fats as a raw material for soap and fatty acid manufacture.

The symposium attracted 84 participants from various fields of scientific research; its organiser was **Dr Peter Barnes,** Rank Hovis McDougal, who is married to **Ron Hicks'** granddaughter. (As many will know, Ron gave an entertaining talk at the Chairman's dinner in October.)

Not Responsible: The President, **Arthur Campbell,** now back in NZ, has modestly declined responsibility for the whole of TELARC; he is chairman of the Registration Advisory Committee on Chemical Testing.

Recorded: The Dairy Research Insitute, Palmerston North, celebrated its golden jubilee in 1977, and it is appropriate that **Dr W.A. McGillivray,** who was Director at the time, should write a history of the first 50 years in a booklet of some 211 pages (available from the Institute, P.B., Palmerston North, at $8). Since chemistry plays a large part in the work of Institute, chemists will be grateful to a fellow chemist for having put this history on record, especially while some of the original staff are still alive. The book is profusely illustrated, and concludes with a 50 page list of the more significant papers published by the staff. It is a moot point whether some of this space might not have been better used with an index and some readers would have preferred to have Dr McGillivray's own views on the future of the Insitute rather than those of the Director-General, DSIR.

Available: The Proceedings of the Seminar on Trace Elements and Health held as a Section of the ANZAAS Congress in Auckland last January have been published, and are available from the Registrar, **Denis Hogan,** Box 1926, Christchurch at $4 per copy. Group chairman, **Dr John Aggett,** Auckland, in his preface, points out the multidisciplinary nature of the programme, and that it included contributions from the laity as well as scientists — which did not happen in all sections of ANZAAS. This volume of 242 pages will be valuable to chemists both inside and outside the field.

Where would we be without chemists? On a recent visit to USA, Managing Editor **Peter Reaves** was intrigued by the little pottles of "cream" supplied with hotel and restaurant coffee.

On closer inspection, he was even more intrigued by the "cream's" constituency. According to the label it contained: water, saturated coconut oil, sugar, sodium caseinate (a milk derivative), di-potassium phosphate, polysorbate 60, propylene glycol monostearate, sodium stearoyl-2-lactylate, salt, artificial flavour and colour! A rose by any other name?!

Razed: The laboratory of **Prof Rudolf Mossbauer,** famous for discovering the Mossbauer effect, was destroyed by a fierce fire at the Technical University of Munich. The professor has strong rightist views, and arson has not bee ruled out.

Public Affairs: The NZIC Council has appointed a Public Affairs Committee with **Dr Mike Kingsford,** Chemistry Section, DSIR, Gracefield as convenor, with **Dr Ashley Wilson,** NZFP, Wellington, and **Dr John Featherstone,** Dental Research, Wellington as members, and with power to co-opt. The following terms of reference have been laid down:-

(a) To exercise on behalf of Council an oversight of public relations activities within the Institute.
(b) To arrange for the preparation and public release of informed statements on behalf of the Institute.
(c) Where possible, to arrange for the preparation of informed statements for anticipated needs.
(d) To make public statements on behalf of the Institute.
(e) To keep under review existing and pending legislation of potential or actual concern to the Institute.

Subsidy: A subsidy of up to $A200 (which can be divided among a number

15040C

What's Happening (Cont)

of participants) is available to NZ polymer scientists wishing to attend the 11th Australian Polymer Symposium next year, but for whom the cost involved causes difficulties.

The symposium is being held at Lorne, Victoria, February 27 — March 1, 1980, and subsidy applications should be addressed to **C E M Morris,** chairman, National Polymer Division, RACI c/-Material Research Laboratories, Box 50, Ascot Vale, Victoria 3032, Australia, and should reach hime before January 31.

The folio puzzle in our last issue was unintentional. Astute readers would have realised instantly that something was awry when what appeared to be a continuation of **Dr David Rand's** paper on electric vehicle battery prospects was, in fact, the second page of **Warwick Marsden** and **Mark Wainwright's** paper on liquid fuels. The "missing link" appeared on Page 199. We apologise for the production "hiccup" and hope that readers' mystification was soon clarified.

100 Years Of Pharmaceutical Manufacturing

Pharmaceutical manufacturing in NZ celebrates its centenary this year — and it all began with an 1879 partnership between **T. Kempthorne,** an Australian drug salesman, and **E. Prosser,** a Welsh chemist, who registered a public company for the purpose of producing "local" galenical medicines in Dunedin.

Their enterprise succeeded and today the company, now part of the NZ Farmers Fertilizer Co., is still the leading locally owned manufacturer of ethical drug products. They were followed in 1908 by **Salmond and Spraggon** in Wellington.

Further companies were established in the late 1930's with another surge in the sixties, so that now there are 9 companies producing prescription pharmaceuticals. In approximate order of decreasing size, in terms of manufacturing output, they are **Merck Sharp & Dohme, Kempthorne Medical Laboratories, Abbott Laboratories, Chem Industries, Glaxo Laboratories, Wellcome, Stirling Pharmaceuticals, May & Baker,** and **Warner-Lambert. McGaw Ethicals** is possibly bigger than all, but is involved in intravenous solutions and ampoules for injection rather than in pharmaceuticals.

Except for Kempthorne Medical Supplies and Chem Industries, which are wholly NZ owned concerns, the companies are all foreign owned subsidiaries of multi-nationals with almost no local equity participation. Contrary to the normal pattern, there is more American than British capital invested in NZ pharmaceutical manufacturing.

Today's production units make a wide range of dose forms including tablets, capsules, creams, ointments, suspensions, granules and sterile products. The quality of the products is equal to that of any overseas production.

A total of 5000 people are employed by pharmaceutical companies in NZ, but this figure includes marketing and other personnel.

People

Dr Robyn Dormer, retiring Auckland Branch chairman, has resigned from St Cuthbert's College. **Ms B.I. Johnson** has gone from Rangitaiki Plains Dairy, Edgecumbe to Tasman P & P Kawerau. **Mr R.W. Taylor,** Asst. Principal, Porirua College, has retired. **Dr P.D. Chadwick** has left Fertiliser Research, Auckland, to join the Physics and Engineering Lab. DSIR, Gracefield. **Prof I.E. Coop,** Vice-Principal and **Prof. T.W. Walker,** Dept. of Soil Science, Lincoln, have both retired. **Dr D.A. Gray,** Water and Soil Division, Ministry of Works, Dunedin, is now with Mainland Products of the same city. **Dr A.R. Browne** has returned from Ohio State to Chemistry Division, Gracefield. **Mr D.P. Karl** has joined T.J. Sprott & Associates, Auckland. **Mr P.L. Martin** is now with Chemical Cleaning Co, Mt Maunganui. **Mr D.M. Hay** has been appointed Senior Lecturer in Safety Management at Massey. **Mr C.O. Hurrell,** Tutor in Pharmaceutical Chemistry at CIT, Trentham has undergone a metamorphosis into Hurrell Holdings Ltd., Huntly. **Mr P. Fitzgerald** has transferred from Southland Boys' High School to Christchurch BHS. **Mr A.F. Adams** has returned from Western Samoa and is now Reader in Soil Science at Lincoln.

Roy Tasker, who won the prize for the best student paper at the recent Wellington Conference, graduated with honours in chemistry at Queensland University, Brisbane, in 1976, and also completed a Diploma in Education. He started on a Ph.D. at Otago in August of last year, his special interest being in the application of inorganic chemistry to biochemical problems. He startled the Editor (one of the judges at the Conference) by presenting data side by side simultaneously from both slide and overhead projectors, but he did not win on this account alone.

Dr Brian Davis, of Auckland, spending a sabbatical in England has written to a colleague in Auckland saying that he has enjoyed reading the "lively Chemistry in NZ". Bigger hats have been ordered.

Roger Meek has been named manager, chemicals department, Neill, Cropper & Co Ltd, Auckland, with national responsibilities. For the past 14 years, he has been with Robert Bryce & Co Ltd as Auckland chemical sales manager. He is a member of APPITA, NZ Institute of Food Technology and is a past Auckland Chairman of the Oil & Colour Chemists' Association.

Dr Jack Garside took up his new appointment as director, TELARC, in mid-October. He was previously general manager, NZ Portland Cement Association.

Dr John Featherstone, immediate past chairman, Wellington Branch, has been appointed by the Ministry of Health to the Fluoridation Advisory Committee. We hope to publish early next year an article by him on the chemistry of dental caries.

Mr Alan Mackney, chairman, 1981 Conference Committee, and past managing director, NZ Forest Products Ltd., has been appointed to the National Research Advisory Committee. He is also a member of the Liquid Fuels Trust Board.

New Second Vice-President

Dr W.S. (Stan) Simpson, Director, Wool Research Organisation of NZ (WRONZ), has been elected 2nd VP, NZIC. Born in 1933, he graduated M.Sc. from Canterbury, and gained his Ph.D. at Leeds under **Prof. J.B. Speakman** with a thesis on structural studies on metal-keratin complexes. He holds the silver medal of the Worshipful Company of Woolmen. He joined WRONZ on its formation in 1962, and was seconded to the DSIR for 3 years, working on wool protein chemistry. He was appointed WRONZ Director in 1978.

The main theme of his research has been to develop chemical processes for wood which lead to more diverse end uses and enhance its value as a textile raw material. it is interesting to note that already locally manufactured machines and instruments incorporating WRONZ technology are beginning to find international markets and create growth in engineering in NZ as well as encouraging a more competitive international place for wool textiles.

Dr Phil Le Quesne, North Eastern University, Boston has been awarded the D.Sc. by the University of Auckland.

Joe Butchard, Canterbury Frozen Meat (and 1978 Canterbury Branch chairman) recently visited USA. Joe is involved with meat industry by-products and during his visit he called on buyers and users of pelts, wool and casings. He visited meat packing houses, sausage manufacturers, rendering plants, casing producers, tanneries and laboratories of the Tanners Council of America which are on the campus of the University of Cincinnati. The objective of the trip was to gain a better appreciation of the requirements of the users of the various by-products and to build a closer relationship with them.

Rod Shaw has moved from ICI Tasman to the DSIR Industrial Processing Division and **Mr Philip Tree** has decided to seek fame and fortune (whichever comes first) in UK.

The Resins Divsion of ICI (NZ) Ltd has appointed **Ian Treder** (from Dulux) as their Chief Chemist and **Mark Nowicki** from Morrison Printing Inks is now working in the Resins Laboratory.

Mark James has joined the laboratory staff at Unilever (NZ) Ltd. and **Miss Melanie Wong** has development laboratory of Mobil Ltd.

Memo **Gavin Fletcher:** While in Canada Peter Reaves noted with interest the diverse activities of the Kiwanis organisation. In Toronto it operates a local tourist attraction called Casa Loma (a much grander version of Larnoch Castle in Dunedin), while in Calgary the local club has placed bubble gum machines in city supermarkets.

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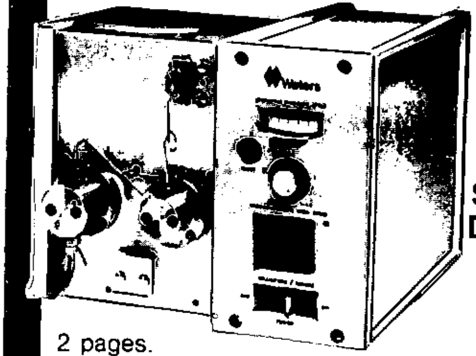

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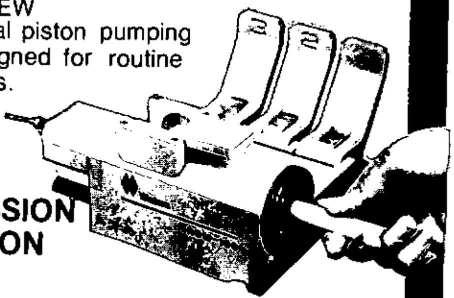

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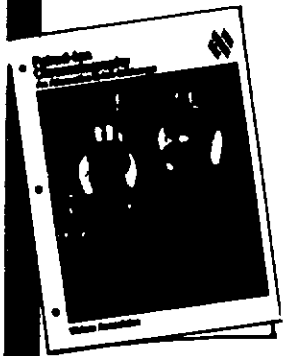

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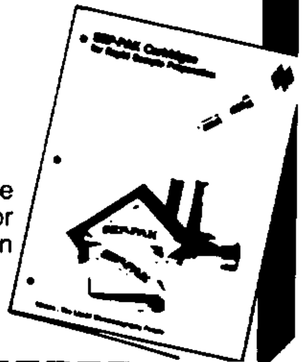

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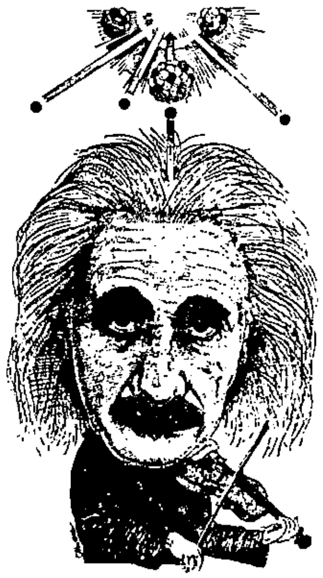
Einstein's Gelegenheitsarbeit

Gordon M. Miskelly and David V. Fenby
Department of Chemistry, University of Otago, Dunedin.



"In my opinion [Einstein] would be one of the greatest theoretical physicists of all time even if he had not written a single line on relativity."
Max Born

(Cartoon from "The Guardian" newspaper, UK.)

In 1900 Lord Kelvin addressed the Royal Institution on "19th century clouds over the dynamical theory of heat and light." He was referring to the inability of "classical" physics to explain a number of recently discovered physical phenomena. At the beginning of the 20th century, with the development of quantum theory and relativity theory, the 19th century clouds were dispersed and physical science underwent its most dramatic transformation since the 17th century. In this Einstein was pre-eminent.

Einstein's fame rests primarily on his work in relativity which has overshadowed his other contributions, those he called his *Gelegenheitsarbeit* (casual work). The latter is, however, much more significant in the development of contemporary science. Our object is to present an impressionistic picture of Einstein's *Gelegenheitsarbeit.*

The replacement of determinism by probabilistic or statistical ideas is certainly one of the greatest revolutions in the history of science. In this Einstein was the pioneer and, at least until 1925, the central figure. He possessed an uncanny facility for statistical reasoning and an innate awareness of the central position of the laws of probability in nature. Einstein's *Gelegenheitsarbeit* is characterised by this statistical reasoning. It can be divided into two groups. Firstly, those contributions associated with classical statistical mechanics; in these Einstein was the successor to Maxwell and Boltzmann, and the contemporary of Gibbs and Smoluchowski. Secondly, the contributions to quantum theory; here he was the contemporary of Planck, Bohr and de Broglie and the precursor of Schrodinger, Heisenberg and others.

Classical Statistical Mechanics

At the beginning of this century the kinetic theory of gases, from which statistical mechanics developed, was by no means widely accepted. Of particular relevance here was the opposition to molecular reality, the very basis of the theory. The "positivists" led by Mach and the "energeticists" led by Ostwald considered atomicity a metaphysical concept not to be taken seriously.

The extension of kinetic theory to statistical mechanics was associated with a new averaging procedure known as ensemble theory. While Boltzmann (1871) and Maxwell (1879) had worked with ensembles of gaseous systems, it was Gibbs (1902) who generalised the ensemble approach for application to all systems. Unaware of this earlier work, although certainly stimulated by Boltzmann's "Lectures on Gas Theory", Einstein (1902-4) also developed ensemble theory; the similarities with Gibbs' work are striking. He was later to remark that, had he known of the previous studies, he would never have published his papers. Unlike Gibbs, who made no major application of his theory, Einstein (1905—) applied statistical mechanics to make experimentally verifiable predictions. The consequences were far-reaching.

Brownian motion: The ceaseless, irregular movements of microscopic particles suspended in a liquid were discovered by Robert Brown (1827). The correct explanation, that the motion arises from the impacts of the solvent molecules on the particles, was proposed late in the 19th century.

Einstein (1905) showed that "bodies of microscopically visible size suspended in a liquid will perform movements of such a magnitude that they can be easily observed through a microscope, on account of the molecular motion," although, in his first paper, he was unsure whether these predicted movements were identical with Brownian motion since he lacked information concerning the latter. He proved that the rectilinear displacements of the particles during some time interval follow a statistical law similar to the Maxwell-Boltzmann distribution of molecular velocities. From this he obtained an equation for the mean square displacement. Einstein's studies of fluctuation phenomena, of which this was the first, were to play a major role in his subsequent work.

In his "Autobiographical Notes" Einstein commented that "My major aim in this was to find facts which would guarantee as much as possible the existence of atoms of definite finite size." He was fully aware that the experimental confirmation of his predictions would provide not only compelling evidence for molecular reality but a means of obtaining molecular dimensions. The first complete verification by Perrin and co-workers (1908-10) was a decisive victory for molecular reality. Ostwald was converted and any lingering vestiges of anti-atomism soon disappeared.

Light scattering: Lord Rayleigh (1881, 1889) explained light scattering in gases by considering each molecule as an independent scattering unit. This approach cannot be applied to condensed systems. Smoluchowski (1908) proposed that light scattering could be attributed to density fluctuations within the medium. Einstein (1910) provided a quantitative treatment of this model. His equation, which accounted for the light scattering by pure liquids and for critical opalescence, was the basis for subsequent work.

Quantum Theory

Black body radiation: The development of quantum theory and the study of black body radiation are inextricably linked. Kirchhoff (1860) introduced the concept of a black body (an object which absorbs all radiation incident upon it, making it appear black) and showed, using thermodynamics, that the emission characteristics of such a body are identical with the radiation within an isothermal cavity at the same temperature. Of particular interest here is the variation of the isothermal cavity energy density with frequency. "Classical" physics provided two theoretical expressions for this: the Wien law (1896) [obtained by assuming that the frequency emitted by a molecule depends only on its velocity and by using the Maxwell-Boltzmann distribution] was in agreement with experiment at high frequencies; the Rayleigh-Jeans law (1900) [obtained using the equipartition theorem] was in agreement with experiment at low frequencies but predicted an "ultraviolet catastrophe" (i.e., an unlimited increase in energy density) at high frequencies.

Planck (1900) proposed "an interpolation formula found by happy guesswork" which was in excellent agreement with experiment at all frequencies. A few weeks later he proposed a proof of this formula, the Planck law, in which, in "an act of desperation", it was assumed that each oscillator could emit and absorb energy only in multiples of $h\eta$. With the appearance of the Planck constant, h, and the quantization of energy, quantum theory was born. For several years the scientific community, including Planck, seemed to consider the introduction of h as an expedient methodological device possessing no deeper physical significance.

Radiation quanta: Einstein (1905), confining himself to high frequencies, accepted the Wien law as an experimental fact and from it obtained an expression for the variation of the entropy of cavity radiation with volume. A comparison of this with a statistical mechanical equation for the variation of the entropy of a perfect gas with volume led to the "very revolutionary" proposal that radiation "consists of a finite number of energy quanta, localised in space, which move without being divided and which can be absorbed or emitted only as a whole." In 1909, starting with the Planck law, Einstein calculated the energy fluctuations within a radiation cavity. Again, he concluded that radiation was composed of quanta (or photons as they were later called) of energy $h\gamma$.

At the conclusion of his 1905 paper Einstein considered the application of his new concept to three phenomena — photoluminescence, photoionization of gases and the photoelectric effect. The last has become legendary. Discovered by Hertz (1887) during his confirmation of the existence of electromagnetic waves, the photoelectric effect soon became another 19th century cloud. By assuming that a quantum of radiation interacts in toto with one electron, Einstein provided a simple explanation of the experimental facts.

The concept of radiation quanta encountered strong opposition. In 1913 Planck, Warburg, Nernst and Rubens wrote to the Prussian Ministry of Education strongly recommending Einstein as van't Hoff's successor. They concluded with the observation that "he may sometimes have missed the target in his speculations, as, for example, in his hypothesis of light quanta" . . . It was not until Millikan's (1914-16) experimental verification of the Einstein photoelectric equation and the discovery of the Compton effect (1922) that the quantum of radiation became accepted. In 1921 Einstein received the Nobel Prize "For his contributions to mathematical physics and especially for his discovery of the law of the photoelectric effect."

Heat capacity of solids: In 1907 Einstein pointed out that Planck's quantization of oscillator energy must have repercussions in other phenomena involving oscillators. By incorporating the hypothesis into a statistical mechanical treatment of the solid state he obtained an expression for the heat capacity which reduces to the classical (Dulong and Petit) value at high temperatures and decreases as the temperature is lowered becoming zero at 0 K. The decline of heat capacity with decreasing temperature had been discovered experimentally towards the end of the 19th century and could not be explained by "classical" physics.

Quantitative confirmation of Einstein's equation required high precision heat capacity measurements. Nernst (1905) proposed his "heat theorem", the precursor of the third law of thermodynamics and, in order to test this, measured low temperature heat capacities. He and co-workers (1910—) found excellent agreement with Einstein's predictions except at very low temperatures [Einstein (1911) indicated the reason for this discrepancy and, in this respect, his theory was refined by Debye (1912) and Born and von Karman (1912).] The experimental confirmation elevated Planck's hypothesis from the *ad hoc* to one of physical significance. Nernst was converted — he was to prove an influential advocate.

Transition probabilities: Accepting the existence of energy levels as introduced by Bohr (1913), Einstein (1916-17) proposed a new derivation of the Planck law. In this he considered the equilibrium between radiation and a gas of particles which can absorb and emit radiation. He proposed that transitions between energy levels could arise through three processes: spontaneous emission, stimulated absorption and stimulated emission. The first was assumed to follow a probability law analogous to that used with radioactive decay. The stimulated processes take place under the influence of the radiation density. Equating the emission and absorption processes, Einstein obtained the Planck law.

The transition probabilities introduced by Einstein were to play a major role in the subsequent evolution of quantum theory. In this work Einstein initiated the spreading of indeterministic statistical reasoning from its origin, radioactivity, into other domains of physics. Significantly, he saw as a weakness the fact that his theory "leaves moment and direction of the elementary processes to chance."

In this study Einstein inferred the existence of stimulated emission. If he had omitted this process he would have obtained the Wien law. From a consideration of momentum transfer he showed that the emitted photon comes off in the line of motion of the incident photon. In this we have the basis of the MASER/LASER developed more than four decades later.

Bose-Einstein statistics: In 1924 Einstein received from Bose, an Indian physicist, a paper presenting a new derivation of the Planck law. In this a radiation cavity of photons was treated as a gas of indistinguishable particles. As well as arranging publication of this work, Einstein (1924,25), by extending it to monatomic gases, developed Bose-Einstein statistics.

Working from Einstein's radiation quanta and special theory of relativity, L. de Broglie (1924) produced his celebrated thesis in which he introduced "matter waves". Calculating the density fluctuation in a gas using Bose-Einstein statistics, Einstein obtained a contribution which could be interpreted as an interference fluctuation by attributing a wave character to the gas particles. With Einstein's support, de Broglie's "matter waves" rapidly came to the attention of physicists.

Quantum mechanics: Schroedinger (1926), by generalizing what he called the de Broglie-Einstein waves to bound particles, formulated wave mechanics. He later stated that his "theory was stimulated by de Broglie's thesis and by short but infinitely far-reaching remarks by Einstein". In the development of "matrix mechanics" by Heisenberg, Born and Jordan (1925) Einstein's influence, while less than that of Bohr, was considerable, special relativity and transition probabilities being particularly significant.

Epilogue

In his "Autobiographical Notes" Einstein acknowledged quantum mechanics as "the most successful physical theory of our era" but he viewed it with "admiration and suspicion".

With Born's (1926) probabilistic interpretation of Schrodinger's wave function, Heisenberg's (1927) uncertainty principle and Bohr's (1925-27) complementarity, the Copenhagen interpretation of quantum mechanics emerged. In one of the great paradoxes in the history of science, considered a "tragedy" by many, Einstein, the master of statistical reasoning, refused to accept this. His role became that of the sceptic.

Unlike most of his contemporaries, Einstein considered the statistical interpretation a transitory facade behind which lies a real world ruled by causality. In 1928

LIFE OF EINSTEIN

1879 — born March 14, in Ulm, Wurttemberg, southern Germany.
1896 — admitted to Federal Institute of Technology, Zurich
1900 — graduates
1902 — technical expert, 3rd class, Swiss Patent Office, Bern.
1905 — gains Ph.D., University of Zurich
1908 — *Privatdozent*, Bern University
1909 — Associate Professor, University of Zurich
1911 — Professor, German University in Prague
1912 — Professor, Federal Institute of Technology, Zurich
1914 — Director in Kaiser Wilhelm Institute, Berlin
1921 — is awarded Nobel Prize
1933 — Professor at Institute for Advanced Study, Princeton
1939 — is signatory of letter to Roosevelt warning of atomic bomb potential
1945 — retires as Professor of Institute for Advanced Study
1952 — refuses Presidency of Israel
1955 — dies in Princeton on April 18.

SCIENCE OF EINSTEIN

1901 — first paper, capillary attraction
1902-4 — classical statistical mechanics
1905 — radiation quanta (photoelectric effect); Brownian motion; special relativity
1907 — unification of mass and energy ($E = mc^2$); heat capacity of solids
1909 — application fluctuation theory to cavity radiation
1910 — application fluctuation theory to light scattering
1911 — principle of equivalence, bending of light in gravitational field
1912 — photochemical equivalence law
1913 — draft for general relativity and theory of gravitation
1915,16 — general relativity, theory of gravitation, perihelion of Mercury, bending of light, red shift
1916,17 — transition probabilities, stimulated emission
1917 — application of general relativity to cosmology
1921 — Nobel Prize
1923 — first work in unified field theory
1924,25 — Bose-Einstein statistics
1927,38 — derivation of motion law from field equations (general relativity)
1932 — expanding universe (— with de Sitter)
1935 — Einstein-Podolsky-Rosen paradox
1937 — solutions of field equations describing gravitational waves (— with Rosen)
1950 — last revision of unified field theory

he wrote that the "Heisenberg-Bohr tranquilizing philosophy — or religion? — is so delicately contrived that, for the time being, it provides a gentle pillow for the true believer from which he cannot very easily be roused". From 1927 to 1935 he attacked this "tranquilizing philosophy" with a succession of ingenious thought experiments, only to have them refuted by Bohr. Einstein was unmoved ("God gave me the stubbornness of a mule and a fairly keen scent") and Bohr himself continued to ponder upon Einstein's arguements for the rest of his life.

For many years the Copenhagen interpretation was the only accepted one. Today, while it continues to be held by most scientists, alternatives exist and the issue is widely debated, particularly by the philosophically inclined. In this debate some of Einstein's thought experiments are significant — and their resolution is still not in sight.

> *In the realm of the seekers after truth there is no human authority. Whoever attempts to play the magistrate there founders on the laughter of the Gods.*
> *Albert Einstein (1953)*

The Production of Xylitol

V. Harwood and K. Mackie, Forest Research Institute, Rotorua

SUMMARY

The preparation of xylitol, a non-cariogenic sweetener, from NZ hardwoods and maize is described. Xylose is first prepared in about 80% yeild by mild hydrolysis of the hemicelluloses present. It is purified by ion exchange resins, and completely hydrogenated in solution with Raney nickel at 170° and 140at. pressure. After a further purification with ion-exchange resins, the xylitol is crystallised from aqueous or alcoholic solution. The overall yield from hardwoods is 11% and from maize 20%.

Research at the Forest Research Institute, Rotorua,into the production of xylitol was initiated following a symposium concerning this possible sucrose substitute which was convened in March 1977 by the Dental Research Unit, NZ Medical Research Council (1). Research in Finland had shown at that time that dramatic reductions in the occurrence of new dental caries occurred when people ate foods containing xylitol instead of sucrose (2).

Because of the high cost of xylitol ($6/kg) the consensus of opinion at this symposium was that it would be practical to replace sucrose with xylitol only in those foods which are consumed between meals, i.e. snack foods. This decision was based on the assumption that most people brush their teeth following regular meals. With this possible usage the amount of xylitol required in NZ would be about 11,000 tonnes annually (3).

At about this time scientists at the FRI were examining a method for utilising NZ beech forest wastes which involved prehydrolysing beech chips and pulping the wood residue by the Kraft process (Prehydrolysis-Kraft pulping) (4). Experimentation to establish conditions for the acid prehydrolysis of beech so that maximum yields of sugars could be obtained from the hemicellulose portion of this wood were under way (5). Interest in the complete hydrolysis of plant materials as a means of producing chemicals from biomass was increasing at this same time and, in particular, the production of ethanol from wood wastes was receiving considerable attention as the price of imported crude oil continued to rise at an alarming rate (6). As xylitol could be produced from wood sources (e.g. birch wood) by selective acid hydrolysis of the hemicellulose component it was therefore propitious to examine the xylitol manufacturing process more closely and to establish whether or not it could be integrated with the total hydrolysis of wood concept.

Xylitol Production

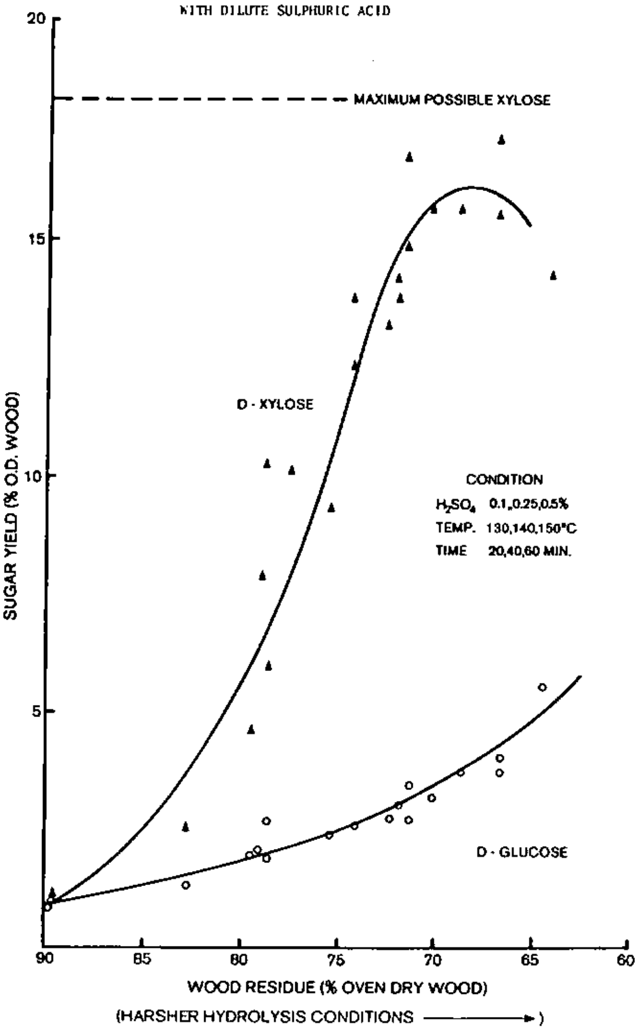
Before outlining the process steps involved in xylitol manufacture it is important that some elementary wood hydrolysis chemistry be mentioned (7). Wood consists of about 25% lignin and 75% carbohydrates. The carbohydrate portion can be divided into two fractions: the easily hydrolysable fraction — consisting of hemicelluloses; and that fraction that is relatively resistant towards hydrolysis — cellulose. The hemicellulose fraction contains hexose and pentose sugars joined head to tail (glycosidic linkages) to form polymers. In hardwoods, e.g. beech, poplar, eucalypt, the main sugar component of the hemicelluloses is D-xylose — and a polymer of D-xylose is termed a "xylan".

There are essentially 4 steps in xylitol manufacture:

(1) **Selective depolymerisation of a xylan:** The objective of this stage is to treat a xylan-rich source and selectively remove as much D-xylose as possible. This is achieved by controlled hydrolysis using dilute (0.5%) acid at elevated temperatures (150-170 °C). Under these conditions the depolymerisation (hydrolysis) of a xylan is considerable faster than that of cellulose (8, 9). Because this step is not totally selective the solutions obtained contain mainly D-xylose but are contaminated with other sugars, e.g. arabinose, mannose and glucose.

(2) **Purification of hydrolysate:** Prior to the reduction of D-xylose to xylitol it is necessary to remove impurities which can poison the Raney nickel catalyst used in the hydrogenation. Such impurities include organic compounds derived from acid soluble lignin or wood extractives, degradation products from sugar and inorganic compounds. Most impurities can be removed using ion exchange resins. The macroreticular exchange resins used in the sugar processing industries are of particular benefit as they absorb organic molecules (coloured material) as well as inorganic ions.

FIGURE 1: D-XYLOSE REMOVAL FROM RED BEECH WITH DILUTE SULPHURIC ACID



Vic Harwood, B.Sc., Ph.D. (McGill) is a Canadian with 40 years' experience as a chemist going back to his early days as a technician during the day and a student working for a university degree at night. After a succession of jobs and a B.Sc. he studied wood chemistry under C. B. Purves, renowned for his work on carbohydrates and lignin. Until 1962 when he came to NZ he had worked in applied carbohydrate chemistry at NRC, Ottawa, University of Edinburgh and McMillan Bloedel (on pulping research) with a brief sojourn into pesticides.

After a session of school teaching in Taranaki, Vic returned to his old love of carbohydrates and as been with FRI, Rotorua, since 1966. During this period he has combined an interest in structural studies with the tasks of finding uses for sugars from waste wood.

Vic has recently resigned his position at FRI to go into business at Tryphena, Great Barrier Island.

Keith Mackie graduated B.Sc. (Hons) in Chemistry from Massey University in 1973. With the award of a Canadian Commonwealth Scholarship he then obtained his Ph.D. at the University of British Columbia, Vancouver, working with Prof. Guy Dutton on structural investigatins of bacterial polysaccharides. He is currently with the FRI and is involved with various aspects of wood chemistry.

(3) **Reduction of D-xylose to xylitol:** The objective of this step is to achieve quantitative reduction as economically as possible. This is a straight-forward chemical reaction that can be accomplished using sodium amalgam, sodium borohydride or catalytic hydrogenation. From considerations of the process used to produce sorbitol from D-glucose it is clear that Raney nickel hydrogenation is the best process for xylitol manufacture on an industrial or pilot plant scale. Most of the parameters such as sugar concentration, hydrogen pressure, temperature, time, catalyst loading and activity, promoters and solvents have been examined for sorbitol production (9-15).

(4) **Crystallisation:** A final purification is needed to provide a pure product.

Impurities in the xylitol liquor are essentially other pentitols and hexitols that were released during the hydrolysis step. Where necessary, ion exchange techniques may be used to reduce these contaminants to an acceptable level.

Xylan Sources In NZ

Xylans are found in high concentration in most grasses and hardwoods (16). Agricultural wastes, often available in large quantities, may also contain considerable amounts of xylan and examples of these include wheat and rye bran, rice and oat hulls, corn (maize) stalks and cobs, bagasse (sugar cane residue) and coconut shells (16). Possible sources of xylan in NZ are listed in Table I with their corresponding analyses. Maize cobs are undoubtedly the best xylan source since not only do they contain 38.5% xylan by weight but they also have a low lignin content and hence hydrolysis of the xylan material is easier than in more lignified materials. Some 35,000 hectares of this crop are planted annually in the central North Island and

Gisborne areas (17). This is by far the most concentrated xylan source available in large quantities.

Waste wood from NZ native hardwoods such as beech, rata, kamahi and from introduced species such as poplar and eucalypt may eventually become available from resources on the west coast of the South Island and elsewhere. If such wastes are utilised in wood hydrolysis-ethanol plants then logically the pentosan fractions from these woods could be used for xylitol production in an integrated plant.

Selective Depolymerisation Of Xylan

Herein lies the economic success or failure of xylitol production. If solutions of virtually pure xylose can be obtained directly from the source material then no difficulty is experienced in making the final product to an acceptable degree of purity. Unfortunately there has to be a trade off between producing relatively pure xylose solutions and removing as much xylose from the material as possible.

By varying the hydrolysis parameters of time, temperature and acid concentration it is possible to examine any source material to establish the opyimum hydrolysis conditions. We have established these conditions for red beech (see Fig. I) and if these optimum conditions are exceeded not only does the yield of D-xylose drop due to its conversion to furfural but also the release of other unwanted sugar contaminants increases (18).

When the conditions for optimum D-xylose removal from red beech were applied to other xylose sources e.g. maize cobs and other hardwoods (see Table II), the yield of D-xylose was greater than 72% of the potential amount in each case. Analysis of the hydrolysis liquors from these different materials showed that D-xylose comprised between 72-85% of the carbohydrate material.

Hydrogenation And Crystallisation

Prior to hydrogenation, hydrolysis liquors are neutralised with $Ca(OH)_2$, filtered, treated with ion exchange resins and concentrated. In our own laboratory, treatment of neutralised liquors with Amberlite IR 120 (H +) cation exchange resin and subsequently with Amberlyst A-21 (OH –), Zerolit MPH (OH) – or Amberlite IRA 93 anion exchangers gave solutions which were virtually colourless and, following concentration, were easily hydrogenated. Hydrogenation was complete in 1-2 hours at 170°C under 40 atmospheres hydrogen pressure using a catalyst loading of 3-5% based on sugar content.

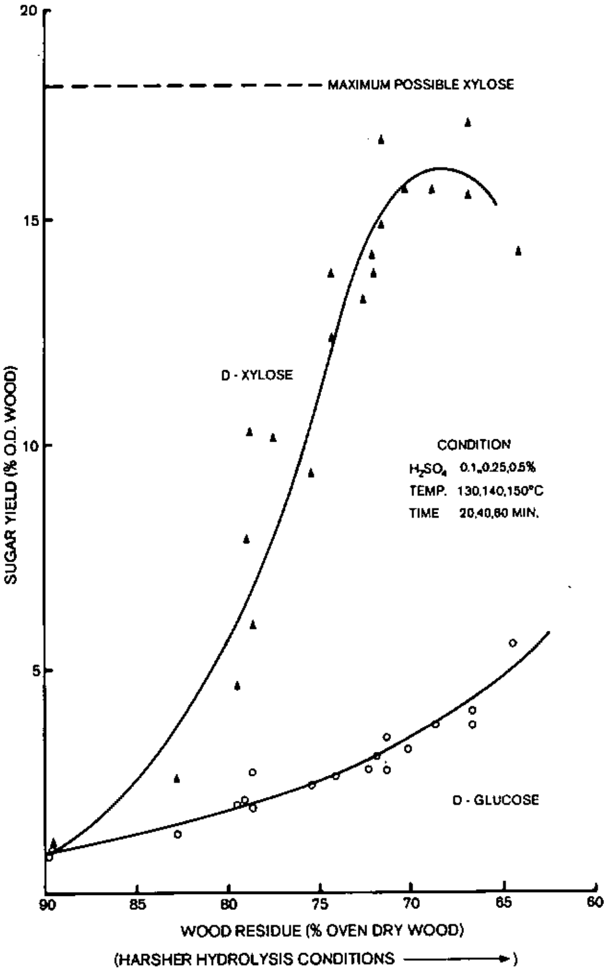
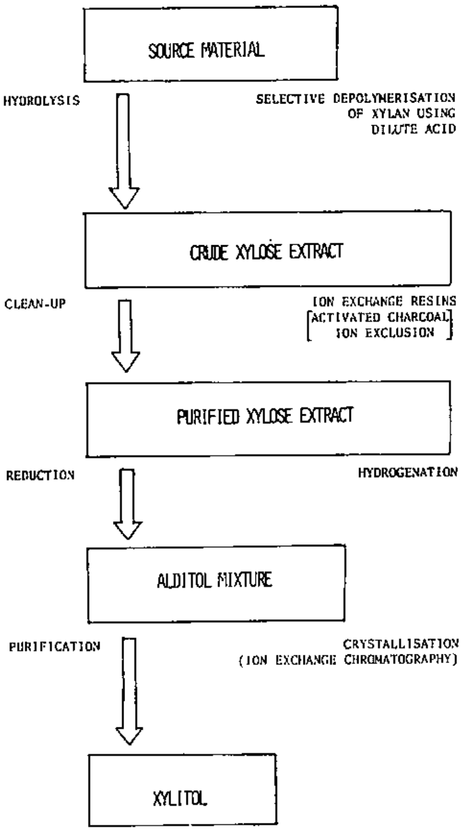


FIGURE 2: THE PROCESS TO PRODUCE XYLITOL



Concentrations of the reduced liquors gave syrups in which crystallisation was induced by the addition of methanol or ethanol and seed crystals of xylitol. Alternatively the aqueous syrups were seeded and left in a refrigerator for several days. In one experiment a syrup containing 59% xylitol and 25% sorbitol gave a first crop of crystals in 42% yield which was 96.4% xylitol. Usually liquors contain at least 70% xylitol and the first crops of crystals are correspondingly higher. On the basis of these recoveries of what may be called "technical grades of xylitol" it was concluded that hardwoods will yield 11% of xylitol and maize cobs 20% on an oven dry basis.

The Overall Process Of Producing Xylitol

The production scheme is summarised in Fig. 2. To date we have had no trouble obtaining xylitol of some 97% purity from native hardwoods or maize cobs. With beech hardwood, however, there are larger quantities of non-carbohydrate materials in the acidic liquors and the preferred hardwood sources are poplar and eucalypt. Maize cobs, as mentioned previously, are the best source material overall if xylitol production is considered as an independent process.

As has been demonstrated by our results to date it is possible to obtain D-xylose liquors from hardwoods while leaving the hexosan portion of the substrate relatively untouched. In this respect xylitol production could be integrated with a wood hydrolysis plant

Xylitol Production (Cont)

without seriously affecting ethanol production. Additionally, the ethanol available 'on site' would be very useful in the recrystallisation of the xylitol.

On an industrial scale the purification of D-xylose solutions by the use of ion exchange columns alone would be extremely costly. Once an attractive source material is selected then further work will be necessary in this area. The treatment of liquors with activated carbon or the application of ion exclusion techniques to reduce gross contamination by large inorganic impurities and coloured substances will alleviate the fouling of macroreticular resins (19, 20). The purification sequence will need to be tailored to suit the source material.

TABLE II: ANALYSIS OF HYDROLYSATES FROM HARDWOODS AND MAIZE COBS

	Red Beech	Silver Beech	Poplar	Eucalypt	Maize Cobs		
					A*	B	C**
Rhamnose	1.3	1.3	1.2	1.0	-	0.2	0.1
Arabinose	2.7	2.1	2.1	1.4	9.8	6.0	6.5
Xylose	72.2	75.3	73.3	81.3	65.2	82.0	80.3
Mannose	3.6	5.3	10.3	5.9	4.0	0.7	0.6
Galactose	4.7	4.9	3.5	4.6	10.4	3.8	4.0
Glucose	15.5	11.0	9.6	5.6	10.5	7.5	8.4
Xylose yield (As % possible xylose)	89.0	84.6	76.4	75.5	28.5	72.5	73.4

Conditions: sawdust samples in sealed glass vials. 0.25% H_2SO_4, 40 min, 150°C.

* 0.1% H_2SO_4, 40 min, 150°C. ** 0.5% H_2SO_4, 40 min, 150°C.

NZ Demand And Supply Of Xylitol

At present the demand for xylitol in NZ is negligible. This is because of the current 'in limbo' status of xylitol as a general food additive (21-23) and also because the general public is unaware of the advantages of using this compound. Should, however, xylitol receive the blessing of the US Food and Drug Administration or the World Health Organisation it is quite probable that a demand for xylitol of about 5,500 tonnes/annum could arise. This figure is based on the consumption of 10 g of xylitol per day for half of the population and represents 8% of the average sucrose intake per person per day. It is envisaged that xylitol would be incorporated in chewing gum, confectionery, toothpaste and "snack" foods.

To meet this demand it would be possible to use

(a) South Island hardwood wastes — A wood hydrolysis-fermentation unit consuming 100 oven dry tonnes of wood/day could produce some 4000 tonnes of xylitol/year.

TABLE 1: NZ XYLAN SOURCES

	Hardwoods					Softwood	Non Woods	
	Red Beech	Silver Beech	Eucalypt[1]	Poplar[2]	Tawa	Pine[3]	Maize Cobs	Maize Fibre
Klason lignin[4]	23.3	24.2	21.7	23.0	28.1	25.4	16.0	6.1
Total Carbohydrate[5]	66.7	63.0	70.6	69.2	58.8	72.4	77.2	73.9
Rhamnan	0.7	0.5	0.2	0.3	0.6	0.1	-	0.1
Arabinan	0.6	0.8	0.3	0.7	2.3	1.4	4.1	14.9
Xylan[6]	16.0	14.4	18.1	21.8	11.5	4.4	38.5	27.6
Mannan	1.0	1.5	1.6	3.3	2.9	12.6	-	0.5
Galactan	1.2	1.0	0.8	1.0	1.3	2.3	2.1	4.5
Glucan	47.3	44.9	49.6	42.2	40.2	51.7	32.5	26.3

[1] *Eucalyptus regnans* [2] Lombardi Poplar [3] *Pinus radiata*

[4] Done on unextracted material % oven dry [5] Expressed as anhydro polymers % oven dry material [6] Considered to be polymer of D-xylose units exclusively

(b) Maize cobs — In June 1976, 26,500 ha of maize were planted in NZ (essentially in the Gisborne, Waikato and Bay of Plenty areas). About 20,000 tonnes of xylitol could be manufactured from the cobs of this maize.

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News From Govt. Departments

DSIR

Dr. A.J. Ellis 1st Vice President NZIC has been appointed Assistant Director General and **Dr. I.R.C. McDonald** as his successor in the Directorship of Chemistry Division.

Mark W. Pritchard, a Massey graduate, recently took charge of the Grasslands Division Analytical Laboratory. He spent a year at the Institute for Soil Fertility at Haren (G.R.), The Netherlands, on a Fellowship from the Dutch Ministry of Education carrying out research on trace elements translocation in plants. Mr Pritchard was elected Manawatu Branch secretary at the recent AGM.

Miss Sally Roach, a graduate of the Department of Microbiology, Otago University, recently joined the Biochemistry and Microbiology Section of Applied Biochemical Division. She is now studying the degradation of cellulose by ruminant micro-organisms.

Dr Claude Willemot, Canadian Department of Agriculture, Ste-Foy, Quebec, who is interested in the role of lipids in the adaptation of wheat and lucerne to low temperature, is spending a year's sabbatical study at Plant Physiology Division with **Dr Roger Slack** developing techniques of measuring fatty acid synthesis and desaturation in roots.

Dairy Research Institute

Jac Roeper has resigned and departed for The Netherlands. His place in the Casein and Related Products Section has been taken by **Miss J. Kay Butterick,** a recent Massey Food Technology graduate. **Ross B. Mockett** has also recently joined this section.

Invermay Agricultural Research Centre

John Grigg, a specialist in soil chemistry and soil fertility, is visiting USA to study the latest developments in soild testing and plant analysis. **Dr Terry Reid,** formerly of the animal health division at Invermay has been transferred to the MAF research division, Whangarei.

MIRINZ

The Director, **Dr Lester Davey,** is currently visiting USA and UK studying the quality of NZ lamb in these overseas markets in relation to their local product.

GLC ANALYSIS OF EDIBLE OILS AND FATS

L. Eyres Abels Ltd. Auckland

Abels Ltd is the major producer of edible oils, cooking fats, shortenings and margarines in NZ. Their processing requires a high level of technology and strict laboratory control. A major technique used to establish the identity of imported oils, to monitor processing and to check the accuracy of formulations is Gas-Liquid Chromatography (GLC).

Fats and oils are generally analysed as their fatty acid methyl esters on intermediate polarity stationary phases such as P.E.G.A., D.E.G.S., EGSSX and more recently cyanosilicone phases such as SILAR 5CP and SILAR 10C (1). The latter two phases have increased thermal stability over the polyester phases and can be temperature programmed to 250°C thus reducing analysis time and increasing the potential number of daily samples. Criteria for establishing the identity of oils and fats by GLC have been laid down by the WHO and set down in the Codex Alimentarius (2,3). The ranges for fatty acid values are very wide and tend to permit adulteration although typical analyses of oils imported into NZ tend to fall within much narrower ranges and these are given in Table 1.

Additional information can be gleaned concerning the composition of fats and oils by analysing the intact triglycerides by high temperature GLC using non-polar, high thermal stability stationary phases such as OV-1, SE30, JXR and Dexsil. An excellent review of this technique is given by Litchfield (4). These non-polar columns separate oils and fats according to carbon number. The separations of triglycerides differing by 2 carbon atoms are achieved but no resolution with respect to polarity is obtained on these non-polar columns although recent reports in the literature suggest that this may now be possible (5).

Dr. Laurence Eyres completed his Ph.D. in applied catalysis in 1972 at U.M.I.S.T. (Manchester, UK). On emigrating to NZ later that year he was employed by Laboratory Services as a research chemist. In 1974 he moved to Abels Ltd. as a research and development chemist, carrying out basic research into the properties of fats and oils, improving processing techniques and looking at the introduction of new products.

His principal interest is in gas chromatography as applied to the study of reactions occuring in frying and to lipid research in general. He is a member of the American Oil Chemists' Society, and the S.C.I. (London), and has been on the NZIC council for two years and will shortly become chairman of its Publications Committee. Dr Eyres is married and has one son.

The analyses presented in Table II are typical of the more common oils and fats used in NZ. The carbon number depicted in the table is the sum of the carbons in the 3 fatty acid chains attached to the glycerol molecule, thus triolein and tristearin would be represented as C54 and trilaurin as C36.

GLC is also used in this laboratory to analyse for tocopherols and sterols the composition of which varies from oil to oil and can also be used as a guide to their identity. (6) Recently trans isomers have been analysed on a 5m, 15% OV-275 column and these analyses will be the subject of a future paper.

Experimental:

Analysis Of Fatty Acid Methyl Esters (F.A.M.E.)

F.A.M.E. were prepared from fats and oils by either of 2 methods:-

(a) For fats with free fatty acids less than 2%, base catalysed transesterification at room temperature was used utilizing sodium methoxide (7) or tetramethylammonium hydroxide (8) as catalysts.

TABLE I. FATTY ACID COMPOSITION OF OILS AND FATS BY GAS CHROMATOGRAPHY

Common Name of FATTY ACID.	DESIGNATION.	BUTTER	CHICKEN FAT	COCOA BUTTER	COCONUT	COTTONSEED (Winterized)	FISH OIL	HUMAN MILK FAT	LARD	MAIZE OIL	OLEO OIL	OLIVE OIL	PALM OIL	PALM OLEIN	PALM KERNEL	PEANUT OIL	RAPESEED OIL	N.Z. COLZA OIL	SAFFLOWER OIL	SOYABEAN OIL	STEARINE	SUNFLOWER OIL	TALLOW
BUTYRIC	4:0	4.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CAPROIC	6:0	2.3	-	-	0.8	-	-	-	-	-	-	-	-	-	0.4	-	-	-	-	-	-	-	-
CAPRYLIC	8:0	1.4	-	-	7.9	-	-	0.3	-	-	-	-	-	-	5.2	0.1	-	-	-	-	-	-	-
CAPRIC	10:0	2.8	-	-	6.4	-	-	1.7	0.2	-	0.1	-	-	-	4.4	0.1	-	-	0.1	-	0.1	-	-
LAURIC	12:0	3.1	0.1	-	47.9	0.1	0.2	6.5	0.2	-	0.2	-	-	-	46.4	0.4	-	-	0.4	-	0.2	-	0.2
MYRISTIC	14:0	9.0	0.9	0.1	17.2	0.8	3.9	8.9	2.2	-	2.8	-	1.0	1.0	14.0	0.2	0.1	-	0.3	-	2.9	-	2.7
MYRISTOLEIC	14:1	1.4	0.4	-	0.3	-	0.6	0.8	0.2	-	1.5	-	0.1	-	-	-	-	-	-	-	1.1	-	0.3
PALMITIC	16:0	22.0	24.3	25.5	8.2	19.7	16.9	22.2	25.4	10.4	22.5	12.8	42.2	36.3	8.0	12.7	4.0	3.9	6.7	10.3	27.0	6.0	23.6
PALMITOLEIC	16:1	2.7	7.7	0.5	-	0.7	7.2	3.9	3.8	0.1	4.1	1.2	0.7	1.0	-	-	0.2	0.4	0.2	0.3	3.4	-	3.0
MARGARIC	17:0	0.9	0.3	-	-	0.1	2.6	0.6	0.7	-	0.8	-	0.2	0.1	0.6	-	0.1	0.1	-	0.1	1.9	-	1.9
STEARIC	18:0	15.0	7.2	33.0	2.9	2.8	6.5	10.1	13.1	2.0	19.9	4.1	4.6	4.6	2.4	4.2	1.3	1.6	2.5	3.6	34.2	4.2	22.8
OLEIC	18:1	26.0	43.9	36.0	5.9	19.8	26.8	30.4	37.9	27.8	41.6	70.5	39.5	43.5	15.0	39.9	16.2	61.8	11.4	23.2	22.9	22.4	38.3
LINOLEIC	18:2	1.9	11.9	3.5	1.4	54.5	1.9	9.7	11.5	58.3	3.1	9.1	10.5	12.5	3.1	34.5	15.1	21.3	76.0	53.8	1.0	65.0	3.2
LINOLENIC	18:3	1.2	0.6	0.2	-	0.7	0.8	0.8	1.0	0.8	1.0	0.7	0.2	0.2	0.2	-	8.7	8.4	0.2	7.6	0.2	0.4	0.8
ARACHIDIC	20:0	1.3	0.4	1.2	0.1	0.4	0.4	1.0	0.8	0.2	0.1	0.6	0.2	0.3	0.3	1.8	0.8	0.8	0.4	0.5	0.1	0.2	0.1
GADOLEIC	20:1	0.4	0.6	-	-	0.2	4.9	-	1.4	0.2	0.2	0.4	0.1	0.3	-	1.0	10.5	1.3	0.3	0.2	0.3	0.2	0.2
BEHENIC	22:0	-	0.1	-	-	0.2	0.3	-	-	-	-	-	0.1	0.1	-	3.7	0.2	0.3	0.2	0.4	0.1	0.6	-
ERUCIC	22:1	-	-	-	-	-	0.7	-	-	-	-	-	-	-	-	-	40.4	-	-	-	-	-	-
LIGNOCERIC	24:0	-	-	-	-	-	0.4	-	-	-	-	-	-	-	-	1.3	0.1	-	-	-	-	-	-
Others-																							
BRANCH		1.0	0.3	-	-	-	0.4	0.4	0.9	-	1.5	-	-	-	-	-	-	-	-	-	2.0	-	2.0
ODD No.		1.0	1.2	-	-	-	1.5	0.7	0.2	-	0.3	0.7	-	-	-	-	-	-	-	-	2.0	-	0.7
20 : n		1.3	0.1	-	-	-	13.0	1.5	0.5	-	0.3	0.6	-	-	-	-	0.2	-	-	-	0.6	-	0.2
22 : n		-	-	-	-	-	11.0	0.5	-	-	-	-	-	-	-	-	0.7	-	-	-	-	-	-
Iodine Value		32	68	38	7.5	113	130	46	55	126	49	78	53	59.6	19	95	106	112	140	132	28	132	44
Melting Pt.°C		29	23	33	25	-	-	34	36	-	39	-	39	20	27	-	-	-	-	-	55	-	47

TABLE II TRIGLYCERIDE COMPOSITION OF OILS AND FATS ACCORDING TO CARBON NUMBER (WEIGHT %)

TRIGLYCERIDE DESIGNATION BY CARBON NUMBER.	BUTTER	CHICKEN FAT	COCOA BUTTER	COCONUT OIL	COTTONSEED	FISH OIL	HUMAN MILK FAT	LARD	MAIZE	OLEO OIL	OLIVE OIL	PALM OIL	PALM OLEIN	PALM. KERNEL	PEANUT OIL	RAPESEED OIL	N.Z.COLZA OIL	SAFFLOWER OIL	SOYABEAN OIL	STEARINE	SUNFLOWER OIL	TALLOW
28	0.2	-	-	0.5	-	-	-	-	-	-	-	-	-	0.4	-	-	-	-	-	-	-	-
30	0.7	-	-	3.1	-	-	-	-	-	-	-	-	-	1.3	-	-	-	-	-	-	-	-
32	1.8	-	-	14.2	-	-	-	-	-	-	-	-	-	6.9	-	-	-	-	-	-	-	-
34	4.1	-	-	17.5	-	-	0.3	-	-	-	-	-	-	9.3	-	-	-	-	-	-	-	-
36	8.6	-	-	19.5	-	-	0.8	-	-	-	-	-	-	22.9	-	-	-	-	-	-	-	-
38	12.6	-	-	16.3	-	-	1.9	-	-	-	-	-	-	17.0	-	-	-	-	-	-	-	-
40	10.5	-	-	9.8	-	-	3.1	-	-	-	-	-	-	10.1	-	-	-	-	-	-	-	-
42	6.8	0.8	-	6.6	-	0.8	7.6	-	-	-	-	-	-	9.1	-	0.2	-	-	-	-	-	-
44	6.0	0.3	-	3.5	0.2	0.6	11.0	-	-	0.7	-	-	-	6.5	-	0.6	-	-	-	0.2	-	0.6
46	6.8	0.8	-	1.8	0.2	2.8	13.2	-	1.0	2.5	-	0.8	0.4	4.8	0.9	0.5	-	-	0.3	2.5	1.0	2.5
48	8.7	4.6	0.9	1.7	1.6	7.1	13.2	4	0.5	8.6	-	7.6	2.4	5.5	1.4	0.5	-	0.3	0.9	10.3	1.0	8.9
50	12.1	16.7	18.3	2.5	8.5	11.8	17.3	20	3.2	20.9	3	37.6	35.5	1.9	4.0	1.9	1.2	1.4	3.9	24.6	1.7	21.8
52	14.7	38.5	45.6	2.4	43.6	18.5	23.9	62	26.2	49.1	28	42.2	46.9	2.0	25.3	5.6	12.9	18.2	26.7	39.9	17.1	40.4
54	4.2	36.2	33.1	0.6	43.0	18.2	6.6	15	64.8	16.3	67	8.7	13.6	1.7	49.3	9.4	75.2	80.1	64.7	21.9	75.1	22.3
56	0.2	1.7	1.75	-	1.6	11.9	0.9	-	1.0	-	1	0.2	0.9	-	11.6	11.2	6.3	-	2.7	-	1.0	1.2
58	-	-	0.4	-	0.3	14.5	0.1	-	0.2	-	-	-	0.3	-	4.4	17.6	2.6	-	0.6	-	1.9	-
60	-	-	-	-	-	8.3	-	-	0.1	-	-	-	-	-	1.9	18.9	1.2	-	-	-	0.7	-
62	-	-	-	-	-	2.9	-	-	-	-	-	-	-	-	-	32.3	0.7	-	-	-	-	-
64	-	-	-	-	-	1.8	-	-	-	-	-	-	-	-	-	0.4	-	-	-	-	-	-

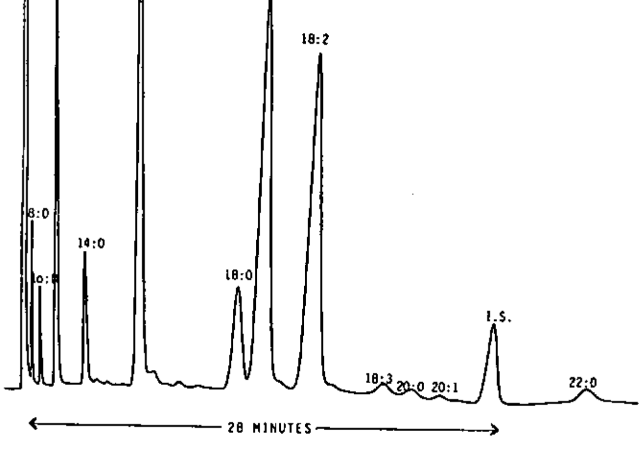
GLC Analysis (Cont)

(b) For fats with a high content of F.F.A. or complex lipids the method of Hartman was used (9). This method involves refluxing the saponified lipid with a mixture of methanol, sulphuric acid and ammonium chloride. This technique makes use of readily available bench chemicals thus avoiding the need for boron trifluoride/methanol reagent which has the disadvantages of being shipped only by sea-freight, having a limited shelf life and a tendency to produce artefacts in the fatty acid methyl ester preparation.

Methyl esters were analysed on a Pye GCD Gas Chromatograph on 2.0m (1.6 mm I.D.) columns packed with 10% SILAR 5cP on 100-120 mesh Gas Chrom Q (Applied Science Laboratories). Nitrogen flow rates of 10ml/min were used and the temperature was programmed from 195°*C to 220*°C. A typical chromatogram is shown in Fig. I. Comparative analyses have been carried out on 10% P.E.G.A. columns achieving the same results but with longer analysis times.

FIGURE I

ANALYSIS OF FATTY ACID METHYL ESTERS



Analysis Of Triglycerides

Sample size was 0.5 microlitres of a 5% solution of the fat or oil in chloroform or hexane. The analyses were carried out on 0.5m (1.6mm I.D.) colums packed with 3% OV-1 on 100-120 mesh Gas Chrom Q. The nitrogen flow was 20ml/min and the temperature was programmed from 150°C to 360°C at 10°C min $^{-1}$. A typical chromatogram is shown in Fig. II. The instrument used was a Pye GCV gas chromatograph equipped with dual columns. Peak areas were quantitated using an electronic integrator.

These columns can be used also for the analysis of emulsifiers in oils and fats and for the analyses of tocopherols and sterols but for the latter, longer columns(1.5m) packed with 3% OV-17 are preferred.

Use Of An Internal Standard

For quantitation of methyl esters in a sample or for measuring the amount of lipid in a food sample, triheptadecanoin (C51) or heptadaconoic acid or methyl heptadecanoate are often used as internal standards. Heptadecanoic acid, however, is a minor constituent of animal fats (up to 2.0%) and therefore an alternative internal standard was sought. Hexyl heptadecanoate was found to elute between eicosadienoic acid (20:2) and docosanoic acid (22:0) methyl esters and was therefore suitable as an internal standard for fatty acid analysis. This material was not available commercially and was synthesized by esterifying heptadecanoic acid (Sigma Chemicals) with A.R. Hexanol (BDH) by refluxing for 3 hrs in the presence of Amberlite IR-120 (BDH) catalyst, collecting the water of reaction in a Dean and Stark Apparatus. The resultant ester was distilled under vacuum (1.5mm Hg) collecting the fraction boiling at 208°C. GLC analysis showed the purity to be greater than 99%.

Notes On The Tables

The samples analysed were typical fats and oils as received in this laboratory and were assumed to be genuine samples. The sample of fish oil for fatty acid analysis was a composite sample of oil produced by an Auckland factory processing mainly snapper, gurnard, flounder etc.

Oleo oil and stearine are the low melting and high melting fractions respectively of tallow, the sample of which is a composite blend of beef and mutton tallow.

Human milk fat was extracted from a freeze-dried mature pool of breast milk obtained at the Auckland Medical School.

The oils listed in Table I which comply with the description "Polyunsaturated" according to the Food and Drugs Act are maize, soyabean, sunflower and safflower. It is hoped that these tables will prove of use to Food Chemists, Nutritionalists and Industrial Chemists.

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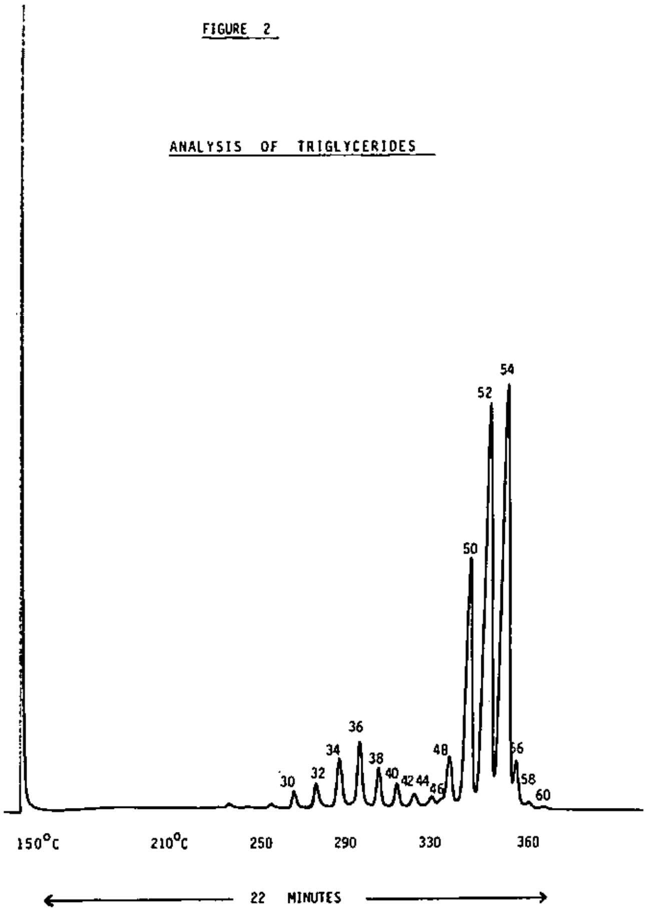
FIGURE 2

ANALYSIS OF TRIGLYCERIDES



PROSPECTS FOR NEW BATTERIES FOR ELECTRIC VEHICLES

Part II. Molten-Salt, Non-Aqueous and Solid-State System.

D. A. J. Rand, CSIRO, Institute of Earth Resources, Division of Mineral Chemistry.

In the first part of this review (see Chemistry in NZ, October 1979 - Pp 185-188) of secondary batteries for electric vehicle power source applications, low-temperature, aqueous-electrolyte systems were discussed, i.e. Pb-acid, Zn-Cl_2, Ni-Zn, Ni-Fe, Fe-air and Zn-air. This concluding part reviews high-temperature and other advanced concepts based on the use of alkali metals as high energy electrode materials. Finally, the relative merits of the various battery types are discussed in terms of their efficiency, performance and cost.

Molten-Salt Batteries

These batteries promise high energy densities through selection of highly reactive, low equivalent weight materials, and high power densities through the use of molten-salt electrolytes of low electrical resistance. Molten alkali metals are used for negative electrode materials and molten sulphur, or halogens, for positive electrodes (Table I).* There are few of the morphology or shedding problems encountered with solid electrodes. The Na-S and Li/Al-FeS systems (Table II)* are the most promising power sources for future electric vehicles. The Li-Cl_2 system operates at very high temperatures (~650°C) and there are formidable materials problems in handling the extremely corrosive reactants. The Na-$SbCl_3$ battery being developed by ESB in USA benefits from a lower operating temperature (~200°C), but cell life is still quite low and relatively expensive materials are involved.

Sodium-sulphur: This cell consists of 2 liquid electrodes (molten sodium and molten sulphur-sodium polysulphide) separated by a solid ceramic electrolyte (β-alumina) which can selectively conduct sodium ions. The battery operates between 300-375°C. Companies and institutions have been involved in Na-S battery research in several countries including: USA (Alcoa, Dow Chemical, EIC, ESB, Ford Motor Co., General Motors, NASA, Shell Oil, TRW, Tyco Laboratories and US Navy); UK (British Rail, Chloride Silent Power and UK Electricity Council); France (CGE); Germany (Brown, Boveri and Cie AG); Japan (Toyota, Toshiba, Yuasa Battery, Showa Denko, Japan Storage Battery, Daini Seikosha and Nichiron Capacitor); South Africa (CSIR); Switzerland (Battelle Memorial Institute); and USSR.

Most cell designs employ tubular geometry, the cell consisting of a hollow, close-ended cylinder of β-alumina sealed into a cylindrical metallic can. The Dow cell uses a special borate glass for the electrolyte. Batteries have been tested in prototype vehicles in

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**Tables I and II appeared in the first part of Dr Rand's paper, published in our October, 1979, issue (pages 186/7)*

What's the big idea?

four energy developments from Lucas!

You may think we're just a little ahead of ourselves, but we feel that there's nothing quite like a few new developments on the motoring scene to stir up a little excitement. That's why Lucas have stepped in with, not one, but four new developments to help cope with today's energy problems, and who doesn't have those. Three new batteries from Lucas. Just for starters, take our new Lucas Low-Maintenance Battery – it's called the Pacesetter 3, and it's so advanced that we've extended the free of charge replacement guarantee by 50% ! Ask for it next time, it's better for you and your car. If you're into water, you'll already be using a Lucas totally dependable Marine battery in your boat.

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.

It may be that your problem isn't on the road or in the water – no problem, development number three is the new Lucas Stationary Battery for standby power and fire or burglar alarms, specially developed to give a low rate of self discharge.

Charge your battery with solar panels, energy from the sun

Last on the list, for the time being anyway, is an item not concerned directly with motoring, but with a method of providing energy, becoming more and more popular and increasingly important every day.

If you run a car, marine or stationary battery you can now have them recharged effectively with the use of solar energy.

The Lucas Solar Energy System is self-contained, therefore ideally suited for unattended use at remote locations – mountain peaks, desert floors, even off shore locations.

With no fuel costs, pollution or noise, you'll be doing yourself a favour as well as the environment.

Lucas Solar Energy Systems – custom designed to power you through a minimum of 10 years continuous service, 24 hours a day, 365 days a year.

There's more to

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England and Japan; the Japanese system gave more than 180 W h/kg at the 4-hr rate. 350 Wh cells have now been developed in UK by Chloride Silent Power Ltd. and energy densitites of around 100 W h/kg (or 100-250 W h/l) are attainable, battery performance being dependent on system design and the amount of the thermal insulation (10).

Although the Na-S cell offers certain advantages over other systems (e.g. high energy, power and open-circuit voltage; capacity largely unaffected by discharge rate; cheap and abundant reactants; no self-discharge; ~100% current efficiency; rapid recharge), there are major problems associated with operating at fairly high temperatures. These include corrosion of the container, current collectors and ceramic seals and premature failure of the β-alumina membrane. British research groups have reduced the incidence of seal failure and corrosion by exchanging the normal position of the reactants so that sulphur is now contained in the central tube and sodium in the container. Efforts have been made to lower the operating temperature by adding dopants to the sodium polysulphide melt and thus permit the use of teflon seals. Great improvements in the life of the ceramic electrolyte have been achieved recently and the main problem now seems to be one of quality control during the fabrication process.

Lithium-sulphur: This battery has been developed mainly in USA at the Argonne National Laboratory (contracted companies: Atomics International, Eagle-Picher, Catalyst Research Corp. and Gould) and General Motors, and in Germany by the Battelle Institute. In initial studies, the system consisted of liquid lithium and sulphur electrodes in an electrolyte of molten LiCl-KCl eutectic at 380-450°C. The development of such cells is beset with any practical difficulties, but problems with the lithium electrode of corrosion, containment and self-discharge have been alleviated by using solid Li-Al (Argonne, Gould, Battelle) or Li-Si (General Motors) alloys, and problems of sulphur loss from the positive electrode have been reduced by using iron sulphide materials (FeS or FeS_2) More recently, even better electrode performance has been obtained using ferrosilicon ($FeSi_2$) alloys (11). The use of these new materials has resulted in the development of practical cells with energy densities in the range 70-115 W h/kg and service lives of over 200 cycles.

Much of the work now in progress is concerned with evaluating materials and design for electric vehicle batteries. Finding effective, low-cost separators and positive electrode current-collectors has proved difficult. Present cells use a boron nitride cloth separator and molybdenum current-collectors but these are expensive and difficult to fabricate. Efforts are being directed towards the development of porous felt or loose powder (e.g. AlN, MgO, β-Si_3N_4 and CaO) separators.

The most recent design of the Argonne cell uses 2 (or 3) positive electrodes and 3 (or 4) negative electrodes which are separated from one another by nonwoven ceramic cloth. The cells are prismatic in shape with each positive electrode having 2 facing negative electrodes. The first in-vehicle battery is scheduled for late 1979 and it is anticipated that a fully developed Li-iron sulphide cell will have a specific energy above 165 Wh/kg, a peak power of 200 W/kg and a cost of $US35-40/KW h. Cell cycle life is still uncertain.

Organic Electrolyte Batteries

These systems are generally based on the use of lithium as the high-energy negative electrode and offer the attraction of operating near room temperature. Non-rechargeable versions are already commercially available. Since lithium is unstable in water, cell electrolytes consist of aprotic organic solvents (e.g. propylene carbonate) containing dissolved lithium salts. A variety of materials have been tested as positive electrodes and favourable systems appear to be those using lamellar transition metal dichalcogenides (i.e. sulphides, selenides or tellurides of Ti, Zr, Hf, V, Nb or Ta). These compounds are similar in structure to mica and graphite, and because of its light weight and relatively low cost, TiS_2 is the most promising for motive power-source application.

Lithium-titanium disulphide: The discharge of this system proceeds via the insertion (or "intercalation") of lithium ions between adjacent sulphide layers in the dichalcogenide (Table I). Research and development of the Li-TiS_2 system has been pioneered by Exxon Research and Engineerng Co., USA (12) and it is believed that electric vehicle batteries have reached the pilot-plant stage of manufacture. As yet, few details are available on the performance and durability of this battery but energy densities ~ 130 W h/kg have been reported. Typical problems to be faced with intercalation systems include: low cycling efficiency and discharge rates; positive electrode stability and utilization; formation of lithium dendrites and lithium electode shape change; self-discharge; electrolyte conductivity, purity and stability; separator durability; temperature control; and high manufacturing costs. A likely competitor to the Exxon Li-TiS_2 battery is the lithium system recently developed by Bell Telephone Laboratories in which vanadium disulphide is the basic positive electrode material with some vanadium being replaced by iron to improve rechargeability.

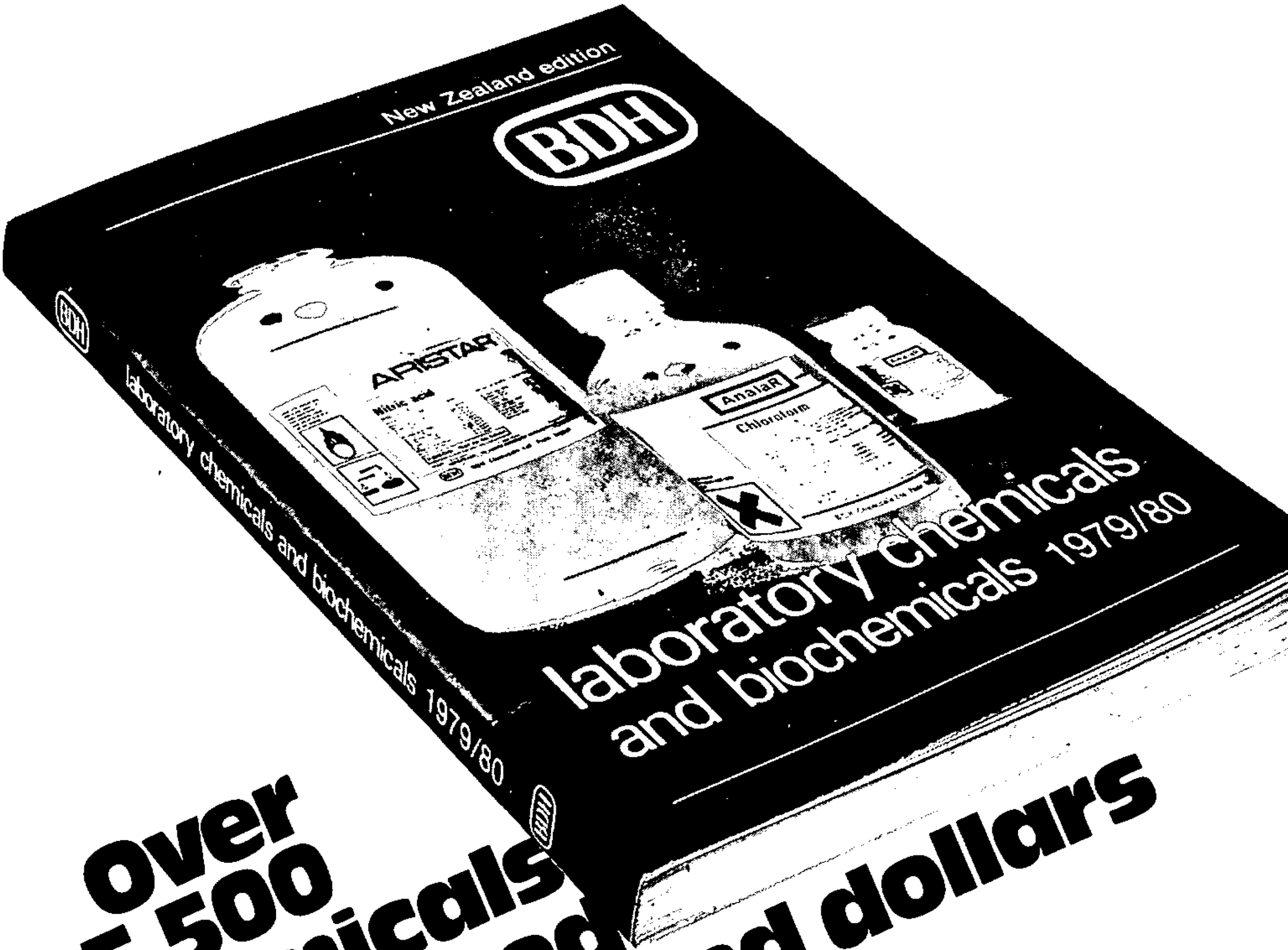
Solid-State Batteries

All-solid traction batteries are still very much at the experimental cell stage. The main attraction of these systems is the avoidance of problems such as constituent migration, morphological changes, corrosion and seal-failure which accompany the use of liquid components. The future development of these systems for vehicular propulsion depends greatly on the level of success of the present search for better solid electrode and electrolyte materials. These materials must be relatively inexpensive, easy to fabricate, have good mechanical strength, high chemical stability, give a good geometrical match at interfaces and exhibit high ionic conductivity — preferably at low (below 100°C) temperatures.

There has been a tremendous growth of interest in the subject of fast ionic conduction and in particular in the quest for new and improved alkali ion conductors since these ions offer the greatest possibility of large cell voltages and high energy densities. However, despite numerous recent research efforts, sodium β-alumina has remained unchallenged in its position as the best of the alkali ion conductors. The only serious contender appears to be $Na_3Zr_2PSi_2O_{12}$ (referred to as "Nasicon") which can be fabricated at lower temperatures and exhibits good strength and stability. Generally, Na^+ conductors are superior to their Li^+ counterparts. Li_3N ceramic shows some promise as a Li^+ conductor, but the long-term stability of this material has yet to be demonstrated.

Since a basic requirement of a battery electrolyte is high electrical conductivity, moderate conductors have to be used in thin film configurations to enable reasonable current densities ($\sim 10^3 A\ m^{-2}$) to be drawn. Lithium-containing glasses are attracting much attention because they can easily be fabricated in thin sheets. A completely solid-state Li-TiS_2 battery is being evaluated at Imperial College (UK); the system uses a flexible thin film of polymeric Li^+ conductor which maintains excellent interfacial contact with both electrode phases during charge/discharge cycling.

Despite such developments, it is clear that much more research is required into fast ionic conduction in the solid state, thin film technology and structural changes during battery cycling before solid-state systems can become practical for vehicle traction applications.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BDH
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Nitric acid
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Chloroform
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The Most Promising Traction Battery

The future of the electric vehicle as a viable transportation alternative to the i.c.e. depends upon the development and commercial availability of a battery which can meet a number of requirements, among the most important being: high energy density (for long range), high power density (for good acceleration and hill-climbing performance), long life (for low vehicle operating costs), great simplicity, low manufacturing and materials costs, safety in operation, low maintenance, low self-discharge, easy, efficient and rapid rechargeability, good high- and low-temperature characteristics, small size and easy replacement. With these requirements in mind, the advanced batteries discussed in Parts I and II of this review may be categorized principally into near-(0-10 years) and long- (over 10 years) term prospects for traction applications (Table I).

There are 3 near-term prospects: (i) improved lead-acid, which offers the lowest initial cost (Table 1); (ii) nickel-iron, which promises the lowest cost per km; and (iii) nickel-zinc which gives the greatest range but highest cost per km. All other battery systems — Zn-Cl_2, metal-air, molten salt, non-aqueous, solid-state — are generally considered to be long-term prospects.

The lead-acid battery will certainly take the lion's share of the electric vehicle market until the nickel systems, at present only in the prototype stage, can prove themselves and reach commercial production. Provided cycle life can be improved, Ni-Zn will be more attractive than Ni-Fe. The latter system suffers from poor power density, low charge/discharge efficiency and self-discharge problems.

Metal-air batteries (Fe-air, Zn-air) suffer from very low efficiencies associated with the fundamental problem of finding a low-cost, high-performance, rechargeable oxygen electrode. System complexity is another unattractive feature here. The most sophisticated of the systems so far developed — the CGE circulating Zn-air battery — will be economic only if produced in large numbers which presupposes a well-established, thriving electric vehicle market.

The Zn-Cl_2 hydrate cell is unlikely to find use in electric cars. The battery is complex and requires a large auxiliary refrigeration/storage system and stringent safety precautions. It appears better suited to stationary energy storage applications, e.g. load-levelling.

Molten-salt batteries are viewed with great optimism — they are the only types now under development that are capable of providing the high energy densities required by private electric cars. Na-S is the favourite in this field but there has been little road-testing of this system and it is not known how well the ceramic materials used to contain the molten materials will stand up to road vibrations, let alone a crash. The complexity and safety risk presented by the unit may be unacceptable for private cars. High-temperature batteries are more likely to be used in the public transport sector, e.g. for supplying off-line power to track-following vehicles such as trains, trams, and trolley buses.

At present, no confident prediction can be made about the prospects of lithium-organic electrolyte or solid-state batteries for electric vehicle propulsion. Their commercialization seems a long way off although Exxon are believed to be close to manufacturing a Li-TiS_2 type for electric vehicles. Some concern has been expressed over world lithium supplies (13).

Power source limitations indicate that the future of electric propulsion lies in its application to specialized vehicles and the degree of penetration into the electric vehicle market of any of the battery systems discussed here will depend greatly on the service a given vehicle has to provide. In Australasia, as in most other parts of the world, electrics will find increasing use as short-range delivery and service vehicles and perhaps also in city public transport. The electric car is not likely to be a substitute for most conventional "first" cars — this is a vehicle required for both long country journeys and short local trips. Nevertheless, electric cars may make ideal second cars. A recent survey showed (14) that 11% of cars in metropolitan Melbourne could be replaced without a significant change in use. For second-car application, simply-built batteries with energy densities in the region of 50-100 W h/kg will be required. The battery that would best meet these requirements in the immediate future is the nickel-zinc system.

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Electric Test Vehicle For NZ Next Year?

A prototype electric vehicle — possibly a van with a 1 tonne payload — could be available in NZ next year for evaluation purposes and to continue worldwide field trials.

This is the aim of Lucas Industries NZ Ltd, although **Mike Cooling,** head of its battery division, comments "We must stress that our electrical drive system will not be commercially available for at least 2-3 years."

Lucas Electric Vehicle Systems, UK, which last year won a French government-sponsored international contest for the design for electric vehicles, has spent 11 years and nearly 2 million km of road tests developing electric vehicles. It has evaluation units currently under test in Australia, UK, France and Austria.

But, according to **Geoffrey Harding,** manager of the Lucas Electric Vehicle Project, it may be a decade or two before electric cars become available for the private motorist. Mr Harding told technical seminars in Auckland and Wellington during early October, that while the private motorist might have to wait for a hybrid car, the technology was already being developed for powering larger vehicles with electricity.

In UK, Lucas has converted some 60 Bedford vans to test batteries and electric drive systems; to date that fleet has notched up 1.6 million km in trials, mainly on short delivery runs. The company has also developed an electric 36-seater bus, which has driven 147 km non-stop from Birmingham to Manchester becoming the first battery driven vehicle to travel between 2 major English cities under its own power, taxis and 1-tonne payload vehicles achieving speeds up to 100 kmh and, at less speeds, a range of up to 240 km between charges.

Zina Demchenko Retires

Zina Demchenko, Head, Ceramics Advisory Testing Service, recently retired from the NZ Pottery and Ceramics Research Association after 28 years' service with the Association and having served under all PACRA's 5 Directors to date. Her wealth of experience and pleasant personality will be missed. She was affectionately farwelled by past and present PACRA staff at a special lunchion.

Zina arrived in NZ in October 1950 as one of a contingent of displaced persons from Europe. She joined PACRA as a technician in April 1951 only 4 years after PACRA's own inception as a fully fledged research association.

In 1960 Zina was appointed head of the newly instituted Ceramics Advisory Testing Service, a confidential service for members of PACRA. She commanded the respect of members by the detailed consideration she gave to their individual problems.

Zina always showed a concern for people in all her activities. Many of the present and past staff will remember a generous hostess at the Demchenkos' home in Wellington or their holiday hous at Waikanae. However, Zina will undoubtedly still retain many of her "Wellington-based" activities in her well earned retirement. She is very much involved with the Russian Orthodox Church community, particularly in the teaching of Russian, and she will continue with her interests in reading, the translation of foreign language scientific works

Radioactive Materials In NZ Industry: Applications And Hazards

K. Murray Matthews
National Radiation Laboratory

Radioactive materials are widely used in industry. In NZ the material is in the form of sealed sources employed mainly in gauging operations, radiography and static elimination where there are currently some 270, 50 and 11 sources in use respectively, together with 1 industrial processing (sterilization) plant and many smaller sources in various other applications. These radiation sources are controlled by 230 licensed operators. An extensive range of radionuclides is used including: Ir-192, H-3, Am-241, Cs-137, Kr-85, P-32, Sr-90, Tl-204, Co-60, Pm-147, Pu-238, Ra-226, Po-210, and Ni-63.

Alpha, beta, gamma and neutron radiations all find application in industry. Neutron radiation, unlike the others, is produced by reaction rather than by direct decay. Most neutron sources are of the americium/-beryllium type, commonly involving about 4 GBq (GBq = Gigabecquerel = 0.027 Curie) of Am-241, the main reaction being

$$^{9}\mathrm{Be}\ (\alpha,n)^{12}\mathrm{C}.$$

Industrial applications of radioactive materials usually rely on the variation between substances of the ability to absorb or scatter radiation. The more dense a substance, for example, the more effectively it will stop or scatter beta particles. Hence by measuring beta particle transmission or the amount of backscatter, an indication of thickness or density can be obtained, relative to that of a standard sample. The high penetrating power of gamma rays is used for measurement of heavier materials. Neutrons are slowed down, or moderated, very effectively by ordinary (light) water and so are suited to the measurement of moisture content.

Industrial applications of radioactive materials in NZ are described briefly below and principles involved are illustrated in Fig. 1.

1. Thickness gauges: Thickness gauging involves measurement of either the count rate due to backscattered β particles (Fig.1a) or transmitted β particle or γ ray beam intensity (Fig.1b). Radionuclides such as Kr-85, Sr-90 and Tl-204 are used as β-emitters (up to 1GBq for backscatter and up to 40 GBq for transmission) and Am-241 us used as a low energy γ source.

Their application in industry is varied and specific examples include controlling thickness of chipboard, paper, coatings and plastic sheet.

2. Density gauges: Density gauges use the more penetrating γ radiation from Co-60 or Cs-137 for measurement of density of heavier and thicker materials than is possible with the β thickness gauges. Again, the decrease in transmitted beam intensity (Fig.1c), or the amount of backscatter (Fig.1d), gives a measure of sample density. Source activities involved are up to 2 GBq Cs-137 for backscatter and up to 40 GBq for transmission measurements.

Examples of this application include monitoring pipeline density of ironsand slurries or sewage, and the technique is also used for controlling pulp density in pulp mills. Some β-emmitters are used in density gauges for smaller jobs such as controlling cigarette firmness.

3. Level gauges: Level gauging is an extension of density monitoring. A γ source, usually Co-60 or Cs-137, is used to control levels in various industrial processes as depicted in Fig. 1e.

In the steel industry, for example, level detectors control the plant in the continuous casting of steel and in the beverage industry they are used to automatically reject under-filled cans. (AM-Z41 is used in the latter application.)

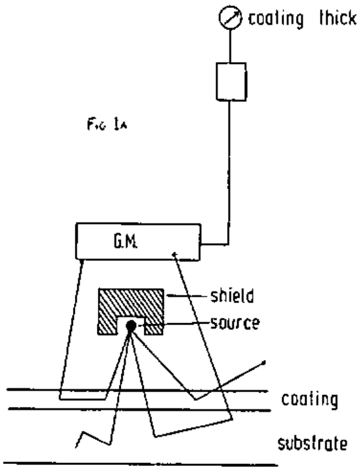
4. Industrial gamma radiography: Gamma radiation sources used in industrial radiography (Fig.1f) are of much higher activity than those used in most other applications and therefore cause most concern as potential radiation hazards. The most common source is Ir-192 (up to 4 TeraBq) though some lower activity Cs-137 sources are also used.

Examples of the use of this technique include checking of materials and welds on the Kapuni and Maui pipelines, Huntly power station boilers and penstocks at Twizel. Aircraft engines and components are also checked by this method.

5. Elemental analysis: Another application of γ-emitting radionuclides is in x-ray fluorescence analysis (Fig.1g) where a source such as Pu-238 (typically 1 GBq), Pm-147 or Am-241 is used to induce secondary x-ray emission from the sample under study. X-ray energies and intensities define sample composition.

This technique is also used to measure the thickness of coatings of one element upon another, as in zinc plating of steel.

Fig 1a



BETA BACKSCATTER THICKNESS GAUGE

Fig 1b BETA TRANSMISSION THICKNESS GAUGE

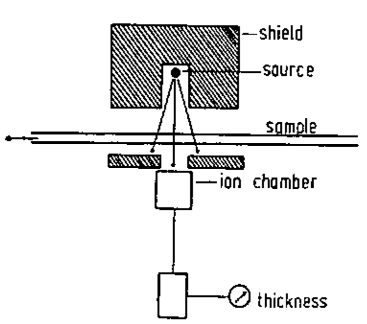
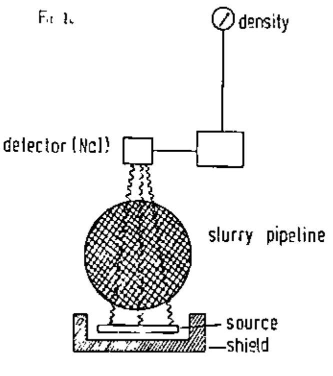


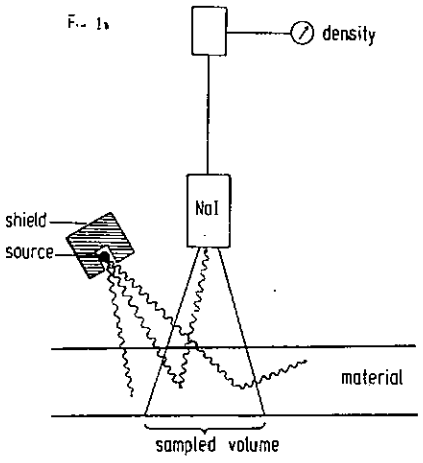
Fig 1c



GAMMA TRANSMISSION DENSITY GAUGE

Address for communications, Box 25-099 Christchurch

Fig 1b



GAMMA BACKSCATTER DENSITY GAUGE

Fig 1e GAMMA LEVEL CONTROL

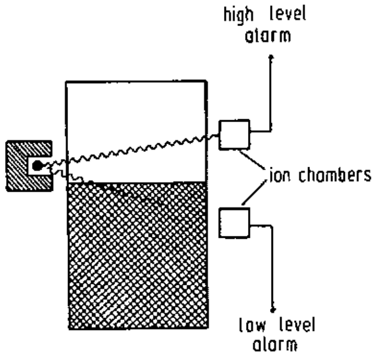
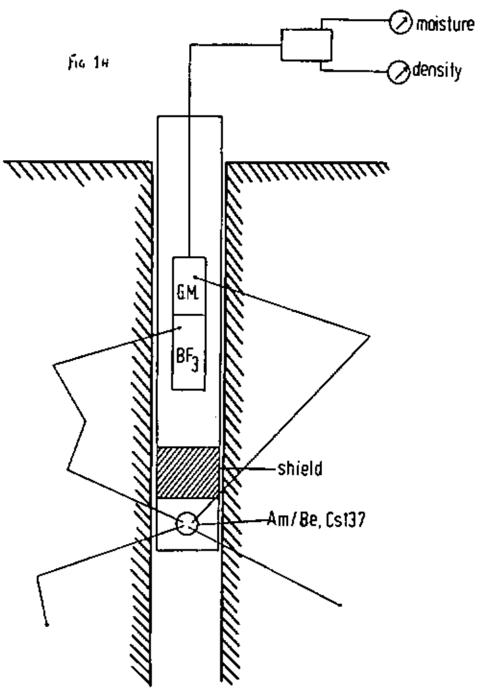


Fig 1H



SOIL MOISTURE – DENSITY GAUGE

Fig 1F GAMMA RADIOGRAPHY

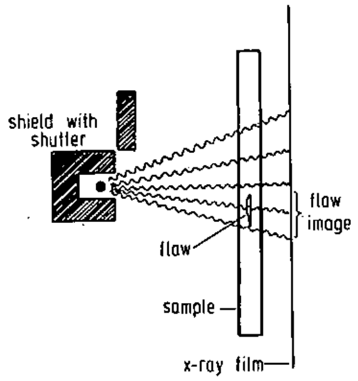
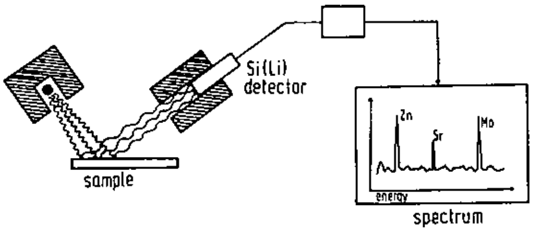


Fig 1G X-RAY FLUORESCENCE SPECTROSCOPY



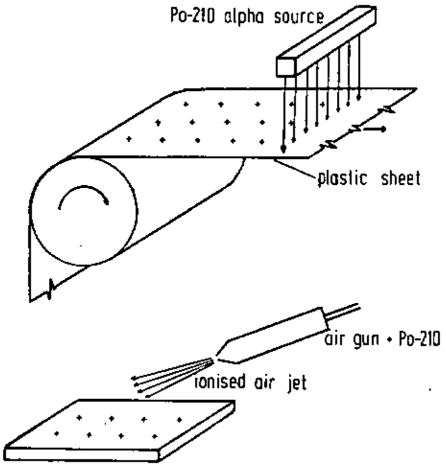


Fig 1I STATIC ELIMINATION

6. Soil moisture and density gauges: Soil moisture/density gauges are combination gauges employing a Cs-137 γ source for density measurement (by backscatter), and an Am/Be fast neutron source for moisture measurement. In some gauges a Ra/Be source is used as a combined neutron/γ source. A boron trifluoride proportional counter detects the moderated, backscattered neutrons while a Geiger tube detects backscattered γ rays. Sources and detectors are mounted in a probe which is inserted into the soil as shown in Fig.1h.

Gauges of this type are used in agricultural studies, road building, civil engineering and in well-logging.

7. Static elimination: In many industrial processes the generation of static electric charge causes problems in the handling of materials. An α-emitting radionuclide such as Po-Z10 (typically 6 GBq) can be used to reduce the problem by creating a region of ionized, and hence electrically-conducting, air through which the charged material is passed, as depicted in Fig.1i.

This technique is used in the printing, plastics and fabrics industries and also in film processing (to keep dust off negatives).

8. Other applications: Other applications of radioactive material in NZ industry include **radiation sterilization** where a 7500 TBq Co-60 γ source is used to sterilize surgical supplies etc.; **smoke detectors** where Am-241 (up to 10 MBq) is used as an alpha source (domestic appliances use less than 0.04 MBq); **luminous devices** where β-emitting Pm-147 and H-3 have replaced the more hazardous α-emitting Ra-226; **gas chromatographs** where electron-capture detectors use Sr-90, Ni-63 or H-3.

There are other industrial applications of radioactive materials but the above are the main ones found in NZ.

Biological Effects And "Permissible Dose"

Biological radiation effects result from ionization and consequent changes in cell chemistry which occur on absorption of radiation. Susceptibility to radiation varies between cell types. All radiation may produce some effect, but whether or not this effect is significantly detrimental, or even detectable, depends on the organ irradiated, the dose and the duration of exposure.

At doses of the order of 0.2 Sv (Sv = Sievert = 100 rem) slight changes may be detected in human blood even though there may be no clinical symptons; while the mean lethal dose (50% mortality) is approximately 4 Sv, delivered to the whole body over a short period. Maximum permissible does for radiation workers have been determined assuming that small doses produce correspondingly smaller effects and that there is no dose, however small, which will not have some effect. The (whole body) dose limit set by the International Commission on Radiological Protection, for people exposed occupationally , corresponds to 0.05 Sv/year, while for members of the public it is 0.005 Sv/year. To put these doses into perspective — the natural background radiation dose, which we all receive, is approximately 0.001 Sv/yr.

Industrial Radiation Hazards

While a dose of 0.2 Sv may produce only a barely-detectable effect on a human such a dose, whether delivered as a single burst or as a number of small doses over a long period, would result in increased pro-

Radioactive Materials (Cont)

bability of carcinoma appearing perhaps years later. All radiation doses must therefore be kept to a minimum, and the control of the use of radioactive materials should be sufficiently stringent so that no worker can receive more than the 0.05 Sv annual dose limit.

There are three protective principles: time, distance, and shielding. Time of exposure, and distance from source are entirely under operator control and so are subject to human error. In practice, industrial instruments include sufficient built-in shielding so that no special control is required, the equipment is safe under all normal conditions, and there is no need for workers to wear personal monitors.

An exception to this is industrial radiography where large sources and intense γ beams are involved. Built-in shielding cannot be relied on exclusively in this case so radiographers must be specially trained and wear personal monitors.

Sealed radiation sources give rise to a potential hazard from external radiation, rather than internal irradiation (which arises following ingestion or inhalation of radioactive material), provided source integrity is not in doubt. Under accident or adverse conditions source encapsulation may be damaged and radioactive material released. The primary precaution against this is that all sources are regularly inspected for damage.

Gamma sources can have substantial encapsulation because of the penetrating nature of γ-rays, but with less energetic γ and β sources such robust encapsulation would render the source ineffective. Alpha radiation, in particular, has very low penetrating power and consequently alpha sources must have relatively fragile coverings. This has caused problems in the past with static eliminators employing alpha radiation. Because of the danger of radioactive material being released into the working environment, Po-210 is now the preferred alpha-emitting radionuclide in this application — it has a reasonably short half-life (138 days) and is less toxic than Am-241 ($T_{1/2}$ = 433yr) which is used extensively overseas.

Many modern sources are prepared in such a way that loss of encapsulation is of less concern because the radioactive material is incorporated into ceramics, enamels or glasses which prevent dispersal. Then, however, there is the additional problem that it cannot always be predicted how these materials will stand up to long periods of irradiation. So in all cases sources are regularly inspected, the frequency of inspection depending on source robustness, its working environment, its physical and chemical form, half-life and toxicity.

The National Radiation Laboratory's Role

The National Radiation Laboratory, as a specialised unit of the Department of Health, has responsibility for controlling and advising on the use of x-rays and radioactive materials. It also advises on safety aspects of the use of microwave and ultraviolet radiation and lasers. Its functions include administration (licensing, import/export control, transport), hazard investigation, advisory work, personal monitoring, calibration, environmental monitoring, training and research and development.

The Laboratory investigates any incident resulting in overexposure. Several incidents are investigated each year and these are usually in the field of industrial radiography.

The worst incident to date involved a radiography source which came adrift in its housing. In replacing it the operator received a whole body dose of 0.17 Sv. On another occasion, during construction of the Kapuni pipeline, 6 workers were taken off the job with exposures in excess of 0.05 Sv in 4 weeks.

So with the types of sources used in NZ industry, the worst incidents may result in exposures of 0.2 Sv or so, though higher doses are possible. Wherever sources of radiation are used there exists a **potential** hazard. In the context of NZ industry however, and given the protective measures built into instruments and administration, the **actual** hazard is likely to be small compared to other more common and generally-accepted hazards.

The Present And Future Of Hazardous Chemicals In NZ

A.C. Kennett
Chairman, NZIC Hazardous Chemicals Committee

(Delivered at NZIC Conference, Wellington, August 1979)

It is doubtful if anybody in NZ would argue against the NZIC as a professional body of chemists having an active part to play in the handling, packaging, labelling and disposal of hazardous chemicals. Yet it was not until February 1973 when as spillage of tributyl phosphorotrithionite occured in the inner Auckland suburb of Parnell that serious and widespread attention was drawn to the dangers that could arise through chemicals being inadequately labelled, mishandled so that their packaging was damaged and that the situation could be complicated by aging and contact with the environment. Clearly there had been inadequate control of the chemical from the time that its container had been damaged on the ship through the time it had been transported by road and became a major hazard in Parnell.

How could the Parnell emergency have been avoided? If chemists had been consulted before the event, so that they could have collaborated with the handling and disposal authorities, the Parnell incident would not have occurred or at worst would only have been on a very small scale. However, the experience gained, summarised in the Report of the Commission of Inquiry into the Parnell Civil Defence Emergency, did lead to a number of valuable recommendations for reducng and handling any further emergencies.

1. Government support should be obtained to control the containment of hazardous chemicals by:-
   1.1 holding those organisations involved in handling, packaging, filling, labelling and transporting hazardous chemicals responsible for ensuring their safety and, in the event of spillage, for providing first aid instructions and chemical disposal advice.
   1.2 maintaining the necessary documentation and informing a central registry of the identity of the chemicals in storage or transit.
2. Education is required on securing loads, segration of incompatible chemicals, packaging, documentation, labelling and emergency procedures.
3. The Standards Association of NZ should co-ordinate activity in the control of design for intermodal containers for hazardous materials.
4. In the event of a chemical incident or spillage, the local Hazardous Substances Technical Liaison Committees (as sub-committees of the local Emergency Services Co-ordinating Committees) should be consulted to provide, as necessary, a consensus of opinion for action at the scene.
5. Furnaces should be made available for the controlled high temperature incineration or waste organic materials.
6. High security storage should be provided by local authorities for chemicals salvaged from incidents for temporary storage and subsequent use or disposal.

One of the immediate outcomes of "Parnell" was that the Fire Service was given authority in the Fire Service Act of 1975 to take action in the event of a non-fire emergency. Apart from this single action taken by the authorities, the NZIC was not satisfied with progress in the field of prevention of chemical accidents, particularlybecause of the public's growing disenchantment with chemicals, the dangers of which were being amplified by reports in the new media.

In 1974 the Emergency Services Committee in Auckland formed the Hazardous Substances Technical Liaison Committee which had its inaugural meeting in May of that year. The NZIC was invited to send representatives to a meeting in September and areas of mutual concern in dealing with hazardous chemicals were discussed.

At this time the Auckland Branch of NZIC had formed a Hazardous Chemical Subcommittee which organized a very successful symposium in April 1975 on "Hazards with Chemicals". The symposium was part of a programme of education to bring attention to the need for better control of dangerous chemicals in NZ.

Arising from the meeting, submissions were sent to the Government Interdepartmental Committees concerned with the handling, packaging, labelling and spillage of hazardous substances.

The submissions were that the Government should:-

1. Provide or arrange provision for areas near cities where dangerous chemicals could safely be disposed of in the event of a spillage.
2. Provide legislation for the enforcement of recommendations given in the Report of the Commission of Inquiry into the Parnell Civil Defence Emergency.
3. Set up a National Dangerous Goods Centre under the guidance of professional chemists.

Since 1975 some of these recommendations have been accepted directly or indirectly. For example in Auckland, facilities for safe storage were established in the magazines at Ardmore.

There have been numerous changes in Acts, Bills, Regulations, Orders, Rules and Codes dealing with dangerous chemicals in recent years and the NZIC has commented on a number of drafts including the following:-

Pesticides Bill 1978
Toxic Substances Bill 1978
The Asbestos Regulations 1978
The Dangerous Goods (Labelling) Regulations 1978.
Code of Practice for the Safe Use of Isocyanates 1978.
The Shipping (Dangerous Goods) Rules 1979.
The Dangerous Goods Amendment Act, Commencement Order 1979

The progress of the Hazardous Chemicals Sub-Committee of the Auckland Branch in matters of national interest and its recommendations to Goverment departments and their Ministers through the Council of the NZIC resulted in its official appointment as the Hazardous Chemicals Committee (HCC) at the August 1978 Council Meeting. At the time it consisted of 3 members from the Auckland Branch but was then enlarged to include representation by all branches of NZIC in May 1979.

In 1977 two committees were formed by the SANZ, one dealing with "Labelling of Hazardous Materials" and the other with the "Containment of Hazardous Substances for Multi-Modal Transport". This was in line with recommendations by the 1975 Standing Advisory Committee on the Transport of Hazardous Substances reported in **"Chemistry in New Zealand'** in July 1977. Unfortunately, representation by NZIC on these SANZ Committees was not obtained until June 1978 but since that time much progress has been made by the committee concerned with the specification for warning labels and a code of practice for general information on labelling.

The HCC has also been active in making contact with the Commissioner for the Environment and providing assistance to the Driver Support Training Committee in conjunction with NZ Road Transport Industry Training Board.

The functions of the HCC at present include commenting on existing and proposed legislation, maintaining contact with the National Dangerous Goods Centre, and being as up-to-date as possible with information on the identification (labelling), packaging and safe handling in industry and in the laboratory of dangerous chemicals.

In reviewing the present state of the Act concerning the handling, transit, spillage action and disposal of hazardous chemicals the evidence is that:-

1. Chemicals can be identified if the supplier chooses to do so although reactions with all other chemicals in mixed loads and their reaction with the environment are not always known or understood.
2. Apparently inevitably, accidents still occur but the frequency, particularly in road transport, appears to be reduced since the spate in 1974 and this is believed to be the result of improved education in driver courses.
3. Spillage action and disposal of hazardous chemicals have improved and this includes advance warnings to the harbour boards of trouble at sea with dangerous materials.

This third action allowed the Hazardous Substances Technical Liaison Committees to plan their action well in advance of the possible danger within the harbour.

In the last part of this paper I hope to predict some of the changes which may occur in the labelling, handling and transport of hazardous substances in NZ. It would be prudent to think that to a great extent we will have to depend on imported chemicals for the next 10 to 20 years. As a result, we may hope that the despatching country will have experienced all the difficulties in packaging and labelling of the chemical goods and in providing emergency procedures in the event of the chemical spillage in transit.

In order to control hazardous chemicals the communication of information has to be established at any cost. The chemist who is concerned with a chemical spillage must be prepared to explain to non-chemists the reason for his advice. Sometimes the advice given and precautions taken do not appear to be necessary unless the non-chemists have already seen how an apparently harmless chemical e.g. calcium hypochlorite, can turn into a raging giant. It is not hard to understand that education must play a large role in reducing the number of hazards and while it is impossible to convert the non-chemists overnight, it is possible to inform such people of the real dangers with some explanation, albeit brief, to ensure that precautions and action will be taken.

In theory it is no more difficult to move a dangerous chemical from one place to another than it is to send a letter. However, to extend the analogy, once the letter gets out of the envelope the situation changes dramatically and the need for accurate labelling, documentation, emergency producures and the seeking of advice from an authority becomes so important. In fact, it is not difficult to predict that the following requirments will become mandatory for the road haulage of hazardous materials:-

1. All hazardous chemicals will have to be centrally registered.
2. Chemicals will have to be identified by chemical name, cross referenced with all trade names e.g. from Chemical Abstracts Service.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3. Packages must be labelled with standard warning labels with hazards rated according to the degree of danger.
4. Documentation will accompany the goods in transit with the following:-
   - 4.1 Diamond warning labels.
   - 4.2 UN Chemical identity number.
   - 4.3 Action Code.
   - 4.4 Telephone number for specialist advice (ideally linked with a computer centre).
   - 4.5 Emergency procedures including first-aid and chemical disposal.
5. Spillage fighting chemicals and equipment, together with first-aid treatments, would need to be on the vehicle.

Information 4.1 to 4.2 would be given as a placard placed prominently on the vehicle to warn the public in the event of an emergency to keep all well away from the dangers and advise the authorities dealing with the accident on how to proceed safely.

The best action the public can take is to keep out of harm's way and telephone the emergency services so that the police can take the necessary steps to cordon off the danger areas leaving free access for the other services to do what is required.

However, all road vehicles transporting hazardous chemicals should be equipped with RT in the cab to assist the driver in communicating impending danger and to decide what has gone wrong after an accident.

Vehicles for the carriage of dangerous chemicals will have to be designed and approved for the purpose and, for liquid loads, will require to be equipped with non-flash pumps which can be operated by an independent power source. Release of the vehicle at the start of the journey will be the responsibility of the tally-clerk who, with the driver, will complete a check list requiring both signatures before departure. In addition, the safest possible route should be laid down and rigidly enforced except in some other emergency. Containerisation has solved some problems and created others. Containers have isolated spillages and are usually well marked with danger signs. However, goods inside the container are not always suitably packaged for journeys outside the container and may be unlabelled or badly labelled. It may become necessary to insist that overseas despatchers label all goods according to the requirements of NZ Standards or, on checking, the goods will have to be labelled after unloading at the point of distribution.

In conclusion I would hope to see an area set well aside from the main receiving areas capable of storing and dispatching dangerous goods and for a new controlling authority which would be responsible for the safe disposal of dangerous chemicals should the need arise.

Chemical Spillages During Transport: Health Dept. Survey Results

M.N. Bates

The so-called "Parnell Incident" of 1973 drew public attention to the problems which could arise from mishaps during the transportation of chemicals. In Auckland's Parnell suburb noxious fumes of the volatile butyl-mercaptan caused by the hydrolysis of an organophosphorus cotton defoliant were responsible for the evacuation of thousands of people from their homes for a night. Drums of the defoliant, known as merphos, had been damaged during a storm at sea and, although bound for Australia, were offloaded at Auckland because of leakage. Spontaneous hydrolysis ensued when moisture was present.

A number of recommendations for improvements in the legislation and the emergency services arose from the Commission of Inquiry into the incident (1973). However, it became clear to some of us involved in the implementation of the recommendations that there was a lack of readily available quantitative or qualitative information on the frequency, magnitude and cause of chemical spillages associated with the transport industry in NZ. It was felt that this information was essential for decisions on the best means of implementing the recommendations of the Commission of Inquiry. This paper presents the results of an attempt to gather such information.

Method

A questionnaire was devised and sent in May 1975 to each of the Health Department's district offices with instructions that a copy was to be completed for every transport-related chemical spillage with which the department was associated.

The questionnaire was divided into sections which separately probed such matters as the details of the accident, the nature of the chemical and its container and measures taken to clean up the spillage. Questionnaires were to be completed during the incident and forwarded to head office within a week. At the end of a 20-month period the data received were collated and the results are presented below.

Results

By the end of the 20 months 23 questionnaires had been received. However, the department was aware, largely through newspaper reports, of 4 other relevant incidents which had occurred, but for which no completed questionnaire had been received (Presumably because, in these cases, the department was not involved in the clean-up operation.) In the interests of clarity and consistency the results reported here, unless otherwise specified, relate only to those incidents for which a questionnaire was received.

The nature of the chemicals involved in the reported incidents and in those learnt about from other sources is shown in the list.

Broadly speaking, the 23 incidents can be divided into 4 categories: 4 involved containers rolling off the back of a truck; 5 occurred in ships during sea voyages; 7 were a result of haphazard loading techniques; 7 involved damage incurred during transportation in railwagons.

In 10 cases it was considered that securing of the loads was inadequate and a contributing factor; in 4 cases the information was not given.

Of the 23 incidents 16 involved containers which werelabelled with the chemical or common name of the contents and in another 3 cases the proprietary name appeared; the adequacy of labelling in 3 incidents was not reported and in 1 incident, involving nitric acid, there was no identification by either chemical or pro-

The author, senior toxicologist, Division of Public Health, Health Department, Wellington, wrote this paper in 1976 but feels the period examined would be representative of any similar period subsequently and that the results and general commentary are still relevant. His address for communications is Department of Health, P.O. Box 5013, Wellington.

prietary name although a warning of the contents' corrosive nature did appear as did the consignee's mark. In 14 of the 20 cases where labelling was reported the name of the shipper or the name or shipping marks of the consignee appeared.

In 7 of the 23 incidents there were complaints of adverse effects to the health of people involved, but in 5 of these the symptoms were non-specific, being largely headache as well as dryness of the throat and vomiting, and difficult to unequivocally relate to the toxic nature of the chemical substance involved. In one other incident, involving sodium metabisulphite, one man reported a burning sensation in the throat and shortness of breath and another reported tightness in the chest. Sodium metabisulphite reacts with water to form an acid solution with some evolution of sulphur dioxide, a well-recognised pulmonary irritant.

The seventh incident, involving a spillage of sodium arsenate powder, was reported to have caused blisters on one man and diarrhoea in 3 others. Although these symptoms are not altogether inconsistent with those caused by arsenic compounds it is very doubtful whether, in this instance, the exposure was sufficient to have been responsible. Diarrhoea usually occurs only after very high doses and is accompanied by other symptoms which appear at much lower doses (Dreisbach, 1974). These men were involved in cleaning up the powder and at the time their symptoms were attributed to failure to wear protective clothing. There have been no reports of permanent ill-effects arising from any of the incidents. In 3 incidents food was contaminated by the spillage and subsequently destroyed.

Generally, clean up and disposal operations were undertaken jointly by various government departments and local authority emergency services working with industrial firms and cartage contractors. Of the 23 cases, the Health Department was directly involved in the clean-up and disposal of 18, fire services in 12, the police in 7 and the DSIR in 4. In 2 instances none of these organisations was directly involved, clean-up being performed by NZ Railways in one case and waterside workers in the other.

In five of the clean-up procedures absorptive materials such as sawdust, sand or pumice were used to mop up the spillage and, in another 4, decontaminating materials such as lime or hypochlorite were used to break down the spilt material.

The final destination of the spilt material in 10 incidents was burial, usually at a controlled tip; in 9 cases the material was washed away with large quantities of water, in one it was burnt and in a further 3 cases the final manner of disposal was not reported.

Most of the incidents involved spillage of some or all of the contents of 1 or 2 drums or containers which were part of a much larger consignment, although there were a few incidents involving a very considerable part of a large shipment. The 2 most significant of these involved 80 five-gal. drums out of a total of 448 and 48 112lb drums out of a total of 100. The quantities of chemical spilt in the incidents ranged from a total of 2 gal. to the larger amounts described.

In 16 incidents metal containers were implicated; in 4 the container was a bag, either multiwall paper (3) or synthetic (1); in 2 the container was plastic and in one there were glass containers wrapped in plastic and packed in sawdust in a box. In a single incident the nature of the container was not reported.

Of those incidents which did not occur at sea, all but one, which happened at about 8 pm, occurred or were noticed during normal working hours.

Seven of the incidents were described has having occurred in railway yards or on railway tracks, 6 on wharves and only 2 each in rural, urban residential and industrial areas.

Discussion

This paper presents the results of a questionnaire survey intended to encompass all significant transport-related chemical spillages occurring in NZ over a 20-month period, although it does not cover the multitude of petrol spillages which the fire services deal with. The results, as obtained, do not lend themselves to statistical analysis and may be subject to all the errors associated with questionnaires and variations in individual reporting techniques, but certain broad inferences may be derived.

Other reports in the literature of similar surveys are notable by their apparent absence, making it difficult to compare the situation in this country with that overseas. Wolfe (1972), however, does document a number of instances when spillages during transportation have been responsible for deaths or serious illness. Most of these incidents involved the contamination with insecticide of foodstuffs or clothing carried in the same compartment. Deaths or illness caused directly by spillages appear to be relatively rare. In the present survey there were 3 instances of contamination of food, which was subsequently destroyed, and certainly no serious illnesses attributable to spilt material.

Perhaps the most surprising aspect to emerge from this survey is the small proportion of the reported incidents involving the road-transport industry and the high proportion involving carriage by rail. This can probably be related to the closer personal involvement of the truck driver with both the loading and transport operations whereas those who load railway wagons do not have this continuing responsibility.

It was notable that in nearly half the incidents inadequate securing of loads was reported as being a significant contributor to the cause of the spillage. In at least one incident steel shifted and punctured the drums, emphasising the importance of securing everything in the wagon.

In all 20 cases in this survey where the labelling was reported it would have been possible, given sufficient time, to deduce the nature of the chemical contents from the information on the label without resort to chemical analysis. However, the key to handling such an emergency situation is rapid chemical indentification and in those 4 cases where the common or chemical name did not appear on the drum label this would have presented difficulties.

Considering the thousands of different chemicals which are reportedly used in this country's industry it is interesting to note that in such a small number of incidents certain chemicals occur more than once. There is a commonly-held belief that chemical accidents are likely to involve little-known chemicals capable of causing presently unrecognised types of catastrophe. It is instructive, however, to consider the chemicals in the list. Of the 21 chemicals involved in the 27 incidents, information on their chemical and physical properties and their potential hazards was available in 19 cases in "Dangerous Properties of Industrial Materials", (1975), in 20 cases in the "Toxic Substances List" (1974) and in 18 cases in the "Merck Index"(1968).

The one substance which does not appear in any of these publications is alodan, an insecticide of moderate toxicity. Information on this may be found in "Pesticide Manual", (1972).

It seems then that the considerable majority of spillage incidents involved chemicals whose properties and hazards are widely-recognised and well-documented in a small number of widely available reference books. This comment also applies to merphos, although it may be argued that such books may not predict the much greater hazards of breakdown or reaction products of chemicals such as merphos. This may be so in some cases, but there does not seem to be any compelling evidence for it. As far as merphos is concerned the problem caused by hydrolysis was more one of a public nuisance than a genuine health hazard.

In conclusion, the impression which emerges from this survey is that the problem of transport-related chemical spillages in NZ is not a big one although it may be exaggerated in the public mind by disproportionate media coverage. When spillages do occur they are generally effectively dealth with, initially in terms of

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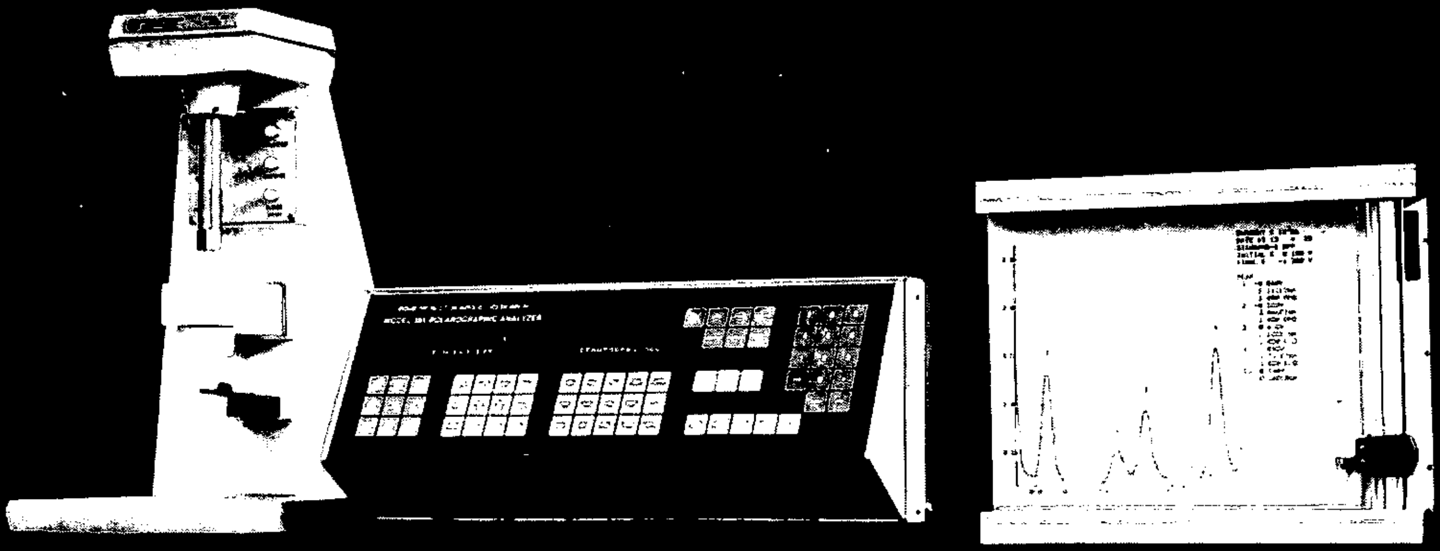

general containment principles and then in more specific terms, once the chemical's precise nature has been determined. Important factors which would contribute much to reducing the number of incidents and facilitating the speedy clean-up of those that do occur are improved securing of loads and labelling of all containers with the chemical or common name of the contents and a warning, where appropriate, of the hazardous properties of the contents. The diamond shaped labels adopted by the International Maritime Consultative Organisation (IMCO) and the International Air Transport Association (IATA) are admirably suited to the latter purpose. The complete provision on the label of chemical or common names may present difficulties for complex chemical mixtures and in such cases at least the names of any particularly hazardous substances should appear, preferably supported by adequate documentation containing the total composition. A small collection of reference books readily available to the emergency services is essential.

CHEMICALS INVOLVED IN SPILLAGE INCIDENTS

(Numbers in brackets refer to the number of incidents in which chemicals were involved, if more than once).

A. Chemicals for which Questionnaires were completed

Alachlor
Arsenic compounds (4)
Benzyl chloride
Calcium hydroxide
Chlorosulphonic acid
Cyanide, sodium
Diazinon
Mercaptobenzothiazole
Metabisulphite, sodium
Methylene diisocyanate
Morpholine
Nitric acid (4)
Pentachlorophenate, sodium
Perchloroethylene
Phosphoric acid
Sulphide, sodium
2,4,5 - T
Toluene diisocyanate

B. Chemicals for which no Questionnaire was completed

Dursban
Maleic anhydride
2,4,5 - T
Tetrahydrothiophene

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BRANCH NEWS

Waikato

The October meeting was a welcome chance for those who had missed **Dr. Robin Mitchell's** Easterfield Lecture at the Conference, and for those who had not, to hear him speak about the most recent developments in his research on plant bacteria toxins ain an entertaining lecture entitled *"Molecular Design for Natural Advantages."*

Manawatu

Dr John S. Ayres (Department of Chemistry, Biochemistry and Biophysics, Massey) addressed the Branch at its September meeting on "Developments in N.Z. Cellulose Ion Exchanges".

At the Branch AGM on October 12, **Stan W. White**, Works Chemist, Borthwick-CWS, Fielding, was elected Chairman for the coming year. **Stan Brooker** briefly addressed the meeting on matters pertaining to **"Chemistry in New Zealand"**. The Chairman's Address was given by **Dr Andrew M. Brodie** (Department of Chemistry, Biochemistry and Biophysics, Massey) on "The Red Milk Protein Human Lactoferrin".

MANAWATU SCIENCE FAIR

The Branch donated a prize for the best entry in the Chemistry Section. The prize was won by **Alan Mountford** and **Robert Walker** of the Collegiate School, Wanganui, with the subject "Destructive Distillation of Coal".

Wellington

"Women in NZ Science" was the subject discussed by a panel at the September meeting. A last minute caucus meeting prevented guest MP **Marilyn Waring** from attending. However, her paper, "The View from the House", was made available and read by the panel convener, **Dr. Joan Mattingley**, (Research and Development Unit, Wellington Hospital).

Ms. Marie Keir (Head Office DSIR) discussed the problems associated with broken service experience by many women in the scientific field while "Problems in Progression Through the University System" was discussed by **Prof. Joyce Waters** (Chemistry Department, Auckland University). The Ministry of Agriculture and Fisheries was represented by **Dr. Doug Wright** (Assistant Director) who spoke about the MAF policy towards women in science.

In October the annual Wellington Mellor Lecture was delivered after an informal dinner at the Institute of Nuclear Sciences. The 1979 speaker was **Dr. Peter Rothbaum** (Chemistry Division, DSIR) whose address "Silica in Theory and Geothermal practice" covered methods of silica scale control and the mechanism of silica polymerization.

Canterbury

The August meeting was addressed by **Dr John Cutfield**, Biochemistry Department, University of Otago, who spoke on "The Chemistry and Biology of Insulin".

The regular September meeting was addressed by **Dr Murray Munro**, University of Canterbury, Chemistry, who discussed the production of biologically-active compounds from the sea.

A special meeting was held in September under the auspices of the NZIC when **Prof. Albert Weller**, who is Director of the Max-Planck-Institute fur Biophysikalische Chemie, Gottingen, Germany, gave a most interestng lecture on "Magnetic Field Effects in Photochemical Reactions".

The October meeting included the Branch AGM and was later addressed by the outgoing Branch chairman, **Joe Butchard** of Canterbury Frozen Meat Co. Joe spoke on "Novel Meat Protein Sources" and examined potential sources of protein for human consumption which are presently discarded in the meat industry.

Otago

In September **Dr George Chapman**, Biochemistry Department, Auckland University, gave a talk on "The Study of Protein Structure by Proton NMR". The AGM was held on October 11, followed by an enjoyable talk by **Jack McChesney** on his experiences in "30 Years of High School Chemistry".

A special meeting was held in November to honour five eminent Branch members who are retiring soon. They are: **Joan Kennedy, Fred Festier, Jimmy Robinson, Jock McChesney** and **Doug Lockhart.**

University News

Waikato

Dr. Ken Mackay, who has been Reader at Waikato since 1970, has been appointed to the Chair in Chemistry. Chemistry students conducted a crowning ceremony to mark his ascent at a recent celebration by School of Science staff.

He graduated B.Sc (Aberdeen) in 1957 and Ph.D (Cambridge) in 1960. He then lectured at Nottingham University until he was appointed Reader at Waikato in 1970.

His major research interests lie in hydride and organometallic chemistry, areas in which he has published many paper and reviews. Two books *"Hydrogen Compounds of the Metallic Elements"* and *"Introduction to Modern Inorganic Chemistry"* have been published. The latter, coauthored by **Anne Mackay,** is soon to be published in a third edition.

Ken was chairman, Waikato Branch, Association of University Teachers, 1976-8. He has served on the Waikato Branch Committee, NZIC, and was Chairman of the organising committee for the 1977 Conference. He is a Fellow of both the NZIC and the Royal Institute of Chemistry.

Massey:
Chemistry, Biochemistry and Biophysics Department

Professor R. D. Batt has been awarded a 3-year grant from the Medical Research Council for research into alcohol and acetaldehyde metabolisms in humans.

Dr G. G. Midwinter has also received a grant from the Council to carry out a project on the primary structure of mammalian phosphofructokinase.

In August **Dr J. Clem Hawke** returned from a year's study leave

Biotechnology Department

Dr R. Chong was recently awarded a contract from the Wool Research Organisation for research into products from wool grease.

Victoria

Dr. Bill Jordan has been appointed as the Wellington representative of the NZ Biochemical Society in succession to **Dr. Alan Clark. Dr Martin Banwell** has left the Chemistry Department to undertake postdoctoral work with **Prof. Leo Paquette** at Ohio State University.

Recent visitors to the Department have included **Prof. Ross Grimmett** (Otago University), **Prof. Roy Jackson** (Monach University) and **Prof. Emerson** (Montana University).

Canterbury

Dr Gordon Rodley has returned after a period of study leave which he spent at Cambridge, England and the University of Maryland.

Recent visitors to the Chemistry Department who have given seminars have included **Prof. Roy Jackson,** Monash University, Melbourne (Organic reactions involving palladium) and **Dr Craig Tennant,** Chemistry Division, DSIR (^{57}Fe Mossbauer Spectroscopy).

Prof. Leon Phillips was recently awarded the Hector Medal and prize for 1979 by the Royal Society of NZ for his researches into reactions of atoms and small molecules.

Lincoln

Prof. Paul Mulcock, Microbiology Department, recently visited Hawaii and during his stay attended a conference at the East-West Center on "the Future of Large Scale Energy Systems".

Otago

Chemistry Dept: Prof. A.D. Campbell, the new NZIC President, has returned from 5 months overseas where he visited insitutions in Europe, UK and USA. He attended the General Assembly of IUPAC in Switzerland and the meeting of Chemical Societies' Presidents in Washington DC.

Prof. R.E. Corbett has returned form 5 weeks in USA.

Prof. Ray Jackson, Monash University, visited the department and lectured on "Organic Reactions using Palladium Compounds."

Biochemistry Dept: Dr N Forrester has been awarded a Ford Foundation Grant for work in Spermatozoa.

Nutrition Dept: Joan McKenzie left for Deakin University, Australia, last month to give the General Foods annual oration in "Foods and Nutrition". Her address was entitled "The Nutritional State of New Zealanders — a Trace Element Problem?". She then left for the Rawett Research Institute, Aberdeen, Scotland, to undertake research on human zinc metabolism until August, 1980.

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NZ Company Wins US Award For Safe Transport, Handling Of Hazardous Products

Lauded as perhaps the most sophisticated company of its type anywhere in the world in that it probably carried a wider diversity of hazardous products than any other single transport operator, Freightways Bulk Services Ltd. Lower Hutt, last month received a safety award from the National Tank Truck Carriers Inc., USA.

Making the presentation, **Mr K. Boyden**, regional traffic superintendent, Ministry of Transport, praised the company on its safety record and the expertise it had accumulated over the years. The US award, its participation in the Defensive Driving Council's safe driving award scheme and its in-house driver qualification system emphasised the importance Freightways Bulk Services placed on safety and product knowledge, said Mr Boyden, who also presented drivers with Defensive Driving Council's driving award badges and certificates and the company's own qualification certificates.

The prestigious US award (the company is a member of the NTTC) serves merely to emphasis Freightways philosophy in handling hazardous substances. At an Auckland seminar, its general manager, **Brian Mountjoy**, underlined this philosophy.

There is an "urgent" need for greater product knowledge and awareness by all those who come into contact with hazardous or potentially hazardous materials, says Freightways Bulk Services.

Underlining this, it cites:

- The potentially diastrous practice of some companies, which, it says, deliberately mislabel or fail to label packages of hazardous product "in order to avoid surcharges that may be incurred on freight costs."
- Two recent separate incidents of leaking drums of butyl acrylate in rail wagons — when they should not have been in those particular wagons.
- The incident several months ago when a container of organic peroxide — which should not have been on the aircraft — caused an emergency on a Boeing 737 when smoke was detected in the cargo hold.

For its part, the company has published, as a service to its customers, three booklets covering the safe handling and transportation of hazardous materials. Freely available on request, they are entitled "Corrosive Chemicals", "Hydrochloric Acid, Aqueous" and "Sulphuric Acid".

Hazardous substances properly contained were no hazard "until you introduce the people factor", he commented. "There's no such thing as hazardous materials if you know what you're doing. But there are hazardous people!"

Proper training stands high on the company's list of essentials for the handling, transportation and storage of hazardous materials for the greatest danger occursduring handling and shipment of such materials.

When moving materials in bulk transport specially designed to carry particular products Freightways:

- Advises date, time and route of movement to NZ Fire Service, traffic and local authorities through whose areas the goods are being moved.
- Provides full details of the cargo and the steps that should be taken should an accident occur — particularly if the driver suffers injury and is unable to act himself.
- Provides details of an emergency response system so that people on the spot obtain immediate advice on appropriate action to be taken.

Citing the value of such precautions, Mr Mountjoy quoted an incident when one of his company's tankers carrying oleum (comprising 98% concentrated sulphuric acid) capsized and ruptured, resulting in a spillage.

Because of Freightways' standard procedure, local emergency services knew exactly how to deal with the situation, thus avoiding a much more serious disaster.

Stressing the value of proper, informative labelling, Mr Mountjoy showed examples of inadequately described containers, noting that to discover exactly what hazards were involved, someone would have to climb a 5-pallet high stack to read the labels — which has been stuck on top of the containers!

Packaging of hazardous materials was also vitally important, he said, again emphasising this with slides of damaged containers, improperly stacked drumsand inadequately labelled storage containers — often associated with littered holding areas.

But again and again he returned to the need for proper training of personnel, which included the need for suitable protective clothing — and an insistence on personnel wearing it.

Freightways Bulk Services has recently improved its NZ-wide emergency response system to one Wellington telephone number — 686-089 — which is monitored 24hrs a day year-round. The company says this is more efficient than the previous system which offered several alternative numbers, the choice depending upon the location of the vehicle. The improved centralised system ensures a greater degree of immediate response by emergency services and company management.

Illustrating this, he showed a slide of a Freightways driver properly clad posing alongside a bulk tanker just before discharge. Ten minutes after the photograph has been taken, a valve burst and showered him with a corrosive chemical!

Packaging also came in for critical scrutiny. Manufacturers, declared Mr Mountjoy, had to consider what the container or packaging — "whether it's a paper bag or a tanker" — had to put up with during its life.

He deplored, too, a current practice whereby non-specialised carriers were transporting hazardous materials without any detailed knowledge of what they were actually carrying — a prime cause of the Parnell emergency. This was because all documents relevant to the cargo were held either by the ship or its agents.

(In contrast, Freightways Bulk Services will not accept any consignment unless full information is supplied.)

C037 For further details, use Reader Service Card.

Disposable Coveralls

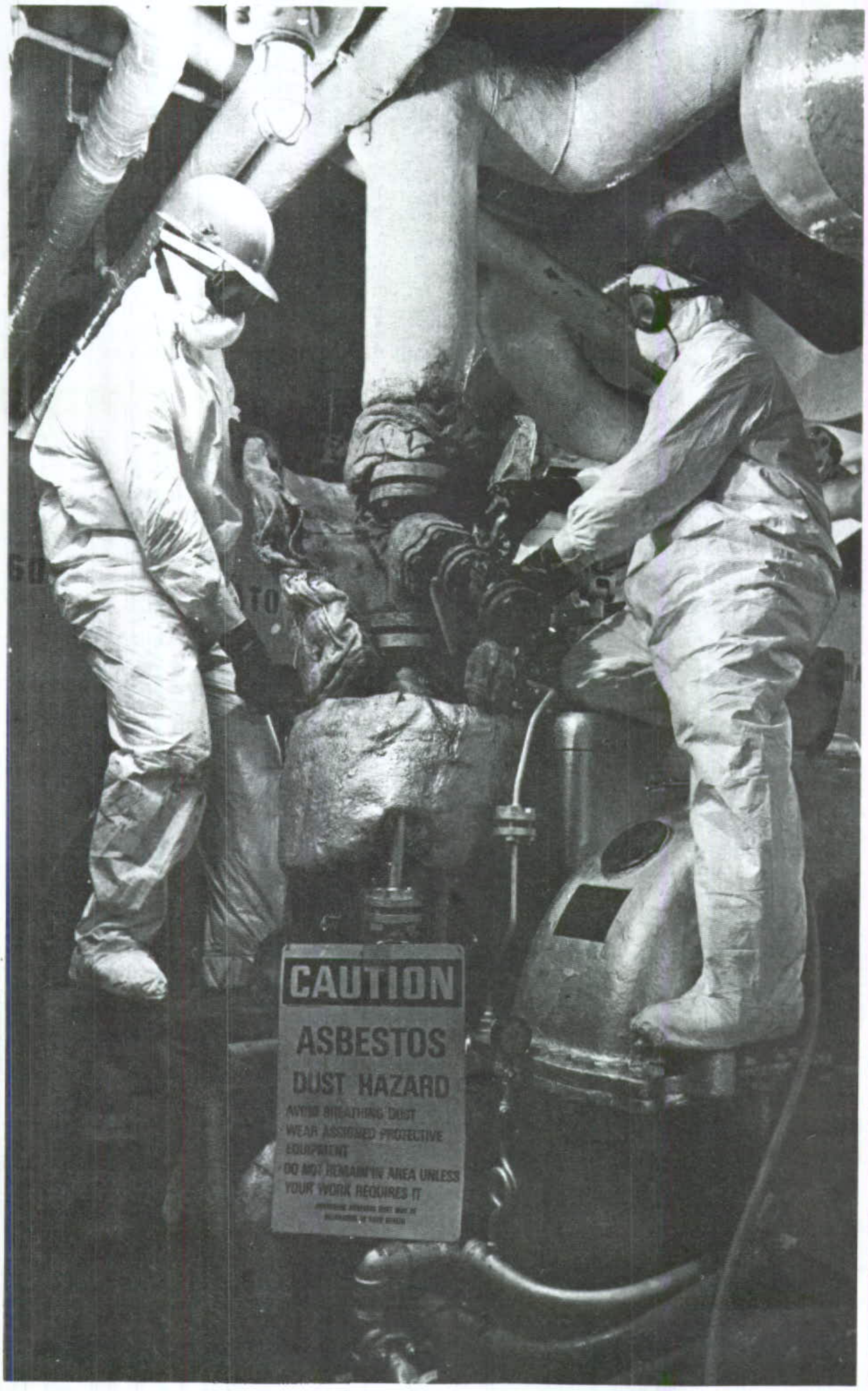
Disposable protective coveralls available from a Papatoetoe, Auckland, manufacturer feature a material that is neither film, fabric nor paper, yet combines the good qualities of all three.

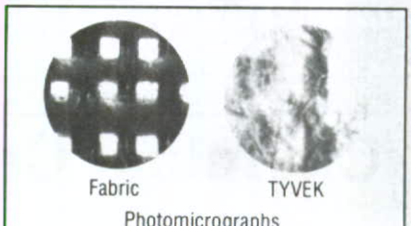
Fabri-Cell Developments Ltd. manufactures protective clothing from a Du Pont material — "Tyvek" spunbonded olefin — made of a very fine polyethylene fibres. No binders, sizes or fillers are used; the fibres are continuously interconnected in a network structure which is self-bonded under heat and pressure.

Two types are used in garment application. Type 14 offers high strength, softness, good barrier characteristics and relatively low porosity; Type 16 products are perforated with microscopic holes and are used where comfort is more important that barrier properties.

While "Tyvek" garments are so priced as to be classed as disposable, they have demonstrated durability that may permit multiple wearings, say the manufacturers. Under proper conditions they can be laundered;, offering high isotropic strength, wet or dry, the material is not degraded by moisture, mildew or rot. Its strength is said to be unaffected by most chemicals.

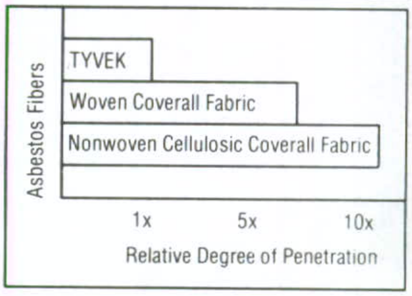
C036 For further details, use Reader Service Card.

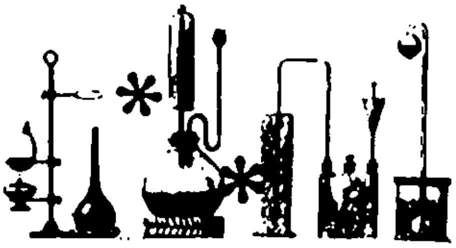




Fabric TYVEK

Photomicrographs
(40X magnification)





New Products, Services

AA System With Video Furnace Programmer

The Pye Unicam Atomic Absorption system SP9 with microprocessor data handling and a completely new video furnace programmer is said to be flexible and easy to use. Available for both flame and flameless operation, the system incorporates many extra and unique features such as silica coated optics. State-of-the-Art electronics contribute to precise, error-free working and permit fully automated analysis of routine samples.

The new furnace programmer, available through Philips Electrical Industries of N.Z. Ltd, enables easy elemental determinations down to very low concentration levels using electrothermal atomisation. It provides complete microprocessor control of the furnace and is the first such unit in the world to be equipped with built-in autosampler controls. Up to 10 complete furnace programmes can be stored — each comprising 6 phases of up to 3000°C, all with linear or non-linear temperature ramp, gas stop and temperature or voltage control. The video display gives a clear indication of set parameters and current status.

Designed specifically for AA spectrophotometry, the SP9 computer provides data handling capacity which meets most applications. Curve correction employing up to 5 standards in fixed or variable ratios offers maximum flexibility and accuracy. Precision calculations are possible on an operator-selectable number of samples, using either peak height or peak area measurements. There is also a Running Mean Mode.

Automatic warning of over calibration and excess curvature reduce the risk of errors, while built-in self testing routines give confidence in results.

The keyboard-equipped computer has an universal output (RS 232C) for interfacing to external data processing facilities for the users' choice. Completing the system is a broad choice of accessories, including a hydride kit, mercury cold vapour kit, electrodeless discharge lamps, wavelength scanning unit and a chart recorder.

C033 For further details, use Reader Service Card.

New Agency

ANAC Ltd has been appointed exclusive NZ distributors for EG & G Brookdeal Electronics, Berkshire, England. This company specialises in instrumentation for signal recovery and enhancement.

Top of the line is the 9500 series of Lock-In Amplifiers featuring single or dual phase, wide band operation with excellent signal overload margins to dig out the most deeply buried signals. Complementing the Lock-Ins are the 9558 AC & DC Instrumentation Amplifier and the 9575 Swept-Frequency Quadrature Oscillator. When combined with the 9505 Lock-In, a complete Engineering Measurement System is the result, giving one package to allow:

★Spectrum Analysis
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  — Audio system test and design
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The 9400 series is a set of modular instruments, such as Phase Sensitive Detectors, AC & DC Amplifiers, Signal Sources, Linear Gates and Delay Generators, allowing configuration of complex measurement and analysis systems.

Rounding-off the line up is the 5C1 photon counting system. This comprises a mainframe, allowing numerous plug-in options to create a system for photon analysis of light signals.

Brochures, specification sheets and application notes are available free on request.

C032 for further details, use Reader Service Card.

Pesticide

A pesticide, now available in 6kg or 31kg cylinders and which, in the larger size, can be set to spray for a set duration at preset intervals, is now available from N.Z. Industrial Gases Ltd. Called Pestigas, it has been developed for use against flying and crawling insects; it is non-toxic to humans.

The smaller cylinder uses an airless spray gun, which disperses the gas throughout the required area at a pressure of 830 psi; the cylinder can be carried by a handle round its neck or on a cylinder trolley. The larger cylinder is suited to use in areas such as food stores.

The product consists of Pyrethrin insecticide with the synergist Piperonyl Butoxide dissolved in liquid carbon dioxide, which aids the insecticidal activity on the insects.

Pestigas can be used for insect control in such areas as hospitals, hotels, motels, restaurants, food preparation and storage areas, canteens and industry generally and offers an insect control system that can be operated by anybody.

C035 For further details, use Reader Service Card.

Video Scanning Count/Area Totalizer

A high resolution count/area totalizer which can count or measure automatically most objects that can be seen with the naked eye or through a microscope is now being marketed by New Brunswick Scientific Co through Watson Victor Ltd in N.Z. The BioTran III video-scanning totalizer operates at the touch of a button. The objects may be macro or micro in size, light or dark, and almost any shape.

C034 For further details, use Reader Service Card.

Chemical Crossword

By Mike and Laurie

(who say "actually it's quite easy this time"!)

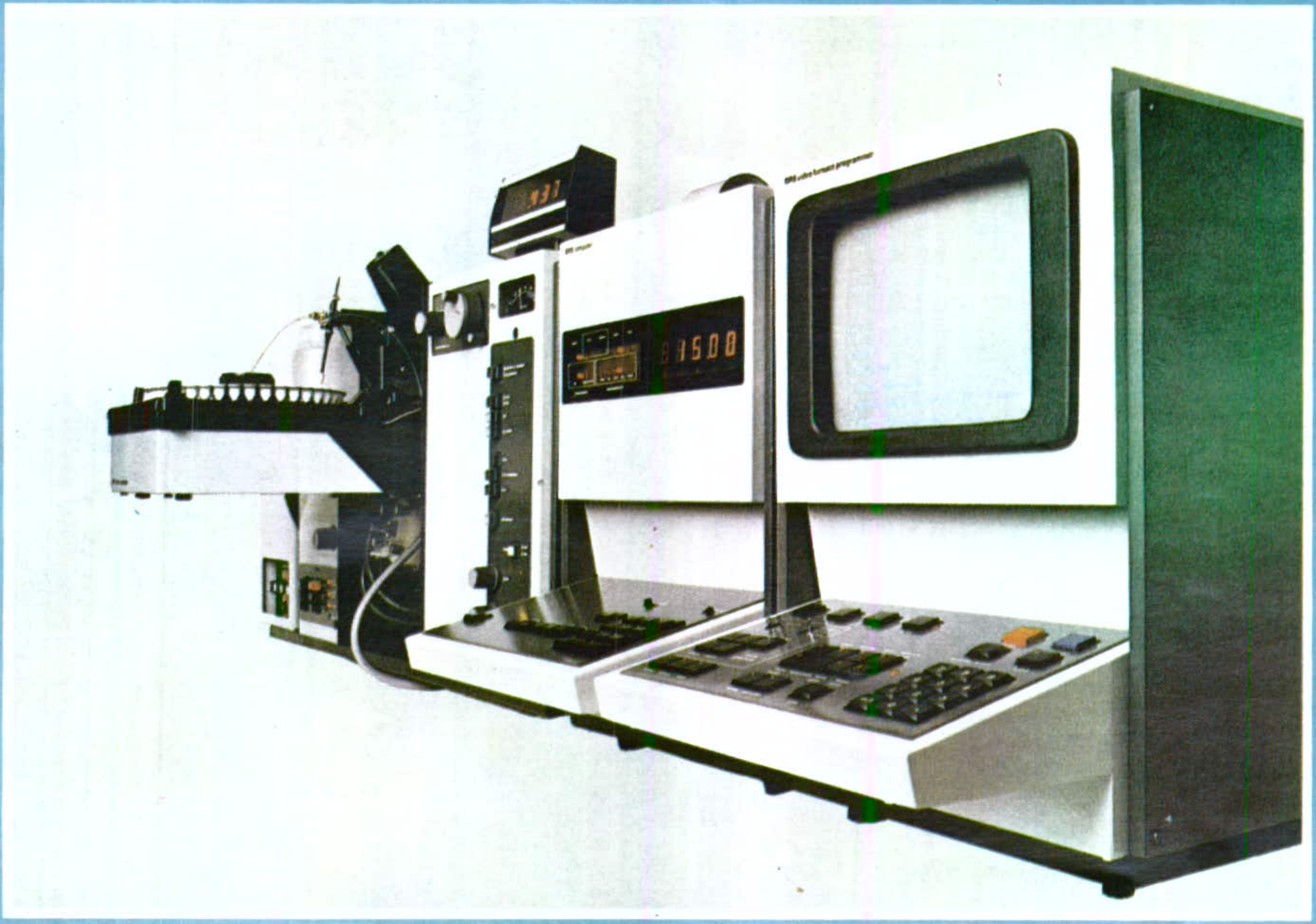
CLUES:

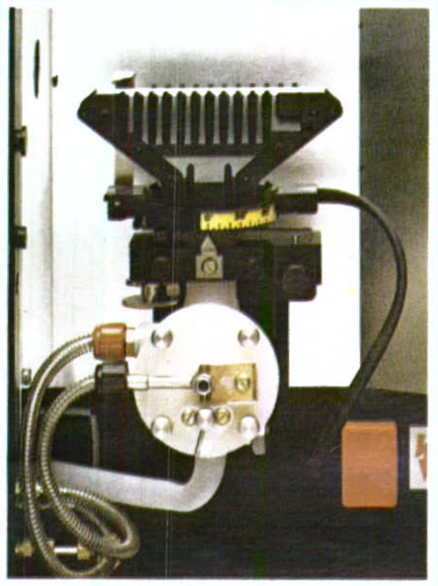
The use of 3 (7) 8 (11) s, such as 24 (6) and 25 (6) as major sources of 7 (6), is 13 (11) an important 1 dn (6) in a worsening economic situation. As we can less 16 (6) the products of the 23 (3-4), we must look to alternatives such as 17 (6) 6 (7) and the process of 18 (7) et.al. to produce high 4 (6) 25 (6). If we could, say, 19 (5) our use 22 (2,3) and use these alternatives to 14 (7) the balance, we might avoid a 1ac (6) in which the 21 (5) 9 (4, 3), the 12 (4-3) will turn the 15 (3,4) in a different way — and we will all 11 (5) have to 10 (5).

OTHER CLUES:

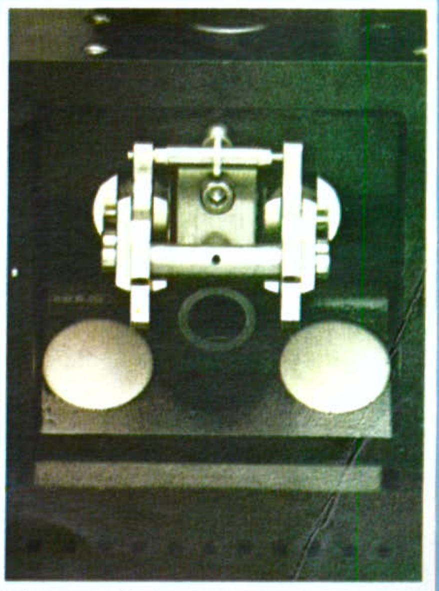
2 Principle of 10 in the mirror (5)
5 Expensive import, unrelated to the above (5)
20 Possibly 21 uses it for protection (5)

1		2		3		■	4	5		6		7
	■		■		■	8	■		■		■	
9							■	10				
	■		■		■		■		■		■	
11					■	12						
	■	■	■		■		■	■	■		■	
■	13	14						15				■
16	■		■	■	■		■		■	■	■	17
18				19			■	20		21		
	■		■		■		■		■		■	
22					■	23						
	■		■		■		■		■		■	
24						■	25					





SP9 Burner System



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MODEL MHP 200
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STIRRING RANGE 10/500 + R.P.M.

FEATURES

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- TRANSISTOR DRIVEN MOTOR
- STAINLESS STEEL MOTOR BEARINGS
- ALUMINIUM DIE CAST TOP PLATE
- ELEMENTS CAST INTO TOP
- CONTROLS PROTECTED FROM SPILLAGE
- SANDANYO COOLING RINGS
- WELL VENTILATED STEEL CASE
- ANTI CORROSIVE PAINT
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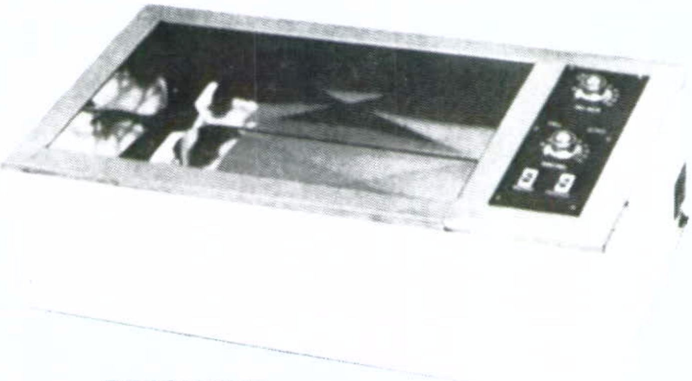

PRECISION WATER-BATHS

FEATURES

- WELDED STAINLESS STEEL TANK
- STEEL CASE FINISHED IN ANTI CORROSIVE PAINT
- BUILT IN CENTRIFUGAL PUMP
- SAFETY OVER-RIDE THERMOSTAT FULLY ADJUSTABLE OVER THE FULL RANGE
- FACILITY FOR FITTING A CONTACT THERMOMETER
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