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FOOD & BEVERAGE MANUFACTURING FOCUS

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CHEMISTRY IN NEW ZEALAND

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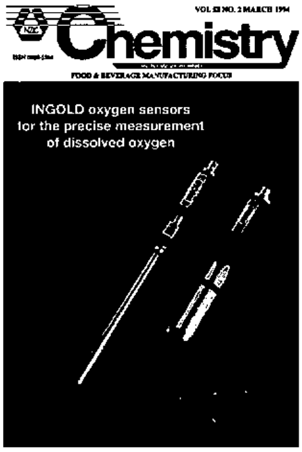
FRONT COVER

INGOLD DISSOLVED OXYGEN SENSORS



Ingold oxygen sensors have been specially developed for operation in harsh industrial environments and are ideal for precise measurement of dissolved oxygen in biotechnology applications and the food and beverage industries.

For more information on these and other Ingold products **see the cover story on page 2.**

CONTENTS

COMING UP ...

May 1994 Issue - Focus on the Dairy Industry
July 1994 Issue - Focus on Chemical Pathology, Forensics, Clinical Chemistry

Deadline for material:
10th of the month of publication

contributions and enquiries to:
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COVER STORY

JOHN MORRIS SCIENTIFIC LTD
EXCLUSIVE INGOLD REPRESENTATIVES FOR THE PAST 7 YEARS IN NEW ZEALAND

INGOLD oxygen sensors for the measurement of dissolved oxygen in biotechnology applications, as well as the food and beverage industries.

INGOLD oxygen sensors have been specially developed for use in harsh industrial environments and undergo continual improvement thanks to Ingold's close collaboration with its customers.

Operating principle
The oxygen sensor consists of an anode and a cathode conductively linked by an electrolyte. A gas-permeable membrane separates the electrodes from the process solution (Clark principle).

Oxygen diffusing through the membrane from the process solution is reduced by a polarization voltage at the cathode. This produces a current which is directly proportional to the pressure of oxygen (pO_2) in the process solution. A built-in temperature sensor allows automatic compensation of the output signal.

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All wetted parts are made of stainless steel and Teflon, together with silicone rubber for sensors of 25mm shaft diameter. The sensors can also be steam sterilised, autoclaved or cleaned in place.

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or circle number 1 on the reader reply card

ENVIRONMENTAL ISSUES

The New Zealand Chemical Industry Council Inc. was established in 1985 and the New Zealand Institute of Chemistry has been an associate member of the Council for much of that time. The objectives for the Council are as follows:

To provide a coordinating organisation to harmonise and strengthen the chemical industry's activities in all areas relating to health, safety and environmental protection which affect the total industry and the community at large. i.e.

i To coordinate industry activities in the above areas, to develop and promote uniform standards and practices, and to encourage compliance with them.
ii To provide an organisation to which government and other groups may turn for discussion and advice on all matters relating to the industry.
iii To communicate with the public on behalf of the industry and its members.
iv To contribute to the establishment of a balanced community understanding of the industry's operation and its products.
v To encourage development within New Zealand of Industry's skills and technology.
vi To establish and maintain liaison with related organisations in New Zealand and overseas industry.
vii To keep members informed of developments relating to the Council's interests.

A major activity of the Council is the Responsible Care Programme. A condition of membership to the Council is a commitment, at the chief executive officer level, of each member to the principles of Responsible Care. This programme incorporates the essentials of health, safety and environmental management and includes codes of practice in the following areas:

- Programme leadership and administration (including product stewardship).
- Operating a chemical site.
- Emergency preparedness.
- Health controls.
- Materials handling (including storage, transport and distribution).
- Environmental protection and controls (including waste management).
- Training and task analysis
- Accident investigation and analysis.

A guide for auditing compliance with these codes is also incorporated.

A Manager's Handbook, designed to provide managers at all levels of chemical industry management with a comprehensive guide to the Responsible Care Programme, is to be released by the Council early this year.

The Council is also very active in education and training activities. It conducts regular training activities, for example on the management of environmental hazards and risks. It has sponsored a teaching resource kit which will shortly be released to secondary schools. This kit forms a teaching resource package that supports the new national science curriculum for the third and fourth forms. It includes a video, a wall poster and three student exercises based on the video. The video features aspects of the operations of three Council-member companies, Dow Elanco, Ciba-Geigy and ICI Paints.

The current New Zealand Institute of Chemistry representative on the Council is the Convenor of its Environmental Committee. He is also an active member of the Council's Health, Safety and Environment Committee. Members of the Institute who would like to know more about the New Zealand Chemical Industry Council or to contribute to its activities are encouraged to contact the Convenor as below.

Norman Thom, Convenor, NZIC Environmental Committee,
C/- Environmental Science, Faculty of Science,
University of Auckland, Private Bag 92019, Auckland,
Ph (09) 373 7599 extn 5659, Fax (09) 373 7470.

COMPANY AND INDUSTRY NEWS

New Professor Is Keen to Boost Scientific Awareness

Dr Douglas Russell, who is passionate about "making science live", has become professor of physical chemistry at the University of Auckland. He hopes to make Auckland a world-recognised centre in the laser chemistry which is his speciality. Professor Russell, British-born and educated, was previously at the University of Leicester.

"Physical chemistry is a difficult field whose complexities may seem rather 'dry' and mathematical" he admits - "anything can be interesting, though, if you teach it in the right way." He always tries to make his subject appealing and exciting to his students. "I am regarded as rather an exhibitionist in my lectures."

His aim is not simply to entertain but to catch the imagination. His own ambition was fired when, as a 16 year old, he heard Sir George (later Lord) Porter, a Nobel Prize-winning chemist, talking about chemical reactions. "Some were fast and some, such as 200 year old wine which was still maturing, were slow. His talk instantly turned me on to chemistry."

Professor Russell is as much an advocate of science in general as of his own discipline. He wants not to create more research scientists ("we probably produce enough already") but to raise scientific awareness. "Science and technology are now very significant in our lives yet there is a lot of ignorance about them. People tend to get confused, for example, between ozone depletion and the greenhouse effect. Those in positions of public influence need to know about advances-current and future-in all areas of science", he says, "and take them into account in making decisions".

Professor Russell employs lasers in his research for two purposes; to investigate the structures of compounds and to initiate chemical reactions. The first is largely fundamental ("curiosity driven") and the second more applied. One type of reaction with which he experiments is organometallic pyrolysis. This has helped create the metal deposits needed for semiconductor devices. He plans to take this research in a different direction in Auckland, working with the School of Engineering to produce protective coatings for aluminium and fuel additives for car engines. In Britain he attracted considerable outside funding for research, much of it from industry. He intends doing the same here and is prepared to solicit money from overseas, in particular Japan.

Professor Russell, 46, has an MA degree in natural sciences from Cambridge and a PhD from the University of Southampton. After a period as a research associate at the University of Southern California, he spent six years as a research fellow at Cambridge. From 1979 until late last year he lectured at the University of Leicester and as well as running one of the larger research groups, he collaborated with researchers at Cambridge, Edinburgh and Harvard Universities His reputation as a teacher led to the Higher Education Funding Council appointing him to assess chemistry courses at English universities. He is compiling a textbook for first year students in physical chemistry. The challenge of a professorial post lured Professor Russell to New Zealand. While research funding from university and government sources is highly competitive here, he notes that the same is true worldwide. "One of the recognised kiwi traits is your ability to do your best with what you have".

He is not worried by this country's physical isolation which electronic mail and facsimile machines have greatly reduced. "In any case, science is international. Universities here compensate for their distance from other countries by encouraging academic visitors and appointing staff from abroad, and by providing regular conference and study leave".

* * * * *

Review of the Output Framework for the Public Good Science Fund

The Ministry of Research, Science and Technology (MoRST) is reviewing the Output Framework for the Public Good Science Fund in order to improve it as a strategic tool for setting priorities. A discussion paper is being circulated to those likely to be most interested in the use of the Output Framework for this purpose. If you are interested in the issues and would like to receive a copy of the paper, please contact Ms Kathy Garden at the Policy Division of the Ministry, Tel. (04) 472 6400.

* * * * *

GBC Scientific is Appointed SGE Distributor

GBC Scientific (NZ) is proud to announce their appointment as distributor for SGE in New Zealand.

SGE is a successful Australian manufacturer offering quality accessories for the international chromatography market. SGE have a large modern manufacturing plant situated in Melbourne and over 90% of their production is exported, so quick, efficient, cost-effective delivery is a feature of their business. SGE's proximity to New Zealand is a definite advantage to New Zealand customers.

GBC Scientific (NZ) will stock standard lines such as commonly used chromatography syringes in Auckland and intend to offer rapid ex-factory delivery times of 1 week or less for other consumable lines.

* * * * *

Jim Turnbull, who joined Labsupply Pierce (NZ) Ltd in July 1993 as Marketing Manager has recently become a shareholder in the company and has been appointed to the board of directors, as Executive Director - Sales and Marketing. Prior to joining Labsupply Pierce, Jim held a number of senior marketing positions with Life Technologies Limited.

* * * * *

Industrial Research Leaves Palmerston North

Industrial Research Limited will transfer its small Palmerston North operation to Wellington on 30 June 1994, the company announced in November. The four staff involved have been offered transfers to Wellington where they will continue to work on current research programmes. Chief Executive Geoff Page said the decision was made after careful analysis of the investments facing the company. "I reviewed the investment needs of the company and what would be needed to develop the Palmerston North site to make it scientifically and financially viable. That led me to the inevitable conclusion that we should consolidate our biotechnological activities at the Gracefield campus in Lower Hutt". The company currently has around 20 staff working in the biotechnology field at its Gracefield site.

* * * * *

Salmond Smith Biolab Buys Rhone-Poulenc

Salmond Smith Biolab recently announced that it has agreed to buy theAustralian and New Zealand business of Rhone-Poulenc laboratory products. The buy is expected to become effective 1 March 1994 and the 20 staff employed by Rhone-Poulenc laboratory products will also transfer to the new owners. Rhone Poulenc currently markets laboratory chemicals and plasticware in New Zealand.

* * * * *

Alltech and Hamilton Company

Alltech Associates has announced it is to represent exclusively in New Zealand the range of Syringes, Valves, HPLC Columns and Resins and the Microlab™ instruments manufactured by Hamilton Company (Reno, Nevada, USA).

To date, Hamilton is the only manufacturer of precision syringes who has ISO900 certification for its entire worldwide organisation.

News from Across the Ditch

I wonder if New Zealanders are besieged with government reports? In Australia, we in the higher education system receive them at the rate of about one a week, dealing with such things as transition from schools, quality in education, job markets, and reviews of specific disciplines. In this latter category which engages me today, and especially the report entitled *Chemistry: A Vision for Australia* which was prepared by a review panel appointed by the Royal Australian Chemical Institute under a commission from the Australian Research Council.

The reviewers were Dr Tom Spurling, Chief of the CSIRO Division of Chemicals and Polymers, Professor David Black, Professor of Organic Chemistry and Head of the Department at the University of New South Wales, Professor Frank Larkins, Professor of Chemistry and Deputy Vice-Chancellor at the University of Melbourne, and Mr Terry Robinson of ICI Australia.

The panel noted two changes which would have profound effects on the nature of Australia's chemical research over the next fifteen years. The first is the expansion of the university system which has resulted in many more academic chemists wishing to pursue research as part of their occupation, and the second is the transformation of the Australian chemical industry from a highly protected industry to one which is almost completely tariff-free. Many of the panel's recommendations matched nicely with directions taken by recent Australian governments, including the need for Australian research to make greater contributions to Australian-based business and industry, and the need to market internationally our significant R&D capability. It was noted that CSIRO had, in recent years gone ('been pushed' would have been more accurate, although to be fair it was nothing like the push given to DSIR which knocked it out of existence) down these paths, with great benefit to Australia. Retaining the job satisfaction that comes from strategic and pure basic research should also be a CSIRO aim, according to the panel.

The recommendations in the report avoided the obvious bullying which characterised a similarly-commissioned report on physics, released early in 1993. 'Give us more money for physics research or the country will go down the drain' lacks the effect that it once had and the chemists were wise to avoid this tactic. The chemistry report contains a mass of data, especially on inputs and outputs for Australian chemistry, and it invites chemists' involvement in seven 'critical technologies' - materials, manufacturing, energy, transportation, public health, information/communications and environment. There are 55 recommendations in all, but I thought I should single out just a few for you.

Memories of Ontario in the late 1960s and Britain in the 1980s were evoked by a recommendation that 'the minimum size for a stand-alone research-related chemistry department should be 10 teaching-and-research staff and 20 honours and research higher degree students. Other recommendations were that departments should establish advisory committees to help link them to industries, and that more attention in universities should be paid to occupational health and safety.

The report also made recommendations concerning peer review and government support for key areas of research and development, international collaborations, women in chemistry, patenting of discoveries, and ways of establishing future directions. All in all the report was well received and formed the basis for discussions at the national meeting of professors of chemistry, which is held annually in Canberra during February.

At about the time of the national meeting I also received my copy of the more limited report on Australian Research Council funding of organic chemistry in Australia. For this the ARC commissioned Professor Athel Beckwith, Professor of Organic Chemistry in the Research School of Chemistry at the Australian National University, Professor Lloyd Jackman from Pennsylvania State University (an Adelaide graduate and former professor at Melbourne), Professor Bob Ramage from the University of Edinburgh, and Dr Keith Watson from the CSIRO Division of Chemicals and Polymers. Perhaps the most interesting feature of the report was that it contained, alongside the panel's 15 recommendations, the Research Council's comments on each of them.

In general the Council supported the recommendations where they dealt with details of grant applications and interviews, identification of suitable assessors, and emphasis on the publication records of applicants. They disagreed however, with recommendations that (i) a parallel system of small grants ($5,000 - $25,000) administered on the ARC's behalf by institutions be abandoned, (ii) special efforts be made to support newly appointed researchers, and (iii) grants should be awarded solely on the basis of merit, without regard to the size of the research group. On the face of it, this last one is rather curious: surely merit is all? The Research Council argued, however, that 'the size of the research group is, in some cases, an important factor to be considered in assessing the likelihood of a successful outcome.'

Introducing their review, the panel noted that research in organic chemistry in Australia is strong, spanning the full gamut of sub-disciplines and leading to quality and productivity which are most impressive. They agreed with submissions made to them and which had appeared earlier in a government report on quality in university research, that publication in refereed journals was the most important indicator to be taken into account. Second was the award of a competitive grant. We had already reached this conclusion at Monash University, where 12% of the operating budget for academic activities in the faculties is allocated on the basis of a research index composed of these two factors.

Together, these two reports but especially the first (157pp), give a useful picture of Australian chemistry. They are available from the Australian Government Publishing Service, and I should be happy to assist interested readers to obtain copies.

With kind regards

Ian D Rae
Dean, Faculty of Science
Monash University
Melbourne, Australia

PRODUCTION OF BEER BY CONTINUOUS FERMENTATION

Barry Axon
Brewing Division, DB Breweries Ltd, Auckland

INTRODUCTION

In February 1994 the prestigious International Brewing Awards were held at Burton on Trent in England. Held every two years they are considered the "Olympic Games" of brewing and this year attracted more than 830 entries from 37 countries around the world. The results of this year's competition have stunned the brewing world. Never in the 100 year history of the awards has one brewery been so dominant in winning not one but five of the seven classes it was eligible to enter. A total of 5 gold, 3 silver and 2 bronze medals had brewers looking to the history books to see if something like this had ever happened before. It hasn't.

This success was achieved by a brewery from New Zealand, DB Breweries, using a method of fermentation unique to DB, continuous fermentation.

This paper discusses the continuous fermentation of beer with the emphasis on two important aspects - quality and process control.

CONTINUOUS FERMENTATION

The production of beer for the market place consists of five processes:

(1) Wort production
(2) Fermentation
(3) Maturation (storage)
(4) Filtration
(5) Packaging

While each of these processes is important in producing the final product it is fermentation which produces the flavour profile specific to that beer. The quality of the final product is dependent on being able to control the fermentation to produce the desirable flavour attributes while at the same time ensuring that production of undesirable characteristics is minimised.

The continuous fermentation of beer is a process unique to DB. The original design was proposed and patented in the mid 1950s and although the present day plant is still based on that as reported by Coutts[1] it has undergone many modifications to enhance microbiological and flavour control.

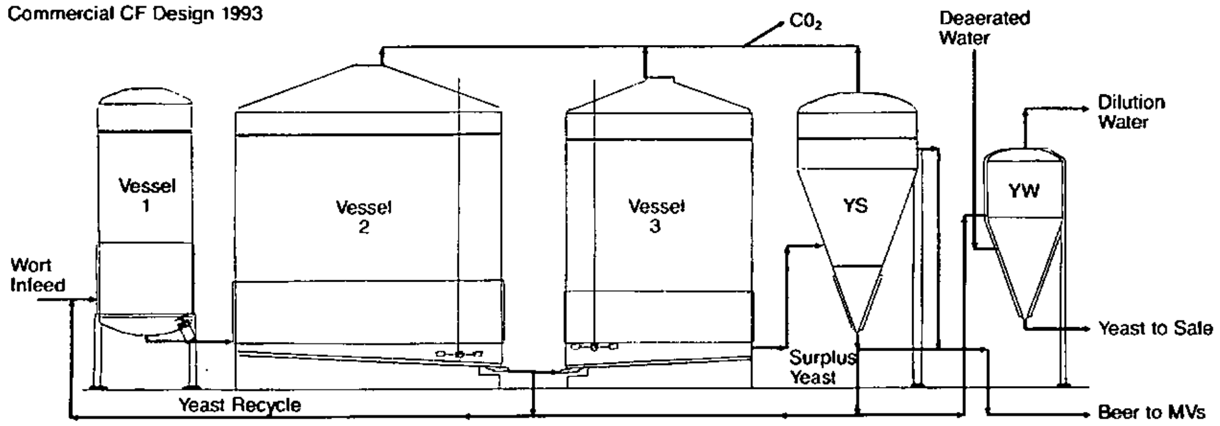
The continuous fermentation (CF) plant in operation at DB today is shown in Figure 1. It consists of a 3 vessel cascade of stirred tank reactors where a continuous infeed of microbiologically sound wort is mixed with culture yeast and allowed to ferment while passing through the three vessels. Fermentation time can vary from 40 to 120 hours depending on production requirements.

Hold Up Vessel

The first vessel is known as the hold up vessel (HUV) and represents 6% of the total system volume. The purpose of this vessel is to provide contact time between the culture yeast and the fresh oxygenated wort. By keeping the volume low, nutrient levels are maximised which facilitates uptake. The "pitching" yeast added to this vessel is recycled from the outlet of the plant and is therefore highly active and will exhibit no lag phase.

Microbiological control is of paramount importance in a continuous fermentation system and the hold up vessel has an important role to play. By recycling a portion of the contents of the second vessel to the hold up vessel the pH is reduced and the ethanol concentration increased. This combined with actively growing culture yeast provides an unfavourable environment for competitive growth by potentially contaminating organisms.

Figure 1: **Continuous Fermentation**



The uptake of oxygen in this first vessel is essentially complete. The incoming concentration of oxygen is critically controlled and has been shown to be an important parameter in affecting yeast growth and hence beer flavour.

Fermentation Vessels

The second vessel in the cascade is known as continuous fermenter 1 (CF1) and represents 63% of the system volume. This vessel accomplishes the bulk of the fermentation. The third vessel (CF2), at 31% of the system contents, incorporates an important control parameter as it is here that the desired fermentation end point is accurately achieved.

Yeast Separator

A fourth vessel not actually involved in the fermenting process separates the yeast from the fermented product. Some of this yeast is returned to be mixed with incoming wort while surplus yeast is countercurrent washed in the yeast washer (YW) to recover all available fermented product.

FLAVOUR CONTROL

The key control parameters associated with the CF system are:

(1) Oxygenation
(2) Specific gravity
(3) Yeast concentration
(4) pH
(5) Flowrate
(6) Level control.

All of these variables are measurable and constantly monitored. Because the CF is a steady state system small trends away from ideal are quickly noticed and can be acted upon. The final result is the consistent production of high quality beer fermented under conditions controllable by the brewer.

Because continuous fermentation is a multi-vessel system, each vessel provides a time window into the various stages of fermentation. It is therefore possible to monitor the production of flavour active components in the beer.

Vicinal Diketones and Continuous Beer Maturation

Diacetyl (2,3-butanedione) and 2,3-pentanedione are vicinal diketones (VDK's) that are formed as a result of fermentation. If present above threshold concentrations in the beer they impart a butterscotch flavour which is an undesirable characteristic to have in the final beer. Diacetyl is formed from α-acetolactate and 2,3-pentanedione from 2-acetohydroxybutyrate and both compounds are removed from the beer by the yeast. The mechanism for formation and removal of diacetyl in beer is shown in Figure 2.

The levels of acetolactate plus diacetyl present in each of the vessels of the CF system have been measured and are shown in Table I. The formation and removal of 2-acetohydroxybutyrate and 2,3-pentanedione follow the pattern found for acetolactate and diacetyl and so have not been reported.

The results show that the flow rate at which the plant is operating has a significant effect on VDK production in each of the individual vessels. When the CF system is operating slowly (70 hours residence time) the α-acetolactate concentration reaches a peak in CF1 after which there is a decrease in CF2 followed by a further decrease in the yeast separator. When the system is running at higher flow rates/ shorter residence time, peak diacetyl levels formed are much higher and no reduction is found in the latter vessels of the system.

In the latter case a much greater volume of beer has been produced in a shorter period of time. If in this case the beer was allowed a period of maturation to give a total production time of 70 hours (40 hours fermentation and 30 hours maturation at 15°C) then the final diacetyl level in the beer is approximately the same as that in beer produced using a residence time of 70 hours.

Figure 2. Diacetyl Formation and Removal in Beer.

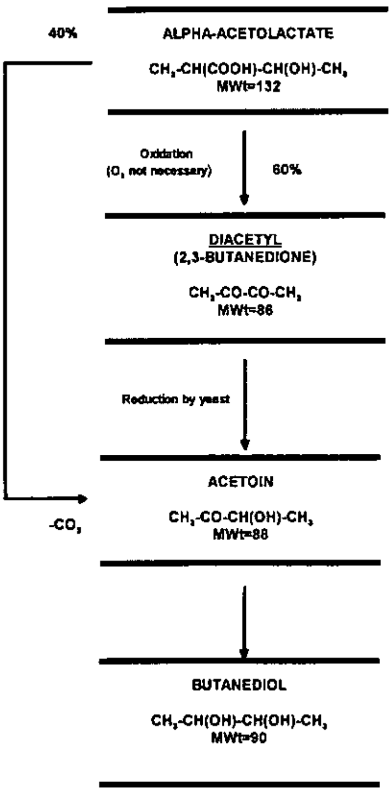


TABLE I

AVERAGE ACETOLACTATE + DIACETYL LEVELS IN A STEADY STATE CONTINUOUS FERMENTATION SYSTEM WITH A RESIDENCE TIME OF 40 AND 70 HOURS AT AN ORIGINAL GRAVITY OF 1.036

Vessel	40 hours [acetolactate + diacetyl] (mg/L)	70 hours [acetolactate + diacetyl] (mg/L)
HUV	0.27	0.25
CF1	0.41	0.35
CF2	0.40	0.25
YS	0.40	0.22
Finished Beer	0.05	

The conversion of α-acetolactate to diacetyl is a chemical reaction that occurs independently of the yeast and is the rate limiting step in the sequence shown in Figure 2. It has been shown that the rate of the reaction is both temperature and pH dependent. The removal of diacetyl to acetoin and subsequently to butanediol is carried out by the yeast. It was clear from the results in Table I that at higher CF flow rates longer maturation of the beer would be required to ensure adequate removal of diacetyl from the beer. In order to gain control of the levels of diacetyl in the final product a further vessel (the Maturation Vessel (MV) was added to the CF system. Fermented beer from the yeast separator was allowed to pass into the Maturation Vessel which was held at 15°C with a minimum residence time for the beer of 36 hours. Oxygen was excluded from the vessel to ensure that no further yeast growth was stimulated in this vessel. The extended time period at higher temperature allowed for full control of diacetyl removal before the beer went to cold storage at 0°C.

Flavour Volatiles

The level of flavour volatiles produced in each vessel remains relatively constant when the plant is running under steady state conditions. Average levels in each vessel are shown in Table II.

All components reach a maximum concentration in CF2 with a slight decrease in the yeast separator. Rates of production are highest in the HUV with the exception of isoamyl acetate which is slightly higher in CF1.

The relative and total overall concentrations of the flavour components in the final beer determine the aroma profile for that beer and, along with the bitterness / sweetness balance and overall drinkability of the beer, has a significant effect on the acceptability of the beer. The levels and types of esters and higher alcohols produced are determined by the yeast and the environment in which the yeast is allowed to ferment. Of critical importance are the nutrients required by the yeast present in the wort, oxygen to stimulate yeast growth and pH. In a CF system these conditions can be monitored and controlled to produce an ester balance that is pleasing in the final product.

TABLE II

AVERAGE CONCENTRATIONS OF FLAVOUR VOLATILES IN EACH CF VESSEL
(1.036 ORIGINAL GRAVITY, 46 HOURS RESIDENCE TIME)

Volatile Compound	Concentration (mg/L)			
	HUV	CF1	CF2	YS
Ethyl acetate	9	17	21	20
1-Propanol	5	9	11	11
Isobutanol	3	5	7	7
Isoamyl acetate	1.1	2.1	2.6	2.5
Isoamyl alcohol	23	42	51	50
Ethyl hexanoate	0.10	0.22	0.23	0.22

Flavour Balance: Sweetness/Bitterness

The bitterness compounds present in beer are derived from the hops during the production of wort and are not affected during the fermentation. Beer sweetness however is derived from the residual sugars that remain at the end of fermentation. A good beer will have a pleasant balance of bitterness and sweetness and since bitterness has been pre-determined in the brewhouse the fermentation must be controlled to obtain the desired fermentation end point to balance the beer. Wort contains a mixture of different sugars formed during mashing from the enzymic breakdown of starches from the malt. The decrease in the concentrations of each of the fermentable sugars is shown in Figure 3.

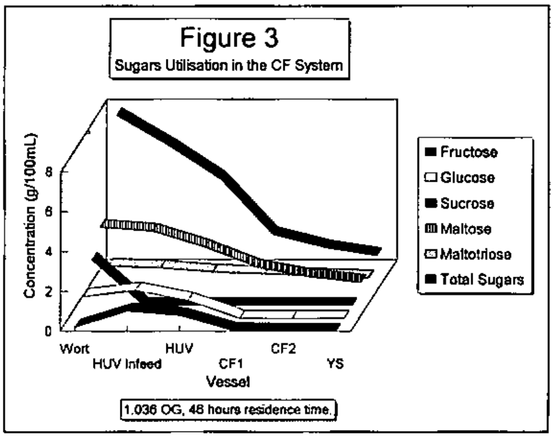


Figure 3
Sugars Utilisation in the CF System

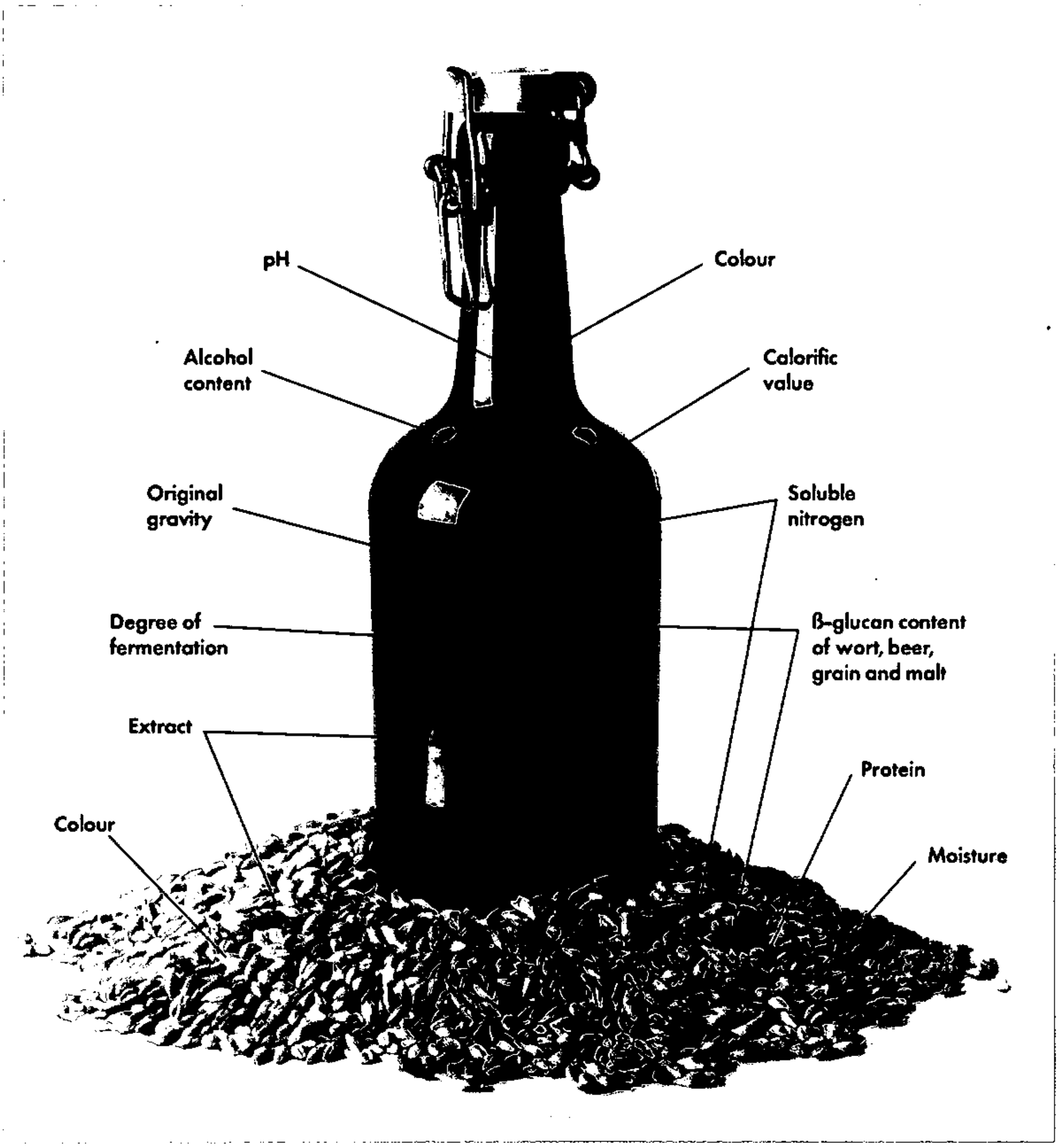
The results show that sucrose is inverted to glucose plus fructose extremely rapidly and is virtually completed in the in-feed line to the hold up vessel. Very little uptake of sugars occurs in the hold up vessel with only glucose and a small amount of maltose being utilised. This is not unexpected as there is a relatively short residence time within the vessel and aerobic growth with it's associated efficient energy usage is occurring within this vessel. The removal of sugars from the fermentation liquor is: glucose first then fructose, maltose and finally maltotriose. The largest drop in specific gravity occurs in CF1. A significant level of fermentation is still occurring in CF2 and in the yeast separator only relatively low levels of maltose and maltotriose remain. Beer sweetness will depend on the levels of residual sugars. The degree of fermentation can be controlled in the CF system by adjustment of yeast concentration and fermentation temperature. Thus dry or less dry beers can be produced as desired.

CONCLUSIONS

The process of continuous fermentation of beer has undergone modification and upgrading on many occasions since its commercial introduction in 1958. Developments in beer flavour control and microbiological improvements have influenced modern CF plant design and, during an operating life of 9-12 months before cleaning, high microbiological performance, consistent beer quality and production efficiency gains have been achieved. Two modern CF plants commissioned in August 1993 at DB Breweries Waitemata Brewery represent the current state-of-the-art in this style of fermentation. The success story of continuous fermentation cannot be doubted. The results achieved speak for themselves.

REFERENCES

1. Coutts, M. W., *Proceedings of the 9th Convention of the Institute of Brewing, (Australian Section), Auckland,* 1 (1966).


pH
Colour
Alcohol content
Calorific value
Original gravity
Soluble nitrogen
Degree of fermentation
ß-glucan content of wort, beer, grain and malt
Extract
Protein
Colour
Moisture

THRESHOLD LIMIT VALUES: PART 1

By Ian B Campbell and Douglas M Hay
Occupational Safety and Health, Massey University

Douglas Hay is Senior Lecturer in Occupational Safety and Health at Massey University. He is currently on a long term contract with the International Labour Organisation as Chief Technical Adviser in China where he is establishing a National Training Centre in Occupational Safety and Health. He was educated at Auckland University, Canterbury University and Imperial College, London and holds the degrees BSc, BE(Chem), MSc, DIC.

Ian Campbell is a Teaching Fellow in Occupational Safety and Health at Massey University. Holding the degrees of BCom and PhD he was formerly Director of Safety for the Accident Compensation Commission and previously Chief Executive for the Workers' Compensation Board.

INTRODUCTION

After covering some general aspects of the value and use of Threshold Limit Values, the primary objective of this is to examine the assessment of TLVs for binary mixtures. TLVs for three such liquid/vapour systems have been calculated using differing methods. It has been demonstrated that theoretical concentrations can vary up to an order of magnitude depending upon the method used. This poses problems for those who have to assess acceptable exposure levels for such mixtures and has thrown considerable doubt on the method commonly used.

Clearly any effort aimed at reducing and hopefully eliminating any concentration of harmful substances in the working environment is only to be welcomed. In these endeavours Threshold Limit Values (TLVs) have played an important if, at times, a controversial role. What then have been some of those more arguable aspects and is there good reason for questioning the viability of thresholds, under which exposure to a contaminant is presumed to be safe and thus the value of TLVs? Life is full of hazard, much of it man-made but a great deal of the material benefits that each of us enjoy in our daily round are only made possible because others have regularly faced considerable risks[1].

TLVs have a long history with the first recorded attempt to assess an acceptable exposure being made in Germany in 1885 by Lehmann who ordered his laboratory servant to stay for an hour in an enclosed room while vaporizing a volatile fluid and also using an analytical sampling device. As Henschler (1985) comments: If the servant left the premises with significant signs of survival, the concentration was rated 'just tolerable for short term exposure'. Henschler contended that the primitiveness of this procedure should not detract from its achievement, it being the first report of a standard based on a quantitative approach.

In the United States the TLVs of the American Conference of Government Industrial Hygienists (ACGIH) followed the earlier Maximum Allowable Concentrations (MACs). The ACGIH TLVs are used in many countries especially in the English-speaking world. The USSR has developed its own standards, as did Germany in 1968 and more recently Sweden and Holland. Efforts to form an international list have been unsuccessful to date but the advent of the European Community may speed that day. However for some years the World Health Organisation and the International Labour Office have been developing Health-Based Limit Values (HBLVs) which are scientifically based and not influenced by socio-economic or political factors. (Phoon (1988)[2].

THE DOSE-RESPONSE RELATIONSHIP

In considering the applicability of TLVs, the response of the subject to a given dose becomes a matter of some importance. It is not too difficult to accept that, with a given increase in exposure to a contaminant, any effect from that exposure will increase. The question is, however, the relationship between the two; then there is the time factor; the length of exposure and the interval between exposures. Another confounding aspect which has not always been given its due weight is the fact that some conditions, including cancer, may arise as a result of exposure to more than one substance.

It is commonly thought that for many, if not all toxic substances there exists a valid threshold up to which there will be no adverse health effect. However, at the same time it is accepted that that point could vary widely from individual to individual and even an individual's susceptibility may not be constant. Having said that at least three major problems still remain. The most obvious one is the tremendous problem of determining that threshold for the vast number of substances in regular use - then there are the individuals who may be hypersusceptible to particular substances and one has only to think of the allergic reaction to many common substances of a substantial proportion of the general populace. Additionally there are those whose health makes them either permanently or temporarily more susceptible to some harmful substances. To these three problems can be added that of synergistic reactions with the exposure to more than one substance. The multiplicative effect of smoking combined with exposure to asbestos is graphic evidence of the importance of this aspect and this is where there are some of the greatest gaps in our knowledge.

A valid criticism of TLVs is that they cover only about 600 substances whereas there are many thousands of chemicals and substances in daily use, though admittedly, in some cases, the use of many would be very limited and those listed may well cover the bulk of the potential exposure. Important too, would be the accuracy of the monitoring of the environment or the exposed individual, whether by sample or continuously.

There remains an area wide open to the gathering of data and subsequent research. Even accepting that the TLV approach is justified, it is very questionable as to whether the current standards are being adequately observed; many would be extremely doubtful. Much will depend on education and training and it is suggested that the promotion of this aspect deserves the greatest attention rather than a seemingly pointless debate on question of existence of thresholds and the value of TLVs.

THE LIMITATIONS OF TLVs

The most obvious limitation of TLVs will be the extent and adequacy of the monitoring where there is exposure to a contaminant. However the validity of any TLV rests on the data from which it has been derived. Considerable reliance has been placed on animal bioassays but apart from the time taken to undertake such tests, the expense and problems of extrapolating from animal reactions to humans, there has developed considerable opposition from animal rights groups. Epidemiology provides another avenue for confirming suspicions about the toxicity of substances but is less helpful in arriving at an acceptable threshold.

Despite the considerable criticism that has been cast on the value of TLVs, Henschler (1985)[7] gives a sense of reality maintaining that presently there is no preferable alternative despite their inherent inadequacies. He considers that we have to live with TLVs for some part of the foreseeable future. Lacking adequate evaluation of existing occupational toxicants, serious efforts to increase research activities, both at the quantitative and the qualitative level are needed. Henschler emphasised a number of important points such as the difference between substances where the toxic effect is reversible and those which cause cell damage and necrosis of individual cells. After commenting on the problems of relying on animal tests he suggests that the more we learn about the effect of species differences through increasing testing, the "better our extrapolation from animals to humans will be and the more reliable our predictions will become". Other matters commented upon were the problems of reliance on time-weighted averages and that of mixtures of more than one chemical.

Henschler (1985)[7] concluded: There always has been unanimous agreement in the scientific community that the creation and evaluation of data relative to effects and thresholds are entirely scientific issues and have nothing to do with political or socio-economic parameters nor with technical feasibility. What differs from country to country is the degree to which scientists are ready to participate in the political decision process. Nourished by the above-mentioned inadequacies of the present system of standard setting and being further pressurized by the rapidly increasing numbers of newly introduced substances, a tendency for a steady strengthening of social and political influences can be foreseen. Up to now, we have been successful in trying to keep the business clean. Whether and how long this position can be held will depend mostly on the speed and the extent with which scientific progress can fill the existing gaps and also on the natures of the persons engaged in these matters: persons who have to survive in a classical conflict situation between Homo sapiens and Homo politicus. Are our forces facing the compromise of unification?

THE POLITICAL ASPECT

In the long run, the setting and enforcement of standards must be a matter for authority, and therefore, this must be regarded as a political issue and the outcome may well depend on the pressure that can be brought to bear by the contending interests. There are other aspects too, such as that of the preventive method to be adopted - expensive but passive engineering controls or much cheaper personal protection but which depends on the active participation of the individual. Another major difficulty is that much of the data which would be needed to establish the cost of any proposed measure would be mostly, if not entirely, in the hands of industry and there is evidence of cases where industry's assessment of the likely cost of a proposed standard has been very wide of the mark. Again cases are also on record where workers have opposed more stringent measures fearful of job losses. The weighing of cost as against any benefit has been a hotly debated issue in many countries.

When adopting standards developed in other countries there is a need to be attentive to the criticisms that have been made elsewhere concerning TLVs. Castleton and Ziem (1988)[4] are very critical, of the lack of comprehensive documentation to back up the ACGIH TLVs as well as the undue influence industry representatives have played in setting those standards. Indeed it would seem that many standards have been set by the manufacturers themselves and they are obviously interested in keeping the level as high as possible. The manufacturers' opposition to a substantial reduction in the TLV for vinyl chloride, despite the overwhelming evidence of its carcinogenic properties provides clear evidence of industry's involvement.

Zielhuis and Wibowo (1989)[10], after referring to the views of Castleman and Ziem concerning the undue corporate influence, are very critical of the lack of detail in the criteria documents that underpin TLVs - commenting: Another aspect of validity is whether the various available criteria documents adequately underpin the OELs [occupational exposure limits]. It is not always possible to detect where the scientific health-based evaluation ends and where policy decision-making begins.

RISK ASSESSMENT

Considerable attention has been given to substances that are suspected of being carcinogenic, mutagenic or teratogenic. The difficulty is that though many substances already in use are under suspicion, relatively few have been definitely accepted as such. The task of either proving or disproving that any substance is carcinogenic to man is no light one and, whilst it is possible to incriminate a particular chemical or substance on reasonable evidence, on the other hand, it is quite a different matter to clear any substance with any degree of assurance especially if the substance is of recent origin or little used. The result is that many remain on the suspect list. Barth and Hunt (1982)[1] record that of the 25,000 toxic substances listed by National Institute of Occupational Safety and Health, 2,415 are identified as suspect carcinogens.

Another trap is the part that emotionalism may play especially through sustained media pressure. Thus it is very questionable whether standards instituted in response to a public demand will necessarily result in the most needed and most effective standards. As Haddon *et al* (1964)[6] comment, the history of safety legislation also demonstrates that costly safety devices or regulations can be most swiftly and effectively forced upon a specific industry by a public that has been outraged by a specific disaster or by a widely publicized death toll. In the absence of such disaster, the public as a whole appears to have been largely unwilling to assume the cost of countermeasures when lives to be saved or lost are the cumulative result of many accidents widely distributed in time and location.

Kinnersley, (1973)[8] who is highly critical of the effectiveness of much government intervention, gives seven reasons "why the TLV concept should be viewed with suspicion", his major one being that: It accepts industry's economic assumption that it's all right to expose workers to contamination. Some of the limits are based on nothing better than 'reasonable freedom from irritation, narcosis, nuisance or other forms of stress' (p 116).

Again such a view however, though easy to make would not apply in many cases, nevertheless the right of workers to be consulted and have their views heeded cannot be denied. Finally Kinnersley comments: It is clear that most workers

are getting no protection from the TLV system. The whole idea is an uneasy compromise between what the more conscientious hygienists would like and what industry wants to be able to get away with. At no stage are workers asked what limits they would find acceptable - even from the point of view of discomfort, let alone risk.

While Kinnersley includes some TLVs in the directory of toxic substances in his book acknowledging that they provide a starting point, he suggests no alternative other than to have zero contamination which he optimistically believes possible. But surely few would accept his proposition that "most workers are getting no protection from the TLV system". Not surprisingly other writers that have some criticism of the TLV concept are more moderate in their comments: e.g. Stellman and Daum (1973)[9].

Campbell and Hay (1984)[3] exemplify how a particular TLV has been developed as knowledge has been gained; that of vinyl chloride monomer. The TLV has been successively lowered from 500 ppm in 1962 to 5ppm in 1978. Prior to B F Goodrich announcing the death of three workers from a rare cancer of the liver (angiosarcoma) the TLV stood at 200 ppm. This illustrates the problems associated with the setting of hygiene limits; on the one hand the acute exposure is well documented and on the other the effects of chronic exposure are not noticed until years later. Nevertheless even after the Goodrich and other deaths the PVC industry in the United States opposed the setting of a lower TLV. Tafler (1982) reported that the industry studies on the cost of the proposed measures which claimed a cost of $69-90 billion and a loss of 2 million jobs have turned out to be greatly exaggerated.

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APPENDIX

Threshold Limit Values (TLVs) are to be found in *WORKPLACE EXPOSURE STANDARDS* and *BIOLOGICAL EXPOSURE INDICES FOR NEW ZEALAND* published in association with Occupational Safety and Health, a service of the Department of Labour. TLVs and Workplace Exposure Standards (WES) do not mark the boundary between safety and danger but should be regarded as guides to the maintenance of a healthy working environment. There is a wide variation in personal susceptibility to contaminants and some workers may experience discomfort at levels well below the standards that have been set. However personal discomfort is not the only criteria for permanent harm which can be caused to an individual without any discomfort being experienced.

TLVs are generally based on 5 shifts of 8 hours each working week. In addition there are Short Term Exposure Limits (STEL) but they are based on less well documented information than the time-weighted average values (TWA).

EXAMPLES OF TLVs:

	Adopted Values TWA		STEL	
	ppm	mg/m^3	ppm	mg/m^3
Ammonia [7664-41-71]	25	17	35	24
Hydrogen peroxide [7722-84-1]	1	1.4	-	-
Trichloroethylene [79-01-6]	50	269	200	1,070

Many materials do not have STEL values and in these cases a new recommendation in the WES is:
The 15-minute average exposure standard. Applies to any 15-minute period in the working day and is designed to protect the worker against adverse effects of irritation, chronic or irreversible tissue change, or narcosis that may increase the likelihood of accidents. The WES-STEL is not an alternative to the WES-TWA; both short-term and 8-hour time-weighted average exposures should be determined.

General Excursion Limited. Often there are insufficient toxicological data available for the establishment of a STEL. Peak exposures should, however, still be controlled even in situations where the 8-hour TWA is not exceeded, *A 15-minute exposure limit of three times the TWA is recommended.* Where a STEL has been assigned, the STEL value takes precedence over the general excursion, regardless of whether or not it is a stricter standard. (WES 12).

*To be continued in a future issue of 'Chemistry in New Zealand' with **Threshold Limit Values - Part 2***

NZIC CONFERENCE 1993 REPORT

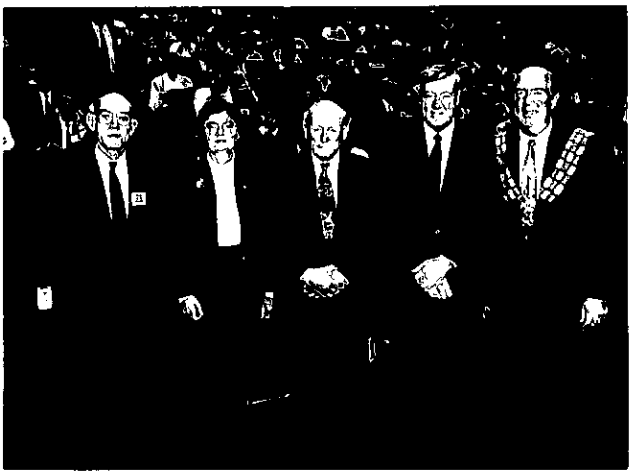
The Institute's 1993 conference in Auckland was judged by all who attended to be a most successful event. Registrations were high, the quality of the science, and its presentation, were excellent and many fruitful interactions resulted.

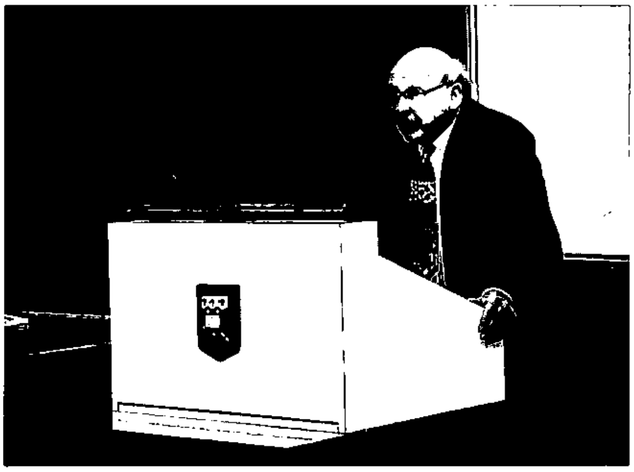
The 461 registrations included no fewer than 116 graduate students, with attendance of 61 for the one day Education Symposium. A particularly pleasing feature was the number from overseas - nearly 60 Australian registrants and 65 from further afield. The Conference was organised in conjunction with the Medicinal and Agricultural Division of the Royal Australian Chemical Institute and was built around a series of symposia covering a range of topics in pure and applied chemistry. The very high standard of the plenary lectures was a mark of the conference. Professors Ray Baker (Merck Sharp and Dohme), Bob Bergman (Berkeley), Ron Prinn (MIT), John Albery (Oxford) and Dr Ian Paterson (Cambridge) gave lectures that were notable both for their content and their presentation. No less excellent was Dr Margaret Brimble's Easterfield Lecture.

The large number of parallel sessions - up to eight at any one time - made choices difficult for many participants but ensured that there was always something of interest. The whole conference was compressed into four days, which allowed for a Council meeting on Monday and a Mixer in the evening. Other social events during the week included a tour to the Muriwai gannet colony on Wednesday afternoon and a barbecued conference dinner on Thursday evening. The informal style of both occasions received favourable comment.

As is common these days, poster presentations were an aspect of the conference with prizes being awarded both for scientific content and for presentation. The conference, and the plenary speakers, received attention in the media, with Professor Ray Baker talking about Alzheimer's disease on the Kim Hill nine to noon programme, and others receiving some notice in the daily press. The 1993 conference committee was headed by Brian Davis, Allan Easteal and Cliff Rickard from the University of Auckland's Chemistry Department. The next Institute Conference is planned for Dunedin in 1996.

Easterfield Lecture
Above: Dr Margaret Brimble, University of Auckland, Easterfield Lecturer, being presented with flowers from research students: Tim Brenstrum, Letecia Duncalf, Michael Nairn, Andrew Johnston and Julie Whalley





Scenes From the Opening Ceremony
i) *Top Right* (standing from left) Professor Brian Davis - Conference Chairman; Dr Doreen Clark - President RACI; Professor Arthur Williamson - President NZIC; Sir Colin Maiden - Vice Chancellor, University of Auckland; Mr Les Mills - Mayor of Auckland

ii) *Above Right:* Arthur Williamson giving the Presidents Address
iii)'*Left:* At the Opening Ceremony

NEW PRODUCTS AND TECHNIQUES

CAPILLARY CHROMATOGRAPHY NEWSLETTER

RESTEK's bimonthly newsletter, The Restek Advantage, features new column and accessory innovations, as well as practical "Hints for the Capillary Chromatographer". The February 1994 International Volume features articles on RESTEK's new Rt-Alumina PLOT column that displays unique selectivity for light hydrocarbons and unsaturates, TCEP micro packed and capillary columns for the analysis of petroleum oxygenates and aromatics in gasoline, analysis of phenothiazines, FAME analysis, and quantitative FAME mixtures. The helpful hints section discusses "Vapourising Split Injectors". New products introduced include a septum nut and needle guide septum nut for Varian GC's, an electronic flow calibrator, split/splitless sleeves for Shimadzu 17A GC's, a finger-tight nut and recessed gooseneck inlet sleeves for HP 5890 GC's.

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NALGE INTRODUCES NEW MEDIUM VOLUME TANK FOR BIO-PROCESS WORK

The new 75 litre Nalgene closed dome biotank is designed to be used for preparing media components and growing cultures. This 75 litre tank bridges the gap between large Nalgene carboys (50 litres) and Nalgene tanks (up to 380 litres) for bioprocess work. Manufactured of polypropylene, the tank and all component materials, including gasket and closure, are non cytotoxic and comply with FDA Regulation 177.1520 for food service work. The large 150mm closure makes filling and dispensing easy while molded-in body grips provide safe, convenient handling. The tank is graduated with molded-in graduations in one litre increments and is leak proof and autoclavable.

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NEW REPORT ON ELECTRIC HEATING FOR HYDRIDE GENERATION ATOMIC ABSORPTION FROM GBC

GBC Scientific has released another report in its informative AA Applications series. The report (number 25 in the series) details for hydride work, the advantages of electrical heating of the quartz cell over flame heating of the cell. Electrical heating provides more accurate temperature control as well as improved sensitivities and detection limits. Comparisons are made for a number of common hydride forming elements and mercury.

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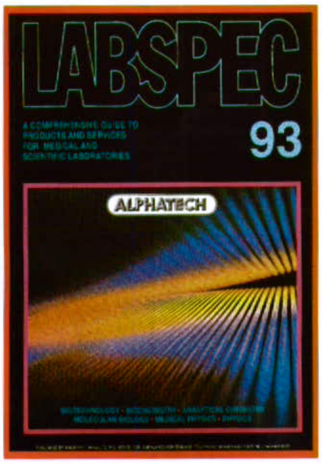

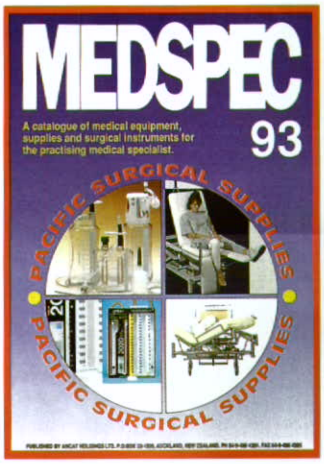

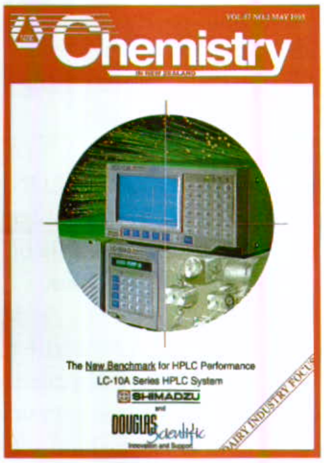

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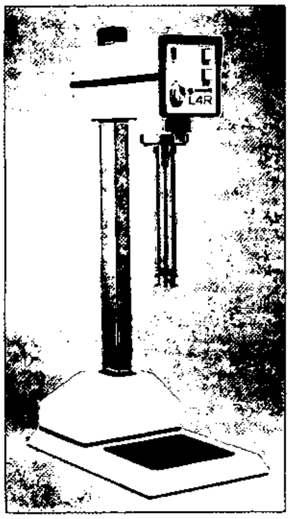

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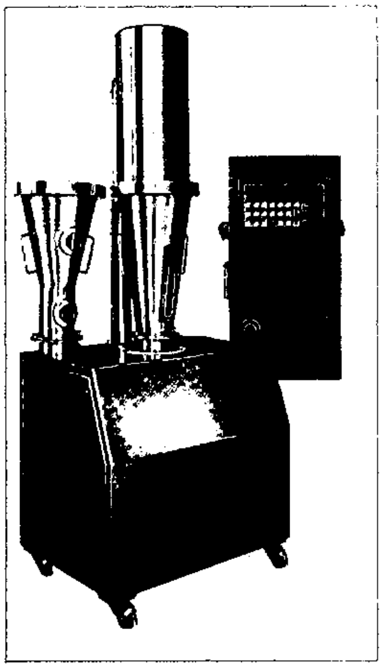

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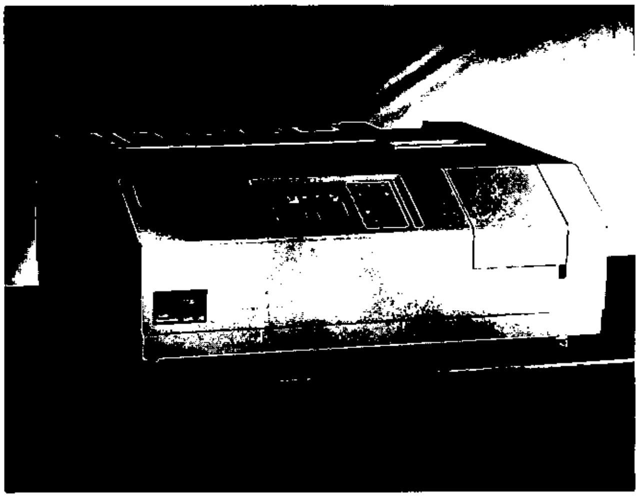


The Lambda 11 is based upon the proven reliability of the Perkin-Elmer Lambda 2 Spectrometer's optical system. A variety of accessories are available for automated sample handling and specular reflective measurements.

Contact: Perkin-Elmer New Zealand, P O Box 22-159, Otahuhu, Auckland. Ph. (09) 276 2230, Fax (09) 276 5602
or circle number 40 on the reader reply card.

FINGER TIGHT NUT FOR HP 5890 GC'S

RESTEK's new Finger Tight Nut for Hp 5890 GC's seals columns rapidly without wrenches. Two versions are available for use with either standard Swagelok® - type ferrules or HP type ferrules. Both versions can be used with 0.25, 0.32 or 0.53 mm ID columns.

Contact: Stuart Tyler, Alphatech Systems, P O Box 37583, Parnell, Auckland, Phone (09)377 0392 Fax (09) 309 8514
or circle number 41 on the reader reply card

SIMPLE, RELIABLE, LOW PRICED ELECTRONIC SCALES

EMC are now offering a new model electronic scale in two capacities at the same price. The NKS-series scale is available in capacities of 2000 x 1g and 4000 x 2 g. The scales have liquid crystal display with four digits 9mm in height and can be operated using one 9 volt battery and have auto shut-off function to protect battery life. Each NKS scale comes complete with AC/DC adaptor so that it can also operate from a standard three-pin plug.

These accurate NKS electronic scales are 185 x 165 x 33mm in overall dimensions with a 160 x 132mm weighing platform. They feature "HOLD" function and "AUTO TARE" function, manual adjustment calibration, and come with a plastic container for safe storage when not in use. Both scales are usually available ex-stock from the New Zealand distributor EMC.

Contact: EMC Industrial Weighing, P O Box 31 145, Milford, Auckland, Telephone (09) 444-9229, Fax (09) 444-1145.
or circle number 42 on the reader reply card

THE GBC DOUBLE-BEAM UV/VISIBLE SPECTROMETERS

GBC has drawn on its experience and success as a manufacturer of high class atomic spectroscopy instruments to produce a powerful, feature-packed range of new true double-beam, UV/visible spectrometers.

The high speed crystal-locked optical chopper in each instrument gives superior wavelength resolution, even at high scan speeds. This is combined with a rapid chopper-synchronised wavelength drive allowing virtually distortion-free spectra even at scan speeds up to 7000 nm/min. Add to this a slew rate of 15000 nm/min and data collection has never been so fast or so simple.

By measuring and correcting for detector dark current twice every chopper revolution, errors due to detector dark current drift have been eliminated, significantly improving measurement stability and linearity. A totally new design approach incorporating high speed, focused aperture chopping achieves the optimum ratio of signal sampling time to scan speed. This means improved signal-to-noise ratios and more accurate results. The unique design of the chopper system automatically corrects for any beam movement caused by slight eccentricities in chopper wheel rotation ensuring an extremely stable signal. The innovative detector optics effectively view the sample compartment at infinity with respect to the detector location. This eliminates spurious effects due to differences between the refractive indices of samples. Precise, reproducible optical performance is achieved day after day, through a fully automated setup. Everytime the instrument is powered up, wavelength is calibrated and the source mirror optimised.

The new GBC UV/visible instruments feature PC based software designed to meet the needs of the user, providing fully integrated instrument control, data analysis and report generation. Incorporating such features as "zoom", "re-scale" multiple scan overlap and 3-D graphical displays the software is extremely powerful and versatile but very simple to use.

With four models available in the range there is a GBC double-beam UV/visible spectrometer to suit all quality control, teaching or research applications and most budgets.

Contact: GBC Scientific (NZ),
P O Box 68-330, Newton, Auckand,
Phone (09) 373 5764 Fax (09) 360 0683.
or circle number 43 on the reader reply card

PERKIN-ELMER'S NEW SERIES 200 LC PUMPS

Top performance characteristics are what users have come to expect from Perkin-Elmer HPLC pumps. Perkin-Elmer have taken the exceptional patented design from the Model 250 (isocratic and binary) and Model 410 (quaternary) pumps and put all the best features into a common, upgradable pump platform.

The result is the Perkin-Elmer Series 200 LC pump, a fifth generation pump with superior flow rate precision, compositional accuracy and exceptional retention time repeatability for all of your separations - isocratic or gradient. Start out with the isocratic version and upgrade to binary or quaternary gradient capability with a cost-effective upgrade kit. System control options include stand-alone capability or full external control through the 1020 LC Plus Controller or the Turbochrom Chromatography Workstation running under Windows™. Biocompatible pump options are available to cover all LC applications including those in life sciences.

The new Series 200 pumps feature:

* small, compact design saving valuable bench space
* snap-in contact closure connections and fingertight plumbing fittings to make it simple to connect or disconnect your system
* pump module slides out of the instrument case on a tray for close inspection and easy servicing allowing the pump module to be removed without having to "unstack" other LC modules.
* directory of up to 20 methods, each of up to 20 steps with built in method linking to increase sample throughput
* graphic display of solvent profile on-screen shows real-time modifications to gradient method
* automatic shutdown of the pump method at the final gradient conditions.

All Perkin-Elmer LC systems feature complete diagnostics and full method documentation to simplify GLP compliance. An Instrument Log records the history of operation for quick diagnosis and servicing and a Maintenance Log coded by the serial number of the pump records the full service history of the pump including pump and seal cycles.

Contact: Perkin-Elmer New Zealand P O Box 22-159 Otahuhu, Auckland, Phone (09) 276 2230 Fax (09) 276 5602.
or circle number 44 on the reader reply card

J& W SCIENTIFIC GC COLUMNS FOR FOOD AND FLAVOURS APPLICATIONS

J&W have a wide range of GC columns which can be used in food and flavour applications. Using the handy J&W catalogue and reference guide you can easily find the best column for your application.

Applications groups listed are:
Essential Oils
FAMES - Fatty Acid Methyl Esters
Organic Acids
Fats & Oils
Natural Products
Sugars
Alcohols

Contact: Douglas Scientific, P O Box 45 027, Auckland 8. Ph (09) 837 5447, Outside Auckland Ph (0800) 735 725, Fax (09) 836 0668.
or circle number 45 on the reader reply card

NEW STOMACHER 400 AVAILABLE FROM SEWARD

The Stomacher lab blender has found approval worldwide in the food manufacturing and dairy industries for its unique but simple method of blending. The latest stomacher lab blender 400 has all the benefits of the original model but with added improvements, including-

- microprocessor control
- 3 pre-set speeds
- 3 time settings plus continuous running
- double lock feature on the door

As with the earlier model 400 this stomacher retains all the original advantages such as no sterilisation of component parts required, no unnecessary cleaning due to the blending process being contained within a stomacher bag, minimal maintenance, excellent recovery of bacteria microbiological analysis of laboratory samples.

Contact: Medic Corporation Limited, Private Bag, Lower Hutt. Phone (04) 569 3539, Fax (04) 569 7984.
or circle number 46 on the reader reply card

THE MULTIFUNCTIONAL TITRONIC T200 PISTON BURETTE COMMUNICATES WITH ALL THE DEVICES IN A MODERN LABORATORY:

With its own high-performance processor, the Titronic T200 piston burette can operate both as a stand-alone unit and as an integral part of the modern Schott-Gerate titration and dosing systems. The T200 has the interfaces for control and data exchange most widely used in modern data processing:

Two RS-232C serial input/output ports compatible with any PC, a port for commercially available PC keyboards (MF2), optionally an analog plotter interface and a multifunctional I/O port for remote control and other PC applications. The most attractive feature, however, is that all the interfaces can be assigned and used at the same time.

The Titronic T200 is the ideal burette in the PC-controlled TPC 2000 titration system from Schott-Gerate. In addition, the T200 serves as a data junction which allows other devices to be linked to the TPC 2000 system controller.

Contact: Labsupply Pierce (NZ) Ltd, P O Box 34-234, Birkenhead, Auckland, Ph (09) 443 5867 Fax, (09) 444 7314.
or circle number 47 on the reader reply card

ISCO SFE FOR FAST, INEXPENSIVE FAT DETERMINATION

The most expedient method for fat determination is by weight loss of the sample, an indirect method. Extraction can be performed very quickly through Supercritical Fluid Extraction (SFE) by passing industrial grade CO_2 though the sample at a high flow rate. The assumption that the weight loss of the sample is due to extracted fat has been validated by comparing results with established methods. Where samples have a high moisture content small amounts of dessicant are added to the sample to retain water and assure accurate results.

Isco's exclusive equalisation of pressure inside and outside the extraction cells lets you seal the samples with your fingers instead of wrenches. Eliminating leaky fittings saves your time and patience for more important things than reconnecting and testing plumbing.

Isco SFE systems use syringe pumps for positive CO_2 metering and the most accurate on-line modifier addition. No tool sample reloading, dual chambers, and no waiting for heat-up or cool-down between extractions let you perform forty 20-minute extractions in just 7½ hours! And you can slip in priority samples at any time - a real advantage when production decisions are waiting for analysis results.

A new automated version the SFX 3560 with 24 sample capacity, bar-coded sample cartridges, and printed reports, means 24 samples can typically be extracted overnight unattended. This delivers throughput equivalent to dozens of soxhlets with only one hour of labour. Programmable system wash between extractions eliminates cross-contamination.

The large interactive display of the SFX 3560 sets up all extraction parameters. For method development you can automatically repeat extractions using changed parameters. Data and methods are stored on ordinary 3.5" diskettes. No computer is required.

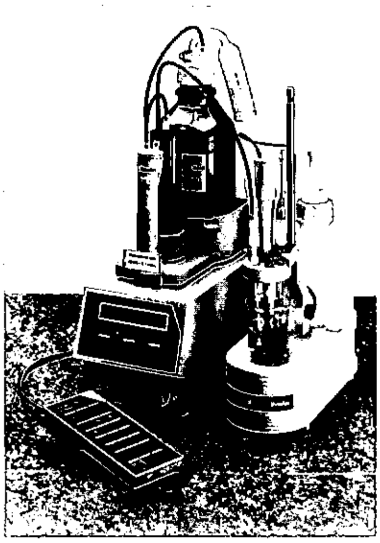
The superior extraction conditions of SFE assures fast and clean extraction, easily outperforming traditional soxhlet and sonication methods. You can expect extraction cycles of minutes instead of hours or days. CO_2 extraction eliminates regulated solvent purchase and disposal costs, along with fire and health hazards. A change for good!

For further information on SFE applications contact Douglas Scientific, P O Box 45 027, Auckland. Phone (09) 837 5447, Outside Auckland Phone (0800) 735 725, Fax (09) 836 0668.
or circle number 48 on the reader reply card.

THE METROHM 727 TITRATION STAND

In pH measurements, direct potentiometry and titrations performed in analytical laboratories; both the stirring of samples and thorough cleaning of the measurement setup are of immense importance. The 727 Titration Stand from Metrohm offers a complete solution to the problem of stirring, rinsing and manual sample changing. Pressing the rinsing unit "showers" electrodes, burette tip and rod stirrer from above with the rinse nozzles integrated in the measuring head. In the centre of the beaker base is an outlet for any spilled solvents.

Depending on the model, the titration stand allows stirring to be performed either from above or from below or alternately from above and below. The speed range of the rod stirrer is between 500 and 2400 rpm. To change the sample, simply raise the measuring head. This automatically switches off the stirrer. As soon as the measuring head is in the measuring position again, the stirrer restarts. Two electrode holders ensure the safe storage of electrodes.



Contact: John Morris Scientific Ltd, P O Box 6348, Wellesley Street, Auckland. Ph. (09) 444 5836, Fax (09) 444 0974.
or circle number 49 on the reader reply card

ION MEASUREMENT FOR THE NEXT DECADE WITH THE METROHM 692 PH/ION METER

The 692 pH/Ion Meter from Metrohm has been specially designed for ion measurement with ion-selective electrodes. This method of quantitative analysis is a time-tested alternative which produces rapid results with good accuracy. Thanks to the integrated dynamic standard addition or subtraction in combination with Metrohm Dosimats (addition of fixed volume increments or a specified mV), this versatile precision instrument has a resolution of 0.001 for pH, 0.1 °C for temperature and 0.1 mV for voltage.

pH buffers from Metrohm, DIN, NIST (NBS), Ingold, Merck Riedel-de-Haen, Fisher, Radiometer, Beckman and Ciba or buffers entered by the user are recognised automatically. Thanks to Pt100 or Pt1000 temperature sensors, manual entry of the temperature is no longer necessary. The unique electrode test provides cleat assessment criteria for pH electrodes - an important element for compliance with GLP regulations.

In pH or concentration measurement, the display shows the pH or concentration value and the LCD dialogue window provides a continuous display of the current measured or input temperature.

As required by GLP, the printout of a real-time record is possible. Date and time of the last calibration can be recalled whenever you like. Experimental data and instrument configurations can be output on an external printer at any time.

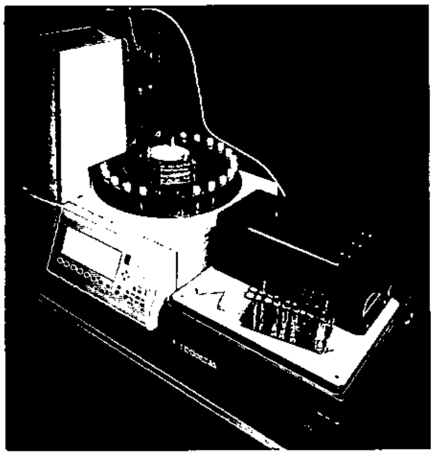
The instrument is equipped with an analogue and a remote control output as well as an RS-232C interface to communicate with a PC or other data processing systems.

Contact: John Morris Scientific Ltd, P O Box 6348, Wellesley Street, Auckland. Ph. (09) 444 5836, Fax (09) 444 0974.
or circle number 50 on the reader reply card.

AUTOMATED SFE-FTIR

AUTOMATED 24 SAMPLE SUPERCRITICAL FLUID EXTRACTOR COUPLES TO IR SPECTROMETER FOR RAPID, ON-LINE ANALYSES

An on-line version of Isco's new automated SFX 3560 supercritical fluid extractor interfaces via a heated transfer line and special high-pressure cell to virtually any infrared spectrometer having standard sample cell geometry. Using no solvents other than safe and inexpensive CO_2, this system provides typical extraction/analysis cycles of 5 to 30 minutes and throughput equivalent to dozens of Soxhlet extractors. With appropriate software support for the host analyzer, the SFE-IR system allows unattended analysis of up to 24 samples for process monitoring, quality assurance, environmental testing, and other applications.



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RESEARCH/DEVELOPMENT ☐
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31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
46	47	48	49	50	51	52	53	54	55	56				

CHEM NZ MAR 1994

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INSTITUTION OR COMPANY:
DEPARTMENT:
ADDRESS:
TEL: FAX:

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(please tick)
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RESEARCH/DEVELOPMENT ☐
PRODUCTION ☐
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CONSULTING/ADVISORY ☐
OTHER (please specify) ☐

3 WHAT EQUIPMENT/TECHNIQUES DO YOU USE? (Please Tick)
GC/GC-MS ☐
UV/VISIBLE SPECTROSCOPY ☐
AA SPECTROSCOPY (FLAME) ☐
NMR ☐
THERMAL ANALYSIS ☐
MICROSCOPY ☐
pH/ELECTROCHEMISTRY ☐
ELECTROPHORESIS ☐
CENTRIFUGES ☐
XRF ☐
HPLC/LC ☐
FLUORESCENCE SPECTROSCOPY ☐
AA-GRAPHITE FURNACE ☐
POLYMERASE CHAIN REACTION ☐
FTIR/IR SPECTROSCOPY ☐
OTHER (Please Specify)

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Please tick ☐

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31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
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PO BOX 12 909
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AUCKLAND

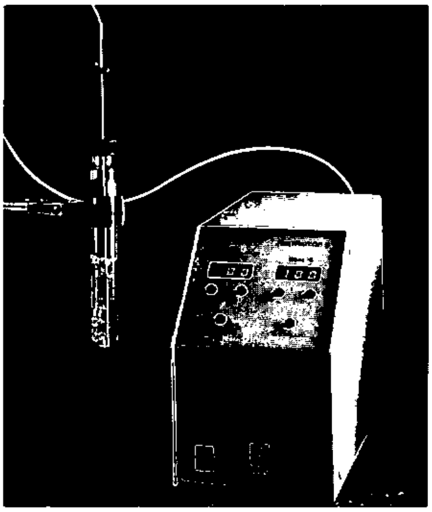
Samples up to 10mL are extracted in exclusive finger-tight cartridges. Static and dynamic extraction steps at up to 10000 psi and 150°C, calibration standards and blanks, and other SFE parameters are programmable for individual samples or groups. Additional capabilities include bar-code scanning of sample cartridges, and printed reports documenting extraction conditions for each sample.

Contact: Douglas Scientific, P O Box 45 027, Auckland 8.
Phone (09) 837 5447, Outside Auckland Ph (0800) 735 725,
Fax (09) 836 0668.
or circle number 51 on the reader reply card

NEW SFE RESTRICTORS

Reduce plugging problems in supercritical fluid extraction; compatible with most SFE systems.

Isco's new patent-pending restrictors are heated uniformly along the full length - all the way to the tip - to resist plugging caused by buildup of ice or by heavy, sticky extracts. Two coaxially heated restrictor probe types - capillary and wide-range adjustable flow - provide flow rates from 0.5 to 10 mL/min (compressed CO_2) and temperature control from ambient up to 240°C for optimum results in practically any SFE application. Both types are rated for 10000 psi and can be used with many non-Isco SFE systems as well as Isco SFX® extractors, and are designed for compatibility with virtually all extract collection methods, including liquid solvent trapping. Uniform, coaxial heating of the entire restrictor flow path allows successful SFE even with the most difficult samples such as those having a high content of moisture, fat and oil, or other aggregate-forming extractables.



Contact: Douglas Scientific, P O Box 45027, Auckland 8.
Ph (09) 837 5447. Outside Auckland Ph 0800 735 725,
Fax (09) 836 0668.
or circle number 52 on the reader reply card

RAPID HYGIENE TESTING SYSTEM LAUNCHED BY BIOTRACE

Biotrace has recently launched a state-of-the-art system, *Multi-Lite*™ - the most sensitive portable luminometer in the world. Providing ultra-sensitive monitoring of process hygiene and cleaning procedures, *Multi-Lite* is also suitable for bacterial determinations in a growing range of applications. Its introduction is another major step forward by Biotrace in providing systems which fully support HACCP and BS5750 programmes.

The heart of the new *Multi-Lite* system is a lightweight, robust and fully portable monitor. It incorporates a photon detector providing more than ten times the sensitivity of Biotrace's popular M3 system, already in routine use with hundreds of major British, European, American and Australian beer, drink and food processors.

As well as providing highly sensitive measurement of hygiene and sanitation efficacy, this new standard of sensitivity makes the system especially suitable for Biotrace's growing range of rapid microbial testing applications: ultra-sensitive detection of spoilage organisms in beer and soft drinks, detection of low levels of micro-organisms in water and CIP rinses; and total bacteria determination in raw milk.

Multi-Lite has the added benefit of enhanced power conservation technology, allowing a full week's testing from a single charge of its built-in Ni-Cd power pack. Mains operation is also possible. The system is fully supported with a twelve month warranty, technical hotline and a comprehensive Customer Care Programme.

A compact, rechargeable mini-printer is included in the system providing hard copy reports for full result traceability, together with a multi-volume, electronic digital pipette which ensures accurate and consistent dispensing of reagents.

With process hygiene, contamination can be sensitively detected and accurately measured by this system in minutes, and this instant response allows the "real-time" monitoring and control capability demanded by HACCP procedures. If contamination levels are found to be above a specified limit, immediate re-cleaning can be carried out, and the subsequent status of the production line re-tested before production recommences.

This swiftness of response allows "positive release" of process lines for production. Adoption of this regime has been shown to yield lower levels of micro-organisms in finished products, leading to fewer batch rejections, cost savings, and longer shelf life for perishable products.

With beer and other drinks, the new *Multi-Lite* system allows rapid and ultra-sensitive detection of spoilage organisms, providing faster release of finished product, reduced product rejection levels and reprocessing costs.

Other important uses of *Multi-Lite* include rapid and sensitive testing of CIP rinses, process water and raw milk. With CIP rinses, *Multi-Lite* can detect both micro-organisms and product residues, providing effective monitoring of CIP systems and allowing reduction of sanitiser costs. With process water, the detection of low levels of bacteria within minutes allows immediate action to optimise biocide dosing levels. "Dumping" of flumes and water replacement can be carried out on an informed basis, minimising waste disposal costs and water charges.

Contact: Laurie Powell, Radiometer Pacific Ltd,
P O Box 12 416, Penrose, Auckland.
Ph (09) 573 1110 Fax, (09) 573 1106.
or circle number 53 on the reader reply card

GRAINSTORE CAN BE CHECKED IN MINUTES!

Moisture and temperature of hundreds of tons of grain can be tested in minutes with the GrainSpear from Sinar Technology. It measures moisture and temperature of crops at depth simply by insertion. Readings are shown instantly without the need for sampling, weighing or grinding.

An essential crop store management tool, the GrainSpear is ideal for monitoring on-floor drying, and provides the farmer with a three dimensional picture of the whole store through both vertical and horizontal moisture and temperature profiling.

Calibrated for 6 different crops, the GrainSpear is available with either a 1 metre or a 2 metre shaft.

Contact: Glenn Grayston, Sci Tech, P O Box 663, Dunedin. Ph (03) 477 7860, Fax (03) 477 7870.
or circle number 54 on the reader reply card

CERTIFIED BUFFER SOLUTIONS

Reliable pH measurement depends on:

- the use of high quality equipment
- the maintenance of electrodes
- high quality calibration solutions

Confidence in Radiometer buffer solutions is based on stringent production conditions and product control. Chemicals of the highest quality are used to produce the buffers, and all standards used for product control are traceable to NIST references (National Institute of Standards and Technology, USA).

Radiometer operates the ultimate standard - The Hydrogen Electrode Measurement Apparatus. Radiometer is one of the very few companies in the world having such equipment and has an authorisation to perform high precision pH measurements.

Furthermore, by placing the buffers in thick polyethylene bottles inside a can they are protected from the effects of microbial growth, light and carbon dioxide. This air-tight can guarantees the buffers for a 4 year life from the date of production. For superior pH measurement Radiometer is the solution.

Contact: Laurie Powell, Radiometer Pacific Ltd,
P O Box 12 416, Penrose, Auckland.
Ph (09) 573 1110 Fax, (09) 573 1106.
or circle number 55 on the reader reply card

NEW MOISTURE BALANCES FROM A & D

Advantage Data Systems have added to their range of A & D moisture balances with the release of the AD 4713 and AD4714 series. The AD4713 is the top of the line moisture balance. Weighing resolution is 0.01%. The infra red lamp minimises measurement error caused by uneven heating or burning of the sample and any temperature between 50°C and 200° C may be selected. Sample sizes can be selected from 1 to 300g. The AD4713 also has three time setting modes. It is possible to input the minutes to be heated, use the exclusive automatic selection, or the continuous measuring process to determine the moisture percentage of your sample.

The AD4713 moisture balance comes with a remote cordless keyboard as a standard option to enable remote operation of the balance.

The AD4714 moisture balance has been designed for the price conscious user. It offers fast and easy moisture percentage determination with a weighing resolution of 0.1%.

Like the AD4713 the high efficiency infra red heating lamp minimizes measurement error caused by uneven heating or burning of the sample. The AD4714 allows an operator to load any sample from 5 to 75g. Heating times can be set up to ninety minutes or set manually.

Contact: David Middleton, Advantage Data Systems Ltd, Level 1, 9 Wilkins Street, College Hill, P O Box 68-281, Auckland. Phone (09) 360 0916, Fax, (09) 360 0074.
or circle number 56 on the reader reply card

CONFERENCES AND SEMINARS

5-8 April, 1994 **Polymer Processing Tenth Annual Meeting**
Venue: Quaker Square Hilton Inn, Akron, Ohio, USA
For further information contact:
Ms Marcinda Jackson
Conference Secretariat
Institute of Polymer Engineering
Akron, Ohio 44325-0301, USA
Phone 1-216-972 5893

28 April - 1 May, 1994 **4th Joint Conference of the Australian and New Zealand Societies of Cosmetic Chemists**
Venue: Conrad Jupiters Hotel,
Gold Coast, Australia
For further information contact:
Grant Binney
Unit Pack Pty Limited
P O Box 423, Mt Ommoney
Queensland 4074
Australia
Ph. 61-7-376 6700
Fax. 61-7-376 6532

19-24 June, 1994 **20th International Symposium on Chromatography**
Venue: The Bournemouth International Centre
Bournemouth, Hampshire, England
Contact: Dr C E Roland Jones
Conference Coordinator
The Chromatographic Society
Suite 4, Clarendon Chambers
32 Clarendon Street
Nottingham, NG1 5JD
United Kingdom
Ph. 44-602-500 596
Fax 44-602-500 614

3-8 July, 1994 **RACI Division of Organic Chemistry 14th National Conference**
Venue: University of Wollongong
Wollongong, Australia
For further information contact:
Professor John Brenner (Chairman)
University of Wollongong
Department of Chemistry
Locked Bag 8844
South Coast Mail Centre
NSW 2521, Australia
Ph. 61-42-214 255
Fax. 61-42-214 287

11-15 July, 1994 **MACROAKRON '94, 35th IUPAC International Symposium on Macromolecules**
Venue: Akron, USA
Contact: Cathy Manus-Gray
Institute of Polymer Science
University of Akron
Akron, OH 44325-3909, USA
Fax. 1-216-972-5463

19-21 July, 1994 **Chromatography '94**
Venue: Australian Jockey Club
Alison Road, Randwick, Sydney, Australia
Contact: Dr S Grant Wylie
RACI Analytical Group
(NSW)

24-29 July, 1994 **30th International Conference on Co-ordination Chemistry**
Venue: Kyoto International Conference Hall
Kyoto, Japan
For further information contact:
Professor Koji Taraka
Secretary of XXX ICCC
Coordination Chemistry Laboratories
Institute of Molecular Science
Myodaiji, Okazaki, 444
Japan
Ph. 81-564-55-7252
Fax. 81-564-54-2254

25-29 July, 1994 **Polymer Networks 94, 35th Microsymposium on Macromolecules**
Venue: Prague, Czech Republic
Contact: Dr B Valter
Institute Macromolecular Chemistry
Academy of Sciences of the Czech Republic
Heyrovskeho Nám 2, 162 06
Prague, 6-Petriny, Czech Republic

1-4 August, 1994 **9th International Drying Symposium (IDS '94)**
Venue: Gold Coast, Australia
The NZIC is co-sponsoring this conference and further information can be obtained from:
Alan Turner
General Secretary/Executive Officer NZIC
P O Box 12 347
Wellington
Ph. 04-473 9444
Fax. 04-473 2324

8-12 August, 1994 **13th International Conference on Chemical Education**
Venue: Metropolitan Campus
Inter American University
San Juan
Puerto Rico
For further information contact:
Professor Ram S Lamba
Chairman 13th ICCE
Department of Chemistry
Inter American University of Puerto Rico
P O Box 191 293
San Juan
Puerto Rico 00919-1293

6-9 September, 1994 **Downstream Processing and Separations of Biological Molecules International Meeting**
Venue: University of Cambridge, England

This meeting is a coordinated effort of industrialists, manufacturers and scientists involved in downstream processing who have come together to provide an opportunity to present the latest advances in the technologies and to face its new challenges including regulatory and standards. Representatives from major manufacturers will be available to answer your questions and show the latest technological innovations.

Contact: Dr G Subramanian
60B Jubilee Road
Littlebourne
Canterbury
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APPLE SCALD : UNRAVELLING THE CHEMISTRY

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Apples are affected by several important postharvest physiological and pathological disorders. Identification and knowledge of the disorders that occur during storage, shipping, or marketing is important as they can reduce quality and hence lead to substantial losses on fruit that require large inputs of labour, materials and capital to produce. Some of the control measures for these disorders require the use of chemicals on fruit creating negative attitudes from consumers and regulatory agencies. Superficial scald is one such postharvest disorder of apples characterized in extreme cases by brown-black patches which appear on the skin during or after cold storage (Figure 1).

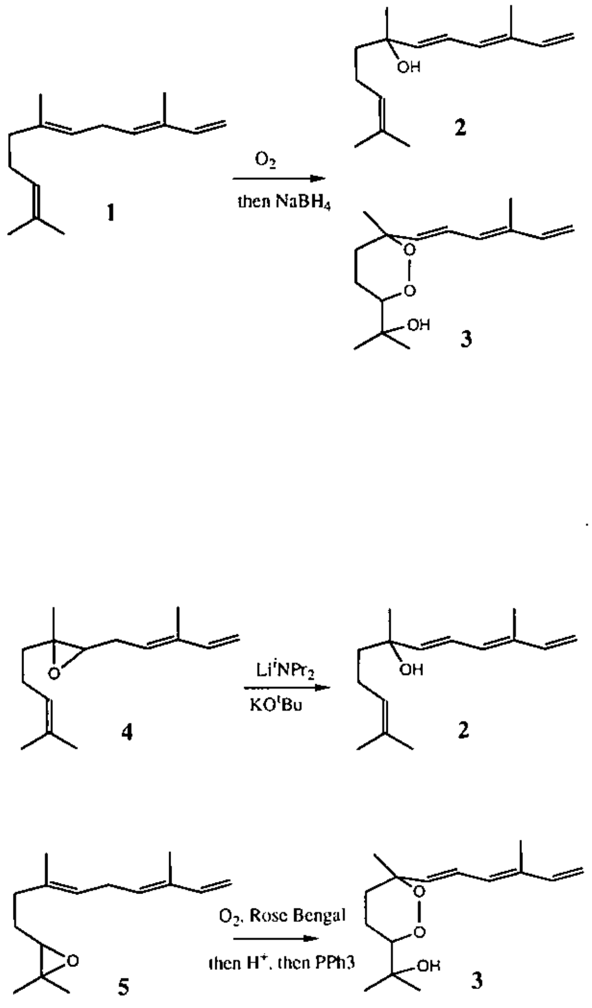
The occurrence of superficial scald is associated with the accumulation of the sesquiterpene α-farnesene **1**, the concentration of which increases and then decreases in apple peel during storage[1]. In 1969 Anet[2] isolated and characterized the conjugated trienes **2** and **3**, after reduction of the corresponding hydroperoxides, from autoxidised samples of α-farnesene. The UV absorbances of these conjugated trienes were similar to that of extracts from long stored apples[3].


Figure 1: *Superficial Scald on Granny Smith Apple*

Subsequent work[3], [4] demonstrated that the extent and severity of superficial scald was more closely correlated with the concentration of conjugated trienes, as measured by UV spectroscopy of apple skin washes, than with α-farnesene itself. These conjugated trienes probably injure the hypodermal cells of the fruit, their effects being moderated by natural antioxidants such as vitamin E which may inhibit oxidation.

At present superficial scald is controlled by dipping apples in emulsions of the antioxidant diphenylamine (DPA) prior to storage or previously 6-ethoxy-1,2-dihydro-2,2,4-trimethylquinoline (ethoxyquin). However, the availability of these chemicals for future use is uncertain. More satisfactory control measures are increasingly being sought and this might be achieved by a better understanding of the autoxidation of α-farnesene and its relationship to the occurrence of scald.

Our initial work[5] in this area focussed on the site specificity of α-farnesene oxidation using several traditional oxidising agents. This provided fully characterized oxidation products of α-farnesene **1** as standards to aid the identification of α-farnesene oxidation products formed in the skin of stored fruit but not the conjugated trienes **2** and **3**. Autoxidation of α-farnesene following Anet (1969) proved unreliable as a source of the key trienes **2** and **3**. Chemical syntheses of these trienes from monoepoxides **4** and **5** prepared in turn from α-farnesene **1**[5] was therefore undertaken to provide pure samples of these compounds (Scheme 1).



SCHEME 1

With samples of trienes **2** and **3** in hand, high performance liquid chromatography and gas chromatography-mass spectrometry were then used to identify and quantitate these compounds in the skin of a number of apple varieties. Triene **2** was the major triene found in all varieties examined with routine quantitation by HPLC and confirmation of identity by GC and GC-MS (Figure 2). Surprisingly triene **3** was found to be at most a very minor component of the trienes present in the apple extracts. Even in extracts carefully prepared to minimise decomposition of unstable hydroperoxides (and containing traces of the unstable hydroperoxide derivative of triene **2**), only traces of triene **3** were present. Perhaps *in vitro* autoxidation experiments are not a good model for the processes occurring in the apple skin during storage. Prolonged exposure of stored apples to low doses of triene **2** lead to discolouration of the skin and other symptoms resembling those of superficial scald. These results strengthen the link between α-farnesene oxidation and superficial scald and encourages the hope that understanding the chemistry occurring in the skin of stored fruit might lead to alternative strategies for the control of this disorder.

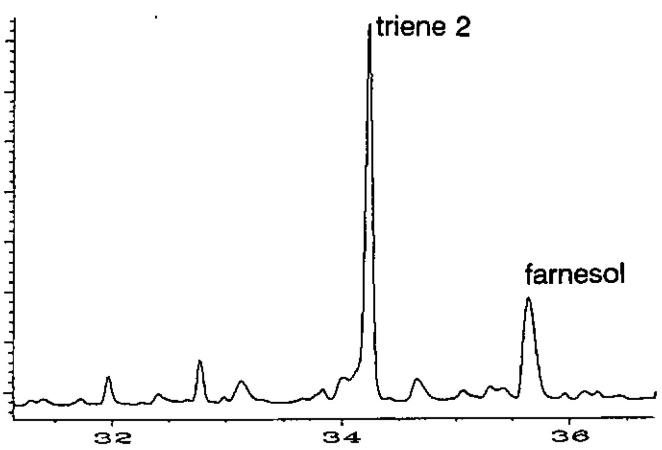


Figure 2: *Gas chromatogram (30m DB1 column, 40° to 150°C @8°C/min., 5°C/min to 250°C) showing presence of conjugated triene 2 and farnesol in purifed apple skin.*

ACKNOWLEDGEMENT

We thank the Horticulture and Food Research Institute Ltd. for a PhD scholarship (J. Spicer) and other financial support.

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THE GREENHOUSE EFFECT AND ITS CONSEQUENCES

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SUMMARY

The greatest difficulty for computer models of the climate based on the greenhouse effect has been their failure to explain global temperature change over the past 130 years. It is made plain by the Report of the Intergovernmental Panel on Climate Change[1], in the text, but not in the Summary, by their statements that the theory is only "broadly consistent" with the observed temperature record if,

- All the observed temperature rise is assumed to be caused by greenhouse gases, including the rise which took place from 1910-1940, which the IPCC itself admits was "very likely to have had a mainly natural origin".
- The theory can only explain the temperature rise over a century, but not over one, or ten years.
- A value of 1.5°C needs to be chosen for the "climate sensitivity" (the equilibrium temperature rise caused by a doubling of CO_2.)

The "Best Estimate" climate sensitivity of 2.5°C used by the IPCC, cannot be justified unless there is a plausible "anti-greenhouse effect", incorporated into the model, counteracting the excessive warming predicted by the straightforward theory,

Such an effect is now available in the form of sulphate aerosols, plus some other effects, which now permit a "best fit" climate sensitivity of 3.7°C; to the past temperature record; enough to allow for some other effect from natural variability. However, this fit is still a poor one, only valid over a century scale.

The recent supposition that the sun's radiation is related to the length of the sunspot cycle gives a much better prediction of past temperature change than the greenhouse effect itself. If incorporated into a model which includes the greenhouse effect and sulphate aerosols it comes close to a decadal prediction of temperature, with a "best fit" climate sensitivity of 2.0°C, which is just within the range of the calculations of the computer models.

Predictions of temperature change from IPCC futures scenarios have been flawed by exaggerated estimates of the rate of increase of carbon dioxide in the atmosphere, and of the proportion of emissions which remain there. If these errors are corrected, and other reasonable assumptions for likely population expansion and future usage of nuclear power made, the most plausible projections for the future are that carbon dioxide levels will stabilise below the doubling figure, and that the average temperature change in the next century from the greenhouse effect will be small, and only slightly larger than that of the last century.

ORIGINS

In 1827 Jean Baptiste Joseph, Baron de Fourier, the French physicist and mathematician, in a memoir to the French Royal Science Academy[2] argued that the atmosphere acts like the glass of a hothouse, because it lets through the light rays of the sun but retains the dark rays from the ground. He must therefore be credited with having originated the idea of the "greenhouse effect".

In December 1895 the eminent Swedish chemist Svante Arrhenius delivered a paper to the Royal Swedish Academy of Sciences in Stockholm, which calculated the effects on the earth's climate of increasing carbon dioxide concentrations in the atmosphere from the combustion of fossil fuels. A summary of his paper was published in the British *Philosophical Magazine* of April 1896[3].

His calculations were in essence exactly the same as those being made today on elaborate computers. He measured the absorption of infra red radiation from the earth by the "greenhouse gases", water vapour and carbon dioxide, and calculated the temperature rise at the earth's surface for different latitudes which would occur if these gases increased by specified amounts.

He was able to make use of spectral absorption figures of the earth's atmosphere which had been published in 1884 by the American physicist Samuel Pierpoint Langley[4] (later to become well known as an aeronautics pioneer). Langley had measured the spectrum of the infra red radiation from the moon, using the instrument he had invented, the bolometer, to determine the energy of each wavelength band. The difference between the spectrum of the moon, and that of the earth itself represented the energy absorbed at each wavelength by the earth's atmosphere. From figures obtained at different angles to the earth, and by using estimates of cloud cover at different latitudes published by Teisserenc de Bort in 1884, Arrhenius was able to deduce the effects of increasing concentrations of water vapour and carbon dioxide on the earth's mean temperature for different latitudes.

The only difference from this technique today is that the spectral absorption of the earth's atmosphere can now be measured directly by satellites. The other, minor, difference is that the absorption by water vapour is regarded as a feedback, since it is assumed that its concentration rises (by enhanced evaporation) with the elevated surface temperature caused by a carbon dioxide increase.

Arrhenius calculated that a doubling of the carbon dioxide concentration in the earth's atmosphere would cause a temperature rise of 6.05°C near the poles and 4.95°C at the equator. The effect was greater in winter than in summer, greater at night than in the day, and greater on land than over the sea.

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THE TEMPERATURE RECORD

It is now appropriate to ask why such a convincing and indisputable set of calculations was ignored for some eighty years. The answer can be found by contemplation of the record of annual mean global surface temperature for the past 130 years, given in Figure 1. (From *Climate Change 1992*[5],plus added figures for 1992 and 1993). These figures were not, of course, available until recently, but their effects must have been fairly evident at the time.

From 1896 to 1910 there was a fall in global temperature of about 0.3°C, thus discouraging any immediate calls to action from Arrhenius's calculations. After that, however, from 1910 to 1940 there was (with a few fluctuations) a steady temperature rise of 0.4°C, a rise which was much greater than could have been expected from the 3% rise in atmospheric carbon dioxide over this period (also available only recently). The reason why there was no public alarm over this global warming is obvious. There were two world wars and a world slump to occupy public attention. By the time the war was over the global temperature stabilised, showing even a slight fall from 1940 to 1977, a period of stability of 37 years. Over this period there was an 8% rise in atmospheric carbon dioxide (also measured recently), yet it seemed to have no effect at all on the climate.

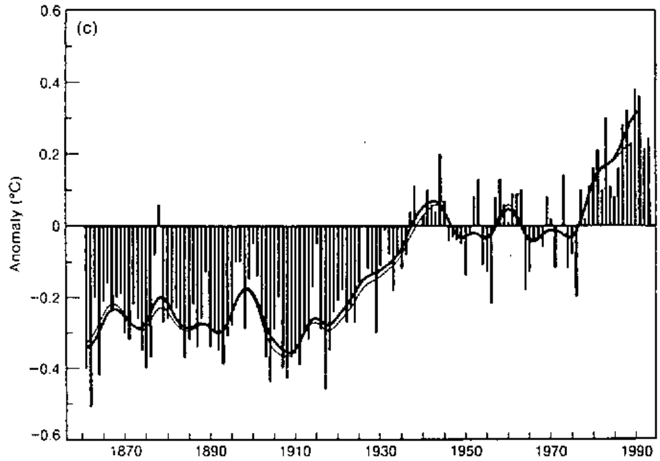

FIGURE 1. *Mean Annual Global Temperatures 1861-1992 , land and sea combined, relative to 1951-1980 average. (IPCC92)*

The present concern over possible global warming from the greenhouse effect is a result of the global temperature increase of 0.3°C that took place between 1978 and 1990, giving several years (1983, 1987, 1990 and 1991) that had higher mean temperatures than any annual averaged figures over the past 130 years. The temperature history previous to 1978 tends, however, to be forgotten, and there seems to have developed a firm belief that a continuing increase of 0.3°C per decade in global temperature is inevitable unless there are drastic reductions in emissions of carbon dioxide and other greenhouse gases. This belief has so far been unshaken by the recent fall in global temperature (a drop of 0.2°C between 1990 and 1992), which is ascribed to the effects of the Mount Pinatubo volcanic eruption in June 1991 (after the temperature began to fall), which, it is considered, provides only a temporary respite from the increased global warming.

SATELLITE MEASUREMENTS OF TEMPERATURE

The greenhouse effect is due to absorption of infra red radiation from the earth by the greenhouse gases in the troposphere; thus heating it. The additional heat is then radiated in all directions, part of it causing a rise in the surface temperature of the earth. The most direct way to study the greenhouse effect, therefore, is to measure the mean temperature of the mid troposphere, several kilometres above the earth, rather than the temperature of the earth's surface. This has been possible since 1979 by the use of Microwave Sounder Units (MSU's) mounted on polar orbiting satellites. The latest temperature record from these satellites is given in Fig 2.[6] The temperature has been corrected for the effects of volcanoes (El Chichon and Pinatubo) and for the El Niño Southern Oscillation (ENSO), but not for possible changes in solar irradiance. The record from 1979 to 1993 shows an upward temperature trend of 0.09°C per decade. This is well below the IPCC90[1] ("Business as Usual Scenario") predictions of 0.3°C per decade, and is 64% of the modified predictions of Wigley and Raper[7] (0.14°C over the decade 1980-1990 for a 2.5°C climate sensitivity).

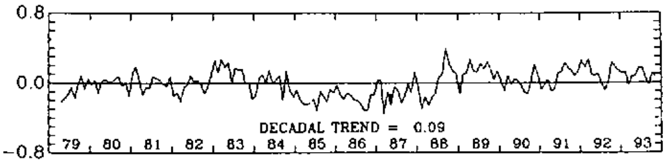

FIGURE 2. *Monthly global temperature, (°C), relative to 1982-91 average, as measured in mid troposphere by MSU on satellites; data adjusted to allow for volcanoes (El Chichon, Pinatubo) and El Niño.* (Source, Christy and McNider 1994)

The satellite measurements of the mid troposphere started after 1975 when the mean global surface temperatures began to rise, but the satellite record shows no signs of the continued surface temperature rise between 1980 and 1990 of 0.24°C which (with 1991) included four of the highest recorded temperatures.

COMPUTER MODELS

The scientific background to the greenhouse effect, with a summary of most of the detailed work now in progress on climate models has been summarised by two reports from the Intergovernmental Committee on Climate Change set up by the World Meteorological Organisation and the United Nations Environmental Programme[1,5]. These reports (henceforth referred to as IPCC90 and IPCC92) cover most of the current background but they need to be updated by some recent developments.

There are at present at least fifteen elaborate computer models of the atmosphere, designated as General Circulation Models (GCMs) operating in European and United States research laboratories. Their main effort is concentrated on calculating the additional radiative forcing (radiant energy) produced by absorption of infra red radiation from the earth by the greenhouse gases in the atmosphere , and from this to derive the climate sensitivity which is defined as the equilibrium mean temperature rise at the earth's surface produced by a doubling of the carbon dioxide concentration in the atmosphere.

The forcing is modified by a whole series of feedbacks. Besides the straightforward feedback due to an increase in water vapour by evaporation, a large number of other feedbacks have been identified or postulated, some positive (increasing the forcing) and some negative (decreasing the forcing), all of which modify the final calculated change in radiative forcing, responsible for a change in temperature.

There are considerable differences of opinion between the operators of the different computer models. The largest of these concerns the treatment of clouds, which may have varying feedback effects, some positive, some negative, depending on their height, density and composition. Even the extent of the forcing change due to the carbon dioxide increase itself is in dispute[8]. The IPCC has attempted to reconcile these differences by assigning a range; 1.5 to 4.5°C to the calculated sensitivity, and selecting a Best Estimate, 2.5°C. However, the recent survey of 15 GCMs[8] disagreed with this. It found a mean value of 3.82°C for calculated sensitivity, with a range of 1.8°C to 5.0°C. The IPCC low value of 1.5°C is below the lowest calculated value, the high value of 4.5°C is below the highest calculated value, and the "Best Estimate" of 2.5°C is over 1.4°C below the mean of the calculated values.

The range of disagreement between the models seems now to be permanent. The IPCC92[5] revision document was unable to narrow the range, and there has even been fairly high level support (T.R.Karl[9]) recently to extend the range downwards, if the arguments of R.S.Lindzen[10] on water vapour feedback being largely negative are taken seriously.

All these calculations for sensitivity are equilibrium figures; the temperature that would be reached after the earth has been allowed to settle down to a doubled concentration of carbon dioxide. Under practical conditions it will take time for an increased radiative forcing to raise the temperature of the earth, particularly of the ocean. There have therefore been developed four transient climate models; coupled ocean-atmosphere General Circulation Models, which allow for this delay in reaching equilibrium. These models require very large computer resources.

The transient models calculate that the actual, transient, temperature rise for a doubling of carbon dioxide is reduced from the equilibrium value by an amount that depends on the time scale of the increase, and the assumed amount itself. Thus, for a sensitivity of 2.5°C and a carbon dioxide doubling time of 70 years (assumed by most models) the reduction is 32%, that is to say the actual increase after 70 years would be 1.7°C instead of 2.5°C.

VALIDATING THE MODELS

It is a firmly established principle in computer modelling that unless a model can explain an existing or past situation to a satisfactory level of accuracy, then it is worthless for predictive purposes. The message is "back to the drawing board".

The most serious problem for the substantial effort now being put into computer modelling of the climate is that none of the models fit the past or present temperature record. A steady rise in temperature cannot be discerned from that record (Fig 1.) on a yearly, or even on a decadal basis. Also most of the models predict a temperature rise over the past 130 years which is much greater than has actually occurred.

There has, however, been a global temperature rise on a century-based scale, of about 0.45°C. The amount is subject to dispute as it depends where you start and where you finish. Also the earlier measurements were poorly representative (only 42% of the earth's surface in 1890, mainly on the land and in the Northern Hemisphere), and various biases may not have been adequately corrected. Thus page 143 of IPCC92[5] states "Warming due to urbanization may still affect these results but is probably not serious".

As has already been mentioned, almost all (0.4°C, 89%) of this temperature increase took place between 1910 and 1940, before any corresponding increase in human-produced greenhouse gases. Of the 1.92Wm^{-2} (watts per square metre) additional radiative forcing due to greenhouse gases between 1900 and 1990 only 0.42Wm^{-2} took place before 1940.

This point is accepted by IPCC90[1], as follows: (page 233) "It is possible that some of the warming since the nineteenth century may reflect the cessation of Little Ice Age conditions. The rather rapid changes in global temperature seen around 1920-1940 are very likely to have had a mainly natural origin." So, we are not left with very much temperature rise during the last century to explain by the greenhouse effect.

IPCC90[1], page 243 says "If the sole cause of the warming were the man-induced greenhouse effect, then the implied climate sensitivity would be near the lower end of the accepted range of model prediction."

Recently one of the authors of that statement, T.M.L.Wigley[11] (with P.M. Kelly) has carried out a curve-fitting exercise on the past temperature record, using a current (transient) climate model, and finds that the best fit, explaining 50.9% of the variance, needs the assumption of a climate sensitivity value of 1.5°C. In other words you need an assumption of climate sensitivity which is not just "near the lower end" of accepted model predictions, but is right at the bottom of the chosen range, and even below the results of any existing model, to explain the temperature rise of the past century.

The next sentence on page 243 of IPCC90 is "Natural variability of the climate system could be as large as the changes observed to date".

In other words, there is no evidence that any part of the global warming that has been observed to date is caused by the greenhouse effect. It could all have been due to "natural variability".

The Executive Summary of IPCC92[5] (page 5) states "The size of this warming is broadly consistent with the predictions of climate models, but it is also of the same magnitude as natural climate variability".

The term "broadly consistent" omits the three important conditions from page 243 of IPCC90. The predictions from climate models are only "broadly consistent" with the observed century-scale warming if:

- It is assumed that all of the increase over the past century was caused by the greenhouse effect, (considered unlikely on page 233 of IPCC90).
- It is "broadly consistent" only over a century scale, but not with one or ten year averages.
- It is "broadly consistent" only if a value for climate sensitivity of 1.5°C is chosen.

The IPCC has ignored these qualifications with its predictions. It has spoken of likely increases per decade, and it has selected a value of 2.5°C as its "Best Estimate" sensitivity for prediction, instead of 1.5°C, the only figure "broadly consistent" with the past record.

The Executive Summary of IPCC92[5] also says (page 5) "The observed increase could be largely due to this natural variability; alternatively this variability and other human factors could have offset a still larger human-induced greenhouse warming".

It has already been established that the warming could have been entirely due to "natural variability". We are now told, that it could have been only largely due to natural variability, although no evidence has been produced that any part of it was caused by the greenhouse effect.

The next part of the sentence about natural variability offsetting a still higher greenhouse rise is confusing. "Natural variability" is, presumably, variable; that is to say, it varies upwards as well as downwards. In order to justify the use of a larger figure for climate sensitivity on the grounds that it might be offset by natural variability it is necessary to assume a natural variability that is consistently downwards over a period of 130 years. This may preferably be termed a bias, or perhaps an anti-greenhouse effect. Even if it exists, it does not justify for prediction purposes the use of climate sensitivity values higher than those needed to fit the observed temperature rise, unless the bias is identified, and included in the predictions. This the IPCC has failed to do.

THE ANTI-GREENHOUSE EFFECT

Help is, however, on the way. Wigley and Raper[7] revised the model predictions to take into account carbon dioxide fertilization (increased plant growth), feedback from stratospheric ozone depletion and the radiative effects of sulphate aerosols, all of which have a negative effect on the temperature, so providing the needed anti-greenhouse effect.

Wigley and Raper's paper[7] gives a set of figures for the radiative forcing resulting from the IPCC92 scenarios which are different from, and greater than, those given in IPCC92, because of a recalculation using an improved model. As a result the paper increases the predicted temperature rises for the IPCC92 scenarios (Table 1). The result of this is that the temperature reductions they justify are not very great when compared with the original IPCC figures.

When the modified Wigley/Raper model, taking into account carbon fertilization, ozone depletion and sulphate aerosols, is applied to the past temperature record, the best fit[11], explaining 55.7% of the variance, is with a climate sensitivity of 3.7°C, well within the predictions of the models, so that a Best Estimate of 2.5°C could be assumed in addition to some warming caused by "natural variability". It can therefore be said that, if Wigley and Raper's amendments are accepted, a plausible explanation for the global temperature rise over the past century can be given by the models, using an average value for climate sensitivity, including an assumption that part of it can be ascribed to a negative "natural variability" (now identified as mainly sulphate aerosols).

There is one serious problem, however. The aerosols, and the carbon fertilization are mainly produced in the Northern Hemisphere, so there should be significantly higher temperatures in the south, not so far evident in the IPCC92 temperature records. The apparent absence of this effect limits the possible scale of aerosol and fertilization cooling, and thus the upper value for climate sensitivity that could be justified. However the straightforward greenhouse effect is expected to heat the land (and thus the Northern Hemisphere) more rapidly than the sea, so perhaps these two effects compensate one another.

SOLAR VARIATION AND AN IMPROVED MODEL

The most obvious possible cause for changes in the earth's temperature is changes in the sun's brightness. Unfortunately sufficiently accurate measurements of the "solar constant" (as it is called) to check this idea have only become available since 1978, with the coming of satellites. Recently two Danish scientists (Friis-Christensen and Lassen[12]) have speculated that the sun's brightness might be proportional to the length of the sunspot cycle, the time it takes for the number of sunspots to increase and decrease, which varies between 8 and 14 years.

Figure 3 shows the correlation which they found between the assumed solar irradiance and the global temperature record. The agreement is so good as to give hope for a yearly temperature prediction.

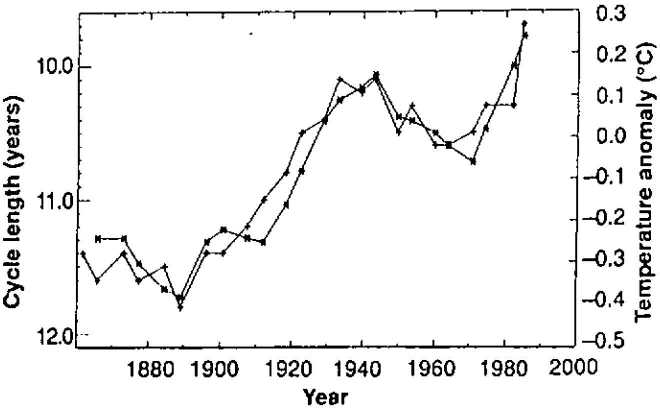

FIGURE 3. *Correlation between calculated solar radiation and past temperature record (Friis-Christensen and Lassen 1991).*

This correlation is less impressive after Kelly and Wigley[11] tried to combine the greenhouse effect, the effects of aerosols etc. and the presumed solar variability in one model. They found the best fit (explaining 60.8% of the variance) for a climate sensitivity of 2.0°C and a mixture of two parts greenhouse effect and one part solar variation. Their fitted model is given in Figure 4. We are now getting close to a model that can predict global temperature on a decadal basis. It might be noted that the rapid temperature rise from 1910 to 1940 and the excessively high temperatures of the past few years are both now partly attributed to changes in solar brightness.

Some reservations need to be emphasized. We still explain only 60.8% of the variance, and ignore several sources of "natural variability" which should be included in the model, such as volcanic activity and ocean-atmosphere circulation events like El Niño. The calculations of the effects of aerosols are subject to considerable uncertainty, and the assumed relationship between the length of the sunspot cycle and solar irradiance is at present lacking theoretical justification and may require a different mathematical function from the linear one assumed.

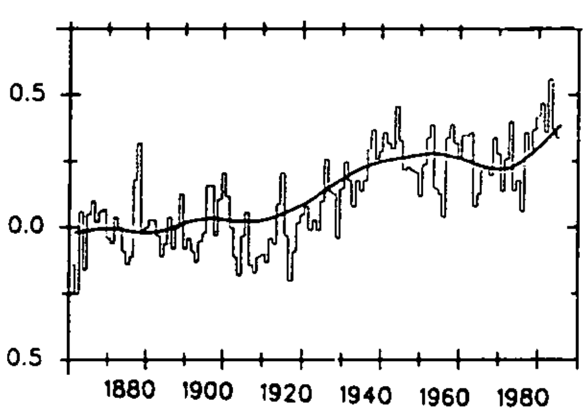

FIGURE 4. *Correlation between combined effects of Greenhouse model, solar variation and sulphate aerosols etc., and past temperature record (Kelly & Wigley 1992), assuming a climate sensitivity of 2.0°C.*

Kelly and Wigley[11], and the authors of the following paper in the same copy of *Nature* by Schlesinger and Ramankatty[13] try to argue that their correlation somehow proves the existence of the greenhouse effect. Schlesinger and Ramankatty put it this way "We find that, since the nineteenth century, greenhouse gases, not solar irradiance variations, have been the dominant contributor to the observed temperature changes." This is surely premature. Volcanoes, El Niño, and other forms of "natural variability" are still capable of explaining the whole temperature rise, even if we are closer to a plausible explanation of the past temperature record as a combination of several factors, including the greenhouse effect.

Acceptance of the Kelly/Wigley prediction of past temperature change would imply the use of a "Best Estimate" climate sensitivity of 2.0°C, and a mitigation influence of sulphate aerosols, ozone depletion feedback and carbon fertilization for prediction of future trends. It also requires the development of ways of predicting future trends in the various elements of "natural variability" such as solar radiation, volcanic activity, El Niño and others.

Although the Kelly/Wigley model gives, at last, a plausible explanation, which includes the greenhouse effect, for past global temperatures on a decadal basis, there remain several other difficulties for the greenhouse gas theory. One of these goes back to Arrhenius, for all of the models predict a greater warming at the poles than at the equator. This appears to be unsupported by observations.

Arrhenius predicted that night time temperatures would rise more than daytime, and that the land temperatures would rise faster than the sea temperatures. Modern models are not so sure about the first point, but it does appear to be true, and it would considerably mitigate any possible adverse effects from warming.

The differential warming of land and sea, as well as greater warming by the Southern Hemisphere, is not at present evident, but it may be a balance between the land warming of the greenhouse effect and the cooling caused by sulphate aerosols.

PREDICTING THE FUTURE

In order to indicate possible future changes in climate involving the participation of the greenhouse effect it is necessary to make informed guesses about future trends in economic growth, population change, energy usage and emission control. IPCC90[1] developed four scenarios involving different assumptions for future changes in these parameters, but they tended to emphasize only one of these scenarios which they called the "Business as Usual" scenario; presumed to indicate what might happen if present trends continue. This scenario has been widely used to predict a rather large global warming over the next century. Very little information about the assumptions made for this or the other scenarios was given in the 1990 Report, so it was not easy to judge whether the predictions were realistic or not. One thing that can be said is that the choice of the "Best Estimate" climate sensitivity of 2.5°C (and credence given to the even higher figure of 4.5°C) without mitigation by sulphate aerosols etc., could not be justified.

The IPCC92[5] report provided a new set of future scenarios which were intended to replace the previous ones, to help indicate the possible consequences of greenhouse warming. A supplementary report gave fairly full details of the assumptions made[14]. IPCC92 continued, however, to use the "Best Estimate" climate sensitivity of 2.5°C and give credence to the higher figure of 4.5°C for the temperature predictions. In a caption to a graph showing "Temperature change under Scenario IS92a" in a separate summary report[15], they were prepared to state "The effects of sulphate aerosol and ozone depletion have not been taken into account", but this proviso is not mentioned under the same graph in the main report.

IPCC92[5], page 9 states: "Scenario outputs are not predictions of the future, and should not be used as such." However, many policy makers have ignored this advice by concentrating on only one of these scenarios, IS92a, considered to be a modification of the superseded IPCC90 "Business as Usual" Scenario, without examining the plausibility of its assumptions.

THE RATE OF INCREASE OF CARBON DIOXIDE CONCENTRATION

The climate sensitivity gives the global rise in temperature, at equilibrium, for a doubling of the carbon dioxide concentration in the atmosphere, abated by sulphate aerosols, and subject to a time delay for the earth to heat. But the important question is, how long will it take for the concentration of carbon dioxide to double?

Measurements of the carbon dioxide concentration in the earth's atmosphere began seriously only in 1955 at the Mauna Loa Observatory, Hawaii. Since then a network of measurement stations has been established, but, so far, no globally averaged figures have been made available, partly because there are calibration difficulties between stations, and partly because there is no agreed technique for dealing with "noise", random fluctuations which are particularly prevalent near industrial emissions. So-called "global average concentrations" published by Charles Keeling of the Mauna Loa Observatory[16] turn out to be averages from only two stations, Mauna Loa and South Pole. Figures before 1955 have had to be deduced from measurements on air bubbles trapped in a small number of ice cores recovered from the Arctic and the Antarctic.

On page 88 of IPCC90[1] it is stated "atmospheric CO_2 concentrations ... have been growing by about 0.4% per year". This amounts to 1.4ppmv (parts per million by volume) a year. It appears to have been linear for the past fifteen years or so and the figure has recently been confirmed for a wide selection of measurement stations, including Baring Head (New Zealand).

IPCC90[1] (page 7) and IPCC92[5] (page 31) made a major blunder by giving a figure of 0.5% increase a year (1.8ppmv) as the current rate of increase of carbon dioxide concentration in the atmosphere. The figure was apparently obtained by averaging only three readings (1985-8) from Keeling's record, which must have been unduly influenced by El Niño. IPCC90 and IPCC92 used the 1.8ppmv figure for all their scenarios, so that all of them start out with the handicap of a figure which is 29% too high.

The assumptions for rate of increase in carbon dioxide concentration made by the transient coupled ocean-atmosphere computer models[5] are even worse. Two out of four assume that carbon dioxide will increase by 1% a year, compound, and another 1% a year, linear. Note that this applies from the year 1990. The original idea for such a grossly exaggerated rate of increase (2½ times the actual amount) (page 183 in IPCC90[1]) seems to have been that it would take into account increases in the other greenhouse gases (methane, CFCs, nitrous oxide etc.) whose influence, for the same concentration, is greater than carbon dioxide, because the infra red absorption bands are not so near to saturation.

Since then it has been shown that the effect of CFCs is partially cancelled out by the ozone depletion that they cause, and it is also anticipated that the reduction in their usage, as effected by the Montreal Protocol will eventually lead to their disappearance.

The rate of increase of methane in the atmosphere is declining, and it is possible that it may even level off to a steady value. It is at present doubtful if the "equivalent carbon dioxide" effect of the other greenhouse gases is increasing more rapidly than carbon dioxide itself, so there is no justification for an assumed rate of increase of greenhouse gases greater than that shown by carbon dioxide.

It has been assumed that all the increase in carbon dioxide that is at present taking place in the atmosphere is caused by human activities (combustion of fossil fuels and deforestation), but this is by no means certain. Enting[17] of the Australian CSIRO has found that his carbon cycle model predicts much lower carbon dioxide concentrations before 1860 than are measured in air samples from ice cores from the period; implying that some of the carbon dioxide came from elsewhere (an adjustment from the "Little Ice Age}. This idea is supported from the fact that before 1860 a much higher proportion of human-produced carbon dioxide (mainly due to deforestation) appeared to enter the atmosphere than it does today.

Only a proportion of the carbon dioxide from human activities ends up in the atmosphere. From 1960 to 1988 it was about 42%, and from 1978 to 1988 about 48%. 29% is believed to be absorbed by the ocean, leaving a balance of 23% whose fate is unknown, absorbed by a mythical "carbon sink" located in the northern hemisphere[1]. Opinion is beginning to swing round to the idea that the extra carbon dioxide causes additional plant growth (fertilization). Carbon cycle models are at present rather inaccurate, so they do not provide a very useful guide to the prediction of future carbon dioxide concentrations.

Despite all this, the IPCC scenarios chose to assume atmospheric absorption of man-produced carbon dioxide at higher levels than are currently happening, 52-71% instead of 48%. All the scenarios thus exaggerate possible global warming from this factor. Wigley and Raper[7], who provided corrections to the IPCC scenarios for sulphate aerosols, ozone depletion and carbon fertilization, did not correct for the exaggerated atmospheric carbon ratio which had been assumed.

A recent carbon cycle model from Enting and Lassey[18] appears to correct for all the factors, so it is possible to calculate from their model revised figures for the temperature rise predicted by all the IPCC92 scenarios by substituting their figures for carbon dioxide increase for the ones used by Wigley and Raper. With the assumption of a 2.5°C climate sensitivity the modified predictions range between 1.2 and 2.7°C temperature rise between 1990 and the year 2100.

If the new "Best Estimate" figure of 2.0°C for climate sensitivity is chosen (based on the best fit to the past temperature record), then the range of temperature rises by 2100 for the six scenarios becomes 0.9 to 2.1°C.

The doubling time for carbon dioxide concentration from the revised (IPCC92, Enting/Lassey) scenarios are from 90 years (IS92e) to never (IS92c and IS92d). Scenario IS92c stabilises at about 520ppmv (43% above the present value), and IS92d at 440ppmv (26% increase).

The present rate of increase in carbon dioxide, 1.4ppmv per year, seems to have stabilised over a period of fifteen years. At this rate it would take 253 years for the 1990 concentration

(354ppmv) to double, giving an increase between 1990 and 2100 of about 0.4°C for a climate sensitivity of 2.5°C and 0.3°C for a climate sensitivity of 2.0°C.

Linear extrapolation over such a period is, of course, dubious, but hardly less so than extrapolations involving great (for example, exponential) increases, or those involving gradual levelling out to a stable value.

If we were to assume a more likely compound increase of 0.4% a year, then it would take 174 years for the concentration to double. This would mean a temperature increase (assuming a climate sensitivity of 2.5°C) by 2100 of 0.6°C, or 0.5°C for a sensitivity of 2.0°C. This rise would take place largely at night and would be comparable with what has already happened over the past century. It would be unlikely to cause any greater difficulties than those we have had over the past period.

PLAUSIBILITY OF SCENARIOS

Table 1(a) gives the predictions for global temperature increase between 1990 and 2100 for the various IPCC scenarios, using the "Best Estimate" climate sensitivity figure of 2.5°C. SA90 (the "Business as Usual" scenario) is included for comparison, although it is now obsolete and was not revised. Wigley and Raper[10] revised the radiative forcing figures for the IPCC92 scenarios, so that they (second column, "Base Case") give higher temperature predictions for the IPCC92 scenarios than the IPCC itself. Their modified figures ("Feedback)", show the reduction achievable by allowing for carbon fertilization, ozone depletion feedback and sulphate aerosols. The figures would be lower if these modifications were applied to the original IPCC temperature figures.

The final column of Table 1(a) shows the modified figures from Wigley and Raper's "Feedback" set, if Enting and Lassey's figures for carbon dioxide are substituted for those used by Wigley and Raper.

Table 1(b) shows the predicted temperature rise between 1990 and 2100 if the "Best Fit" figure for climate sensitivity of 2.0°C is applied to the final column of Table 1(a). These figures appear to be the best available from current model calculations.

TABLE 1(a)

Predicted Temperature Rises 1990-2100 From Greenhouse Warming in °C.

"BEST ESTIMATE" CLIMATE SENSITIVITY OF 2.5°C

Scenario	IPCC92	Wigley/Raper Base Case	Wigley/Raper "Feedback"	W/R, "Feedback" Modified by Enting/Lassey
SA90	3.3	3.3		
IS92a	2.8	3.0	2.4	2.1
IS92b	2.7	2.9	2.4	1.8
IS92c	1.5	1.5	1.3	1.2
IS92d	1.7	1.8	1.7	1.5
IS92e	3.5	3.8	3.0	2.7
IS92f	3.4	3.5	2.8	2.5

TABLE 1(b)

Predicted Temperature Rise 1990-2100 Using "Best Fit" Climate Sensitivity of 2.0°C, Wigley/Raper as Modified by Enting/Lassey.

Scenario	W/R, "Feedback" Modified by Enting/Lassey
IS92a	1.6
IS92b	1.4
IS92c	0.9
IS92d	1.2
IS92e	2.1
IS92f	2.0

IPCC92 Scenario IS92a, which seems to have been selected by many people as a plausible future projection, predicts a temperature rise (Wigley /Raper "Feedback" modified by Enting/Lassey, referred to henceforth as W/R/E/L) of 2.1°C by 2100 for a climate sensitivity of 2.5°C, and 1.6°C for a sensitivity of 2.0°C. It starts by overestimating economic growth for 1990-2000 in the OECD (2.8%) and in Russia/Eastern Europe (-0.6%), and underestimating it in China/Central planning Asia (3.6%).

It assumes the World Bank medium population growth prediction which already seems unsustainable for Africa, and appears to need reduction from the unexpected spread of family planning in undeveloped countries, the subject of a recent article in the *Scientific American* [19].

IS92a assumes a sevenfold increase in world coal output by 2100, largely because of an assumption that oil supplies will decline after 2025, to be replaced by synthetic oil from coal. A more likely forecast, judging from current trends in Asia, is that present undeveloped countries will invest heavily in nuclear power, and that there will be a general move towards electric traction.

IS92a excludes the possibility of any measures to limit greenhouse gas emissions beyond those that have already been committed.

IS92b is identical with IS92a, except that it includes stated policies in addition to those legally adopted. As might be expected, IS92b is very little different from IS92a, with a predicted temperature rise (W/R/E/L) by 2100 that is 1.8°C for 2.5°C sensitivity, 1.4°C for 2.0°C sensitivity. It is surely probable that additional efforts to limit greenhouse gas emissions beyond the assumptions of IS92b will come into effect before the year 2100, particularly if evidence comes to hand that the gases are involved in global warming.

There is good cause to believe that future global warming from an assumed greenhouse effect will not be as great as that predicted by IS92a and IS92b scenarios.

Scenario IS92c (as modified by W/R/E/L) predicts global warming by 2100 of 1.2°C for 2.5°C climate sensitivity and 0.9°C for 2.0°C sensitivity. It assumes the United Nations "Medium Low" estimate for population growth, where population peaks and then declines after 2050; economic growth of 2.0% for 1990-2025 and 2.3% from 1990-2100, and an expansion of the coal industry by 30%. This scenario also assumes no extra measures to control emissions beyond those already committed.

Scenario IS92d (modified by W/R/E/L) predicts a global warming of 1.5°C by 2100 for 2.5°C sensitivity and 1.2°C for 2.0°C sensitivity and assumes the "Medium Low" population growth, but higher economic growth than IS92c, a threefold expansion of coal output, with increased emission controls, but much dependence on nuclear power.

Scenarios IS92e and IS92f seem impossibly high. IS92e uses the World Bank medium population growth, but high economic growth (3.5% 1990-2025, 3.0% 1990-2100) and the phasing out of nuclear energy by 2075, requiring an expansion of the world coal industry by eleven times. It predicts a (modified, W/R/E/L) temperature rise of 2.7°C by 2100 for a 2.5°C climate sensitivity and 2.1°C for a 2.0°C climate sensitivity.

IS92f scenario assumes the UN Medium High population prediction (which is just not happening), economic growth of 2.9% 1990-2025; 2.3% 1990-2100, and a ninefold increase in the world coal industry. The W/R/E/L modified temperature prediction is a 2.5°C rise by 2100 for a 2.5°C climate sensitivity; 2.0°C for a 2.0°C climate sensitivity.

Scenarios IS92b and IS92d are the most plausible of those presented by IPCC92, if it can be accepted that the UN Medium Low population projection is achievable. They both predict that the carbon dioxide concentration in the atmosphere will level out to a steady value around the end of the next century, and that the temperature rise due to the greenhouse effect between 1990 and 2100 will be about 1.0°C, an increase which is about double that of the last century, and is a rate of increase of the same order as that shown during the last 1½ decades, as measured by satellites, and adjusted for volcanic and atmospheric circulation effects.

Scenarios IS92c and IS92d predict that by 2100 the greenhouse gas concentrations in the atmosphere will have stabilised, so that future increases beyond 2100 would be due entirely to the final approach to equilibrium.

CONCLUSIONS

There is at present no evidence that the greenhouse effect is responsible for detectable warming of the earth's climate, and, despite expressions of belief that we may get confirmation within ten years or so, there is no certainty that we will ever detect it.

It is now possible to provide a plausible explanation, on a decadal basis, of past global temperature changes by combining the computed predictions of the greenhouse effect with the effects of sulphate aerosols and possible variations in solar radiation, but this does not prove the influence of the greenhouse effect, as there are many uncertainties in the calculations, and several mainly natural effects which have yet to be allowed for. However, it provides for the first time a plausible basis for future prediction if the greenhouse effect becomes established. It requires an assumption that the climate sensitivity (the equilibrium global temperature rise for a doubling of carbon dioxide concentration), is 2.0°C, at the lowest end of current computer calculations.

Predictions inevitably depend on informed opinions about possible future trends, opinions which frequently turn out to be wrong. Current ideas about future trends tend to indicate that greenhouse warming, if it exists, is unlikely to lead to temperature rises over the next century greater than 1°C, an amount which is small in comparison with normal yearly and decadal changes, so that it may be unnoticed or even undetected. Since the warming is likely to take place mainly at night it may be mainly beneficial to man's activities.

From the evidence presented here there is no urgent need to carry out arbitrary or economically damaging control measures on greenhouse gas emissions.

ACKNOWLEDGEMENTS

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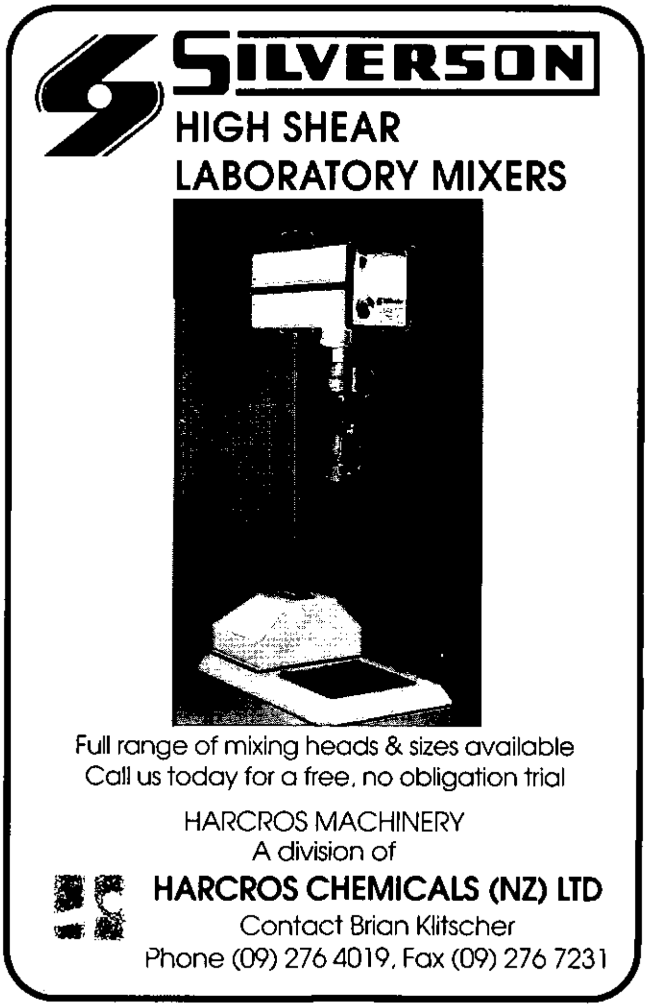

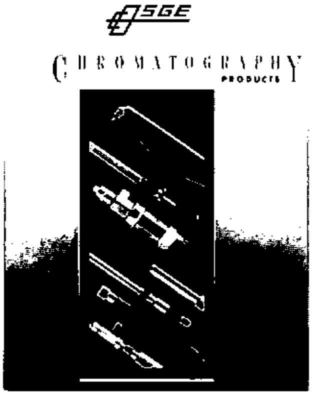

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UNIVERSITY OF AKRON OFFER SHORT COURSES IN PLASTICS TECHNOLOGY

Five new short courses in plastics processing technology will be offered this summer by The University of Akron, Ohio, USA, which has gained international recognition for its programs in polymer science and polymer engineering.

Offered on a 'first-come, first-served' basis, the courses are as follows:

Introduction to Plastics, June 20-22, 8:30 a.m. to 5:30 p.m. Monday and Tuesday, and Wednesday until noon, at Stow-Munroe Falls High School; covering bonding, chemical nomenclature, thermoplastics, thermoset, polymerization, and materials testing.

Introduction to Compounding, June 23-24, 8:30 a.m. to 5:30 p.m., at UA's new Akron Polymer Training Center; providing a practical working understanding of compounding, including raw material influences, mechanical design, operator input and processing techniques.

Extrusion Processing, June 23-25, 8:30 a.m to 5:30 p.m. Thursday and Friday, and Saturday until noon, at the Akron Polymer Training Center; focusing on materials (thermoplastics), equipment (screw design, venting, gear pumps, heating and cooling systems) with emphasis on quality concerns and practical applications.

Introduction to Injection Molding, June 27-28, 8:30 a.m. to 5:30 p.m. at the Akron Polymer Training Center; concentrating on materials, molding cycle, viscosity, filling and packing, machine components, screw design and performance as well as troubleshooting injection molding equipment.

Principles of Colour Technologies, June 27-29, 8:30 a.m. to 5:30 p.m. Monday and Tuesday, and Wednesday until noon, at the Akron Polymer Training Center; providing an overview of various processes of adding dyes and pigments to basic polymer compounds with a focus on reactions (melt flow, viscosity, etc.).

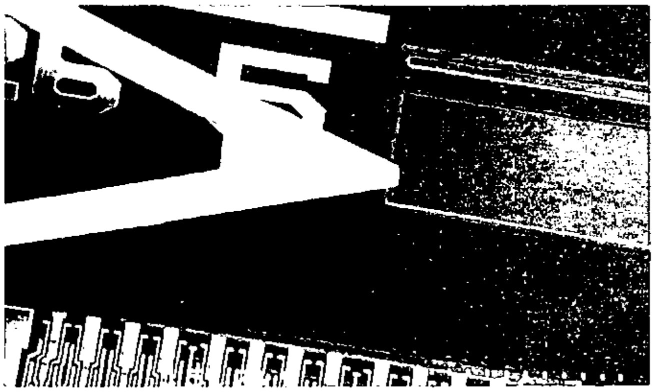
Course costs range from US$304.00 to US$315.00, plus textbooks. For details on the June sessions or on other UA course offerings in plastics technology, contact: Nancy Clem, The University of Akron, Akron, Ohio 44325-3109, USA, Telephone: 1-216-972 5292.

TOPOMETRIX SIGNS EXCLUSIVE AGREEMENT REGARDING PATENTS AND TECHNOLOGY FROM AT&T BELL LABORATORIES ON NEAR-FIELD SCANNING OPTICAL MICROSCOPY

TopoMetrix Corporation of Santa Clara, California has announced that it has acquired AT&T's Nano Vision Corporation and an exclusive agreement that includes a license from AT&T for certain patents and technology based on inventions on the near-field scanning optical microscope (NSOM) from AT&T Bell Laboratories. This exclusive arrangement will position TopoMetrix to lead the rapidly growing market for this breakthrough technology. NSOM overcomes the diffraction barrier that limits the image magnification of an optical microscope and allows features much smaller than the wavelength of light to be imaged. With NSOM , the advantages of optical microscopy are combined with the extremely high magnification and image resolution of a scanning probe microscope. NSOM will play a key role in the advancement of semiconductor technology, materials science, medical research, DNA sequencing and gene mapping, and many other important fields.

Dr Gary Aden, TopoMetrix President and Chief Executive Officer, stated that "We are very excited to have reached this agreement with AT&T in this important and rapidly developing field. TopoMetrix has aggressively commercialized new technologies in scanning probe microscopy (SPM), and the NSOM is truly a breakthrough technique. Combining our efforts with the exceptional technology of AT&T Bell Laboratories promises to bring the power of NSOM to the vast microscopy market. We are also very pleased that AT&T Ventures has chosen to invest in our company and share in our future."

AT&T's senior scientists have worked since 1989 on the development of NSOM technology. William Brinkman, Research, Physical Science and Engineering Vice President of AT&T Bell Laboratories, commenting on the capabilities of this technique, said that "The NSOM technique is one of the newest and most exciting inventions in SPM. The ability to dramatically increase the magnification of optical microscopy will be welcomed by all industries and research laboratories."



The NSOM is also known as a SNOM, scanning near-field optical microscope. Topometrix is a licensee of patents in the area of SNOM from IBM.

Prior to NSOM there were two major light microscopy techniques, the optical microscope, and the confocal microscope.

In an optical microscope a sample is illuminated with a flood of light. The lighted area is then imaged and magnified by collecting the light that is either reflected from or transmitted through the sample by a series of glass lenses. A colour magnified image of the sample may be seen directly or displayed on a TV screen. Even if the lenses could be made perfectly, the resolution and magnification of an optical microscope are limited by diffraction effects to approximately one half of the wavelength of the light that is used. Optical microscopes are used routinely to image the general shape of samples as small as human chromosomes or compact disk bits.

In a confocal microscope, the sample is illuminated with a focused spot of laser light instead of a flood. This spot is scanned over the sample and the light is collected in a way which allows an image to be displayed on a computer screen. The magnification system is the same as the optical microscope, however, the small laser spot used in a confocal microscope allows about a 40% improvement in image resolution, and the ability to produce a 3-D image. A compact disk bit could be seen and profiled.

In a near-field scanning optical microscope the sample is illuminated with laser light, but the light is confined in a fiber optic guide. The fiber is prepared by tapering one end to allow only an extremely small exit for the light. The final shape looks like a microscopic eye dropper. This fiber guide is no bigger than a human hair and is tapered so that the end is a few atoms wide. Using techniques common for a scanning probe microscope, this fiber end is held very close to a sample surface and scanned . The magnified image of the sample is then displayed on a computer screen. This small, nanoscale, light source allows more than an order of magnitude better resolution than the best optical or confocal microscope. A near-field scanning optical microscope can be used to see extensive details in a chromosome, image much smaller structures such as viruses, and even make measurements from single molecules.

CHART OF RELATIVE SIZE OF OBJECTS

Object	Size
Small Pin Head	800μm
Human Egg	100μm
Human Chromosome	2.5μm
Compact Disk Bit	1μm
Virus	.05μm
Large Molecule	.007μm

For more detailed scientific information see "Super-Resolution Imaging Spectroscopy," T D Harris, R D Grober, J K Trautman and E Betzig, Applied Spectroscopy, Volume **48**, Number 1, January, 1994.

NZIC NEWS

The Institute "Puts The Acid On"

The Manager
Certified Technology Limited
P O Box 37054
Parnell
Auckland

26 January 1994

Dear Sir,

I have had brought to my attention a television advertisement for one of your company's products, (Derma Protekt", "Skin Guard") in which the quality of the product is demonstrated by pouring concentrated hydrochloric acid into the demonstrator's hand after application of the protectant.

Several of my colleagues, professional chemists, have expressed concern that this kind of demonstration could lead to inexperienced people and those with poor judgement attempting to reproduce the demonstration under unsuitable circumstances.

Our concern about the demonstration is in no way a criticism of the product, its efficacy or performance and none is intended or implied.

I am sure that you would not conduct the demonstration unless the product performance was equal to it, I appreciate that the demonstration is performed in an extreme form for dramatic effect and I recognise that there is a warning on the screen during the demonstration. Nevertheless, having watched the advertisement several times I am of the opinion that the warning can be missed by people absorbed by the demonstration itself. Moreover since the substance referred to in the advertisement (concentrated hydrochloric acid) is fairly readily available it is quite possible that it would be accessible to some inexperienced persons including possibly children.

For these reasons I wish to express the concern of the New Zealand Institute of Chemistry and urge you to modify your advertisement so as to make clearer the dangers involved in the demonstration.

Thank you for your attention.

Yours faithfully,

A.G. Williamson PhD FNZIC FIPENZ
President, New Zealand Institute of Chemistry

"Who Is This Guy Anyway?"

The Executive Officer says I should give an account of myself, more than the simple CV published earlier, for the information of members. Here it is:

So you have a new (not so new now) President.

I started chemical life at Victoria University College in 1949 but having ambitions at that time of becoming an "Industrial Chemist" I moved to Canterbury University College in 1950 and completed a BSc in Chemistry in 1951 along with some of the components of a Diploma of Industrial Chemistry. In 1952 I was lured into a Masters course in Chemistry largely by the charisma of Max McGlasham who had returned from doing a PhD in Britain. The newly instituted two year MSc (Hons) course kept us all busy with course work in the first year and research in the second, and by then I was completely hooked on thermodynamics in general and in thermodynamics of non electrolyte solutions in particular. So much so that I set out in 1954 to do a PhD in that topic despite the fact that McGlasham had returned to Reading University to continue his association with E A Guggenheim. After a year of working with supervision from Max by airmail letter form with a delay time of three weeks (it might have worked had we had Email), I gave up and set off for Reading where I started a new project.

In 1958 newly equipped with a Reading PhD I landed in Los Angeles with £25 and a post doctoral position with R L Scott at UCLA. There followed an exciting 18 months working with one of the fastest minds of the West. In 1959, again attracted by one of the powerful personalities of chemistry, I went to join Hugh Parton's team of young guns (Max Panckhurst and Geoff Malcom) at Otago Chemistry Department where we all had a great time in the period of expansion and optimism following the Hughes-Parry report which told the NZ Government to make the NZ universities into real universities.

In 1967 I moved to the Chemical Engineering Department at Canterbury University for what I thought would be a short sojourn before going back to a chemistry department. In fact I discovered whole new vistas of thermodynamics which chemists hardly ever think about. Better still, all the things I had been doing in the thermodynamics of solutions could be continued and simply relabelled from "Physical Chemistry" to "Chemical Engineering" During this period my interest in thermodynamics expanded to industrial energy conservation and eventually to solar energy use.

After 30 years of this idyllic life having fun and associating all the time with young people who refused to take themselves or me seriously I had the misfortune in 1988 to read the Hawke report. The picture it painted of the future of academia proved too gloomy for me, faced with the possibilities - stay and live with it , stay and fight it, or run away, I chose to run away and took the early retirement option in 1989. While many of the things presaged in the Hawke report haven't come to pass, many (to me) equally distasteful things have been forced on the university system and I have never regretted my decision. Fortunately I had behaved well enough during my University tenure to be accorded the status of "Professor Emeritus"

Following my "retirement" I bought out my partners in a company which manufactures solar water heating equipment based on a design which was developing it into a more general range of products based on heat pipe technology.

The change from academia to commerce provides new challenges and new insights into the human condition including new criteria of what constitutes "success". To a degree these can be summoned up by saying that whereas I used to keep count of the number of papers I had published in international journals, I now keep track of the company bank balance. However that is not the whole story. There are still interesting people to meet and now supervising a couple of research students helps bring me back to earth.

That brings me back to the business of reality. Some of those in the business sector who say that academics live in the unreal "ivory tower" world should really take a hard look at themselves. In my view the worlds of business and of the economist are no more real than that of the academic they just operate to different models. Indeed one of my current hobbies is arguing with economists who are trying to incorporate some of the concepts of thermodynamics into their thinking.

Arthur Williamson
President, NZIC

NZIC COUNCIL NEWS

The summer meeting of Council was held in Wellington in the last week of February. Unlike last year when the airport was fog bound, Wellington's weather was brilliant and all Council members made the meeting. Full details appear later in this issue of the Journal - there is however one highlight - subscriptions!

Subscriptions for 1994 / 1995

Council spent some considerable time assessing the financial strength of the Institute. The Journal had become a "Sword of Damocles" and threatened the very existence of the Institute. Now that the Journal is no longer a severe drain on our finances, we can view the future of the Institute, at least in the financial sense, with relative equanimity. Suffice to say there will NOT be an increase in subscriptions for the next financial year. Subscriptions have now remained at the same level for 5 years!

Institute Prizes

A reminder that the entries for the following prizes should be with the Executive Officer by 30 April 1994:

Easterfield Award
Shell Prizes for Industrial & Applied Research
SGS Prize for Research
Chemical Education Award

The A C Kennett Memorial Award closes 31 August 1994.

The conditions/rules for the above awards are available from the Executive Officer or the local Branch Secretary.

We remind managers in the CRI's to put forward the names of their staff who would be eligible for these awards.

Chemical Olympiad

Following our success with four medals at last years Chemical Olympiad in Italy, another team of bright young chemists is in training for selection to attend the 26th Chemical Olympiad. A team of four students plus two observers/mentors will be chosen for the event to be held in July in Oslo, Norway.

Members are asked to assist by way of donations. Some $25,000 needs to be raised to send the team.

AGM

The 1994 Annual General Meeting will be held in Christchurch during the month of August. Full details will be advised to members in due course.

* * * * *

THE ROYAL SOCIETY OF NEW ZEALAND STANDING COMMITTEE IN THE SCIENCE OF THE NEW ZEALAND ENVIRONMENT

The Royal Society of New Zealand is establishing a Standing Committee on the Science of the New Zealand Environment and is consulting with a broad range of institutions and individuals seeking suggestions for membership of the committee.

Below is the committee's draft terms of reference which focus on the role of the committee, its concentration on the science of the New Zealand environment, its wish to have an education and public awareness role and the need for enhanced international contacts.

NZIC has been asked to forward the names of one or two people whose range of skills would enhance the committee's abilities to carry out its terms of reference Those appointed to the committee will not be serving as representatives of specific organisations; their appointment will be for individual expertise and to provide a balance of skills on the committee.

With the establishment of this committee the national SCOPE committee will be disestablished . One role of the Standing Committee is to liaise with the SCOPE international committee.

We now ask our members for suggestions for membership of this committee. Your suggestions should be received by 8 April 1994 and include a brief resume of the expertise of those you identify as potential members.

Please address correspondence to:

Mr A A Turner, NZIC
P O Box 12-347
WELLINGTON

From the nominations received , a short list will be prepared for forwarding to the Royal Society of New Zealand.

DRAFT TERMS OF REFERENCE

1. The Standing Committee shall advise the Society on matters of concern to scientists working in environmental science and respond, on request, with advice on environmental science matters to the Society.

2. The Standing Committee shall establish and maintain links with societies, groups and agencies with an involvement in issues connected with environmental science.

3. The Standing Committee shall act as an advocate for environmental science in appropriate forums.

4. The Standing Committee shall perform an education and public awareness role in order to promote scientific understanding of the influence humans have on their environment and effects of environmental changes on people, their health, safety and welfare.

5. The Standing Committee shall act to enhance international contacts for New Zealand environmental scientists.

6. The Standing Committee shall be the channel of communication with international agencies, in particular with the Scientific Committee on Problems of the Environment (SCOPE) and shall coordinate New Zealand activities in relation to it.

7. The chief matters on which international communication should be made through the Society are:

i Appointment of delegates to meetings of, or convened by, international organisations.
ii Matters of policy or commitment including any financial commitment.

8. The constitution and membership of the Committee shall be determined by the Council, having regard to representation of the total range of interests to be served by the Committee.

9. The Committee shall report annually to the Council of the Royal Society of New Zealand.

10. Amendments to the Terms of Reference of the Standing Committee shall be made only by the Council of The Royal Society of New Zealand.

STANDARDS COUNCIL: NOMINATIONS FOR MEMBERSHIP

NZIC has been asked by the Ministry of Commerce to submit nominations for members of the Standards Council. Under the terms of the Standards Act 1988, the NZ Institute of Chemistry may submit one nomination. (see below) Any nominations will be coordinated by the Ministry and submitted to the Minister of Commerce for his consideration.

A nomination form and, for your nominee, a curriculum vitae form are available from:

Mr A A Turner NZIC,
P O Box 12 347,
WELLINGTON

Please note that a nomination received without all the information requested will not be accepted.

In accordance with the Standards Act, the Minister will make appointments to the Standards Council having regard to:

- their knowledge and experience of management; and
- their knowledge of and experience in the development and use of standards.

Because the Standards Council currently acts as the Board of Standards Association of New Zealand, an organisation with a $4 million turnover which is expected to operate on a commercial basis, members with good commercial experience at a board or senior management level can be expected to make an important contribution to the organisation. This is particularly important at the present time, as Standards New Zealand is refocusing its efforts to secure its future financial viability. Please take this into account in selecting your nominee.

As the closing date for nomination to the Ministry is Friday, 15 April 1994, we would appreciate receiving your nomination well before that time, say 8 April 1994.

STANDARDS ACT 1988 - SECTION 4

4. *Membership of Standards Council*

1. The Council shall consist of not more than 12 members of whom

(a) Not more than two shall be persons appointed by the Minister:
(b) Not more than eight shall be persons appointed by the Minister in accordance with subsection 2. or subsection 4. of this section:
(c) Not more than two shall be persons appointed by the Council itself.

2. In appointing members under subsection 1.(b) of this section, the Minister shall include-

a) Not more than three persons selected from nominations made by the following bodies each of which may nominate one person:

i The New Zealand Institute of Architects Incorporated:
ii The New Zealand Institute of Chemistry Incorporated:
iii The Institution of Professional Engineers of New Zealand Incorporated:
iv The Federated Farmers of New Zealand Incorporated:
vi The New Zealand Manufacturers' Federation Incorporated:
vii The New Zealand Master Builders' Federation Incorporated:

(b) Not more than one person selected from nominations made by the following bodies, each of which may nominate one person:
i The Electrical Supply Authorities Association of New Zealand:
ii The New Zealand Local Government Association Limited:

(c) Not more than one person selected from nominations made by the following bodies, each of which may nominate one person:

i The New Zealand Chambers of Commerce Incorporated:
ii The New Zealand Retailers' Federation Incorporated:

(d) Not more than one person selected from nominations made by the following bodies, each of which may nominate one person :

i The Vice-Chancellors' Committee established under section 46 of the Universities Act 1961:

* * * * *

NZIC BRANCH NEWS

CANTERBURY

At the local AGM last year the following committee was elected:

Position	Person	Organisation	Phone (work)
Chairperson:	Margaret Leonard	WRONZ	325 2421
Secretary:	Rowena Holder	WRONZ	325 2421
Treasurer:	Gill Worth	WRONZ	325 2421
Members	Judith Douglas	ChCh Polytech	364 9037
	Stan Simpson	WRONZ	325 2421
	Andrew Abell	Univ. Canterbury	364 2923
	Bill Ahlers	ESR	351 6019
Council Delegate:	Jan Gregor	ESR	3516019

We are lacking representatives from the teaching profession and industry. Any volunteers? It may be a good opportunity for anyone new to Christchurch to become involved in the local Branch.

NZIC Prizes - Canterbury
These are awarded each year to a Polytech and a University student for academic achievement.

Fourth Year Polytech Student
Congratulations to Gareth Salt who was awarded his prize at the Polytech Award ceremony in December.

Honours 1 University Student
This year the prize will be awarded to two students Andrew Harvey and Brendon O'Keefe.

For any extra information please contact Rowena Holder.
Tel. (03)325 2421 Weekdays 8:30 a.m. - 4:30 p.m.
or Fax (03) 325 2717

OTAGO

1994 Programme
All meetings unless otherwise indicated will be held in the CHEM 2 Lecture Room, Chemistry Research Building, University of Otago, Union Street West, Dunedin. Refreshments are normally available from 7:30 pm.

15 April	*Friday* 7:30 pm Visit to Weston's Winery, Wakari
21 April	*Thursday* 8:00 pm Professor Ian G. Dance University of New South Wales "New, Big, Elementary Molecules"
13-14 May	Central Otago Visit *Friday:* Clyde Dam and Landslides Dinner at Olivers Restaurant *Saturday:* Black Ridge and Rippon Wineyards
16 June	*Thursday* 6:00 pm NZIC President, Professor A.G. Williamson "Solar Energy - My Way" Dinner and talk at the Joesph Mellor Restaurant, Tennyson Street, Dunedin
14 July	*Thursday* 7:30 pm Student Research Evening Talks, posters, recruitment
11 August	*Thursday* 8:00 pm Corbett Lecture Dr A Wilkins - Waikato University
15 September	*Thursday* 8:00pm Dr Diana Hill AgResearch Molecular Biology Unit "New Zealand Science in the Third(?) Millenium"
20 October	Annual General Meeting followed by Alan McConnon of Mainland Products "Cheese, Art or Science"

MANAWATU

Welcome to new members:

Dr Colin Hughes has been appointed Section Manager of the Analytical Chemistry Section, NZDRI, Colin arrived from Regulatory Affairs, Ministry of Health in Wellington and prior to that he was a lecturer at the School of Pharmacy, Central Institute of Technology. Colin is a NZIC member of 15 years standing and was active in the Wellington branch.

Dr Nick Robinson has returned from the UK to join the Food Science Section of NZDRI. A graduate of Waikato University, Nick has spent three years on post-doctoral work in Chicago and more recently one year in the UK. He will be investigating the triacylglycerol composition and structure of milkfat.

Although the branch has not met this year, the Committee has met three times. We have planned an interesting programme of meetings. The first meeting will be held in early April - watch your mail for details. We have also been busy organising the annual Chemistry Quiz for secondary schools. The quiz attracts over 600 entries - in the face of two Australian competitors - from schools throughout the central region. The quiz has been a success thanks to the efforts of David Officer and we hope to build on his labours this year. We see the quiz as part of the branch's commitment to chemical education in our region. What are the other branches doing? - let's hear about it in the Journal.

Grant Boston

Instrument Training Courses 1994

(Analytical Chemistry By Open Learning)

The Instrument Training Group of the New Zealand Institute of Chemistry are offering the following four day workshops at the Auckland Institute of Technology:

NZIC

Atomic Absorption Spectroscopy: June 14-17
A course designed for both new and experienced users. Topis include: Instrument optimisation - Determination of sensitivity and detection limits - Sample preparation - Minimising interferences - Flame emission - Background correction - Graphite furnace.

Gas Chromatography: September 6-9
A course designed for both new and experienced users. Topics included: Sample Injection - Choice of Stationary Phase - Column selection - Choice of Detectors - Applications.

High Performance Liquid Chromatography: November 15-18
A course designed for both new and experienced users. Topics include: Sample preparation - Solvent selection - Gradient elution - Column selection - Choice of detectors.

These courses have been well supported in previous years. Early applications are advised to secure a place.

For further details contact the Faculty of Science and Engineering on 09 - 307-9999 and speak to Neil Edmonds ext: 8181 or Mark Duxbury ext: 8742 or Fax: 09 307-9973. Or phone the Information Centre on 307 9909. Postal: Auckland Institute of Technology, Private Bag 92006, Auckland 1020

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New Literature and Media

INTERNATIONAL NEWSLETTER ON
CHEMICAL EDUCATION
Issue No. **40** (December 1993)

In this issue Yoshito Takeuchi examines the public image of chemistry in Japan, a theme he developed at the 12th ICCE in Bangkok.

Claudio Gebauer looks at the effects of introducing chemistry into the fifth to eighth grade science curriculum in Chile, and Ann Benbow describes FACETS, a modular course developed by the American Chemical Society to teach science to intermediate children in the U.S in a cross-curricular fashion.

As Chairman of the Educational Committee of the Institute of Chemistry in Sri Lanka, Oleap Fernando paints a picture of the chemical education scene in Sri Lanka.

Half way round the world, there are many science teachers in the U. K with a non-chemistry background who are called upon to teach the chemistry component of the 'balanced science' required by the National Curriculum and are finding it difficult to cope. Mark Atlay describes the Open University's efforts to remedy this situation.

David Kent and Peter Towse report on a partnership established between teacher education and industry which was used as a base for producing resource materials for use in secondary school classrooms in the U. K. There are also brief reports on the 12th ICCE and on the 5th International Chemistry Conference in Africa.

Further details or copies of the newsletter are available from the editor, Chemistry in New Zealand

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Department of Chemistry

Vacancy UAC.393

This vacancy is at Lecturer level, although an exceptionally well qualified applicant may be considered for appointment as a Senior Lecturer.

Applications are invited from suitably qualified chemists who hold a doctoral qualification and have a strong research record. The Department seeks to build strengths in analytical chemistry and applicants with interests in any area of analytical chemistry will be considered. Potential applicants are invited to discuss research requirements with Professor Brian Davis, Head of Department.

Commencing salary will be established within the range $37,440 - $49,088 per annum for Lecturers, or $52,000 - $60,944 per annum for Senior Lecturers.

Further information, Conditions of Appointment and Method of Application, should be obtained from the Academic Appointments Office, University of Auckland, Private Bag 92019, Auckland, phone (09) 373-7999 ext 5097, fax (09) 373-7454. **Three copies** of applications should be forwarded to reach the Registrar by **29 April 1994.**

Please quote Vacancy Number UAC.393 in all correspondence.

W B NICOLL, REGISTRAR

The University has an EEO policy and welcomes applications from all qualified persons

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Organic Chemist Required

Baldwin, Son & Carey is a leading New Zealand firm of patent, trade mark and intellectual property attorneys. The firm is seeking an organic chemist with a PhD or good MSc to join as a member of the professional staff on a patent team in the Wellington office.

Experience as an organic chemist or a law degree would be an advantage, but neither of these requirements are essential. A successful candidate without a law degree would be required to complete one while working with the firm.

The applicant will also be required to pass the New Zealand Patent Attorney Examinations. Appropriate in-house training will be given to prepare for these examinations. The position is an excellent career opportunity for the right candidate.

Please apply, in writing, to
Grant Crowley, Practice Manager,
Baldwin, Son & Carey,
PO Box 852,
Wellington, New Zealand,
Telephone 64 4 472 1094, Facsimile 64 4 473 6712.

FOR SALE

Kodak Ektachem DT60, DTSC, DTE Desktop Biochemistry Analyser. Four years old. Low usage, in very good order. Recently serviced by Kodak. Suited for on site or satellite located laboratory testing. Dry slide technology minimizes waste and maximizes calibration stability and testing accuracy. Simple to operate. Fully supported by Kodak. We have upgraded.

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32
32
47
41
19
10
15
100
100⊕
19
50
15
19
12
41
12
12
40
12
40
65
64
58
335⊕