

# CHEMISTRY IN NEW ZEALAND

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INSTITUTE  
OF CHEMISTRY



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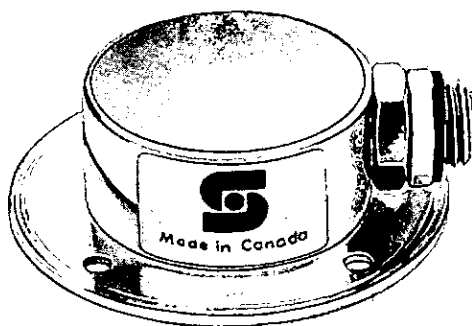
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# CHEMISTRY IN NEW ZEALAND

## Journal of The New Zealand Institute of Chemistry

Vol. 33, No. 1 February 1969

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*Conventional view of Holland. (Photo J.M.).*

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## Guest Editorial

THE practice of chemistry still requires as much thought as it ever did, despite the fact that present day chemistry largely relies on instruments. The variety, complexity and cost of instruments are increasing at an almost unbelievable rate. How does the chemist cope with such changing tools of trade? If he is to do as expected—manipulate an instrument so that when samples are fed in at one end, believable numbers appear at the other—where does he learn the techniques of successfully using new instruments?

The fundamentals of chemical manipulations, such as the use of volumetric glassware and methods of weighing, are taught to students at some stage in their career (whether the responsibility for this lies with secondary schools or universities seems to be a debatable point). Today's students learn about today's instruments. Where, in ten years' time, will these students go to learn the techniques for instruments of ten years hence? Where do the graduates of ten years ago learn applications and techniques of today's instruments?

Post-graduate teaching facilities of this type are practically non-existent in New Zealand.

Universities have run instrumental courses but these have in general lacked much sup-

port. Perhaps one reason is that a chemist with a problem which might be solved with a particular instrument needs his instrumental knowledge right now. Most problems won't wait until eventually the necessary course is put on.

Assistance is often available on a personal basis but this is dependant on knowing who to ask.

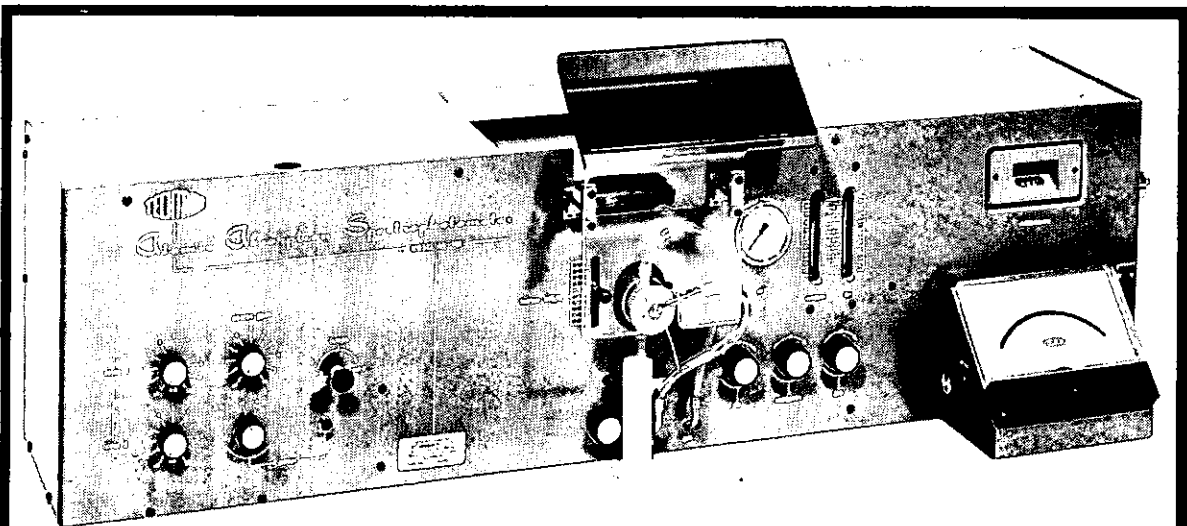
There is a need for Applications Laboratories in New Zealand such as are often available overseas at instrument manufacturers' sites. Local suppliers profits cannot support such facilities here, even though they are vitally concerned with the matter. Should this type of laboratory be provided by government or educational organisations?

Frequently an instrument is blamed for poor quality results when actually the fault lies with a poorly trained user. Perhaps in future, manufacturers may refuse to supply an instrument to a prospective user who does not hold a current license to operate that type of instrument.

If it is economically unsound to equip a high-priced chemist with less than the best modern equipment,<sup>1</sup> is it equally unsound to expect a high-priced instrument to be used by less than an up-to-date chemist.

<sup>1</sup> Perkin Elmer Corporation Instrument News, Vol. 19, 1968, p. 2.

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## A CENTRAL ORGANISATION FOR THE PROFESSIONS IN NEW ZEALAND

*Max Carrie M.Sc., C.Eng., A.M.I.Chem.E., F.R.I.C.*  
(Past President N.Z.I.C.)

OVER the last 30 years, members of the professions in New Zealand have been steadily losing ground economically as compared with the unskilled workers. The "margin for skill" in New Zealand is probably lower than anywhere else in the world and the incidence of income tax is such that the middle-income group, to which most professional people belong, is hit much harder than in most other countries. Not only has the professional man lost ground in comparison with unskilled workers in his own country, but he has also lost ground as compared with his professional counterpart overseas. Economic factors, without doubt, make a significant contribution to the "brain drain" which everybody deplores, but about which nobody does anything effective.

It is true that individuals and professional organisations have, from time to time, raised their voices in protest about the rewards and status of the professions in New Zealand, but the results of these protests have been negligible. The university teachers have achieved some mild success but the results have not been sufficient for the universities to recruit and hold enough staff of the right calibre. It would appear that the time is ripe to take stock of the situation and to consider whether anything more effective can be done. One thing which stands out is that the past outbursts have been spasmodic and on a small scale. A concerted effort on the part of all the professions, whose problems, after all, are very similar, would surely have a greater chance of success.

In this regard, it is instructive to look at what has happened in the Scandinavian countries. The professional organisations there had originally been almost exclusively

concerned with professional qualifications and ethics as is the case now in New Zealand. They had considered that any attempt at collective bargaining by their organisations to obtain better economic conditions for their members would savour of "trade union tactics" and, as such, would be beneath the dignity of professional men. However, from the late 1930's onward, there was a marked deterioration in conditions for the professions. The "margin for skill" was not maintained and, with higher rates of taxation, the incomes of professional men did not keep pace with the rising cost of living. Gradually the professional associations realised that their older policy of leaving members to look after their own economic conditions was satisfactory only so long as the professions were economically secure and favoured. By the 1940's this was no longer the case.

The first move was made in Sweden in 1947 when fifteen of the main professional associations in the country decided to join forces in a national confederation. This was called Sveriges Akademikers Centralorganisation, usually referred to as "SACO." SACO was a success from the start. From the original 15 associations with 15,000 members in 1947 it had grown by 1967 to 31 associations with a total membership of 93,200.

The history, aims and structure of SACO are described in a booklet "Central Organisation of Swedish Professional Workers," published in English by the organisation. It is from this booklet and from information given by the corresponding Danish organisation that I have obtained the material for the next few paragraphs. It may be mentioned that it is difficult to find an exact English equivalent of the term "Akademiker" used by both the Swedes and the Danes.

It refers to holders of university degrees or their equivalents, and thus to all who have a professional qualification. The word "academic" in English has not the same significance and the word "professional" also has a different connotation. The term "professional worker" used in the English version of the SACO booklet has, to me at any rate, a slightly Marxist flavour and I have avoided it here. I have used the expressions "professional men," "professional people" or "members of the professions" for want of a better term.

The objects of SACO, as set out in their booklet, are:—

1. To promote the most desirable development in all matters relating to the education and occupational conditions of members of the professions.
2. To work towards ensuring that the community utilises the special knowledge of the professions to the best advantage.
3. To safeguard the economic and social interests of affiliated groups and to strive to improve generally their conditions of employment.

The organisation looks after the interests of its members in the labour market and in the community at large. It is concerned with improving not only the conditions of employment but also the standard of education of its members. All the activities of SACO are imbued with the aspiration to assure for its members a rightful share of the continuing improvement of living standards.

In 1950 SACO was given the right to negotiate on behalf of its members in the public service and to reach agreements regarding their salaries and terms of employment. Since then the scope of collective bargaining has widened to include industry, banking and insurance.

In the late 1950's SACO was empowered to appoint delegates to government commissions of enquiry preparing legislation in areas of concern to its members and to have its representatives sit on the management

staffs of certain civil service departments and other state agencies.

Within a few years of the setting up of SACO Sweden's lead was followed by the other Scandinavian countries and there are now similar organisations in Norway, Denmark, Finland and Iceland. All five of these organisations collaborate in a body called the Nordiska Akademikerradet which meets once a year to discuss matters of mutual concern.

The Danish organisation, Akademikernes Sambejdsudvalg (AS) is the only one of these other organisations I have any detailed information about. Unfortunately its publications are not available in English, but a translation of the important portion of its rules plus some additional information obtained directly from the AS shows that its aims and development are very similar to those of the Swedish SACO. It also has won official recognition in negotiations with the government and with local bodies, and it exerts a very considerable influence on private employers.

### **Structure of the Scandinavian Organisations**

The Scandinavian organisations are confederations of the professional associations. The individual professional men belong to the organisations only indirectly through their associations. In both Sweden and Denmark everyone with a university degree or equivalent professional qualification is eligible to join one or other of the professional bodies and is thus cared for by the Central Organisation. The situation is probably the same in the other Scandinavian countries. The lists of the member associations belonging to the central organisations in Sweden and Denmark are given in Appendix I and Appendix II.

In both the Swedish and Danish Organisations the highest authority is a Council on which every member body is represented. The Council is responsible for policy matters

and overall finance, but meets only once or twice a year. Between meetings of the Council the business of the Organisation is handled by an Executive consisting of about 12 members who are elected by the Council and who meet twice a month. Executive members are representatives of member bodies, but not all member bodies have a representative on the Executive at any particular time.

The day-to-day business of the Organisation is carried out by a full-time Director and his staff. In the case of the Swedish SACO, this staff numbers about 30, of whom 13 are graduates.

The Central Organisations deal mainly with matters of a general nature which affect all the professions, while the separate professional associations deal with matters which concern only their own professions. Nevertheless, these associations are strengthened considerably in their negotiations by the knowledge that they have the backing of the Central Organisation.

Dealings with private employers are still left to the individual, but the salaries and conditions negotiated with the government and local bodies obviously have their effect in the private field. As well as this, most of the professional associations very actively discourage, if they do not actually forbid, members from applying for any position unless it is advertised in the association's journal. All such advertisements are investigated by the association concerned before they are published, and if the salary and conditions do not meet with the approval of the association, the advertisement is tagged. Very few, if any, members of the association would apply for such a position.

Although the central organisations devote much of their time and energy towards improving the economic conditions of their members, they do not by any means confine their activities to this aspect alone. They concern themselves with education for the professions and with social questions which

affect them or in which their members have particular competence. Their views are communicated to politicians, administrators, leaders of other organisations and to the public generally. Where applicable, they make the fullest use of the mass media of communications—press, radio and television.

Over the years the Scandinavian Central Organisations have acquired considerable influence in many spheres. They have no ties with any of the political parties even although matters of a political nature arise quite frequently. On any particular issue they will lend their support to whichever party holds views which coincide with their own.

### **Application to New Zealand**

Exactly the same conditions which gave rise to the formation of the Scandinavian Central Organisations exist in New Zealand today. The number of professionally qualified people in this country is comparatively small and they must band together if they want to make their voices heard and to have any real influence on the government or on public opinion. From the economic point of view all the professions have many features in common. They involve a lengthy and expensive education and the expenditure of considerable effort and money on the part of their members to keep their knowledge up-to-date. The lifetime earnings of professional men are concentrated into a comparatively short period, thus attracting a high rate of taxation. In these matters and in many others the professions have a community of interest which is shared by virtually no other section of the population. It was for this reason that the Swedish professions formed their own organisations instead of joining with associations of non-professional people whose only common interest with them was that they had the same employer. Perhaps this situation accounts for the complaints sometimes heard about the way in which the Public Service Association represents the professions in the Public Service. If professional men in this country feel that something

should be done to improve their economic and social position, it seems to me that there could be no better or more effective action for all the professional associations to combine to form a central organisation along the lines of the Scandinavian ones.

*I would suggest that, as a preliminary move, a meeting be called of representatives of the main professional associations in New Zealand to discuss the setting up of a central organisation.*

It would not be necessary at this first meeting to invite all such associations, but the invitations should certainly include the professions of chemistry, engineering, law, medicine, dentistry and accountancy. It would be wise at first to include only those professions which have strong and active associations and which demand a university degree or its equivalent as a prerequisite for membership. With regard to this latter condition, the Scandinavian countries do not have a uniform policy. In Denmark a university degree or its equivalent is rigidly insisted on. The secondary school teachers join the Danish Teachers' Association which includes a large number of non-graduates and is not affiliated with the Central Organisation. In Sweden however, the National Association of Secondary School Teachers is a member of SACO. In New Zealand the question of who would and who would not be admitted to membership could be left until an organisation was actually set up.

The most important factor for getting a central organisation going will be an initial policy which will attract support from the large majority of professional people. It is to be expected that similar objectives to those of SACO would be adopted by any such organisation in this country. These objectives have been stated in very general terms and it would be highly desirable, right from the outset, to adopt some specific objectives which would have an immediate appeal for existing professional associations. Improved salary scales would, of course, be one possibility, but with the wide variety of

employers and the number of self-employed, particularly in medicine, dentistry, law and accountancy, such negotiations would be difficult to undertake and would have a somewhat restricted appeal. Salary negotiations must eventually become an important function of any organisation which might be formed, but they would be better left until the organisation had become firmly established and had gained both recognition and experience. There are, however, two other objectives with wide application which would be easier to attain—Income Tax and Superannuation Insurance. These are, to some extent, inter-related.

### Income Tax

This, as it affects the professional man, was dealt with very ably by Henderson (1967) in his Presidential Address to the engineering students at the University of Canterbury, and I have, with his permission, based the whole of this section on his address.

Henderson pointed out that income tax in New Zealand bears more heavily on the middle-income group (\$2,000-\$8,000 assessable income) than it does in Australia, in the United Kingdom and particularly in the United States. The graph, redrawn from Henderson's graph to allow for devaluation both in N.Z. and in the U.K., shows this quite clearly. The rate of taxation rises eventually to much higher values in the U.K. and the U.S. than it does in N.Z., but it does so only for incomes far in excess of those received by most professional men. There are other factors, too. The exemption for pension contributions and insurance in N.Z. is only \$500 (\$650 for non-members of a staff superannuation fund), whereas it is \$1,200 in Australia. I will come back to this in the next section. The exemption for subscriptions to professional societies is limited to a total of \$20 in N.Z. as against \$40 *per society* in Australia. Henderson comments that the N.Z. limit appears to be designed to cover trade union fees, whereas a great number of professional men pay considerably more than

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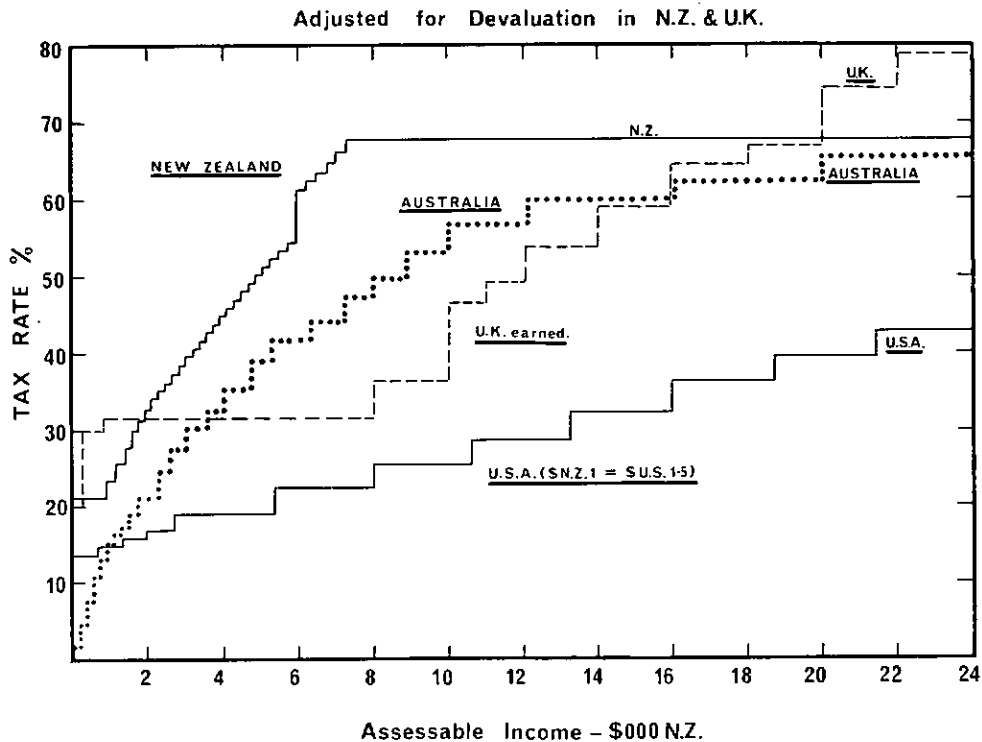
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In the United Kingdom, the rate of income tax rises to over 90%, as compared with a maximum of 67.5% in New Zealand, but it does so much more slowly than it does in New Zealand or in Australia. The first substantial rise does not occur until the assessable income reaches \$10,000. The postponement of the rise until this point seems almost a deliberate attempt to shield professional men, most of whom have incomes below this figure.

In the United States also, income tax rises to over 90%, but it does so more slowly than in the United Kingdom. Admittedly, there is virtually no social security in the U.S., and education is not supported by federal taxes. An exaggerated value for the N.Z. dollar has been adopted to make allow-

ance for this. As in the U.K., the professional man in the U.S. is shielded from the effects of high rates of income tax.

Although the average income tax per head may be no greater in New Zealand, a larger proportion of it is paid by the middle-income group than is the case in other countries. It is in this middle range of incomes that the professional man can expect to find his rewards, and he feels the tax-gatherer's bite much more severely and at an earlier stage in his career than does his counterpart overseas.

One possible explanation of the attitude of the New Zealand Government on this point is that neither political party relies on the professional man for its support and neither is therefore particularly concerned for his welfare. The income tax schedules are devised to protect those on low incomes and those on very high incomes, the latter by the comparatively low maximum rate, by

the low rate on dividends (35%) and by the absence of a capital gains tax. The stalwarts of both parties are sheltered while the middle-income group is left out in the cold.

It is interesting to note that most of these points are made by SACO with regard to income tax in Sweden. SACO also wants the right to deduct repayment of debts incurred while obtaining a degree or professional qualification. The SACO booklet does not say what success has been achieved in having tax rates and exemptions changed in Sweden, but it should be possible to get at least some concessions even in the early stages of negotiations in New Zealand.

### Superannuation Insurance

In my 1967 presidential address to the N.Z. Institute of Chemistry, I drew attention to the unsatisfactory position, as regards superannuation, of those outside the government scheme as compared with those inside it. The "outsiders" include those employed by private enterprise as well as those who are self-employed, while the "insiders" include local body employees, school and university teachers, etc. The fundamental difference between the government scheme and any of the schemes available to "outsiders" is that the superannuation received under the government scheme depends on the employee's salary over the last 5 years of his service, whereas the superannuation received under the other schemes depends on how much the employee has paid in premiums *and when he has paid it*. To illustrate this difference, let us consider the case of a young graduate joining a firm with a subsidised superannuation scheme operated by one of the insurance companies. (This is by far the most common sort of arrangement.)

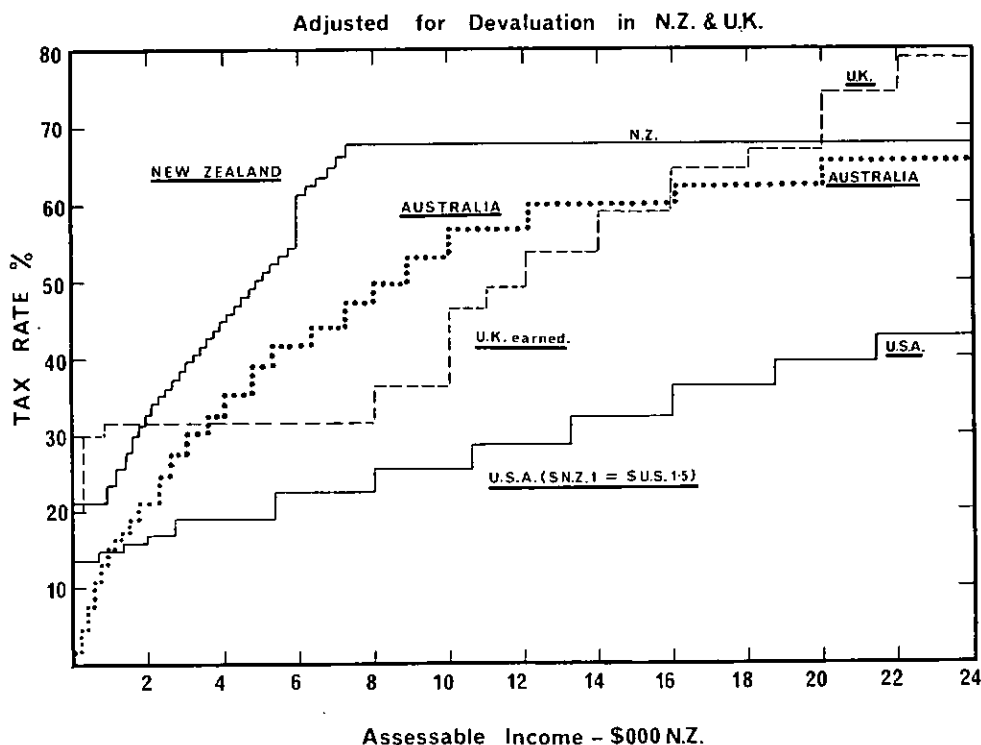
The typical scheme deducts 5% of the employee's salary, and this is subsidised by an equal contribution from the firm. The combined contributions are used to pay the premiums on an endowment policy maturing when the employee reaches retiring age, say

65. In order to compare such a scheme with the government one, let us assume that when he retires, the employee buys an annuity with the proceeds of the policy.

On this basis, the young graduate, aged 25, would get for every \$100 of salary an annuity of roughly \$90 at the age of 65. This sounds very good indeed, and so it would be if it were not for the effects of inflation. Judging by what has happened over the last 40 years, his \$90 will have a purchasing power of not more than \$30 by the time he collects it. Of course, his salary will presumably have increased over the years to compensate for inflation and probably also because of promotion, but the increased contributions of the superannuation fund based on his increased salary will produce smaller and smaller annuities as he gets older. If he gets a \$100 rise at the age of 60, for instance, five years before he retires, his annuity will be increased by only about \$7. If he were in the government service, the \$100 increase even at this stage of his career would give him about an extra \$60 per year in superannuation. The man inside the government scheme is protected from the effects of inflation, as far as his superannuation is concerned, right up till the time when he retires, since his superannuation is based on his final salary which will have been adjusted to take care of inflation. But the superannuation of the man outside the government scheme is affected by inflation right from the moment he starts work. Also, the "outsider" gets very little superannuation benefit from promotion and salary increases late in his career.

A complicating factor is the limit of income tax exemption for insurance premiums. The limit of \$500 a year does not affect the employee who contributes 5% of his salary until this reaches \$10,000, but even before he reaches this figure, it does affect what other insurance he can take out. This limit, of course, affects the "insider" as well as the "outsider" and should certainly be raised to somewhere near the Australian figure of \$1,200. But tax exemption on the employer's subsidy also ceases at \$500 a year,

## RATES OF PERSONAL INCOME TAX 1966-1967.



\$20 in subscriptions. Expenses for higher study either at home or overseas are tax-exempt in Australia, but not in New Zealand.

In the United Kingdom, the rate of income tax rises to over 90%, as compared with a maximum of 67.5% in New Zealand, but it does so much more slowly than it does in New Zealand or in Australia. The first substantial rise does not occur until the assessable income reaches \$10,000. The postponement of the rise until this point seems almost a deliberate attempt to shield professional men, most of whom have incomes below this figure.

In the United States also, income tax rises to over 90%, but it does so more slowly than in the United Kingdom. Admittedly, there is virtually no social security in the U.S., and education is not supported by federal taxes. An exaggerated value for the N.Z. dollar has been adopted to make allow-

ance for this. As in the U.K., the professional man in the U.S. is shielded from the effects of high rates of income tax.

Although the average income tax per head may be no greater in New Zealand, a larger proportion of it is paid by the middle-income group than is the case in other countries. It is in this middle range of incomes that the professional man can expect to find his rewards, and he feels the tax-gatherer's bite much more severely and at an earlier stage in his career than does his counterpart overseas.

One possible explanation of the attitude of the New Zealand Government on this point is that neither political party relies on the professional man for its support and neither is therefore particularly concerned for his welfare. The income tax schedules are devised to protect those on low incomes and those on very high incomes, the latter by the comparatively low maximum rate, by

the low rate on dividends (35%) and by the absence of a capital gains tax. The stalwarts of both parties are sheltered while the middle-income group is left out in the cold.

It is interesting to note that most of these points are made by SACO with regard to income tax in Sweden. SACO also wants the right to deduct repayment of debts incurred while obtaining a degree or professional qualification. The SACO booklet does not say what success has been achieved in having tax rates and exemptions changed in Sweden, but it should be possible to get at least some concessions even in the early stages of negotiations in New Zealand.

### Superannuation Insurance

In my 1967 presidential address to the N.Z. Institute of Chemistry, I drew attention to the unsatisfactory position, as regards superannuation, of those outside the government scheme as compared with those inside it. The "outsiders" include those employed by private enterprise as well as those who are self-employed, while the "insiders" include local body employees, school and university teachers, etc. The fundamental difference between the government scheme and any of the schemes available to "outsiders" is that the superannuation received under the government scheme depends on the employee's salary over the last 5 years of his service, whereas the superannuation received under the other schemes depends on how much the employee has paid in premiums *and when he has paid it*. To illustrate this difference, let us consider the case of a young graduate joining a firm with a subsidised superannuation scheme operated by one of the insurance companies. (This is by far the most common sort of arrangement.)

The typical scheme deducts 5% of the employee's salary, and this is subsidised by an equal contribution from the firm. The combined contributions are used to pay the premiums on an endowment policy maturing when the employee reaches retiring age, say

65. In order to compare such a scheme with the government one, let us assume that when he retires, the employee buys an annuity with the proceeds of the policy.

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and many firms increase their rate of subsidy according to the employee's length of service. If this rate of subsidy has risen to 10% (a not uncommon figure), the tax-exemption limit for the employer's contribution is reached at a salary of \$5,000. The amount of superannuation which the "outside" employee can provide for his retirement is thus restricted in a number of ways. The professional man who is self-employed or whose employer does not operate a superannuation scheme is even worse off. His insurance premiums are limited to \$650 per annum as against a total of \$1,000 for the employees in such a scheme. There is a very strong case for raising the limits on insurance premiums whether paid by the employer, the employee or the self-employed.

Those outside the government scheme suffer from other disadvantages. If an employee changes his job, he may find that his new firm's scheme is with a different insurance company. He will then have to surrender his old policy (possibly forfeiting his previous employer's contribution) and start all over again with a new one. This can mean a sizeable financial loss. Even if the insurance company is the same in both cases and he can transfer his policy, he may have to accept a lower rate of subsidy from his new employer. These superannuation schemes, as they are operated at present, tend to restrict the mobility of the employee, often to his considerable disadvantage. If this is a deliberate policy on the part of the employer, it is a short-sighted one. A reasonable amount of interchange of staff between firms can benefit not only the employee but also the employer by the infusion of new blood and fresh ideas. If a central organisation were formed in New Zealand, it could surely persuade the insurance companies operating staff superannuation schemes to make their policies interchangeable. No individual insurance company would gain or lose much by this. It would then be up to the individual, backed by his professional association, to negotiate his rate of subsidy, etc. with his prospective new employer.

It would be ideal, of course, if the insurance company schemes could be made interchangeable with, and could offer the same terms as, the government scheme. This would facilitate mobility of professional men between private employment and government or universities, to the benefit of the employee and of all three classes of employer. I am given to understand that insurance companies do not offer policies giving the same terms as the government scheme because they say that they cannot legislate for an employee being given a considerable increase in salary during, say, his last 10 years of service. But this is a frequent occurrence both outside and inside the government service. If the government scheme is actuarially sound (and as a taxpayer, I trust that it is), I can see no reason why a comparable scheme cannot be operated by the insurance companies. A central organisation would, I hope, include accountants and actuaries who could devise such a scheme for submissions to the insurance companies.

A campaign to improve superannuation insurance would have only a limited appeal to professional men inside the government or semi-government service, but it would be of very great benefit to those who are self-employed or who are employed by private enterprise. The latter two categories include a very large number of members of the professions in New Zealand.

### Summary

Those engaged in the profession in New Zealand have lost ground economically over the last 30 years as compared with their colleagues overseas and with unskilled workers in their own country. Protests by individuals and by the various professional societies have accomplished very little. The only alternative would appear to be the formation of a strong central organisation, along the lines of the ones which have been so successful in the Scandinavian countries, representing all the professions in New Zealand. Only such an organisation would be

powerful and numerically strong enough to influence government and public opinion. If the professional bodies, possibly because of an abhorrence of what they think of as "trade union tactics," decline to set up such an organisation or to take some other effective action, they will have only themselves to blame if their position declines still further as compared with the rest of the community.

### Proposals

*I would therefore propose that the N.Z. Institute of Chemistry take the initiative in arranging discussions with the other main professional bodies in New Zealand for the purpose of forming a central organisation representing all those who are professionally qualified in the country.*

*Such an organisation would be along the lines of those in the Scandinavian countries and would have similar general objectives.*

*As immediate and more limited objectives to be undertaken as a means of gaining initial support for the organisation, I would suggest the following:*

1. *To obtain increases in income tax exemptions for superannuation insurance and subscriptions to professional societies.*

2. *To obtain tax exemption for expenses incurred for higher study and for repayment of debts incurred while obtaining a professional qualification.*

3. *To obtain a reduction in the rate of income tax on the middle group of incomes and thus to bring the taxation scale more into line with the scales in the United Kingdom, Australia and the United States.*

4. *To obtain from insurance companies interchangeability as between staff superannuation schemes operated by different companies and, if possible, to obtain from them superannuation benefits similar to those of the government scheme.*

### Acknowledgements

I am grateful to Prof. F. M. Henderson for permission to use the material and the graph from his address, to SACO for copies of their publication "Central Organisation of

Swedish Professional Workers" and to the Danish AS for a copy of their Rules as well as additional information which I requested.

### APPENDIX I.

#### Professional Associations Affiliated With the Swedish Central Organisation.

	Membership 31/12/66
Association of Research Librarians ....	165
Association of Business Administration Graduates in Public Service ....	437
Association of Officers in the National Board of Fisheries ....	30
National Association of Registered Physiotherapists ....	2,441
National Association of Secondary School Teachers ....	20,339
Central Organisation of Military Reserve Officers ....	6,001
SACO's General Group ....	757
Association of Headmasters and Directors of Education ....	1,774
National Association of Swedish Architects ....	1,917
Association of Swedish Public Librarians ....	1,030
Swedish Association of Museum Officers ....	560
Union of Swedish Church Clergymen	2,637
Swedish Association of Hospital Administrators ....	573
Association of Swedish Agronomists and Agricultural Teachers ....	1,959
Association of Swedish Archivists ....	83
Swedish Association of Graduate Engineers ....	11,666
Union of Swedish Pharmacists ....	2,920
Swedish Association of Local Assessment and Taxation Officers ....	134
Swedish Association of Liberal Arts Graduates ....	291
Swedish Federation of Jurists ....	8,068
National Federation of Swedish Masters of Forestry ....	1,066
Swedish Medical Association ....	8,040
Swedish Association of Scientists ....	1,065
Swedish Psychological Association ....	1,800
Swedish Association of Social Scientists	2,171
Swedish Union of Graduates in Social Work and Public Administration ....	2,686
Swedish Dental Federation ....	5,700
Swedish Union of Assistant University Teachers ....	2,381
Swedish Veterinary Association ....	1,072
Swedish Society of College Engineers	
University Teachers Association ....	1,700
	91,463

**Categories of Employment (1967)**

Central government	....	....	....	45,400
Local government	....	....	....	12,600
Private employment	....	....	....	10,700
Self-employed	....	....	....	7,000
Not gainfully employed (mostly students and retired)	....	....	....	17,500

**APPENDIX II.****Professional Associations Affiliated With the Danish Central Organisation.**

Architects' Assn.  
 Veterinary Assn.  
 Pharmacists' Assn.  
 Foresters' Assn.  
 Engineers' Assn.

Legal Assn.  
 Surveyors' Assn.  
 Assn. of graduates with higher degrees from Vet. and Agric. Colleges.  
 Medical Assn.  
 Graduates' Assn.  
 Gymnasium Teachers' Assn.  
 Clergymen's Assn.  
 Psychologists' Assn.  
 Dental Assn.  
 Economists Assn.

**REFERENCES**

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 Carrie, M. S. (1967). "Industry for Chemists." *J. of N.Z. Inst. of Chem.* 31, 123.

*This is the second article on Economic Trends and Research and Development in other Countries*

**DEVELOPMENT IN THE NETHERLANDS**

*A. M. Borren, Chem. Doctorandus*

Technical Manager, Philips Electrical Industries of New Zealand

THERE is a general awakening to the fact that the New Zealand economy, to support our high standard of living in the future, will have to complement the existing agricultural activity with a faster growing industrial activity. In order to achieve this, the whole community needs to be involved. For planning reasons it can be useful to study other countries which are in a more advanced phase of this process. An analogy can show what can be expected and the time in which targets could be realised.

The writer during his last European visit (May 1967) had access to some data on the Netherlands.

Hereafter will be shown:

1. The relative position of Agriculture-Industry-Services in the Dutch labour force structure.

2. The growth of Dutch Chemical Industries in three phases (with some remarks).
3. The role of the plastics industry as part of those industrial chemical activities.

**Relative position of Agriculture-Industry-Services (Fig. 1)**

As can be seen, the proportion of the labour force in industry and agriculture in New Zealand at the moment corresponds roughly with that in Holland in 1935.

Although the general circumstances might be sufficiently different to suspect that development in the two countries will not run parallel, it looks likely that the general trend of future development in New Zealand will lead to the same kind of change in labour force allocations.

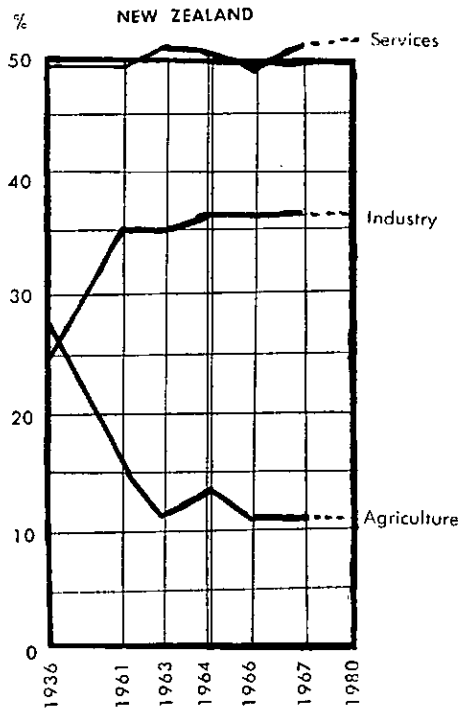
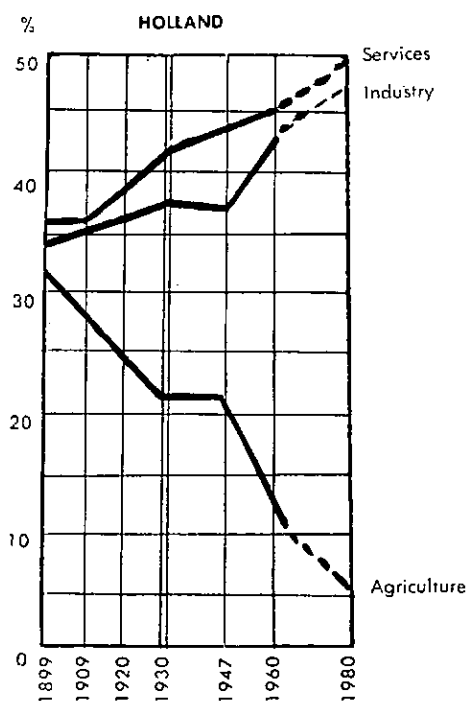


Fig. 1

### Chemical Industry in Holland (see Fig. 2)

(For comparison everything is expressed in pre-devalued £Stg.)

TURNOVER IN  
MILLION £STG.  
For 12.5 million  
people

1938	22.8
50	119.
55	200.
60	300.
61	325.
62	350.
63	375.
64	450.
65	520.
66	610.

FOR COMPARISON — 1966  
MILLION £STG.

Population

Germany	58.5 mill.	2500
U.K.	56.5 mill.	2100
France	48. mill.	1800
Italy	51. mill.	1700

These figures underline the importance of the chemical industry for a country like Holland. It can be seen that per capita it is of the same order as the N.Z. wool cheque per capita. In 1966, 60 percent of this turnover was exported and 40 percent used locally.

The growth of the chemical industry in the Netherlands took place in three phases:

1918-1940

Period of growing chemical "Trade".

1945-1958

Growth of chemical "Industry"

1958-1960

Common Market and U.S.A. influence.

The chemical "Trade" period is characterised by the existence of a number of small industries based on "chances". Some of these industries grew to interesting dimensions within this period.

Typical examples are:

- superphosphate
- hydrochloric acid
- gluc and gelatine
- rayon and dextrine
- chemical products for ink and printing
- some pharmaceuticals
- stearine candles.



SUCCESSOR TO THE  
NEW ZEALAND INSTITUTE  
1957-1933

# Newsletter

THE ROYAL SOCIETY OF NEW ZEALAND

No. 6 DECEMBER 1968

## ROYAL SOCIETY PUBLICATIONS

**TRANSACTIONS:** The following changes will be made when the present volumes of each series are complete—

Zoology (after volume 10 is complete) and Botany (after volume 3 is complete) will be combined as a new series, Biological Sciences, volume 11.

When Geology volume 6 is complete that series will continue as Earth Sciences volume 7.

The General Series will continue unchanged.

**PRICES:** For some years there has been no change in prices although printing costs have increased considerably. The following changes in prices are announced:

(1) To individual members of Member Bodies (paid through the Secretary of their own Member Body):

Transactions—	Biological Sciences	\$4.00 per year
	General	\$1.00 per year
	Earth Sciences	\$3.00 per year

Members' subscriptions will cover a calendar year irrespective of date of payment and will take effect from 1 January 1969.

The rates above are for individual members only and not for institutions.

(2) To non-members: Any series, \$6.00 per volume

### BACK NUMBERS:

Prices of back numbers are now

Volumes	1 - 53	\$2.00 per volume
	54 - 79	\$4.00
	80 - 88	\$6.00

Volumes since 88 \$6.00 per volume, any series.

Members may buy complete volumes of back numbers at 50 percent reduction if ordered through the secretary of their Member Body.

It is recognised that ordering of Royal Society Publications through the Member Body places an added burden on Honorary Secretaries. This seems unavoidable as the reduced rates are for financial members only; the Member Body Secretary, not the Royal Society, has the necessary information.

Proceedings will continue to be free to members on request, again through their Member Body Secretary.

## MEMBERS — CAN YOU HELP?

19th October, 1968.  
74 Preston Road, Papatoetoe,  
Auckland.

Royal Society of New Zealand,  
C/o Victoria University of Wellington,  
P.O. Box 196, Wellington.

Dear Sir,

Could you please supply our class with science as we are studying it at school. Thanking you.

Yours faithfully,

DAVID BELL (Class Secretary).

## SCIENCE IN INDUSTRY COMMITTEE<sup>3</sup>

*Here is further information about this committee. Your ideas on how science can make a more effective contribution to New Zealand's economy are asked for.*

In this past year we have become aware of the need to plan the future development of New Zealand. In August the Targets Committee of the National Development Conference set targets for increase in exports. These called for the greatest growth in non-traditional exports.

Economic growth is not just a matter of increase in the number of workers and of available capital. Substantial technological change is involved. It has been estimated that technological change accounted for two-thirds of the recent growth of the United States economy. An active research programme will not of itself bring about economic growth. The results of research must be translated into successful processes and products. To do this good communication and understanding between science and industry are needed. Management must be able to recognise science as a potential tool and be competent to utilise it. Scientists must be able to recognise the possible applications of their work and want to see their ideas developed into commercial successes.

For many scientists, interest in an idea or piece of research ceases with its publication. Publication informs technically advanced firms which employ their own scientists and engineers, but the majority of New Zealand firms do not employ scientists and consequently have no contact with scientific literature.

To help improve communication between science and industry the Royal Society has established the Science in Industry Committee with the following aims:

- To provide a link between scientists and industrialists.
- To advise on the national policy of scientific and technological assistance to industry, and to define the needs of industry.
- To stimulate technological innovation; the growth of science-based industry; and the profitable application of science in industry.
- To initiate studies and make recommendations aimed at understanding and improving the environment for technological innovation in New Zealand.

To make recommendations on the development of new science-based enterprises.

To encourage Government and university research in fields which are relevant to New Zealand's industrial requirements.

Members of the Committee are:

Mr J. B. Brooke, A.I.D.D., Auckland  
Mr L. Cameron, Gear Meat Co., Wellington  
Mr A. Crothall, Crothall & Co. Ltd., Christchurch  
Sir Woolf Fisher, Fisher & Paykel Ltd., Auckland  
Mr L. W. Fitch, Tasman Vaccine Laboratories, Upper Hutt  
Mr F. W. Holmes, Tasman Pulp & Paper Ltd., Kawerau  
Professor M. Kennedy, University of Canterbury  
Mr C. W. Mace, Mace Engineering Ltd., Christchurch  
Mr A. W. Mackney, N.Z. Forest Products Ltd., Auckland  
Professor J. A. R. Miles, University of Otago  
Dr M. C. Probine, P.E.L., Wellington (Chairman)  
Professor K. Scott, Massey University  
Professor A. Titchener, University of Auckland  
Dr J. S. Watt, Fletcher Industries Ltd., Auckland  
Dr R. W. Willett, D.S.I.R., Head Office, Wellington  
Dr W. G. Whittlestone, Ruakura Animal Research Station, Hamilton.

Have you any ideas? What will happen if you do take the trouble to send an idea to this Committee? While it cannot guarantee to sponsor everything put to it, it will undertake to give every idea serious consideration.

Here is an example; it was suggested that the animal pituitary and pancreatic glands which are byproducts of the meat industry could be utilised, that the economics of extracting their hormones and enzymes should be assessed, or alternatively that freeze-dried glands might be exported to overseas manufacturers for the extraction and purification processing.

As a result, Tasman Vaccine Laboratories are investigating the utilisation of biological wastes in the meat industry. As with all such commercial ventures part of the problem is technical and part commercial. The latter requires the knowledge of the industrialists on the committee.

The committee is considering other ideas. If you have anything to suggest, send your ideas to the Science in Industry Committee,  
c/o The General Secretary,  
Royal Society of New Zealand,  
P.O. Box 196, Wellington.

## **NEW MEMBER BODIES**

Entomological Society of N.Z.  
N.Z. Psychological Society.

Ornithological Society of N.Z.

## **NEW SOCIETY FORMED**

The New Zealand Association of Clinical Biochemists.

## ROYAL ASTRONOMICAL SOCIETY OF NEW ZEALAND

This society's main publication *Southern Stars* is a quarterly journal containing articles and reports of interest to astronomers. A number of these articles are of general interest; e.g. in the September issue are articles on "Why is it dark at nights?", "Rocket Technology", "Paris Observatory is 300 years old" and "Moonwatching in Canterbury".

Subscriptions without membership of the Society are accepted only from recognised scientific societies and institutions and from libraries.

HONOURS: The British Astronomical Association's Merlin Medal and Gift was awarded to Mr A. F. Jones of Nelson.

## NEW ZEALAND ARCHEOLOGICAL ASSOCIATION

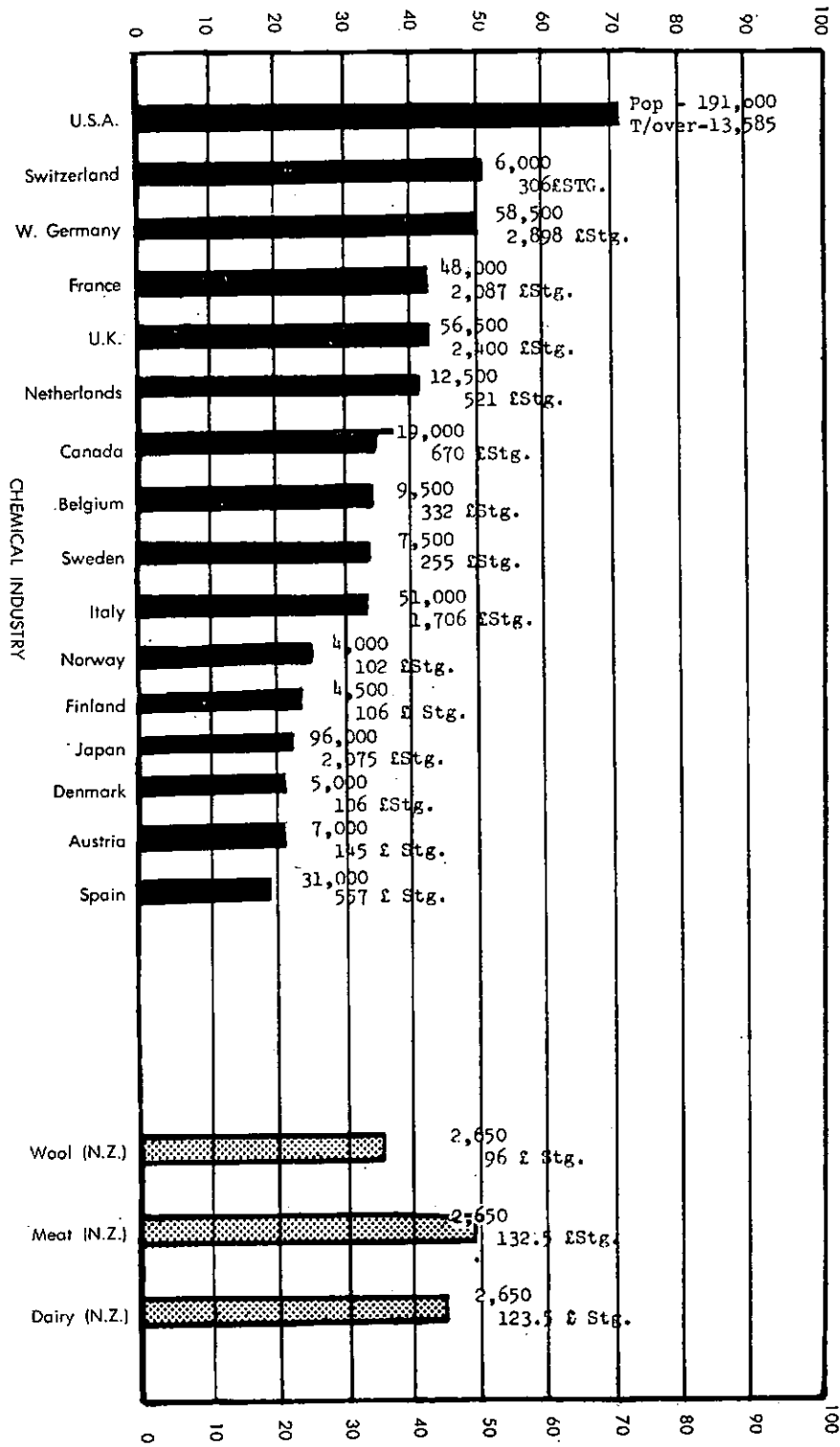
There is a shortage of popular and semipopular literature on New Zealand archeology and most people fail to appreciate the richness of our own pre-history. This shortage is reflected in the meagre information available to those of us who would like to add more interest to visits to various parts of the country. If you are one of these, you will find plenty of interesting information in the articles in the New Zealand Archeological Newsletter. The Moeraki boulders, Waikato swamps, North Cape, pa sites, dendroglyphs, fossils—there is plenty of information to make your visit to any such area more exciting and interesting.

*New Zealand Archeological Newsletter* published quarterly by the N.Z. Archeological Association. Distribution; The Editor, Dr A. G. Buist, Box 147, Hawera.

Wellington Archeological Society reports that it has 126 members and is steadily growing. No archeologist is employed in Wellington, so all work is entirely amateur and sparetime. Frequent evening lectures and a monthly bulletin help to train members, and field activities are well supported.

## COLEOPTERA WORKERS PLEASE NOTE

There are still available some copies of early publications, notably *Bulletin Number 1* and *Manual of N.Z. Coleoptera*. These are substantial works of continuing value.



Turnover expressed in £Stg for comparison reasons.  
 Per Capita/Per Year:  
 (Turnover 1965 in mill. £Stg for Europe)  
 (Population x 1000)  
 (Turnover 1965/66 in mill. £Stg for New Zealand)

Fig. 2

That period is quite comparable with the existing situation in N.Z. Initiating the after (War I) war phase electrolysis led to more HCl and Cl<sub>2</sub> production. In 1930 ammonia was produced from atmospheric nitrogen and hydrogen from coke. In 1940 carbide was being manufactured. Then the war stopped everything and destroyed a lot.

### Growth of Chemical Industry

The years 1945 to 1958 were spent in rebuilding what had been started before 1940. The lack of import money helped because all production could be sold locally. The chemical industry grew with about £20 million per year turnover by intensifying the country's knowledge and knowhow. It was further helped by the fact that quite a few big firms with international contacts threw themselves into the chemical field—e.g. Dutch Mines, Shell, Philips, Unilever, Royal Salt and Dutch Steel Works. The next phase was basically possible from here on and was held up only by the scope of the market.

Up to this stage the development in New Zealand should run parallel.

### Common Market influence

The Common Market with its tariff-free exchange worked as a magnet for Dutch chemical industries.

Access to this market in Germany (Ruhr), France and Italy from Holland with its big ports and rivers, was attractive pricewise. Many European and U.S.A. chemical companies decided from 1959 onwards to start in Holland. The explosive growth as shown in the introduction to this chapter took place in the last 8 years.

The value of this to the Dutch community is considerable and (compared with the New Zealand attitude) it is perhaps interesting to note that there is no worry at all about too much U.S.A. influence. Americans' share of joint ventures plus wholly owned com-

panies is still under 10 percent of total and is unlikely to ever pass 15 percent. It is considered that their coming is a stimulus both because of the knowhow they bring and the markets their mother companies open up for Holland.

Holland seems destined to become the biggest European per capita supplier in the chemical industry.

It is perhaps useful to add some thoughts about the growth of these industries. There are in Holland approximately 400 chemical enterprises producing about 2,000 products. Of these products not more than 30 would show the above mentioned sensational expansion. The enterprises involved in producing this expansion are generally large ones, i.e. among the 25 which have a turnover greater than £2½ million per year. Nowadays only activity of that order can afford the money for research and development. This research is, however, absolutely essential to reach continuity of production and guarantee a negotiating position with other world units in the patent and licence field. It is only such knowledge that can nowadays keep these larger activities going.

### Plastic Industry in Holland

Year	Chemical Ind. (In mill. £Stg)	Plastic Ind.	% from Chemical
1958	250	25	10.0
59	270	30	11.1
60	300	40	13.3
61	325	45	13.9
62	350	50	14.3
63	375	60	16.0
64	450	75	16.6
65	520	90	19.2

The plastic industry is a special case of chemical industry and, as is illustrated above, has grown even faster than the rest. It has now one-fifth of the yearly turnover of all chemical industries. The following list gives an idea of the main firms and their products.

**AKU:**

Nylon 6 as moulding powder, in bars, in yarns  
 Cellophane  
 Rayon yarns and fibres  
 Polyester yarns (Terlenka) and fibres  
 Viscose products  
*Together with Amoco:*  
 Petrochemie dimethylterephthalate  
*Ciagor together with Goodrich:*  
 Synthetic rubbers and latexes based on styrene,  
 butadiene acrylonitrile and acrylates.

**Polychemie and AKU-G.E.:**

A joint-venture with General Electric will produce in the near future a very new product, polyphenyleneoxide.

**Shell:**

Polyvinylchloride, epikotes, alkdressins, synthetic rubbers (A.o. styrene-butadiene and isoprene)  
 Polyethers for urethane foams  
*Joint-venture with Montecatini:*  
 Rotterdamse Polyolefinen  
 Polypropylene.

**Du Point:**

Polyacetal resins (Delrin)  
 Acrylonitrile fibres (Orlon)  
 Polyurethane fibres (Lycra)  
 Announced production of tetrafluorethylene polymers and copolymers.

**DSM (State Mines):**

Polyethylene (low and high density)  
 In the near future ethylene-propylene terpolymers and E-P rubbers and important raw materials for plastics such as urea, melamin, formaldehyde and caprolactam for Nylon 6.

**K.Z.K.:**

Polystyrene, vinylacetate and polyvinylacetate ion-exchange resins, all sorts of lacquer resins soon in a joint-venture with Celanese.

**Konam:**

Polyvinylalcohol and vinylacetate.

**Hercules:**

Penta-, maleinate-, modified alkyl- and phenol-resins and an announced product of dimethylterephthalate for polyesters.  
 Styrene monomer and polymer polystyrene foams, polyvinylidene films, latexes on the basis of styrene, butadiene and acrylonitrile, polyethers for urethane foams.

**I.C.I.:**

Polymethylmethacrylate sheets (Perspex) and moulding powders.  
 (Diakon) Nylon 6.6 polyester films (Melinex).  
 Soon they will produce polyethylene, ethylene-terephthalate (for Terylene) and chlorinated rubber.

**Foster Grant with Hoechst:**

Polystyrene.

**Hoechst (Tercanal):**

Sheets of melamin-formaldehyde and phenol-cresol-formaldehyde resins.

**Lacquer resins:**

Synres (with Allied Chemical), Synthese (Royal Salt), Scada (with Archer Daniels).

**Neville-Cindu:**

Petroleum resins.

**Conclusions**

The New Zealand economy, as regards the role of industry, is in the same phase as the Netherlands was 30 years ago.

In the Netherlands the revenues of the chemical industry have now grown to a level per capita which is comparable with the New Zealand wool cheques.

Although the geographical position of Holland may be more favourable than New Zealand's, everything else indicates that there is no basic reason to believe that New Zealand could not reach comparable activities, up to the point where Holland entered the EEC.

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**BOOK REVIEW**

'Analar' Standards for Laboratory Chemicals, 6th edition, 1967. Published by Analar Standards Ltd., London. \$4.50.

This plastic covered hard cover edition, nicely bound, has 16 new items. Additional tests have extended many specifications and many individual tests have been improved or replaced. The layout is good.

J.M.

## THERMODYNAMIC PROPERTIES OF GASES AND GAS MIXTURES

A. G. Williamson, M.Sc., Ph.D.

Department of Chemical Engineering, University of Canterbury

THE industrious chemical engineer is continually plagued by lack of the data he needs to design economic processes to produce the substances which the ingenious organic chemist has made in the laboratory. The chemical engineer wishes to make these substances to provide, among other things, a more comfortable armchair for the indolent physical chemist to sit in while he tries to figure out a way of providing the chemical engineer with data without actually measuring anything. Some chemical engineers have even joined the physical chemists in their search and some chemical engineers keep "tame" physical chemists. Nevertheless, the fact that the rate of growth of the literature of physical chemistry is as frighteningly large as that in other fields is a measure of our failure so far to achieve the ideal state wherein we need to make no new measurements.

As an example of what is being done, let us look at recent efforts in the study of the properties of gases.

The well-known equation of state for the perfect gas

$$pV = nRT \quad \dots (1)$$

is far from accurate for many real gases even at atmospheric conditions and becomes more inaccurate as the density of the gas is increased. The deviations are, of course, a result of the molecular interactions. These imperfections are often of considerable importance to the calculations of the chemical engineer. It would be an advantage if, instead of having to measure the P-V-T properties over a wide range of conditions, we could calculate the behaviour from the intermolecular forces alone or from measurements under only one set of conditions.

There are two major problems in doing this. Firstly, we must be able to relate the

properties of a large collection (say,  $6 \times 10^{23}$ ) of molecules to the individual molecular behaviour and secondly, we must know what the intermolecular forces are.

Neither of these problems has been solved completely. However, partial solutions to the first have been obtained using the methods of statistical mechanics and to the second using quantum mechanics. Statistical mechanics gives us recipes for calculating the virial coefficients B, C, D, etc., in equation 2.

in terms of the intermolecular forces. For example, in the simple case of spherically symmetrical interactions (3).

where  $u(r)$  is the intermolecular potential energy for an isolated pair of molecules whose distance apart is  $r$ . Quantum mechanics suggests rules for calculating  $u(r)$  as a function of the separation and (for more complicated molecules) the relative orientation of the molecules.

These theories may be tested by comparison of the calculated values of the second virial coefficient, B, with the values determined by experiment. This in turn requires measurements of the P-V-T behaviour of gases down to densities sufficiently low that the terms higher than that in B in equation 2 are negligible.

In the case of gaseous mixtures there is the further complication of the interactions between unlike molecules which cannot be studied independently of the interactions between the like molecules. Statistical mechanics gives us the relation for the second virial coefficient (B in equation 2) for a mixture as in equation 4.

$$pV = nRT(1 + B(n/V) + C(n/V)^2 + D(n/V)^3 + \dots) \quad (2)$$

$$B = 2\pi N \int_0^{\infty} (1 - \text{Exp}(-u(r)/kT)) r^2 dr \quad (3)$$

$$B_m = x_1^2 B_{11} + 2x_1 x_2 B_{12} + x_2^2 B_{22} \quad (4)$$

$$\lim_{p \rightarrow 0} (\partial H / \partial p)_T = (B - T(dB/dT)) \quad (5)$$

$$\lim_{p \rightarrow 0} \Delta_m V = x_1 x_2 (2B_{12} - B_{11} - B_{22}) \quad (6)$$

$$\lim_{p \rightarrow 0} (\Delta_m H/p) = x_1 x_2 (2B_{12} - B_{11} - B_{22})$$

$$-T \frac{d}{dT} (2B_{12} - B_{11} - B_{22}) \quad (7)$$

in which  $B_{12}$  has the meaning given by equation 3 with  $u(r)$  equal to the potential energy of interaction of an unlike pair of molecules. Quantum mechanics suggests recipes for calculating  $u_{12}(r)$  in terms of  $u_{11}(r)$  and  $u_{22}(r)$ . These may be tested using measurements on mixtures of gases over a range of temperatures.

The classical method of obtaining the experimental data has been the accurate measurement of  $p$  vs  $V$  over a range of pressures for each of a series of temperatures. This approach is very tedious and requires measurements of  $p$  and  $V$  with an accuracy of a few parts in  $10^6$  if results suitable for testing the theories are to be obtained. However, there has recently been an increase in interest in these measurements and more elegant and more accurate experimental methods are being used. For example, the temperature dependence of the second virial coefficient can be obtained from the isothermal Joule-Thomson coefficient  $(\partial H/\partial T)_p$ , via the relation in equation 5.

For mixtures, the relation between  $B_{12}$  and  $B_{11}$  and  $B_{22}$  can be obtained from measurements of the volume changes of mixing,  $\Delta_m V$ , of gases at constant pressure 6.

or from the pressure changes on mixing of gases at constant volume. The temperature dependence of the unlike interaction term  $B_{12}$  can be derived from the heats of mixing,  $\Delta_m H$ , of gases in the form 7.

This last experiment may seem rather surprising as a precise method of determining gas properties. The heats of mixing of dilute gases are very small. But so are the heat capacities of gases. The experimentally accessible property is the temperature change and this, even for simple molecules, can be large. For example, the mixing at constant pressure (1 atmosphere) and a temperature of  $85^\circ\text{C}$  of equal quantities of benzene and cyclohexane leads to a temperature drop of a few tenths of a degree.

Studies of the P-V-T properties of gases using these newer experimental methods are being carried out in the Department of Chemical Engineering at Canterbury University. Dr S. P. O'Neill is working on a new apparatus for determining second virial coefficients of pure substances using a method which requires precise measurements of pressures only. The apparatus can, with minor modifications, be converted for the measurement of volume changes on mixing. A flow calorimeter for the heats of mixing of gases, the design of which has been tested, will be constructed later this year. This work (along with studies of the thermodynamics of liquid mixtures) is supported by the Petroleum Research Fund of the American Chemical Society and by the New Zealand Refining Company Ltd. and is aimed at providing data on simple systems of sufficient accuracy for testing some of the theories mentioned above.

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## BOOK REVIEW

*Chemistry, Physics and Application of Surface Active Substances*. Volume 1. Chemistry of Surface Active Substances. Ed. F. Asinger. (Gordon and Breach Science Publishers, New York, 1967.) Pp. Lx + 549. Price \$39.00.

This volume comprises a very tardy record of part of the proceedings of a conference held in Brussels in 1964. About half the pages are in English, about a third in French, and the remainder in German. The papers are research contributions, apart from one plenary lecture of some twenty pages.

The price is, of course, extremely high, especially when it is remembered that the reader might well have to pay for the translation of some of the papers into his own language. I suppose that high cost and the inconvenience of a multi-language book could be justified if very important work were being made rapidly available to interested workers in the field. This book does not seem to me to have any such justification, and I cannot think that many individuals or libraries would wish to purchase copies.

C. G. POPE.

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C. G. POPE.

Current Chemistry . . .

## THE MEASUREMENT OF TRANSITION PROBABILITIES AND OSCILLATOR STRENGTHS

*C. R. Boswell, M.Sc.(Hons.), Ph.D.*

Analytical Sciences Division, Atomic Energy Research  
Establishment, Harwell, England

WHEN a spectral line is observed in the laboratory the two main values associated with it are its wavelength and its intensity. The former is generally known to six significant figures and is determined by the energy change in the atom producing the given line. From quantum mechanics

$$h\nu = E_m - E_n \quad (1)$$

where  $h$  is Planck's constant,  $\nu$  is the frequency of the light, and  $E_m$  and  $E_n$  are the energies of the initial and final states respectively. The absolute intensity of the line depends on the depth of the emitting source, the density of excited atoms in the given upper level, the frequency of the emitted light, and a factor defined by Einstein as the transition probability. This latter term is based on the assumption that the number of spontaneous transitions taking place in unit time is governed by a law similar to that for radioactive disintegration.

If there is only one lower state to which transition can occur this can be represented by

$$\frac{dN}{dt} = -NA \quad (2)$$

where  $N$  is the number of excited atoms in the given state and  $A$  is a constant, defined by Einstein as the transition probability. More generally, when there is more than one lower state to which transition is possible, equation (2) becomes

$$\frac{dN}{dt} = -N\sum A_i \quad (3)$$

where the summation is carried out over all possible lower states.

Under the above conditions the total intensity emitted by an element in transitions

from upper state  $m$  to lower state  $n$  is given by

$$I = \frac{1}{4\pi} (N_m A_{m,n} \lambda) h\nu \quad (4)$$

where  $N_m$  is the density of atoms in state  $m$ ,  $A_{m,n}$  is the appropriate transition probability,  $l$  is the thickness of the emitting layer, and  $h\nu$  is the energy per quanta.

An equivalent relationship can be obtained using the so-called oscillator strength of the line,  $f$ , which is the number of classical oscillators equivalent to one atom in a given state. It can be shown<sup>1</sup> that

$$f = \frac{m c^2}{8\pi e^2 \nu^2} A_{m,n} \quad (5)$$

where  $m$ ,  $e$ ,  $c$ , and  $\nu$  are the mass and charge of an electron, the velocity of light, and the frequency of the transition respectively.

Transition probabilities and oscillator strength are used in a number of fields. These include the calculation of the composition of stellar atmospheres, temperature measurements in hot gases such as in electric arcs and sparks, and in plasma physics. Experimental values are also used as a means of checking theoretical calculations of atomic structure. Although the importance of their use in the selection of suitable lines for spectrochemical analysis has been pointed out,<sup>2</sup> little application has been made in this field, probably because of the paucity of data available until recently. Experimental values of transition probabilities and oscillator strengths often differ by large amounts (in some cases values differing by a factor of up to 500 have been noted in the literature) and new and accurate experimental values are needed for all elements.

A number of techniques have been developed for the measurement of transition probabilities and/or oscillator strengths. Many of them are relatively restricted as they can only be used for strongly absorbing lines such as the resonance or ground state lines of atoms. Although these methods are important in that they supply absolute values for comparison with other techniques, they will not be described here. For an excellent description of these techniques the reader is referred to the review by Forster.<sup>1</sup>

The majority of transition probabilities for the spectra of metal atoms and simple ions have been determined using arc discharges. All these determinations are based on the fact that, for arcs at atmospheric pressures, the processes controlling the populating and depopulating of energy levels do not involve absorption of radiation. It is therefore possible to assume that all excitation is carried out thermally and that local thermodynamic equilibrium holds. Under these conditions Boltzman's relationship can be assumed to hold so that the number of atoms in an excited energy level is given by

$$N_m = \frac{g_m N}{u} e^{-\frac{E_m}{kT}} \quad (6)$$

where  $g_m$  is the statistical weight of the level with energy  $E_m$ ,  $N$  is the total number of atoms present,  $u$  is the partition function,  $T$  is the absolute temperature and  $k$  is Boltzman's constant. The use of equation (6) in conjunction with equation (4) therefore enables the evaluation of absolute transition probabilities, providing that all other quantities are known. Generally the latter is not the case and relative values are obtained which, in some cases, are converted to absolute values by suitable normalisation. This method has yielded one of the most comprehensive sets of transition probabilities. Corliss and Bozman<sup>2</sup> used intensity data from arcs in which the copper electrodes had been dosed with traces of metals to give transition probabilities for some 25,000 lines of 70 elements.

Although oscillator strength can be evaluated from emission data by the use of equations (4), (5) and (6), absolute values are readily determined by measurement of the absorption of light by a cloud of unexcited atoms. Such a system is that of King<sup>3</sup> where light from a continuum is passed through a beam of atoms and, for a given line, the effective amount of light absorbed by the beam is measured. A variation of this technique uses an absorption furnace where the beam of atoms is replaced by a heated sealed tube containing, in the gas phase, an appreciable amount of the element under study. The prime disadvantage of the latter method is the requirement of accurately known vapour pressures for metals at high temperatures. The former technique is used primarily for the study of resonance lines, while the latter is more generally applicable.

One of the most powerful methods for the determination of oscillator strengths is that of anomalous dispersion. Light from a continuum is passed through a Jamin-Mach interferometer, one arm of which is a furnace containing the vapour of the element under study. On resolution by a spectrograph it is possible to calculate  $f$ -values by measurement of the hooks in the interference fringes near absorption lines. An excellent discussion of this is also given in the review by Forster.<sup>1</sup>

With the number of techniques available for the measurement of transition probabilities and oscillator strengths a few sets of reasonably accurate absolute values are being obtained. However there is still considerable uncertainty in both the accuracy and precision of the values obtained. Radical new and accurate methods are necessary before any major advances can be made.

#### References

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## Current Chemistry . . .

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## NZIC CONFERENCE — 1969

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### Programme

See NZIC Journal December 1968, p. 202.

The following speakers have accepted invitations to contribute to the symposia.

#### *Proteins*

Chairman: Dr. A. T. Johns, Director-General of Agriculture.

Introductory and Meat: Dr. R. H. Locker, Meat Research Institute.

Dairy: Dr. P. S. Robertson, Dairy Research Institute.

Plant: Dr. J. W. Lyttelton, Plant Chemistry Division, DSIR.

N.Z.'s Contribution: Dr. W. A. McGillivray, Dairy Research Institute.

#### *Fibres*

Chairman: Mr. Warwick Olsen, General Manager, Tasman Pulp and Paper Co.

Introduction: Professor G. N. Malcolm, Massey University.

Wool: Dr. A. J. Farnworth, Australian Wool Board.

Vegetable: Dr. D. J. Brasch, Otago University.

Synthetic: Dr. A. F. Wilson, N.Z. Forest Products Ltd.

#### *Chemical Based Industries*

Chairman: Professor A. M. Kennedy, Dept. of Chemical Engineering, University of Canterbury.

Introductory Paper: Dr. P. K. Foster, PACRA.

The Fertiliser Industry: Dr. J. Rogers, Fertiliser Research Association.

The Aluminium Industry: Mr. J. Hunt, COMALCO.

Biochemical Industries: Professor R. L. Earle, Massey University.

### Guest Speakers

Dr. A. J. Farnworth, who will give the general lecture on wool in the fibres symposium, is Scientific Advisor to the Australian Wool Board. Although now in administration he previously worked with C.S.I.R.O. where he developed the well known SIROSET process.

Mr. J. W. Rowe, Director of the Economic Research Institute will address the conference on "The Future in New Zealand for Science-Based Industries".

### Public Lecture

Professor H. N. Parton has accepted an invitation to deliver the public lecture on the Thursday evening.

### Group Meetings

As an extension of the notes about group meetings published in the December Journal it is now pointed out that Tuesday evening is also free. If they wish, group organisers may use this time for the formal discussions about the formation of 'groups' or 'sections'; this would allow them to use Monday morning and afternoon for scientific sessions.

## BOOK REVIEWS

*Physical Chemistry of Surfaces.* By A. W. Adamson. 2nd ed. (Interscience Publishers, New York, London, Sydney, 1967). Pp. xx + 747. Price \$15.00 (Australia).

This is a new and somewhat extended edition of a book which was enthusiastically received when it was first published in 1960. The main additions are in the sections on contact angle, adsorption from solution, and the chemical physics of the adsorbed state at the gas-solid interface. In all, the book has been increased by about 120 pages. Adamson rightly claims that the content is somewhat more quantitative and concentrated than before, but despite this, the book still remains eminently readable.

A feature of the text is the large number of problems which are well thought out and often demanding. Rather unfortunately, the answers to the numerical problems are no longer included. The diagrams are very clear and helpful; the use of real experimental data wherever possible certainly helps them to seem more meaningful. The photographs used are always interesting.

It seems doubtful to the reviewer whether as much surface chemistry as is included in this book should be included in any university course, but many teachers will find reference to the particular topics they wish to cover very helpful to themselves and their students. Furthermore, they might reasonably hope that any student looking at a restricted topic could easily be tempted by this book to read on.

In short, this is an extremely good book at a reasonable price by current standards. It can be thoroughly recommended as probably the best introduction covering a wide range of topics in surface chemistry which is at present available.

C. G. POPE.

*Chemistry and Industry.* Edited by D. G. Jones. Published by the Clarendon Press, Oxford, 1967, 217 pages. Price 40s. (Also available in paper covers).

This book has been written to show those who are studying degree chemistry how chemistry is used in industry. It succeeds remarkably well.

The first chapter explains how physical chemistry can help answer the questions that must be asked to test the technical and commercial feasibility of a new process. Examples are taken to demonstrate the use of equilibrium constants, reaction kinetics, and the phase equilibria of multi-component systems. The text is supported by well-selected references to the chemical literature.

Chapter 2 deals with the organic chemistry of several oxidation processes of industrial impor-

tance. A concise account is given of the reaction mechanisms underlying the production of phenol from cumene and of acetic and peracetic acids from acetaldehyde. Much of the work described was carried out in industrial laboratories and there is emphasis throughout on the need in industry for close collaboration among the organic chemist, the physical chemist and the analyst.

Chapter 3 discusses the phase equilibria underlying two long-established inorganic chemical processes: ammonium sulphate manufacture from ammonia and anhydrite, and ammonia oxidation to nitric acid. The point is well made that a simple stoichiometric equation can cover a multitude of complex chemical problems which must be unravelled if a process is to be properly designed and operated. (The author of this chapter—J. Manning—has written "An Introduction to Chemical Industry" which could well be read in conjunction with the present book; and both books would furnish useful case-study material to lecturers in chemistry wishing to show how their chemistry may be used in practice.)

Chapters 4 and 5 discuss product and process development to the commercial scale. Among the topics introduced are flow diagrams; batch versus continuous operation; reaction kinetics applied to continuous flow systems; product separation by distillation, solvent extraction and other techniques. To a chemical engineer these chapters are the least satisfactory in the book. Unlike the earlier chapters, their subject matter is drawn from a context that is not particularly familiar to the chemistry student and they range over the whole domain of chemical engineering. The results are inevitably somewhat scrappy. In a modern chemical plant the capital cost of product separation equipment may be three or four times greater than that of the chemical reaction itself; and separation difficulties, rather than the chemistry of the reaction, may dictate the synthesis route chosen. The process chemist needs an awareness of diffusion and mass transfer rate limitations for a proper understanding of the behaviour of chemical plant. Mass transfer deserves more than passing mention, even though the emphasis in this book quite rightly rests on the application of chemical principles.

Chapter 6 reminds us that chemical plants must make money as well as chemicals. The author shows where money comes from, how much it costs, and how one might assess the economic merits of alternative projects. An admirable account is given of the cost components of chemical production and of the factors involved in the repayment of capital.

The final chapter shows, in slight but entertaining fashion, how a chemist might be involved

in the "systems analysis" approach to the improvement of plant performance. It rounds off a book that should be read by any chemistry student with thoughts of a career in industry and by any chemical engineer who needs reminding of the significance of chemistry to his particular brand of engineering.

*Rotational Spectra and Molecular Structure*, by James E. Wollrab. Academic Press, New York and London, 1967. 468 pages. US\$20.

The author of this monograph is a research scientist with the McDonnell Douglas Corporation, St. Louis, Missouri, and this work appears as a rather surprising by-product of the U.S. Army Redstone Missile defence programme. In content it forms a thorough review of the theoretical background to microwave spectroscopy with particular emphasis on areas which have developed significantly since the standard work of Gordy, Smith and Trambarulo in 1953.

The treatment is well indexed and complete and follows a logical mathematical development. Structural results derived from spectra are, however, mainly confined to a series of tables through the text. For this reason they are not of much purpose in illustrating the application of the theoretical basis, and from this standpoint Wollrab's book can be compared unfavourably in presentation with the volumes of Herzberg and of Wilson, Decius and Cross on vibrational spectra.

Major sections deal with Rigid Rotors (45 pp.), Centrifugal Distortion and Coriolis Coupling (35 pp.), Molecular Structure through Moments of Inertia (25 pp.), Nuclear Quadrupole Coupling (25 pp.), Internal Rotation (60 pp.), Inversion (40 pp.), and Stark Effects (35 pp.). A 30-page chapter on instrumentation is included. An outstandingly good feature is a classified bibliography of over 1,700 references which provides a complete guide to microwave spectroscopy up to 1966.

Clearly this is a book of concern mainly to spectroscopists but it is sufficiently original to deserve a call on library funds. In the context of physical chemistry teaching a perusal of this work serves to show just how much wider the scope of microwave spectroscopy has become than the simple deduction of geometry of small molecules.

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Subject to the consent of the University Council, professors may undertake a limited amount of higher consultative work.

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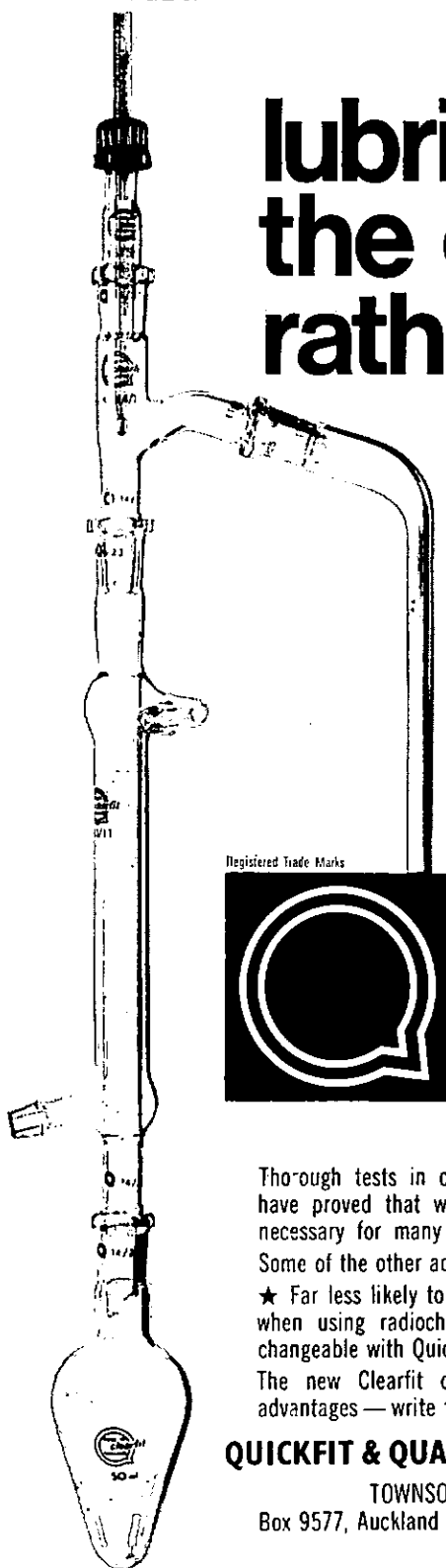
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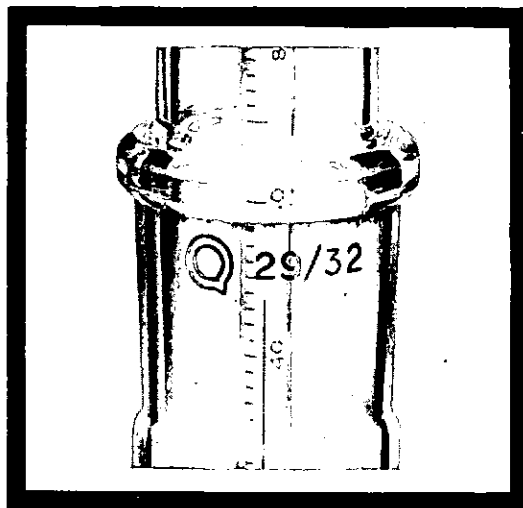
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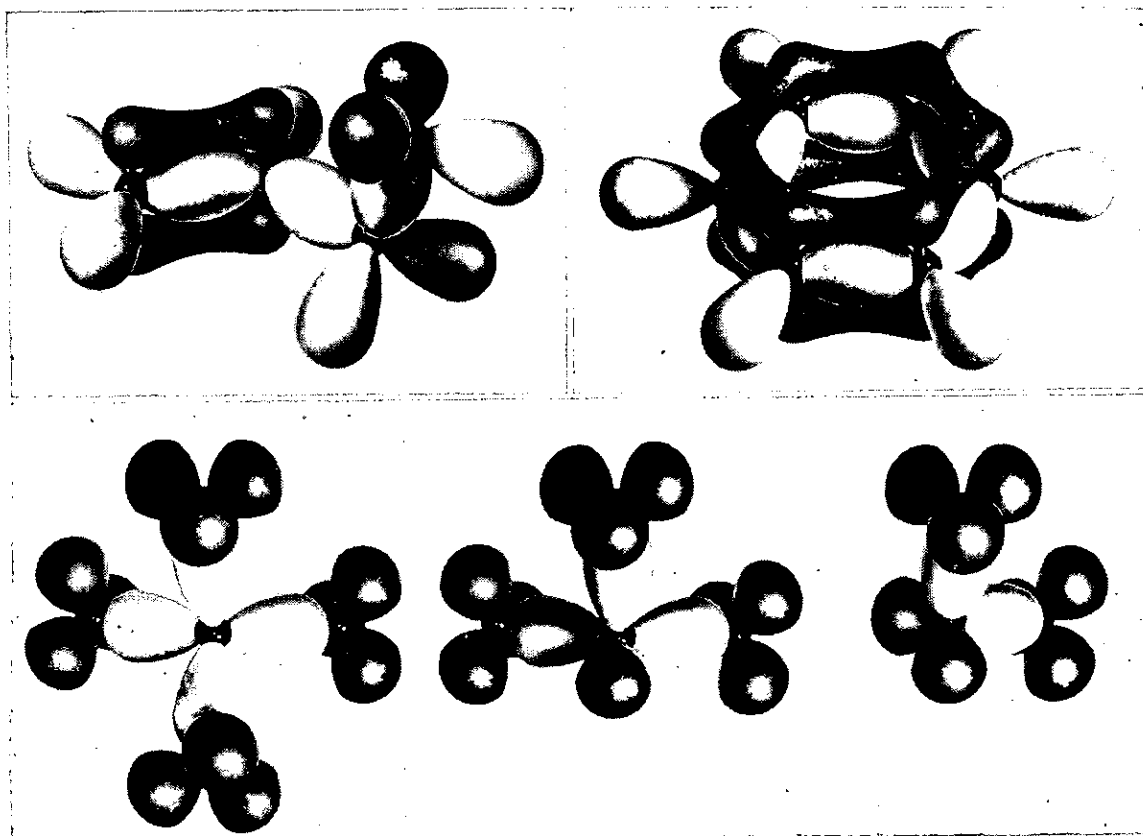
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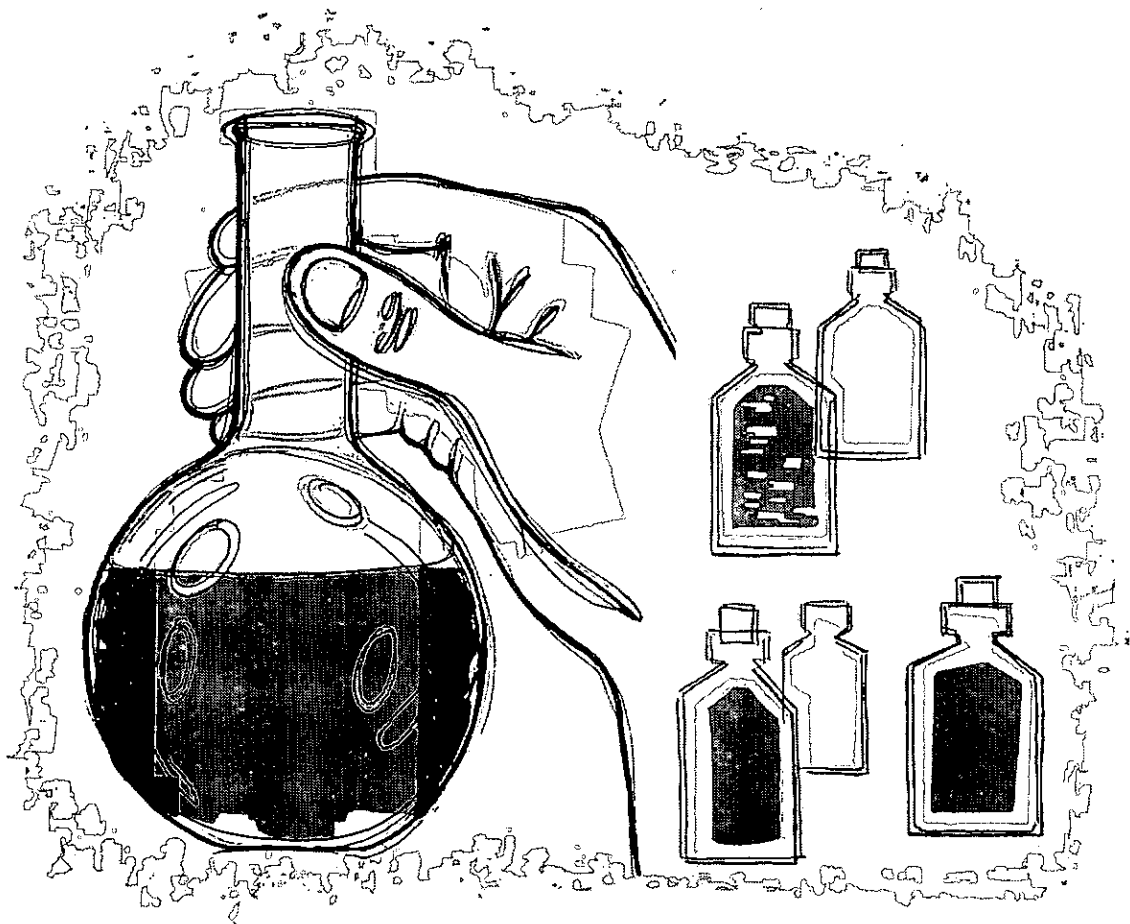
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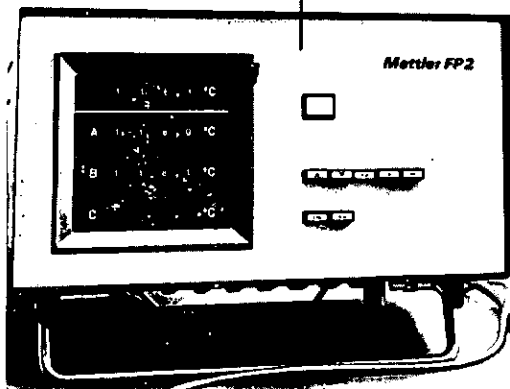
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