

JOURNAL OF THE NEW ZEALAND
INSTITUTE OF CHEMISTRY

Vol. 27 No. 5
October, 1963





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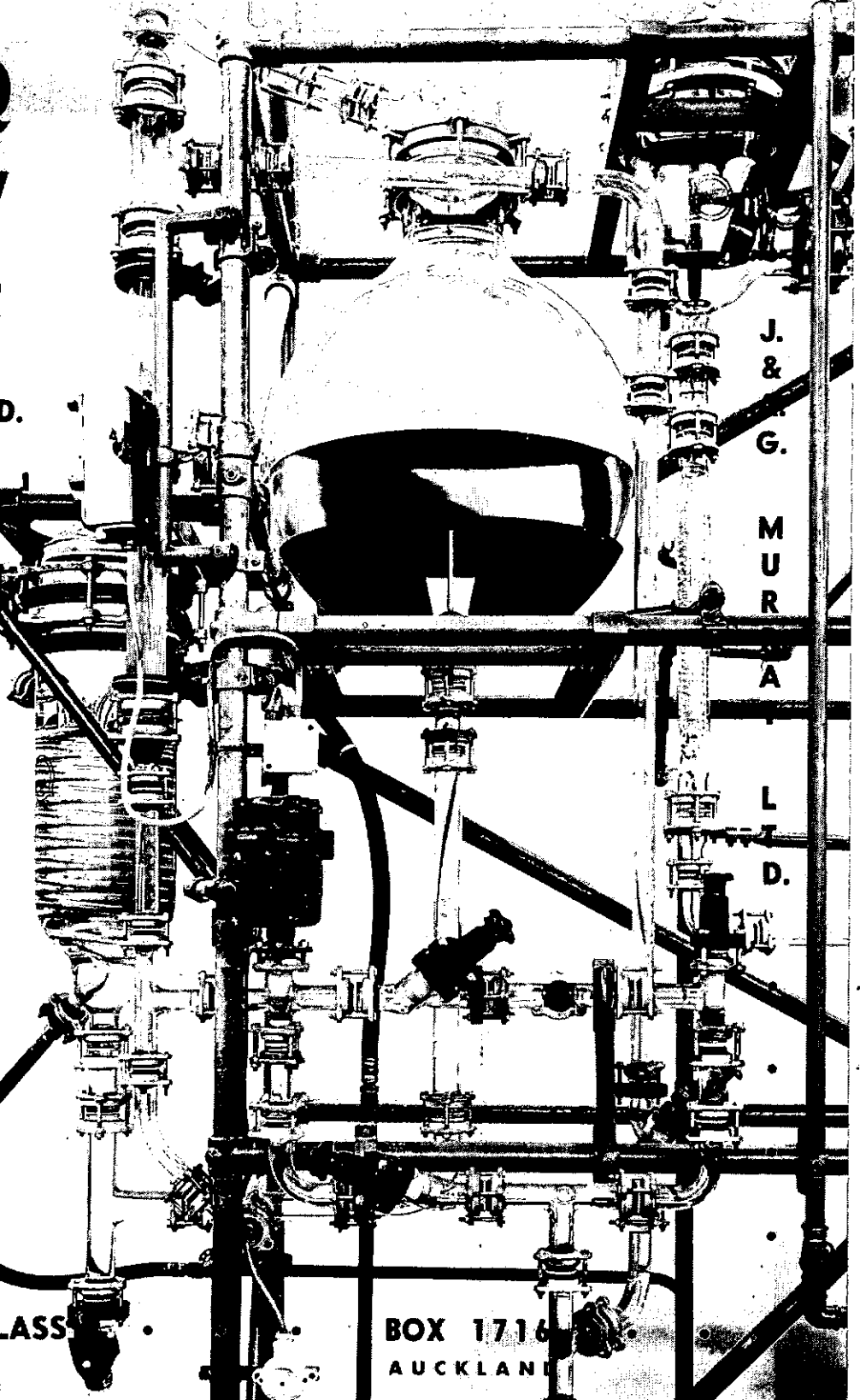
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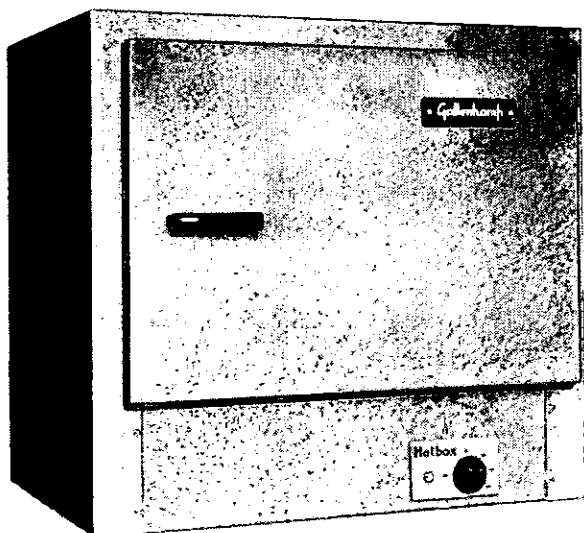
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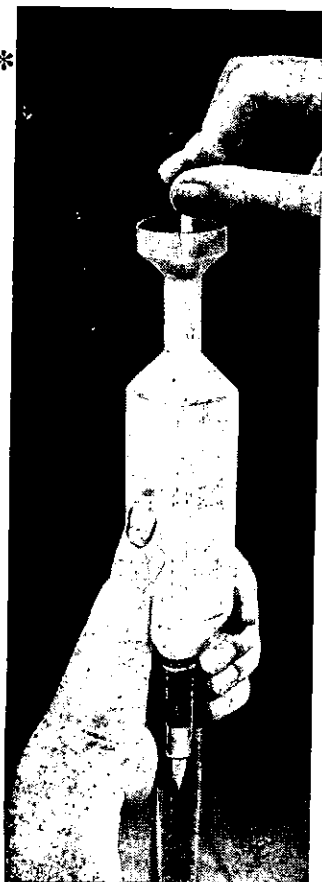
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1. Metcalfe, L. D. and Schmitz, A. A., *Anal. Chem.*, 1961, **33**, 363-4.
2. Mitchell, J., Jnr., Smith, D. M. and Bryant, M. W. D., *J. Amer. Chem. Soc.*, 1940, **62**, 4-6.

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1. Hough, L. and Jones, J. K. N., *J. Chem. Soc.*, 1951, 1122-6.
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3. Bamford, W. R. and Stevens, T. S., *J. Chem. Soc.*, 1952, 4735-40.

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1. Nagakawa, K., Konaka, R. and Nakata, T., *J. Org. Chem.*, 1962, **27**, 1597-1601.



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A COUNCIL TO COUNSEL

At the August meeting the Council of the Institute passed the following resolution:

The Council of the N.Z. Institute of Chemistry expresses its concern at the press statement attributed to the Minister of the Department of Scientific and Industrial Research to the effect that various scientists' organizations are happy with the amended National Research Advisory Council Bill. The N.Z.I.C., along with other scientific societies, has consistently made it clear that it is not satisfied with the Bill as it exists. The organization set up by the Bill is advisory only and lacks executive power. The future development, extension and co-ordination of scientific research in New Zealand is a matter of serious concern and we believe that the issues involved have been largely side-stepped.

Following release of this resolution to the daily press a similar statement was made by the President of the Royal Society of New Zealand, and it is understood that other scientific societies have resolved along the same lines.

The latest draft of the Bill has taken some account of earlier objections to the constitution of the Council by requiring the Minister, when making appointments, to have regard to "the need for adequate representation on the Council of persons qualified in scientific research"; and to representations made by "organizations concerned with the advance of scientific research". Ironically, reduction of the membership by dropping three Heads of Departments from the Council weakens the machinery for "co-ordination" of scientific research which was a major concern of the Commission on State Services in recommending a new Council.

The new draft Bill appears to have two main defects. One is that it sets up a body, presumably intended to improve the organization of scientific research, without prior enquiry into what is required or the form this body should take. The other is that the new Council is still advisory only; it has no executive powers to put its decisions into effect. In fact, apart from some possible advantages derived from its composition it seems to differ little in authority or function from the Council of Scientific and Industrial Research which it abolishes.

It may be that our scientific progress will be best served by State departments advised by a Council; but that does not appear to have been the experience of other Commonwealth countries which are operating more effectively than we are. It is difficult to see how scientific research in New Zealand can be re-organized without a thorough examination of our present services and our needs. Probably one of the first acts of the new Council will be to make its own enquiry into the organization of research. If it does, the learned and professional societies can assist by assembling facts and opinions. If it does not, these societies might go further and combine to institute their own enquiry. Having said that it is not happy with the Bill, the Institute should be prepared to make some positive proposals with which it would be happier.

THE UTILIZATION OF LOW RANK COAL

W. G. M. HUGHSON

Dominion Laboratory, Petone

(Presidential Address to the New Zealand Institute of Chemistry, delivered at the Annual Conference, August, 1963)

WHAT IS "LOW RANK" COAL?

Low rank coal is not necessarily *low grade coal*. A *low grade coal* may be unevenly sized, or it may contain an excessive amount of mineral matter, or have some other undesirable quality. A *low rank coal*, on the other hand, is merely a *young coal* in the lower part of the metamorphic scale which classifies carbonaceous material into peat, brown coals, lignites, sub-bituminous non-coking coals, over the borderline between non-coking and coking coals to bituminous, super-bituminous and anthracitic coals. *High rank coals* are generally taken as those above the borderline and *low rank coals* as the non-coking peats, brown coals, lignites and sub-bituminous classes. The outstanding characteristic of low rank coals is the moisture content and this varies consistently with rank. Peats carry the highest percentage of water—about 80%; Australian brown coals range from 65% to 48%; German, American and New Zealand lignites are found in the 50% to 20% range and our Waikato and Ohai coals represent the best of the low rank coals with moisture contents from 20% to 10%; the non-coking/coking borderline can be taken at approximately 10% moisture. In the Reefton field we have coal ranging on either side of the border, from 15% moisture down to 6% moisture. At 10%, coking properties become evident.

SCOPE FOR LOW RANK COAL

In most countries, industrial revolutions were founded on high ranking bituminous coals and equipment was developed specifically for these coking coals. Britain had no other coal but Germany had high rank coal in the west and low rank coal in the east. German ingenuity therefore soon

The Address on which this text is based was illustrated with about 70 slides, many of which were provided by Mr Claus Gloc, Geologist to the Victoria State Electricity Commission, to whom the author expresses his thanks for this assistance and for hospitality at Yallourn and Morwell.

recognized the possibilities of utilizing these coals for a wide variety of purposes. Since much of the German lignite occurred in seams up to 30 ft thick, with about the same amount of overburden, the development of large and varied machines which could economically remove this overburden and also the coal was encouraged. Germany greatly developed briquetting techniques and produced the revolutionary Bergius and Fischer-Tropsch processes for making petrol from coal and the high pressure, Lurgi, complete gasification process for town gas.

WORLD PRODUCTION OF HIGH AND LOW RANK COALS

Over the last 40 years, other European and Asian countries have followed Germany's lead while nearer home is the rapid development of the Victorian resources in the Latrobe Valley 90 miles east of Melbourne. Between 1951 and 1960 the world production of high rank coal increased from 1,507 million metric tons to 1,971 (average annual increase 3.4%) while low rank (non-coking) coals increased from 417 to 643 (6% annual increase).

THE SITUATION IN NEW ZEALAND

Our reserves of high rank bituminous coals are confined to the coalfields of the West Coast, adjacent to Greymouth and Westport. Much of this coal is of excellent quality (some is unduly high in sulphur) but because of its isolation from centres of consumption, transport costs are high and shipping from bar harbours costly. On the other hand, Waikato and Ohai coals, which can be classed as the best of the low rank coals, occur near large centres of population; recent developments have shown that they can be used, economically, for most purposes. We use annually 700,000 tons (21×10^{12} gross B.t.u.) of our high rank coals and 1,850,000 tons (41×10^{12} gross B.t.u.) of the low rank; that is, about twice as much heat is being obtained from the low rank as from the high rank coals.

Total Energy Produced in New Zealand

In order to study trends in energy consumption in New Zealand over a period of seven years and to show the role played by low rank coals, the total B.t.u.'s supplied by the various sources of energy are set out in Table 1.

Effective Energy

These forms of energy have different efficiency factors — coals 33%, petrol 20%, heating oils 50%, electricity 75% — so that the figures in Table 1 must be multiplied by these factors to compare the effective energies. Expressed as

TABLE 1. Total Energy Used in New Zealand (B.t.u. $\times 10^{12}$)
(Oils used for bunkering overseas ships omitted)

Year	High Rank Coal	Low Rank Coal	Petrol	Heating Oils	Electricity
1956	24	39	38	16	15
1957	25	38	39	18	16
1958	25	41	40	20	18
1959	25	43	40	20	18
1960	24	48	43	23	19
1961	23	43	46	25	19
1962	21	40	47	26	20

percentages of the total effective energy from all sources the proportions contributed by each source during 1962 were: High rank coals 12% ; low rank 23% ; petrol 16% ; heating oils 23% ; electricity 26%.

Effective Energy in Fields Competitive with Coal

Such figures cannot be used to compare coal with competitive sources of energy over a period of years because the use of petrol in internal combustion engines, and of electricity for lighting and certain other purposes, are fields specific to these forms of energy, in which coal has never competed. To make such a comparison possible all the petrol and 50% of the electricity have been omitted and the percentages recalculated (Table 2).

This is a most interesting table from the point of view of "low rank" coals. In 1960, low rank coals led the field by a good margin (38%) but by 1962 had dropped back to "first equal" with petroleum heating oils (diesel and furnace oils) which had been steadily gaining ground over the seven year period.

Heating oils and electricity for heating have gained 11% over the period and at the present time coal carries about 50% of the total load (60% in 1956), heating oils 30%, and electricity 20%.

TABLE 2. Effective Energy (%) in Fields Competitive
with Coal

Year	High Rank Coal	Low Rank Coal	Heating Oils	Electricity (for heating)
1956	23	37	23	17
1957	22	36	25	17
1958	20	36	26	18
1958	20	36	26	18
1960	19	38	26	17
1961	19	33	31	17
1962	17	32	32	19
1956-1962 Plus or Minus	-6	-5	+9	+2

Of the coal load, two-thirds is carried by "low rank" coals which indicates the importance of this supply of energy to New Zealand.

HIGH AND LOW RANK COALS IN AUSTRALIA

As in New Zealand, Australia segregates its high and low rank coals. High rank coals occur in New South Wales and Queensland but only low rank coals are found in West Australia, South Australia and Victoria.

In the Latrobe Valley, 90 miles east of Melbourne, brown coal occurs in phenomenal quantity in a concentrated area. There are two main fields; the Yallourn-Morwell area of 60 square miles which is estimated to contain 10,000 million tons of recoverable coal beneath an overburden of approximately 50 ft, and the Loy Yang field a little further east where several boreholes have encountered over 700 ft of continuous coal and one exceptional drill after penetrating 96 ft of overburden showed 900 ft of coal broken only by three clay bands totalling 9 ft.

Total resources of the Latrobe area are quoted at 27,000 million tons and the seams at present being mined are 200 ft thick in Yallourn seam and down to 400 ft in the deepest part of the Morwell seam.

The history of the development of the brown coal resources of Victoria is a most interesting one and follows the pattern of West Germany. When Germany was deprived of the Saar coal subsequent to the first World War and had to supply much of her Ruhr coal in reparations, ways and means of utilizing her brown coal resources were very urgently investigated with the result that Germany led the world in hydrogenation of coal, the manufacture of petrol from coal, the high pressure gasification of coal for the making of town gas, and also in the manufacture of briquetting machinery. In somewhat similar circumstances, Victoria could not always get high rank bituminous gas or steam coal from New South Wales for various reasons and transport was costly.

How Brown Coal is Used in Australia

I have chosen to pay particular attention to the use of low rank (brown) coal in Australia because of its interesting history, the scale of present operation, and the extensive plans for immediate and future development.

I propose to deal briefly with three aspects of utilization:

- (1) Brown coal for use in boilers for raising steam. This steam is used to generate electricity in a land not over-

flowing with hydro possibilities; it is also used for process steam in the briquette works.

- (2) The conversion of very wet, low rank, brown coal to a high quality briquette. The briquettes are used for household purposes, as a locomotive fuel, for steam generation and for the manufacture of town gas.
- (3) The making of town gas from briquettes in high-pressure Lurgi generators.

(1) STEAM GENERATION

Yallourn was the first power station built for the generation of electricity using steam from boilers fired with Victorian brown coal. The Yallourn Station consists of five sections, A, B, C, D, and E. "A" came in to service in 1924 and "E" has just been completed. The total rated capacity is 621,000 kW for the whole station.

In the twenties, the burning of coal containing 50 or 60% of water was a completely novel experience and combustion engineers had to start designing boilers afresh for this new type of fuel. In the earlier boilers provision was made for drying the coal by allowing it to cascade down the full height of the boiler over a series of staggered louvres. It was then burned on stationary step grates and later, on mechanical step grates or chain grates. Steam pressure in "A" and "B" stations ranged from 270 to 295 lb/sq. in. and the temperature from 650 to 750°F.

By 1938, "A" and "B" stations were fully operational with a capacity of 100,000 kW. After the war, Australia's industrial development surged ahead so that by 1958 "C" and "D" stations were contributing another 206,000 kW to the total capacity of Yallourn. The demand for power continued and "E" station has now been added with a further 240,000 kW.

The "C", "D" and "E" stations all burn raw brown coal as it comes from the pit or opencut. The coal is milled or pulverized in streams of hot gases and blown immediately into the furnace.

Following overseas practice in the burning of raw brown coal, each of the 120,000 kW turbo-generators in the Yallourn "E" station has but one boiler instead of three as in Yallourn "C" and "D". Each boiler has a capacity of 950,000 lb of steam per hour at a pressure of 1,600 lb/sq. in. and a temperature of 1,060°F. For comparison, by 1971 the new Hazelwood Power Station, at present under construc-

tion, will comprise six turbo-generators each with a capacity of 200,000 kW, making a total for the station of 1,200,000 kW. To generate this amount of power requires a considerable tonnage of coal especially if it contains 65% of water when mined.

Coal Requirements

In 1961, the output of brown coal in Victoria was over 16 million tons and the new Hazelwood station, by 1971, it is stated, will require 13 million tons per annum. The latest boilers in Yallourn "E" consume 215 tons of brown coal per hour which means that the station could require approximately 1,000 tons an hour.

The Opencuts and Mining Machines

There are now two main sources of brown coal — the Yallourn opencut and the Morwell opencut about 5 miles south of Yallourn, both situated about 90 miles from Melbourne on either side of the main road and rail route east.

Similar machinery is used in each place and is based on German developments and capable of dredging the soft coal in lifts of about 80 ft. Special machines remove the overburden and transport it to the hole from which the coal has been removed.

The largest and most versatile machines, known as chain-bucket dredgers, originally ran on rails but now most machines move on two enormous pairs of crawler tracks. The chain-bucket dredgers are capable of moving slowly along the full length of the opencut, shaving off a strip of coal from either 80 ft above track level or 87 ft below. The largest of these machines is 90 ft high, weighs 2,200 tons and can mine coal at a rate of 1,750 tons per hour.

The latest and most spectacular machines are the bucket-wheel dredgers which dredge coal to a height of 70 ft above track level by means of a series of 10 or 12 buckets on the circumference of a huge wheel at the end of a 200 ft boom. The coal, at the rate of 1,350 tons an hour, drops through the bottom of the buckets at their highest point, out through the centre of the wheel and on to a conveyor belt which takes it to a hopper at the heart of the machine. From there it is either loaded on to 20-ton cars or boomed to a continuous conveyor belt which carries it direct to power station or briquette factory. Yallourn Power Station operating at capacity would require 50 cars of coal every hour.

(2) THE BRIQUETTING OF LOW RANK BROWN COAL

Sticking materials together usually requires a binder — at the briquetting works in the Waikato the char is crushed

and mixed intimately with atomized pitch which not only binds the particles together but makes the briquette water-proof.

Low rank coal supplies its own binder and the lower the rank the better the binding properties. Yallourn coal, for instance, with an original moisture content of 65.5% makes a much better briquette than Yallourn North coal with a moisture content of 50%.

Theoreticians are not yet decided as to what supplies the binding force. One thing is certain and that is that the moisture content is critical. Very wet material will not bind and very dry brown coal will not bind. The moisture content must be in the region of 15%. In addition to this critical moisture figure there is the cellular and colloidal nature of the coal. The establishment of optimum conditions between these factors is the responsibility of the briquetting engineer. The analyses of both raw brown coal and finished briquette supply a considerable amount of information and are therefore placed on record (Table 3).

TABLE 3. Analysis of Yallourn Brown Coal and Briquettes

	<i>Yallourn Brown Coal</i>	<i>Yallourn Briquettes</i>
Proximate Analysis %		
Moisture	65.5	13.0
Volatile matter	17.5	44.8
Fixed carbon	16.3	40.4
Ash	0.7	1.8
Ultimate Analysis %		
Carbon	22.6	57.2
Hydrogen	1.6	4.0
Nitrogen	0.2	0.4
Sulphur	0.1	0.2
Oxygen	9.3	23.4
Ash	0.7	1.8
Moisture	65.5	13.0
Calorific Value B.t.u./lb net	3,000	9,090

The moisture content, it will be observed, is the major item to be reduced in converting brown coal to briquettes. Although the ash is not high, its variable fusibility can cause trouble. A furnace burning 215 tons of coal an hour, even with as low an ash content as 0.7%, will have 36 tons of ash to dispose of every 24 hours. The need for keeping a close watch on the quality of the coal has been recognized and a programme of detailed analyses of about 3,000 samples a year emphasizes the need of rapid methods of analysis to determine all mineral constituents and especially those that are known to have a nuisance value.

Briquette Manufacture

The manufacture of briquettes can be considered briefly in a series of steps:

- (1) The wet coal from the open cut is crushed, screened and sorted in its wet state. Larger coal goes to the boilers and the evenly sized material is conveyed to the drying building.
- (2) The water content is reduced to about 15%, plus or minus a few per cent., depending on the nature of the coal; the dryers are huge drums, 13 ft in diameter and 26 ft long fitted with about 800 (4 in. diameter) steel tubes. The drums are set at an inclination of 8° and rotate about 6 times a minute. Steam from the turbines surrounds the tubes and the wet coal passes through the tubes. The second half of each tube is fitted with retarding strips of various designs to retard the larger and wetter particles and bring them in closer contact with the hot walls while the smaller particles, which are already sufficiently dried, are escorted more quickly out of the system through small central tubes. This is one of the finer controls made necessary because the moisture content must be adjusted within fine limits if the full binding forces are to operate in making a strong briquette.
- (3) The dry coal is then conveyed by redler conveyors to the cooling house where it gravitates from the top bunker down over a series of staggered louvres open to the air.
- (4) The next process, for the spectator, is the climax of the system. In the pressing process where the briquettes are made there are sufficient engineering controls to occupy the attention of a student for a considerable time. Data from factories with presses of various designs all over Germany, the problems of producing maximum tonnage from minimum space, the best metals for various parts of the machines and many other aspects of design make this section of the factory intensely interesting.

Essentially, the coal drops down from a hopper into the path of a plunger which with a hammer-like blow forces the coal into the press mould which gradually tapers over a length of about 2 ft. The mould holds about 15 briquettes and as the plunger adds *one* briquette at the front, *one* is forced out at the back.

This string or rope of briquettes in a tapering press provides the pressure of about 10 tons per sq. in. which produces the binderless briquette.

- (5) The final process is the cooling of briquettes on a long launder and in hot weather special assistance must be given in order to get a briquette hard enough for loading into wagons for transport.

Yallourn factory makes over 600,000 tons of briquettes a year and one ton of briquettes requires four tons of brown coal for overall manufacture.

Briquettes are made in a variety of shapes, designed for specific purposes. The large brick-like household (H) briquette is now packaged in a 36-briquette paper packet for clean handling by sales organizations. The bars of 5 or 7 nut briquettes are broken into individual "nuts" as they leave the presses and are especially recommended for furnace firing.

(3) TOWN GAS FROM LOW RANK COAL

The possibility of making town gas from Victorian brown coal had been studied since 1930. After World War 2, the Lurgi high pressure method was selected and German experts came to Australia as consultants in establishment of the process. The requirements of coal were so large that a new opencut had to be envisaged at Morwell and a special factory built to supply briquette fuel.

The Lurgi Process

When brown coal briquettes are burned with pure oxygen and steam in a gas producer at 400 lb/sq. in. there is no diluting nitrogen present and a maximum amount of methane is produced. That is the essence of the process but to run it requires the conversion of a large supply of coal to briquettes and the production of tonnage oxygen. After manufacture the gas must be thoroughly purified. The purification train has a special feature — the pressure built up in the generator is maintained throughout the various processes and is actually sufficient to "push" the purified gas to Melbourne through an 18 in. pipeline.

Gas purification consists of:

- (1) A spray-washer and waste heat boiler where some water and tar are drawn off.
- (2) Further cooling in tubular heat exchangers.
- (3) Removal of benzole in a scrubber tower filled with trays where a special wash oil made in the process is used.

- (4) Carbon dioxide and much of the hydrogen sulphide are removed (under pressure) in a tall washtower filled with ceramic rings. The water from this tower passes out through a turbine and is revived in an aeration tower and used again.
- (5) The final process is removal of traces of hydrogen sulphide with iron oxide or luxmasse and the addition of a characteristic "gas odour" for leak detection.

It is then passed through a drying unit to deter corrosion in the long 90-mile pipeline journey to Melbourne. Devices are also added to the pipe to resist "electrical" corrosion. Isolating valves every 5 miles and connecting pieces every 10 miles allow for repairs and for "looping" when the pipeline is duplicated. The line is designed to carry 90 million cu. ft of gas daily and when it arrives in Melbourne its calorific value is raised from 400 to 500 B.t.u. per cu. ft by blending with refinery gases.

Because of fluctuations in demand during the day it is proposed to set up a plant for synthesis of petrol from the Lurgi gas. This will allow continuous running with the synthesis plant taking excess gas when it is not required in the pipeline.

SUMMARY

All coals constitute about 90% of estimated fuel reserves of the world, of which 20% is classed as low rank. All coals supply about one-third of the world's energy requirements — oil supplies one-third and natural gas and hydro power about one-sixth each. Allowing for efficiency, low rank coals contribute about 7% of world energy requirements.

Victoria has shown great enterprise in the development of its phenomenal resources (over 27,000 million tons) of low rank coals. The main use is as a boiler fuel, especially to produce 1,200,000 kW of electricity. Other uses include conversion to a high calorific value fuel as briquettes, thereby saving the transport of 2 tons of water for every ton of useful fuel; and in manufacture of town gas by the Lurgi high pressure process.

Victoria is now mining 16 million tons of brown coal per annum and demands are rising rapidly. Such expansion demands extensive scientific investigations to maintain a knowledge of reserves available, their quality, new methods of processing and more efficient methods of utilization.

Utilization of low rank coal is expanding at about 6% annually and there is every justification for advocating further advancement.

QUALITATIVE ELEMENTAL ORGANIC ANALYSIS

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(Paper based on the Chairman's Address delivered to the Otago Branch N.Z.I.C., March, 1963)

INTRODUCTION

Qualitative organic analysis, the practice of identifying an organic compound by a series of fundamental tests, is a topic of major importance to a wide range of chemists. The toxicologist, the forensic chemist, the consulting chemist, as well as the pure research chemist, are all concerned from time to time with the identification of some organic compound of unknown origin. Although many of us have a wide range of physical instruments at our disposal much information towards the identification of a compound may be obtained by carrying out a systematic series of qualitative tests using quite inexpensive apparatus. The detection of the elements present in an organic compound, including the detection of carbon to prove that the compound or substance is organic or contains organic material, is in many cases one of the most fruitful and rewarding of the possible qualitative tests.

The current trend in analytical chemistry is towards the use of smaller samples. This is particularly important where the compound is expensive — it may be difficult to isolate or difficult of synthesis. In many cases the neat apparatus used in small scale work induces care which gives its reward in accurate results. Qualitative elemental analyses have now been carried out on a milligram scale for over half a century, and with the advent of still more sensitive balances, methods are being devised for carrying out accurate quantitative analyses on a 50 micro-gram scale using a sample which is just visible to the unassisted eye. On the other hand, the success of qualitative analysis is not governed by the use of a balance as is quantitative analysis. The selectivity, sensitivity and reproducibility of various colour and precipitation reactions are the determining factors. The occasional use of a balance to check sample size is worthwhile but no one need consider himself at a disadvantage in qualitative work if he does not possess a highly sensitive balance.

A considerable amount of work on qualitative elemental organic analysis has appeared in recent years largely as a result of the efforts of Feigl and his collaborators. Although these and other recent developments (1) which pay parti-

cular attention to the use of sensitive and selective methods are incorporated in recent editions of Feigl's *Spot Tests in Organic Analysis* (2), successive editions of current laboratory manuals appear with only scant reference to such developments. Many suggest a sample size of 20 mg for the detection of nitrogen, halogens and sulphur; one even suggests the use of 0.1 g merely to detect the presence of carbon or hydrogen. Why use material sufficient for a thousand determinations in one test? Such quantities besides being wholly unrealistic may in many cases be extremely dangerous. In dealing successively with various elements the writer wishes to give publicity particularly to some of the more recent developments and lesser known tests which may be applied in the detection of the elements present in a compound or substance of unknown identity.

CARBON

By definition organic compounds contain carbon. But frequently we wish to know whether or not a particular substance is an organic one. In the field of co-ordination chemistry carbon compounds play an important role and the incorporation of an organic group into such a complex may be checked by noting the presence or absence of carbon. How many organic chemists have extracted and rigorously purified ammonium chloride or elemental sulphur and submitted it for quantitative carbon analysis?

The detection of carbon presents no difficulty if ample material is available. The sample is heated with dry copper oxide and the carbon dioxide produced is led into lime-water. Emich (3), over 45 years ago, described a much more elegant method. The sample is combusted in a sealed tube filled with oxygen and the CO_2 formed is reacted with a single drop of baryta in the same tube. Interference from sulphur and halogens may be eliminated by the addition of a small amount of lead chromate to the tube.

The Lassaigne procedure, the common method used for the detection of nitrogen, halogens, etc., may also be used as a relatively sensitive method for the detection of carbon, for cyanide will be produced only if carbon as well as nitrogen is present. The method involves the addition of ammonium sulphate (4) to provide the necessary nitrogen and the fusion is then carried out in the normal manner, the presence of cyanide in the resulting solution being indicative of carbon in the test substance. The drastic conditions of the Lassaigne sodium fusion procedure may be eliminated by using more recently developed methods. A procedure which is sensitive to 1 μg of carbon involves

fusion of the sample with sodamide (5), this reagent being similar to a combination of sodium and ammonium sulphate as used in the preceding method. A few years ago Caldas and Gentil (6) noted that mercuri-amido-chloride (infusible white precipitate) also produces cyanide when fused with carbonaceous material. In this case hydrogen cyanide is detected in the gas phase by its reaction with copper benzidine acetate to give benzidine blue. A sensitivity down to $1\mu\text{g}$ of carbon in a compound such as urea has been obtained.

There are several other methods available for the detection of carbon but although they have a high sensitivity they also require a fair amount of skill or caution. Use has been made of the reaction of magnesium (7) with carbon to give an acetylide which liberates acetylene on the addition of a drop of water. The colour change on careful ashing with yellow molybdenum trioxide (8) is quite sensitive — the lower oxides of molybdenum are blue in colour. Another ashing technique (2) involves the reduction of brown red silver arsenate to silver. The silver may be detected by the change of colour or by making use of a sensitive colour test following reaction with hydrochloric acid. There are many methods to choose from. The detection of carbon down to 1°g quantity should present no difficulties whatever.

HYDROGEN

Ability to detect hydrogen may be extremely useful providing the test is conclusive and the quantity of sample required is small. We are familiar with the dehydrogenation properties of elemental sulphur with the consequent formation of hydrogen sulphide. Feigl (9) has found this reaction to be an extremely sensitive one for the detection of hydrogen, it being sensitive to $0.5 - 0.1\mu\text{g}$ of hydrogen in a wide range of compounds. The sample is heated with excess sulphur to about 220 or 250°C when hydrogen from the compound or from its decomposition products (including water) produces hydrogen sulphide. The reaction is carried out in a small combustion tube of 4 to 5 mm diameter and the hydrogen sulphide is readily detected with lead acetate paper. Surely this test would satisfy any critic.

OXYGEN

Very little success has been attained in the search for a reagent or reaction which will give a simple but conclusive test for the presence of oxygen in an organic compound.

One method (10) of limited applicability makes use of the solubility of red ferric thiocyanate in oxygenated solvents or in hydrocarbon solvents containing oxygenated solutes. Ferric thiocyanate is, in general, insoluble in compounds lacking oxygen but nitrogen and sulphur compounds do in most cases act similarly to oxygenated compounds.

A reliable method is based on the quantitative method (11) used for the determination of oxygen but the apparatus required is elaborate compared with that normally used in the detection of the elements. By reaction with carbon, oxygen in the organic compound is converted to carbon monoxide which may be detected by its reaction with a reagent such as iodine pentoxide. Although a stream of very pure nitrogen is required to carry the carbon monoxide through the apparatus a very much simplified version of the quantitative apparatus may be used because only a qualitative result is required. Smith and Ohlson (12) have used a pyrolysis method in a helium atmosphere, detecting the carbon monoxide formed with silica gel impregnated with a mixture of palladium sulphate and ammonium molybdate. This yellow complex turns green or blue in the presence of carbon monoxide.

NITROGEN

The classical Lassaigne procedure is one of the most widely used methods for the detection of nitrogen in organic compounds. The compound under test is fused with an alkali metal and the resulting alkali cyanide is easily detected by its conversion to Prussian blue. This method is, however, not entirely reliable. Stephen (1) points out that this technique is not without hazard particularly with completely unknown materials, and certain compounds may even escape reaction. There are two modifications of the Lassaigne method. Castellana replaced the alkali metal by a mixture of magnesium powder and anhydrous potassium carbonate but this mixture is sensitive to atmospheric nitrogen and modifications used to eliminate contamination with nitrogen are not entirely satisfactory. Middleton uses a mixture of zinc dust and anhydrous sodium carbonate which is insensitive to atmospheric nitrogen but Tucker (13) points out that, although both these modifications of the original procedure appear simple, they require a fair amount of skill and are not without hazard. In a recent modification (14), which is very sensitive and gives positive results where the Lassaigne test fails, the cyanide produced by sodium fusion is con-

verted to cyanogen chloride with chloramine T. Reaction with dimedone in pyridine then gives polymethine dyes. Feigl and Amaral (15) fuse the nitrogen-containing organic compound with manganese dioxide in a micro test tube, when nitrogen in the compound is converted to nitrogen oxides which may be detected at the mouth of the tube by the conventional Griess reagent impregnated on a disc of filter paper. Difficulties arising from compounds of low volatility are overcome by suitable modification of the reaction conditions.

The Griess test is an extremely sensitive one for the detection of low concentrations of oxides of nitrogen, or nitrite resulting from the absorption of these oxides in aqueous solution. Ingram's study of the products of combustion of nitrogen-containing compounds in a conventional combustion train for the determination of carbon and hydrogen suggests that even from compounds such as azobenzene, which might be expected to split out nitrogen, some oxides of nitrogen are always formed. It has been shown that combustion of a nitrogen-containing compound in an oxygen filled flask gives nitrite (16), detectable by the Griess test, following absorption of the combustion products in dilute alkali. Using a 50 or 100 ml conical in a scaled down version of the conventional apparatus used in quantitative analysis it has been shown that there is no difficulty in detecting nitrogen in 0.5 mg organic compound (17). Further investigations are under way to test more sensitive reagents than those used by Griess and to investigate the percentage of sample nitrogen which is converted to nitrite. It is known that in the presence of bromine in the sample no nitrite is detected although this defect may be overcome by the use of a copper or silver gauze in place of a platinum gauze in the combustion apparatus. Free bromine produced in the combustion oxidizes nitrite to nitrate which is not detected. The inclusion of copper or silver obviously removes the halide during combustion preventing its reaction with nitrite.

SULPHUR

It is not always necessary to devise a test in order to detect the presence of sulphur in an organic compound particularly if the compound is volatile. However, a test is required for non-volatile compounds. Perhaps the most common test is based on the Lassaigne fusion procedure in which sulphide coming from sulphur in the compound is detected by its colour reaction with sodium nitroprus-

side. Feigl (2) makes use of the extremely sensitive test in which sulphide catalyses the liberation of nitrogen from a solution containing iodine and azide.

A very reliable and remarkably rapid and sensitive test for sulphur is the pyrolytic reduction method of Feigl (2). When sodium formate decomposes above its m.p. (250°C) hydrogen is produced. In the presence of a sulphur-containing compound the sulphur is converted to hydrogen sulphide which may be detected with lead acetate paper at the mouth of the tube. The method is sensitive to 5 to 10 μ g sulphur in most compounds. Combustion of the sample in an oxygen filled flask and subsequent detection of sulphate offers no particular advantage over the previously described method. If the solution is available from a combustion used to detect nitrogen, sulphite is oxidized by hydrogen peroxide to sulphate which may be detected as barium sulphate either in the presence or absence of a protective colloid. Small amounts of sulphate may also be detected by precipitation with 4-amino-4'-chloro-diphenyl hydrochloride (16).

HALOGENS

The time-honoured Beilstein test is a very rapid and simple method for the detection of halogens although it gives many anomalous reactions. The fact that thiourea, 8-hydroxyquinoline, and certain substituted pyridines give a positive test is explained by assuming that HCN or HCNO is produced during the pyrolysis and their copper salts colour the flame. However, many compounds which definitely give HCN on decomposition fail to give a green flame. There are reports that the green colour is lighter in anomalous cases. The simple modification of Jurecek and Muzik (18) overcomes anomalous reactions. The sample is ignited on a platinum spatula and the green colour reaction is observed above a copper gauze held above the flame. For volatile compounds the sample may be burnt in a very small gas jet issuing from a copper tube when halogen will again colour the flame green. The sample is volatilized in a glass tube which is connected on one side to the gas supply and on the other to the copper tube.

Other tests for halogen may also enable the nature of the halide to be determined. The halogen in the compound is converted to a soluble halide by one of several fusion techniques as described for nitrogen. It has also been shown that the solution obtained on combustion of a halogen-containing sample in an oxygen filled flask is a

convenient one for the detection of halogens. It is normally colourless and not contaminated by metals as is that obtained from the fusion procedures.

Fluorine as fluoride may be detected by the zirconium alizarin reaction but the sensitive and specific colour test developed by Belcher, Leonard, and West (19) is superior. The red colour of the cerous complex of alizarin complexone (alizarin-3-methyliminodiacetic acid) becomes blue in the presence of fluoride ions.

Free iodine liberated from a drop of the test solution by concentrated nitric acid will give a blue colour with thyodene or other starch preparation. A test sensitive to $0.001\mu\text{g}$ of iodine has been described by Feigl (20). Use is made of the reaction in which iodine catalyses the oxidation of tetrabase (4,4'-tetramethyldiaminodiphenylmethane) by chloramine T to give blue quinoid compounds. However, it seems that this reaction is only useful in high dilution.

Bromine may be detected in low concentration ($0.1\mu\text{g}$) if iodine is absent. Bromide in the test solution is oxidized by chloramine T and the bromine liberated brominates yellow fluorescein to give the pink colour of eosin. It has been shown (21) that the necessary buffering may be accomplished by the action of acetic acid on an excess of calcium carbonate, the excess providing an excellent background for observing the colour change.

There is no reliable specific test for chlorine. Following removal of bromine and iodine by standard techniques the presence of chlorine as chloride in the test solution may be shown by reaction with a concentrated solution of silver nitrate.

PHOSPHORUS

Phosphorus from an organic compound may be converted to free phosphoric acid by one of three procedures. Non volatile compounds are heated with calcium oxide and the resulting mixture containing calcium phosphate is dissolved in nitric acid. In a method suitable for volatile compounds as well the sample is digested in concentrated sulphuric acid. The oxygen filled flask decomposition procedure also furnishes a suitable solution of phosphoric acid. Formation of yellow phosphomolybdate on addition of ammonium molybdate may be used to detect the phosphoric acid but greater sensitivity is obtained by the following modification (2). The reaction of phosphate ions with ammonium molybdate is carried out on filter paper

and the resulting spot is treated successively with benzidine and ammonia. A blue spot will develop if phosphate is present.

METALS

The most satisfactory procedure to adopt before commencing the detection of metals in organo-metallic complexes is to destroy completely the organic portion of the molecule. The problem then resolves itself into one in the use of inorganic spot test reagents. The volatility of the sample and its ignition products should be taken into account when selecting a decomposition procedure. Wet digestion in sulphuric acid or in a mixture of persulphate and sulphuric acid containing silver ions (2) may be used and dry ashing by ignition followed by solution in acid is also frequently successful. The samples may also be decomposed by ignition in an oxygen filled flask, the resulting oxides being dissolved in dilute acid.

CONCLUSION

This brief survey draws attention to some recent developments in qualitative elemental organic analysis and compares them in sensitivity and selectivity with well established methods. It is hoped that these recent developments will receive suitable recognition in laboratory texts in the near future.

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FATS AND HEART DISEASE

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The most pressing medical problem of the western world is that of coronary heart disease (CHD). In heart disease, insufficient flow of blood through coronary arteries deprives some segment of heart muscle of oxygen and nourishment. The underlying cause might be atherosclerosis. This is a slowly developing disease of the arteries in which the inner lining of the wall of the blood vessel thickens from one to many layers of cells. Cholesterol, phospho-lipids, fats and proteins are deposited within this thickened lining forming a mass or atheroma which protrudes into the opening of the vessel. Later, calcium may be deposited in the atheroma, "hardening the arteries", in a disease called arteriosclerosis.

As atherosclerosis progresses and the atheroma grows, it reduces the opening in the vessel through which blood flows. Haemorrhage may occur in the atheroma and cause additional swelling. A blood clot may form on the atheroma, further closing the blood vessel. Such a clot is called a thrombus and its occurrence is a thrombosis. The event is called coronary thrombosis when it happens in an artery which supplies blood to the heart muscle. When the flow of blood is blocked, the condition is referred to as coronary occlusion and the person is said to have a heart attack.

Most heart attacks are not fatal. If the supply of blood is only partially shut off, the person may feel chest pains and weakness until the flow of blood is re-established. Usually blood flow immediately increases through other undamaged coronary arteries which lie nearby the damaged vessel. The heart muscle formerly served by the closed artery receives oxygen from these arteries until a new network of blood vessels becomes established. The injury to the heart muscle cells caused by temporary lack of oxygen is called myocardial infarction. Scar tissue forms as healing takes place. An electrocardiogram will reveal the location and extent of the injury.

If the blood supply is completely cut off, cells of the heart muscle die, heart beat is interrupted or ceases and all cells of the body die from lack of oxygen and nourishment.

Various diseases such as rheumatic fever can cause degeneration of heart muscle but this paper is concerned only with atherosclerosis.

Pathologists (1) studying aortas taken at autopsy from cases of natural (excluding heart disease), accidental and sudden death have suggested the following sequence of events in human atherosclerosis.

Fatty streaks were observed on all aortas taken from cases 3 years old and over. The amount of surface of the aorta involved increased slowly with age, approximately 20% being involved at the age of 40.

Fibrous plaques appeared in the second decade but did not increase until the fourth. They paralleled the development of fatty streaks but lagged 15 years behind them. A fibrous plaque may become enlarged by surface lipid accretion or be vascularized and undergo haemorrhage and be covered by a thrombus.

The whole gamut of these changes has not yet been reproduced in experimental animals.

Quantitative comparison of various types of atherosclerotic lesions has been made of aortas procured from autopsies in underdeveloped countries and in the U.S.A. (2). Despite wide differences in racial and environmental background all individuals initially show a similar pattern of development of fatty streaks. Differences are found in the occurrence of fibrous plaques — these involve 15% or more of the aortic surfaces in the U.S., and less than 5% of these surfaces in underdeveloped countries. Coronary heart disease is more than five times as common in western countries than in the poorer areas of the world.

Differences in diet (3), exercise (4) and stress of living (5) have all been put forward as causes of atherosclerotic heart disease. Chief among these theories is the belief that the western diet is the culprit. Much experimental work involving laboratory animals has been published supporting the hypothesis that diets high in saturated fats can produce hyperlipaemia and atherosclerotic changes in aortas in some animals (6,7).

Detailed epidemiological studies in various human populations are not yielding such conclusive evidence in man. In Framingham (8) in the U.S.A., the National Heart Institute has been studying a population of 5,000 since 1952. The object of the enquiry was to describe the characteristics of persons who were destined to develop CHD

during the period of observation and to see in what particulars they differed from the rest of the population. Serum cholesterol, blood pressure, electrocardiograph abnormalities, weight, smoking habits and lung capacity were measured at 2-year intervals. Details of deaths and illnesses were recorded. One of the foremost hypotheses under study was that elevation of serum cholesterol was associated with increased risk of developing CHD. The results published so far demonstrate that those persons who smoke cigarettes, who have blood cholesterol levels of over 240 mg/100 ml, who have high blood pressure and who are overweight are at least ten times more susceptible to CHD than the remainder of the population.

The intake of fat in this study was found to be huge, with a mean of 157 g/day and a range of 57 to 299 g/day (9).

Preliminary results have been published recently of a study of Irish males who have emigrated and lived in Boston area for 10 or more years and who still have a brother living in Ireland. These indicate that those in Ireland eat 300 calories a day more, weigh less and get more exercise. They eat more animal fat, getting 94% of their fat intake from this source with an average of a pound of butter a week. They have lower serum cholesterol levels — 206 mg/100 ml compared with 222 mg/100 ml found in the Boston Irish. Hypertension is less than half as prevalent amongst those in Ireland (10).

Detailed analyses of dietary fats and serum lipids have been reported for many underdeveloped countries and compared with data obtained in the U.S. and N.W. Europe, the western dietaries always being correlated to high serum lipid levels. The weakness of all these studies, however, is that populations with low fat intakes are composed largely of individuals of very depressed social and economic status and with a high degree of physical activity. There has recently been reported a study in Switzerland where an Alpine community has been compared with a similar population living in the city of Basel (4). Fat intake in both populations contributed 35% of the total calories but the Alpine villagers consumed 1,000 calories a day more than those in Basel. Despite their high calorie and saturated fat intakes the villagers showed lower serum cholesterol levels than the city dwellers (170 mg/100 ml against 220 mg/100 ml). These differences could not be explained by differences in weight, adiposity, altitude

or smoking. The striking difference in physical activity could be responsible for it.

It will be noticed that in these studies serum cholesterol level is the quantitative measurement most often recorded. The hypothesis that concentration of blood cholesterol and other lipids is a measure indicative of atherosclerosis is based on the following findings.

- (1) Cholesterol is found in the atheroma.
- (2) Individuals with very high levels of serum cholesterol have a higher risk of developing CHD.
- (3) Populations with high average levels of serum cholesterol have a high incidence of CHD.
- (4) Cholesterol concentrations in the blood tend to increase with age and so does severity of atherosclerosis. In certain diseases such as diabetes, individuals have higher than average levels of blood cholesterol. Also they are more prone to CHD than non-diabetics.

On the other hand there is evidence that high concentrations of cholesterol and/or abnormal patterns of lipoprotein cannot be taken as an absolute measure of atherosclerosis.

Many people with low levels of blood cholesterol die of CHD. Recent studies in London have shown that atheromatous patients have plasma lipids within the "normal" range (11). M. F. Oliver considers that at present, no abnormality that can be regarded as indicative of the presence of atherosclerosis has been found in the plasma lipids in man. This may be owing to the fact that in man the atherosclerosis process begins spontaneously at a very early age and by adult life all of us have developed some arterial lesions. The plasma lipid pattern does not deviate from the expected in more than a minority of patients with CHD but the majority of young men with CHD do have abnormal plasma lipids. Plasma lipid levels can be altered in animals and in man by many different factors. Mention has already been made of the western type of diet and exercise. J. N. Morris of the British Medical Research Council has been investigating the possible influence of occupation on the production of CHD (12). An early finding was that conductors on London double-decker buses were less affected than drivers. The advantage to conductors was most marked among younger men and in respect of severe coronary disease, coronary episodes were three times more common among drivers than conductors. A similar situa-

tion was observed among Government servants. Sedentary workers had a much higher incidence than postmen. Further studies covering many occupations have all confirmed the suggestion that physical inactivity is important in coronary heart disease. Surveys have shown that blood lipids are higher age for age in sedentary workers than in moderately active workers. Supporting evidence has recently been published in the U.S. where an experiment was conducted on two groups of men on similar diets; one group was given 1 hour of exercise daily, 5 days a week, the other group serving as a control. After 9 months the average serum cholesterol in the exercised group had fallen to 195 mg/100 ml as against the initial average level of 261 mg/100 ml which was still shown by the control group. This was in spite of an increased calorie intake by the exercised group (13).

It is evident that habitual physical activity or inactivity affects many physiological functions of the body and the question arises whether in the production of CHD we are dealing with the results of increasing cardiovascular inefficiency in middle age or with a specific factor related, for example, to the thrombus itself. Post-mortem surveys found, in general, that people with light occupations had pathological changes similar to those of men in heavy work, only 10 to 15 years sooner. It seems possible that the increase in the sedentary nature of work and leisure may be responsible in some measure for the current incidence of CHD. The rationale for this may be that activity keeps communicating blood channels open and ready to shunt the blood flow if one happens to get blocked by a thrombus.

Another factor influencing the occurrence of heart disease is cigarette smoking. Several workers have shown a connection between smoking and heart disease. In the Framingham study the cigarette smokers had three times more coronary episodes than all other groups. As this correlation ceased when smoking was stopped it was considered not to be connected with the atherosclerotic process but with the acute stages of the disease (8). J. N. Morris has also shown a correlation between hardness of water supply and cardiovascular death rate (14). The softer the water the higher the local mortality rate. So far no explanation of this has been found.

Many studies based on cases of heart disease have not found marked differences between plasma cholesterol ester fatty acids of atheromatous and normal people (15). It is

possible that this failure to detect differences was due to the difficulty of assessing the degree of atheroma in a person presenting no symptoms, *i.e.*, due to the difficulty of finding normals. In a recent study the degree of atheroma was assessed by examining aortas in patients undergoing abdominal operations, thus ensuring that the normals actually had minimal atheroma (16). These workers found reduced levels of dienes and tetraenes in the plasma cholesterol ester fraction and in depot fat fatty acids of atheromatous patients. The authors suggest that a working hypothesis combining both endogenous and exogenous factors would be required to account for the lower levels found in atheromatous patients. At present, however, there is no evidence explaining these differences.

A great amount of experimental work has been undertaken using laboratory animals. Most of this work has been aimed at trying to solve the problems connecting diet, serum lipids and atherosclerosis. Working with rabbits, H. Dam has shown that when he used butter instead of margarine or peanut oil in the diets cholesterol levels were raised 3-fold and the animals developed atheroma (7). F. A. Gresham and N. A. Howard (6) have found with rats that 40% butter in the diet tended to cause thrombosis and myocardial infarction whereas peanut oil caused atherosclerosis — this differs from Dam's finding with rabbits. Thrombosis and atherosclerosis did occur together in rats when butter and methyl linoleate were fed. Further work is necessary using pure glycerides containing linoleic acid before these relationships are fully established. These diets are specially designed to produce the result in the animal used — Gresham's contained 40% and Dam's 25% fat (the rabbit is more susceptible). This experimental approach is justified by the great difficulty in recognizing the disease in humans, where, as has been seen, the disorder is most likely the result of various factors of which diet may be one. In New Zealand another approach using rats has been made by the Fats Research Laboratory in collaboration with the Nutrition Research Department by feeding a fat-free diet as control for a corn-oil supplement (17). These workers have shown that though the serum cholesterol of these animals dropped this did not mean reduction in total body cholesterol. In fact, in the rat, reduction in serum cholesterol suggests an increase in deposition of cholesterol and fatty acids in the cardiovascular system. The greatest caution must be taken in drawing conclusions from experiments with animals and

applying them to humans. The fact that maize oil reduces cholesterol levels has led to its widespread dietary use, especially in the U.S. So far the effect of this on CHD is unknown. It has been shown that the prognosis of patients with ischaemic heart disease is not altered by the lowering of blood cholesterol levels either by feeding a diet low in saturated fat or by the use of oestrogens (18).

Analyses of different patches of the same aorta have shown differences in the distribution of fatty acids (19). Unsaturated fatty acids are increased in areas of fatty streaking. Biochemical analyses have indicated many differences in distribution and activity of various enzyme systems in atherosclerosis (20). Thus many factors affecting the lipid metabolism of the arterial wall are altered in atherosclerosis (21, 22) and the full story will not be known until these have all been investigated.

Much of the data can be interpreted to support the hypothesis that consumption of diets rich in saturated fats will elevate the serum cholesterol with resultant high incidence of myocardial infarction, but high serum cholesterol is not consistently and regularly associated with heart disease, nor is it proven that saturated fat in the diet causes heart disease.

Ischaemic heart disease is a problem of extreme complexity in which diet, endocrine metabolism, enzyme systems and other factors such as sex, heredity, nervous strain, smoking and physical activity may be involved. It would be unfortunate, therefore, if exaggeration of the significance of raised plasma lipids allowed us to lose sight of other aspects of prevention.

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SHELL PRIZE ESSAY

Canterbury Junior Chemical Society

The essay "The Conversion of Chemical Energy into Electrical Energy", published in this issue, won the Shell Prize of the Canterbury Junior Chemical Society, which was awarded this year for the first time. The author, Michael Dunn, is an upper sixth form pupil at St. Bede's College, Christchurch. He is the son of Mr and Mrs E. R. Dunn, Hamilton, and was 15 years old at the time of the competition. He entered St. Bede's College in 1960, obtained a certificate of efficiency in School Certificate in 1961, passed University Entrance in 1962 and is a University Scholarship candidate this year.

The Canterbury Junior Chemical Society is a thriving body comprising upper sixth form chemistry pupils. It was originated in 1960 by the Canterbury Branch of the N.Z.I.C., and is controlled jointly by nominees of the branch committee and of the Canterbury Branch of the Science Teachers Association. The annual programme consists of three lectures and a field trip and, in addition, members may compete for the Lever Bros. award (*Journal* 26, 152 (1962)) and the Shell Oil (N.Z.) Ltd. Prize.

The Shell Prize is an all expenses paid trip to Wellington for three days during which the winner visits Shell installations and, in particular, has the opportunity to carry out some laboratory work at the Shell laboratory, at Seaview. The award was made for an unassisted essay on a set topic which, though related to sixth form work, required the author to seek information from wider sources than textbooks.

THE CONVERSION OF CHEMICAL ENERGY INTO ELECTRICAL ENERGY

MICHAEL R. DUNN

St. Bede's College, Christchurch

(Canterbury Junior Chemical Society Shell Prize Essay)

From early antiquity to the present day, the development of mankind and its advance towards civilization have been dominated by the problem of finding convenient sources of energy. From reliance on his own muscles man turned to beasts of burden and toil to supply his needs. With the advent, a few hundred years ago, of mechanical slaves, some of the forces of nature, the wind and water, fell to his conquering hand. Less than three centuries ago modern civilization had its founding in the sudden and enormous enlargement of man's control over nature, brought about by his harnessing of the potential energy of coal, petroleum and the extraordinary phenomenon of electricity. Now we are beginning to glimpse the remarkable potentialities of atomic and solar energy.

All this progress is based on the deployment, by extremely varied techniques, of one fundamental quantity — *energy*, and on the possibility of the more or less simple transformation of one form of energy into another.

All sources of energy so far exploited by man owe their existence to the solar energy radiated into space by the sun, some of which falls on our planet. Here it is transformed into directly usable energy, such as hydraulic energy, wind energy, and, through photosynthesis, into the chemical energy in our food and fuels.

TYPES OF ENERGY

The word "energy" is derived from the Greek $\epsilon\nu\epsilon\rho\gamma\epsilon\iota\alpha$; $\epsilon\nu$ = in $\epsilon\rho\gamma\omega\nu$ = work. This energy is capacity to do work, and a body has energy if it is able to perform work. The many types of energy fall into two basic classes; those which exist as stored energy, and those which are momentary or instantaneous in their nature. Chemical and hydraulic energies are of the former kind, while dynamic types such as heat, light and electrical energies are of the latter.

It is because these two types of energy exist that we find it advantageous to convert one form of energy into another. Man's ability to bring about such a transformation is a

great triumph over nature, and means that he has readily available means of harnessing all types of energy and applying them to his tasks. Such is the purpose of converting chemical energy into electrical energy. Chemical energy is not very useful for performing work and so it is converted into other forms of energy, including electrical energy. Conversely, while electrical energy is readily turned into mechanical energy or heat energy, and is easily distributed over long distances, it cannot be stored in more than minute quantities. The best solution to these problems is to have a source of electrical energy in the form of chemical energy. This chemical energy can then be converted into electrical energy as required.

Chemical energy is a potential energy resulting from the rearrangement of electrons in atoms and molecules. It should not be confused with nuclear energy, which results from instability in the configurations of groups of neutrons and protons within the atomic nuclei. Nuclear energy will not be considered in this essay.

Electrical energy is the energy of the current in an electric circuit. The current consists of a flow of electrons along a conductor, from a point of lower to a point of higher electrostatic potential. This electronic movement is in the direction opposite to that of the conventional or "positive" current flow.

CONVERSION OF ENERGY

For reasons mentioned before, it is useful to convert chemical energy into electrical energy. Since there is a similarity between the two types of energy, in that both involve transfers of electrons as the means of allowing energy to do work on some system, it is reasonable to expect that a direct and simple method of performing the conversion exists. This is indeed so, but the method is limited in its application, being particularly inadequate for large scale interconversion of these energy forms. It is sometimes more practical to transform the energy by indirect means. In many cases the chemical energy is converted into heat energy (of combustion), then to mechanical energy, and finally to electrical energy. Although this is a roundabout way of obtaining electrical energy, it is used considerably in Britain where coal-burning power stations are commonplace. These two types of conversions will be treated separately.

ELECTROCHEMICAL CELLS

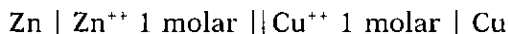
The basis of the direct conversion of chemical energy into electrical energy is the electronic nature of both forms of energy. If the electrons given off by some system of atoms in forming stable configurations of electrons can be made to flow through a conductor before they are absorbed by other atoms which tend to gain electrons, the chemical energy of these two half reactions can be obtained as electrical energy. This is the principle of all electrochemical cells, of which batteries, accumulators and the recently developed fuel cell are examples. Within each we have reactions proceeding which result in a surplus of electrons at one electrode relative to the other. The first electrode becomes more negative in potential than the other, and if they are connected a current will flow in the connecting conductor. This current flow will be maintained by the half reactions proceeding at the poles. Since this current flow represents electrical energy, the cell effectively converts chemical energy into electrical energy.

A cell consists of two electrodes or electrode systems, each dipping into a solution called an electrolyte. This electrolyte may be common to both electrodes, or may be different for each, the two solutions being connected by some system which permits ions to pass between the solutions but prevents their actual mixing. The electrodes may be metals of different kinds, or they may be inert electrodes, usually of platinum, at which the cell reactions take place. The electrode at which oxidation takes place is called the negative electrode, since electrons are released in oxidation, and it is negative in potential with respect to the electrode at which reduction takes place, the positive electrode. The electron flow in the outside circuit is from negative electrode to positive electrode.

Different metals acquire different potentials with respect to molar solutions of their ions. These cannot be measured directly, but a measurement can be made of the potential developed between a metal immersed in a solution of its ions and a suitable standard electrode. The standard electrode chosen is the standard hydrogen electrode, consisting of a treated platinum electrode (inert) immersed in a solution of 1 molar acid (hydrochloric acid is used), and over which a stream of hydrogen is bubbled. The potential of this electrode with respect to the solution is arbitrarily assigned a value of 0.00 volts. Electrode potentials of metal/metal-ion systems are measured against this electrode system, and so their potentials, called their electrode potentials, are determined.

Every oxidation or reduction half reaction (a half reaction is a reaction involving the release or taking up of electrons) can be assigned an electrode potential, and when an oxidative half reaction is coupled with a reductive half reaction, electrons pass from the oxidized system to the reduced system. A cell is simply a device for separating the sites at which the two half reactions occur, thus making the electrons transfer through a metal conductor. These moving electrons constitute the electric current and electrical energy available from the cell.

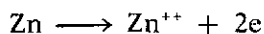
One of the simplest of all cells is the Daniel Cell. This consists of a zinc rod dipping into a zinc sulphate solution which is contained in a porous pot. Outside the pot is a copper sulphate solution contained in a copper can. Both solutions are initially about 1 molar, and the copper sulphate solution is replenished by crystals of the solid placed on shelves around the inside of the can. The cell is written in shorthand form:



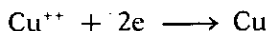
The potential of the cell as written is +1.10 volt, the difference between the standard electrode potential of copper and that of zinc. Thus

$$E^\circ \text{ cell} = E^\circ_{\text{Cu}^{++}/\text{Cu}} - E^\circ_{\text{Zn}^{++}/\text{Zn}} = +1.10 \text{ volts}$$

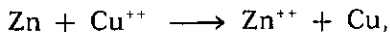
The positive sign means that the zinc rod is negative with respect to the copper can. Notice the zinc rod releases electrons, so it must be the negative electrode, the oxidative half reaction being:



The copper rod is the positive electrode and the reductive half reaction is:



The net result is a coupling of the two reactions,

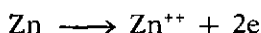


with the electrons performing useful work in the external circuit. Thus the chemical energy of the system ($\text{Zn} + \text{Cu}^{++}$) is converted into electrical energy, leaving the system ($\text{Zn}^{++} + \text{Cu}$) which has a lower chemical energy.

The common dry cell is a practical battery of cheap construction so that when its ingredients have served their purpose it may be discarded. It consists of a case of zinc tubing constituting the negative electrode (oxidative

region) filled with a paste of ammonium chloride. The positive electrode is placed centrally within this, and is surrounded by manganese dioxide paste. It consists of a carbon rod, topped with a brass cap, and the contents of the cell are enclosed by a layer of pitch.

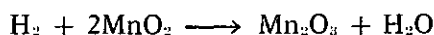
The oxidative half reaction, at the negative electrode is:



The reductive half reaction at the positive electrode is



followed by removal of the hydrogen by the manganese dioxide:



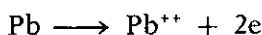
The over-all reaction is:



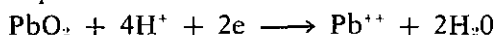
with the production of electrical energy. Once again, the chemical energy of the system on the left side of the equation is converted into electrical energy, the system on the right resulting.

The common dry cell just described eventually becomes "dead" through the consumption of the chemicals inside it. There is no way of reviving it. Such a cell is called a primary cell to distinguish it from another type of cell which can be recharged. This type of cell is called a secondary cell or accumulator. It is essentially a cell which can store, as chemical energy, electrical energy which is passed into it, and at a later time supply this electrical energy to some other system.

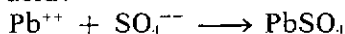
The lead storage battery is such a secondary cell. It consists of a series of lead plates punched with tiny holes or honeycomb depressions, and kept apart by plastic separators. Alternate plates are connected to one another, and the holes in one set of plates are filled with finely divided lead, while those of the other are filled with lead dioxide. The whole assembly is suspended in 3 molar sulphuric acid and packed in a suitable container. The negative electrode half reaction in the cell is:



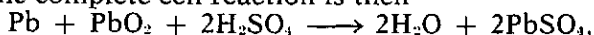
The positive electrode half reaction is:



The lead ions are converted into insoluble lead sulphate by the acid:



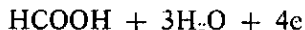
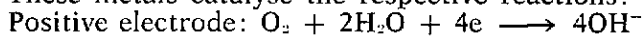
The complete cell reaction is then



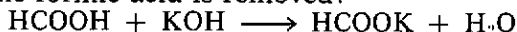
the potential being 2.03 volts. Three or six cells are commonly arranged in a heavy rubber casing to make a six or twelve volt battery. Since the lead sulphate is precipitated in the plates and retained there, application of a charging voltage to the battery results in the reactions being reversed so that electrical energy is stored as chemical energy.

In recent years, advances in electro-chemical technology have resulted in research into the possibility of using the fuel cell as a source of energy. The fuel cell is a device which converts the chemical energy of a fuel-oxygen system directly into electrical energy. It is much like a conventional cell, consisting of electrodes, at one of which fuel is introduced and at the other oxygen, and an electrolyte of a suitable type. The fuel is oxidized, giving off electrons which travel around the external circuit to the oxygen electrode, where the reductive half reaction occurs. The net result is that the fuel is "burnt", not with the evolution of heat energy but of electrical energy.

Fuel cells run on suitable fuels could provide a great deal of power in future times. A hydrogen-oxygen system would be useful on a space ship—the product would be ordinary drinkable water. A working fuel cell can be made using potassium hydroxide as electrolyte, methyl alcohol as fuel and oxygen in air as oxidant. The fuel electrode is of platinum and the oxygen electrode of perforated silver. These metals catalyse the respective reactions:



The formic acid is removed:



The efficiency of a fuel cell is as much as 90%, whereas that of conventional combustion systems is less than 25%, and that of internal combustion engine-generator systems about 20%. However, many problems are to be overcome before the fuel cell can become an energy source of considerable consequence. Furthermore, the fuel cell can supply only direct current.

Batteries and accumulators are an unsuitable means of conversion of chemical energy into electrical energy where large amounts of the latter are needed, or where the current is to be alternating in nature. To produce the millions of watts needed to maintain a nation's economy

other systems must be resorted to. Chemical energy can still be used as a source of electrical energy, but a direct conversion is not possible. The chemical energy of most fuels is readily converted into heat energy by combustion. This heat energy can be used to perform mechanical work in an engine, or in a boiler/steam-turbine system. This mechanical energy is converted into electrical energy by dynamos or alternators. The electrical energy is available as either alternating or direct current. Alternating current is widely used because its voltage can be stepped up in transformers before it is fed into a distribution network. This means that for a given energy the current will be correspondingly less, and so energy losses due to resistance in the wires are reduced. At the other end the voltage is reduced to a convenient quantity. Because of this, it is practical to place power stations near sources of chemical energy and transmit the power by means of wires on pylons.

COAL AND OIL FIRED GENERATORS

The largest-scale production of electrical energy from chemical energy is accomplished in coal or oil fired electric power stations. Coal fired stations are found in this country at Meremere, near Mercer, and also at King's Wharf, Auckland, and Evans Bay, Wellington. The Meremere coal power station has an output of 180 megawatts, and is about 24% efficient in converting the chemical energy in coal into electrical energy.

Such a station is economical to run, though much less so than hydro-electric stations, which are more efficient, 85% instead of 24% of the available energy being converted. The Meremere station stands as an impressive example of the usefulness of converting chemical energy into electrical energy.

In areas where there is no electrical supply, and in places where it is essential to have a standby plant in case the power supply is cut off, as in hospitals, generators driven by internal combustion engines are found. The efficiency of such a plant is limited by the efficiency of the motor, which is about 20%. Thus the system runs at about 17% efficiency.

Gas turbines and similar engines which use fuels can be connected to generators to supply electrical energy. All such units run at low efficiencies, at the most 40%, so a good deal of the chemical energy is lost.

In summary of what has been said about direct and indirect conversion, we may say that the direct conversion

of chemical energy into electrical energy is convenient when the current required is direct, the voltage small, and power requirements are small. The nature of a galvanic cell of any type is such that voltage is limited to a few volts, and currents similarly limited. The indirect conversion is much less efficient, but is used when large amounts of electrical energy are required, or when alternating current is needed. Fuels such as coal and heavy oil fractions are suited to such conversions, though not to any electrochemical conversion. Lighter petroleum fuels power internal combustion engines and the like, which are coupled with alternators to give mechanical-electrical systems.

Energy and its transformations dominate the daily lives of men; indeed, they dominate civilization itself. The whole of human economy is based on the increasingly intense and rational exploitation of sources of energy, through their development by science, and also on the ability of man to seek out and harness new sources of energy. It must be realized, however, that the classical sources of energy may play a great part in the future, if properly exploited with a maximum of efficiency.

The great importance of the conversion of chemical energy into electrical energy can be better understood if it is realized that 80% of the whole world's energy requirements are fulfilled by mineral fuels, and that a large proportion of energy used in industry is supplied as electrical energy. Such is the considerable role of the conversion of chemical energy into electrical energy in our world, and its efficient carrying out is vital to our very livelihoods. Although energy and its conversion make up but one key to civilization, it is a key without which the door to progress can never be opened.

IMPACT OF N.Z.I.C. ON SCIENCE IN NEW ZEALAND

To the Editor

In my Presidential Address last year I expressed concern that the N.Z.I.C., the largest scientific society in this country representing a single discipline, should make such a minute contribution to science as a whole.

This apprehension was recently confirmed on the occasion of the Presidential Address of the Royal Society, held on May 23, 1963, in Wellington. The Royal Society room was packed with scientists representing all the disciplines except chemistry. I located five chemists, comprising the President of the N.Z.I.C., 3 ex-presidents and one other member. All these chemists were at least 50 years of age. It is, to me, unbelievable that no young chemists should have the energy, interest, or curiosity to attend this meeting of the Royal Society, let alone make any effort towards improving the effectiveness of this organization. The subject of the address, "The Promotion of Science in a Commonwealth Democracy" delivered by Dr C. A. Fleming, one of New Zealand's most competent scientists, presented a challenge to the future of the Institute of Chemistry. It appears, however, that the young are too tired to listen to such matters, let alone to offer any criticism.

There is a need in the Institute for young men of vigour who will take prompt action in all matters affecting its welfare. It should be of more than incidental interest to them that whereas in 1951 the chemists provided about 30% of all the Fellows of the Royal Society of New Zealand, in 1962 representation from the chemists had dropped to below 20% with a small decrease in absolute members. The members of the Institute have become too tired to breathe and are not sufficiently alert to nominate their colleagues for fellowship. Moreover, the Council of the Royal Society is now almost depleted of chemists who at one time were rather active in this organization.

Any action relating to our joining up with I.U.P.A.C. has been left almost entirely to the Royal Society. Our relationship with this Society has possibly become a little closer. The present alleged stumbling block is, I understand, the drafting of the new rules of the Royal Society. Instead of playing a leading role in this work we are playing our usual stagnant role of avoiding, at all costs, any sign of initiative.

I am not overwhelmed by the originality of the idea of collaboration between all scientific bodies in New Zealand. It is an old idea. What does overwhelm me is the lack of initiative and progress in this direction by the Institute of Chemistry. Until the N.Z.I.C. becomes a member body of the Royal Society the only way a chemist can enter into New Zealand science as a whole is by belonging to a branch of the R.S.N.Z.

Members of the N.Z.I.C. should be encouraged to review their activities against the background of New Zealand science as a whole. At present, apart from editorials, little space is devoted in our journal to news relating to the general scientific scene in New Zealand and I feel that our journal should follow the example of the Newsletter of the New Zealand Geological Society. In the February Newsletter this year, for example, I find an excellent article entitled "Winds of Change in New Zealand Science" by B. W. Collins.

Matters discussed include National Research Council, Constitution of the Royal Society, International Relations, Report of the Geology Committee, Research Year and so on. I suggest some young and vigorous member of the Institute should be appointed to act as reporter on scientific activities in New Zealand. As a last resort it may even be desirable to ask permission of the Geological Society to reproduce some of their Newsletter reports.

Co-ordination between scientific societies enhances the effectiveness of the scientist without loss of independence of the organization to which he belongs.

The cost of administration of individual scientific societies is considerable and it would appear that it should be feasible to have some central organization to service all such societies in a more effective and economical manner than at present. Perhaps the Institute of Chemistry could bring into being such a central organization.

F. B. SHORLAND

CHEMICAL PLANT AT KINLEITH

The chlorine dioxide plant recently erected for N.Z. Forest Products Ltd. at Kinleith at a cost of over £100,000 is the only one of its kind in Australia or New Zealand.

Designed to provide chlorine dioxide for use in producing bleached kraft pulp for white linerboard, printing and writing papers, the new plant will produce about one ton daily.

Chlorine dioxide gas will be generated using the Holst process which is also used in Sweden. In this process an acidified solution of sodium chlorate is reduced by sulphur dioxide obtained by burning molten sulphur in air. The chlorine dioxide will be dissolved in water and held as an aqueous solution containing 6 to 8 g per litre (which is about the only safe way to hold this compound that is often the cause of a "puff" in a pulp mill) ready to be mixed with the pulp being processed in the adjacent multi-stage bleaching plant.

The Kinleith chlorine dioxide and sulphur dioxide plants will be near the plant that produces the chlorine used for pulp chlorination and for the treatment of public water supplies. All of the chlorine gas is dried by aid of concentrated sulphuric acid and then liquified so that it can be stored under pressure in the usual way. The caustic soda, produced along with the chlorine by electrolysis of a brine solution in cells with a travelling mercury electrode, is all used at Kinleith. A portion is required in the caustic extraction that follows pulp chlorination in the bleaching process, a portion is reacted with chlorine to produce aqueous sodium hypochlorite and the remainder is used to replace some of the soda losses that occur during the processing of pine chips into kraft pulp. Part of the sodium hypochlorite solution is being used to replace that formerly imported and is retailed, for example, as a household bleach. To N.Z. Forest Products, Ltd., the more important use of the hypochlorite solution is in the third stage of the pulp bleaching process.

Part of the hydrogen produced in the electrolytic plant is combined with chlorine in a burner to form hydrogen chloride which is absorbed in water and made available to the New Zealand market as hydrochloric acid in place of that formerly imported.

G.A.N.

THIRTY-THIRD ANNUAL REPORT for the year ending 31st July, 1963

MEMBERSHIP

Membership of the Institute has, during the last year, changed as follows:

New Fellows, 20; New Associates, 48; Resignation, 1; Reinstated Fellow, 1; Reinstated Associates, 2; Deaths, 4; Leave of Absence, 6; Struck off, 6.

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

			1961	1962	1963
- Auckland	.....	.....	111	124	134
Waikato	.....	.....	32	33	35
Manawatu	.....	.....	58	58	61
Wellington	.....	.....	182	182	185
Canterbury	.....	.....	81	96	103
Otago	.....	.....	71	72	74
Overseas	.....	.....	66	62	67
			601	627	659

SUB-COMMITTEES OF COUNCIL

Journal

Mr N. T. Clare has continued as Chairman of the Editorial Committee based in Hamilton. The net cost of the *Journal* decreased slightly in the year under review. There is a steady demand for the use of the Institute's addressograph plates and the revenue obtained from this source is credited to the *Journal*. The decision to publish an annual list of members in the December issue of the *Journal* appears to be appreciated by members. The "Chemistry in Action" lectures delivered to the Canterbury Branch were once again published in the *Journal*.

Examinations Committee

The Examinations Committee, in Auckland, has been considering the requirements for Associateship by examination and has brought down firm proposals which when finalized and approved will clarify the existing Rule, which has seldom been operated and is inadequate for present day requirements. The Laboratory Assistant's Certificate examinations are gradually ceasing as candidates complete their qualification and the National Certificate in Science becomes firmly established.

Rules Revision

This Committee completed the revision of the Rules during the year and several important changes have been made as a result of these deliberations (see below).

Employment Officer

Mr Borthwick has continued to handle enquiries from overseas and reports a steady demand for information. Many enquirers are clearly just "shopping around" but this is perhaps to be expected, and the Institute provides a worthwhile service which should be regarded in that light rather than as a campaign to bring chemists to this country.

Membership Committee

The Membership Committee—Mr Brooker, Professor Batt and Dr McGillivray—has handled an unusually large number of appli-

cations for the Associateship and, in particular, the Fellowship. The amendments made to the Rules covering membership will, it is hoped, simplify the assessment of applications.

Standing Committee of Council

As a result of the decision to decrease the number of full Council meetings the Standing Committee has increasingly dealt with urgent and routine matters, including the election of many new members. The handling of routine matters in this way leaves Council freer to devote its time to consideration of general matters of policy without being over-burdened with day-to-day matters.

INSTITUTE PRIZES

Prizes for 1962 were awarded as follows:

I.C.I. Prize	Dr A. J. Ellis
Morcom Green Edwards Prize	Dr G. W. Butler
Chemical Essay Prize	Mr W. Freitag

The Directors of Imperial Chemical Industries (N.Z.) Ltd. have increased the value of the I.C.I. Prize to £50, thus making it the most valuable of the Institute Prizes.

CONFERENCE, 1962

The Annual Conference was held in Christchurch in association with the N.Z. Science Congress. The N.Z.I.C. and the Royal Society jointly financed a visit from Sydney by Professor C. W. Shoppee who was guest lecturer at both conferences. The profit from the Conference was, as is customary, credited to the Overseas Visitors Fund.

OVERSEAS VISITORS

In addition to the visit by Professor Shoppee, the Institute is arranging to bring to New Zealand later this year Professor A. E. Alexander, who will be guest lecturer at the Conference, and Professor P. V. Danckwerts who will visit New Zealand following a tour of Australia arranged by the R.A.C.I.

RULES REVISION

Council during the year approved amendments to a number of the Rules of the Institute. The changes were in part minor, but those affecting the qualifications for membership, in particular, and the various classes of membership, are of considerable importance. Council agreed to the reprinting of the Rules and these will be issued to all members as soon as they become available.

ROYAL SOCIETY

The discussions referred to in the last Annual Report with the Royal Society of New Zealand have been continued during the year, and the Royal Society of N.Z. and the Institute are now much more aware of the views of both bodies. The President of the Royal Society of N.Z., Dr C. A. Fleming, has done much to clarify the Royal Society position; Dr Fleming has been invited to attend the forthcoming Annual General Meeting so that members will have an opportunity of hearing his views.

NATIONAL RESEARCH COUNCIL BILL

The Institute has been represented by the President on a number of *ad hoc* committees arranged by interested societies and organizations concerned with the proposed Bill. The final drafting of the Bill is still in progress and its ramifications are not yet completely clear.

FINANCIAL

The Balance Sheet for the year ended April 30, 1963, reveals an excess of income over expenditure in the general fund of £8 as compared with a deficit of £109 for the previous year.

W. G. HUGHSON, *President*

W. E. HARVEY, *General Secretary*

BRANCH NEWS AND NOTES

AUCKLAND BRANCH

Dr D. S. Letham of the D.S.I.R. at Mt. Albert is to be congratulated on isolating from the kernels of about 1,000 cobs of corn, a crystalline plant cell division stimulant, christened "zeatin". This is the first growth stimulant of its type to be isolated and was described by Dr Letham at the fifth international conference on naturally occurring plant growth regulators held recently in Paris.

The death in a recent aircraft accident of Mr John Hardley, Manager, J. & A. G. Murray Ltd., the local Q.V.F. Ltd. representatives, is noted with regret.

Mr D. G. Payne, a graduate of London University, and who is now employed by Polymers (N.Z.) Ltd. at Otahuhu, addressed members in July on "The Development of Fine Organic Chemicals and Drugs".

About six holes are to be drilled to near 250 ft in the Ngawha Springs area to determine whether it is worth carrying out further work, according to Mr I. D. Dick of the D.S.I.R.

The University of Auckland's I.B.M. 1620 computer was working nearly 120 hours a week by July and there is already reference being made to the need for a second machine.

Mr W. S. Barr provided members present at the August meeting with a glassblowing demonstration, depicting the union of art and science. The demonstration followed the showing of a film illustrating the Jena Glassworks operations.

Professor R. E. F. Matthews and other members of Auckland University's Department of Microbiology now have a high-resolution electron microscope which was bought with a grant from The Wellcome Trust, London. This instrument will be used in the study of nucleic acids, virus synthesis, virus inhibition and bacteria. The purchase of ancillary equipment was supported by the Auckland Savings Bank and the University Research Grants Committee.

The supply of power to the Auckland Electric-Power Board from the methane gas-diesel turbines at the Auckland Metropolitan Drainage Board's Mangere treatment plant confirms that good can come out of bad. Normally there is enough gas to allow for an output of 800 kW.

CANTERBURY BRANCH

Dr D. A. R. Happer, the first student to be awarded the Ph.D. degree of the University of Canterbury, has been awarded a post doctoral fellowship to Brown University, Providence, Rhode Island, U.S.A.

Mr R. O. Hooker has transferred from Manawatu Branch to become Chief Chemist at T. J. Edmonds Ltd., Christchurch.

This year's programme for the Canterbury Junior Chemical Society concluded with a lecture on Carbon 14 by Dr R. D. Topsom. Members of the Society spent two hours on a Saturday morning inspecting the Chemistry Department, University of Canterbury. Other lectures this year were given by Mr T. N. Coleridge, Chief Technical Officer, Shell Oil (N.Z.) Ltd., and Dr M. H. Panckhurst, Chemistry Department, University of Otago.

This year's winners of the Lever Brothers Award were: A. R. Archer, B. N. Blackett, and M. R. Presland of Christchurch Boys' High School, and R. Butcher of Shirley Boys' High School.

The winner of the first Shell Essay Prize was Michael R. Dunn of St. Bede's College.

CONFERENCE RETROSPECT

The 1963 Institute Conference was without question one of the best, if not the best ever. There were 188 registrations, including those from trade representatives, indicating a considerable increase in the numbers attending annual conferences. It is possible, however, that the central position of Palmerston North was responsible for this situation.

The programme provided for a variety of interests and one could see running through it a much greater awareness of the role of the chemist in meeting the demand for industrial development and for the manufacture of foodstuffs which could be marketed in South East Asia and Japan.

Following the opening by the Minister of Scientific and Industrial Research, the Hon. Mr W. B. Tennent, Mr W. A. Joiner, Deputy Secretary, D.S.I.R., chaired a session on industrial development in New Zealand. The first paper, prepared by Dr W. B. Sutch and delivered by his deputy, Mr H. C. Holden, was concerned with gaps in New Zealand industry. The indications were that New Zealand had reached only the colonial stage of development and that much would need to be done before we could be compared with the more industrialized parts of the world. This was not merely a population question because Israel, with a much smaller population, could already be regarded as highly developed.

The paper on the establishment of the Iron Sands industry by Mr I. D. Dick was presented humorously and very effectively. Dr J. C. Andrews outlined the pre-requisites of chemical industry in New Zealand, and stressed, along with Mr Dick, the necessity for chemists to take far more interest than hitherto in the problems of the business side of the organizations in which they work.

In the session dealing with the food industries, held on Thursday morning, Mr H. A. L. Morris, of the Food Technology Department of Massey University College, outlined the possibility for exporting foodstuffs, particularly in the prepared pre-cooked form. He considered that in this way, *inter alia*, there was a prospect of exporting 60 million pounds of potatoes. Dr W. A. McGillivray, Dairy Research Institute, showed that for a long time the dairy industry had been making progress in regard to exports and it appeared that on general principles the export of dried milk products was economically sound, as such products could be processed at their destination into the desired products. Dr M. D. Cameron, from the Meat Research Institute, Hamilton, referred to the possibility of further utilizing the viscera which form a large part of the body weight. In particular, the rumen, which has 20% of protein and which is used only to a limited extent as tripe, could be converted into other products to increase the value of the animal industry.

Among the main lecturers, Professor J. F. Duncan, Victoria University, impressed members by indicating some of the recent advances in inorganic chemistry, in particular the effect of trace metals in the crystal lattice on surface phenomena. In the lecture on recent advances in intermediary metabolism, Professor R. D. Batt, Biochemistry Department of Otago University, covered a large part of the field of biochemistry. The intricacy of the molecules and their functions were presented in a very lucid fashion. Those of us who left university some time ago were certainly given a glimpse of the present situation in biochemistry. In the lecture by Professor L. H. Briggs of Auckland University on the recent

advances in organic chemistry, the important role of the physical methods was clearly indicated, in particular the potential of mass spectroscopy in the elucidation of the structure of complex molecules.

The presence of the guest lecturers, Professor A. E. Alexander of Sydney University and Professor B. J. Ralph of the University of New South Wales, contributed greatly to the success of the Conference. The guest lecture by Professor Alexander, entitled "The Chemist and the Community", provided us with much food for thought and in particular there was left the impression that to advance the cause of chemistry and the chemical profession the chemist would need to analyse the difficulties that confront him and suggest solutions to the appropriate authorities.

In the teaching of biochemistry, dealt with by Professor Ralph, one could not help being impressed by the awareness in New South Wales, as compared with New Zealand, of the great potential of biochemistry in industry.

Finally, special mention should be made of the Easterfield address by Dr A. T. Wilson dealing with the application of tritium to biological problems. The lecturer did not fail to pass on to the audience his enthusiasm for the subject of the lecture.

Concerning the general lectures, it would be invidious to deal with them individually. Their appeal must vary with the interests of the individual. In the opinion of the writer, however, special mention should be made of the lecture by Dr C. G. Pope dealing with gas solid elution chromatography as a model of clear presentation.

Following last year's criticism of lantern slides, the standard has improved. As usual with concurrent sessions some overlapping occurred so that members sometimes missed out items of interest to them. In particular, some of those attending the symposium on "Diversification of Food Industries" wished also to be present at the session on "Teaching of Biochemistry", and vice versa.

Much interest was aroused by Mr N. T. Clare, who is Chief Biochemist, Ruakura Animal Research Station, in his description of the AutoAnalyzer techniques which could do much to change the future of routine analysis, particularly in respect to their accuracy.

The success of the Conference was not only in the production of a well-balanced programme but also in the provision of good accommodation, including well-heated bedrooms, adequate lecture theatres and an adequate refectory where excellent meals were efficiently served. On the social side, the City Council Reception on Tuesday evening was much appreciated. The interest of the Mayor and the Council in Massey University College is commendable and of long standing. Indeed it could be said that their provision of property for the establishment of the College has been rewarding not only to the College but also to Palmerston North.

Following the guest lecture on Wednesday evening there was held a wine and cheese tasting session, by courtesy of Corban & Son Ltd., wine merchants, and New Zealand Co-op. Rennet Co. Ltd. The occasion did much to provide for informal discussion groups while the wine and cheese were certainly up to a very high standard. The dinner on Thursday was an outstanding success and it is possible that the wine tasting, together with the dinner, removed any serious note that might have been present in the early stages of the Conference. There were many non-ecclesiastical stories told at the dinner. After dinner the President gave his Address on "The Utilization of Low Rank Coal".

In deference to the low rank receptivity of his audience, Mr Hughson subordinated the more scientific aspects in favour of entertainment, with slides illustrating coal processing. Those interested will, of course, be able to read the serious version in this *Journal*. As to the propriety of a programme arrangement which dictates such a procedure, I leave it to members of the Institute to decide.

—F.B.S.

SCHOOL ON LABORATORY INSTRUMENTATION

This school, which will be held in the Chemistry Department, Easterfield Building, Victoria University of Wellington, consists of two related courses of five days each on modern instrumental techniques.

The first course of five days' full-time study (October 14 to 18) will lay emphasis on the underlying principles associated with the design and applications of instruments. The course is *not* one on design of instruments, but is aimed at increasing the general awareness of chemists of the limited polyfunctional nature of most instrumental equipment. The course will feature spectroscopic and allied techniques and gas and thin-layer chromatography.

The second course, also of five days' full-time study (October 21 to 25) will be one in which the participants are invited to indicate beforehand, within the limits of the resources available, techniques they would wish to study. Arrangements will then be made to provide the necessary facilities and instruction. Three special features will be the participation of Dr Lloyd E. Smythe, Head of the Analytical Section of the Australian Atomic Energy Research Establishment, who will be concerned with instruction in electrochemical methods of analysis, Mr J. E. Allan, of Rukuhia Soil Research Station, who has made valuable contributions to the development of atomic absorption spectroscopy, and Mr R. L. Currie, of I.B.M. World Trade Corporation, who will conduct a course in computing machine techniques which will include an afternoon working with the Department of Statistics' 1620 Computer.

THE REGISTRY

Honorary Fellows

(Elected August 19, 1963)

GARDNER, Roy, D.Sc., M.I.Chem.E., F.R.I.C.
GLENDINNING, Tom Aldrich, M.Sc., F.R.I.C.
GRIFFIN, Kenneth Massy, M.Sc., F.R.I.C.
LAWRENCE, Gilbert Alexander, B.Sc., F.R.I.C.

(Biographical notes on the Honorary Fellows will be published in the December *Journal*.)

BOOK REVIEWS

CAHIERS DE SYNTHÈSE ORGANIQUE, by J. Mathieu, A. Allais and J. Valls. Vol. 10. Masson & Cie, 120 Boulevard Saint-Germain, Paris, 1962. 560 pages, 180 Francs.

Previous volumes in this excellent series have been noted before in this *Journal*. This one deals with the formation of heterocyclic rings by bimolecular reactions. Each facet of the subject is dealt with in numerous examples and exhaustive tables. This is a unique work and deserves to be more widely known than it is in New Zealand. Two more volumes will complete the series.

—S.G.B.

LEHRBUCH DER PHYSIOLOGISCHEN CHEMIE, by Prof. F. Leuthardt, Zurich. 15th Ed. Walter de Gruyter & Co., Berlin 30, 1963. 911 pages, DM42.

This is a new edition of a very well-organized textbook on biochemistry, well produced and at a very reasonable price. However, the reviewer noted only a few references to publication since the previous edition of 1959, and it is possible that the author shares with many others the difficulty of keeping a general textbook up-to-date particularly in such a fast-growing area as biochemistry.

—S.G.B.

BOOKS RECEIVED

Books received recently are listed below. Reviews have been arranged for those marked with an asterisk. Members interested in other books in this list may obtain them for a short period for examination on application to the Editor.

Salt Water Purification. K. S. Spiegler. John Wiley and Sons Inc. \$7.50.

Reactor Handbook, 2nd ed. Vol. III, Part A, Physics. H. Soodak (Ed.). John Wiley and Sons Inc. (Interscience). \$10.75.

Transactions of the Society of Rheology, Vol. VI. E. H. Lee (Ed.). John Wiley and Sons Inc. (Interscience). \$11.25.

*The Chemistry of Heterocyclic Compounds, Vol. 14, Part 3. Pyridine and its Derivatives**. E. Klingsberg (Ed.). John Wiley and Sons Inc. (Interscience). \$65.00.

Qualitative Anion-cation Analysis. Emil J. Margolis. John Wiley and Sons Inc. \$5.00.

The Analysis of Titanium, Zirconium and Their Alloys. Elwell and Wood. John Wiley and Sons Inc. \$7.75.

*Natural Organic Macromolecules**. Bruno Jirgensons. Pergamon Press. 63s.

Polymer Processing. J. McKelvey. John Wiley and Sons Inc. \$10.25.

*Methods of Biochemical Analysis, Vol. 10**. D. Glick (Ed.). John Wiley and Sons Inc. (Interscience). \$14.50.

- Gas-Liquid Chromatography**. S. Dal Nogare; R. Juvet, Jr. John Wiley and Sons Inc. (Interscience). \$13.95.
- Progress in Inorganic Chemistry, Vol. III*. F. Cotton (Ed.). John Wiley and Sons Inc. (Interscience). \$15.00.
- Advances in Enzymology, Vol. 24*. F. Nord (Ed.). John Wiley and Sons Inc. (Interscience). \$16.00.
- Radiation Chemistry of Polymeric Systems. High Polymers, Vol. XV*. A. Chapiro (Ed.). John Wiley and Sons Inc. (Interscience). \$21.00.
- Quantitative Chemical Techniques of Histo- and Cytochemistry, Vol. 1**. D. Glick. John Wiley and Sons Inc. (Interscience). \$14.50.
- Reactions of Organic Compounds. A Textbook for the Advanced Student*. R. C. Fuson. John Wiley and Sons Inc.
- Enzymatic Synthesis of DNA*. A. Kornberg. John Wiley and Sons Inc. \$4.00.
- Chemical Reaction Engineering: An Introduction to the design of Chemical Reactors*. O. Levenspiel. John Wiley and Sons Inc. \$10.75.
- Ionization Constants of Acids and Bases*. A. Albert; E. Serjeant. John Wiley and Sons Inc. \$3.75.
- Ions in Hydrocarbons*. A. Gemant. John Wiley and Sons Inc. (Interscience). \$12.50.
- The Biochemical Bases of Psychoses or The Serotonin Hypothesis about Mental Diseases**. D. W. Wodley. John Wiley and Sons Inc. \$11.95.
- Analytical Chemistry of Polymers: Vol. XII, Part II. High Polymers. Molecular Structure and Chemical Groups*. G. Kline (Ed.). John Wiley and Sons Inc. (Interscience). \$17.50.
- Analytical Chemistry of Polymers: Vol. XII, Part III. High Polymers. Identification Procedures and Chemical Analysis*. G. Kline (Ed.). John Wiley and Sons Inc. (Interscience). \$16.50.
- Physical Properties of Polymers*. F. Bueche. John Wiley and Sons Inc. (Interscience). \$9.50.
- Symposium on Adhesives for Structural Applications*. M. J. Bodnar (Ed.). John Wiley and Sons Inc. (Interscience). \$6.25.
- Reactor Handbook. 2nd Edition. Vol. III, Part B. Shielding*. E. P. Blizard (Ed.). John Wiley and Sons Inc. (Interscience). \$9.00.
- Textbook of Polymer Science*. F. W. Billmeyer, Jr. John Wiley and Sons Inc. (Interscience). \$12.75.
- Monographs in Statistical Physics, Vol. 3. Ionic Solution Theory*. H. Friedman. John Wiley and Sons Inc. (Interscience). \$13.50.

BREAD RESEARCH INSTITUTE OF AUSTRALIA

Senior Research Officer (Technologist)

Applications are invited for the position of senior technologist with the Institute, which is a research association supported by the Australian baking industry and the Commonwealth Scientific & Industrial Research Organisation. The appointee will lead the research work in the field of baking technology for which he will be responsible to the Director. He must have the ability to initiate and expand investigations which form part of a comprehensive programme of research into problems of concern to the baking and cereal industries. The successful applicant will be expected to maintain close liaison with industry and to advise on the application of his research results to industrial practice.

Applicants should possess an honours degree with some post-graduate research experience preferably in the food industry.

The Institute has grown rapidly in recent years and the laboratories at North Ryde are well equipped and well staffed.

Commencing salary will be dependent upon qualifications and experience but will be determined within the C.S.I.R.O. salary range of senior research officer £A2655-£A3015 and advancement will be based on merit. There is entitlement to generous superannuation benefits after a probationary period and assistance with fares, transfer expenses and temporary accommodation will be given to an appointee outside Sydney.

Applications giving details of age, qualifications and experience, etc., should be addressed to:

The Director, Bread Research Institute of Australia, Private Mail Bag, North Ryde, N.S.W., Australia.

PALMERSTON NORTH MEDICAL RESEARCH FOUNDATION

Research Fellow

Applications are invited for the above position from graduates in medicine or science. The appointment will be for two years in the first instance.

The salary range is from £1,200 to £2,300 according to experience and qualifications.

Further information on the conditions of employment and the nature of the duties concerned are obtainable from the undersigned.

Applications close on 19th October, 1963.

C. C. Yates, Secretary, P.O. Box 949, Palmerston North.

CHEMIST

An opportunity awaits a chemist who desires to make a long-term study of water supply and purification. Minimum duties will involve orthodox analysis of water samples, but circumstances now emerging in this country require extension of interest into source surveys, involving occasional field trips.

Applicants should preferably be of 25 to 35 years of age, of graduate status, but a capacity of observation in a wide variety of natural sciences would be considered more valuable than academic qualifications as such.

Applications will be considered in strict confidence and should include a resumé of employment to date.

Write to: The Managing Director, Candy Filters (N.Z.) Ltd., P.O. Box 1773, Auckland, C.I.

INDUSTRIAL CHEMIST

Expansion of our activities has created a vacancy for a graduate in the laboratory of this Company, which deals with all aspects of the production and processing of fats for baking and confectionery. The management is keenly interested in improving the processes used, in the production of new lines and in the wider aspects of food technology generally.

We are looking for a graduate in the 30 to 40 age group with or without industrial experience who, after a period of preliminary training, would be capable of taking charge of the laboratory and directing the work of the technicians. There is scope for the application of more rapid and improved methods of analysis. Finance is available for the purchase of instruments which can be of value in the analytical and research programme.

The laboratory is fully responsible for quality control in all stages of production and is also concerned with the development of new lines. There is also a field for research into new knowledge of the fats handled and of methods of treating them. The new appointee will have an opportunity of contributing to this programme.

An excellent library of books and journals of pure and applied chemistry is maintained and constantly added to.

The salary paid will be up to the standard revealed by the last salary survey conducted by the Institute but we regard it as a secondary consideration to securing the right man. Superannuation is available. For a married man living outside of Auckland reasonable removal expenses will be paid.

All enquiries and applications will be treated in strict confidence and should be addressed to: "Industrial Chemist", Abels Limited, P.O. Box 9012, Auckland.

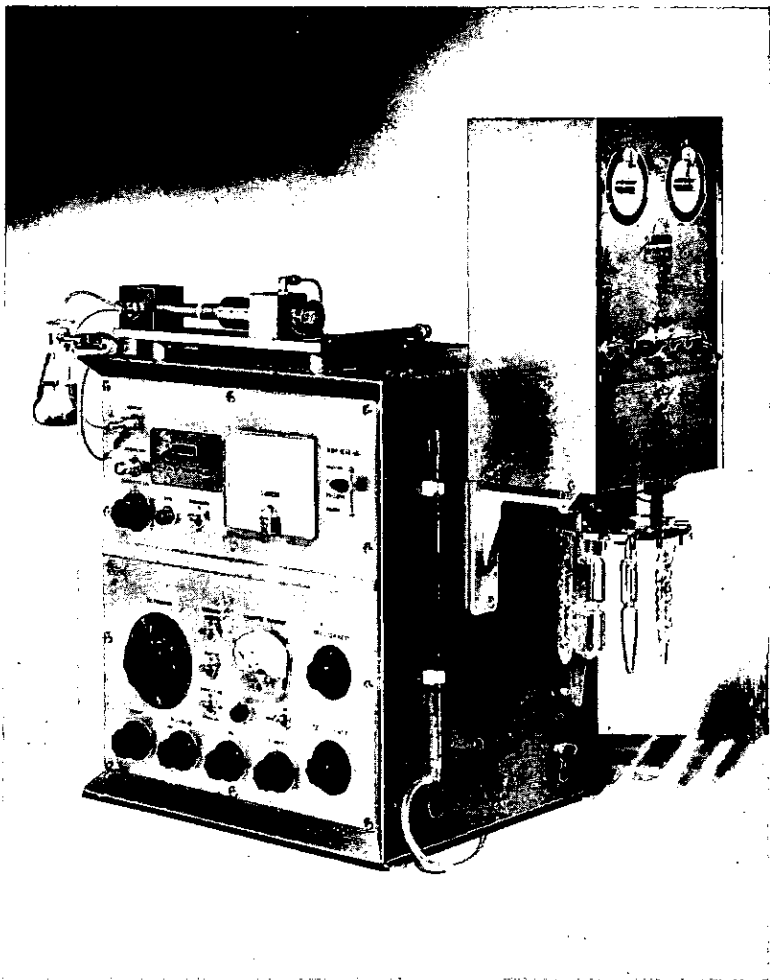
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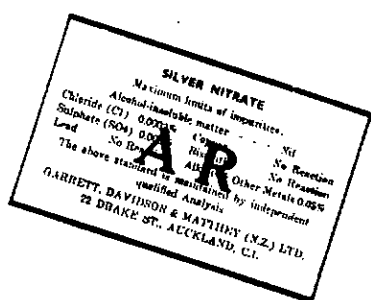
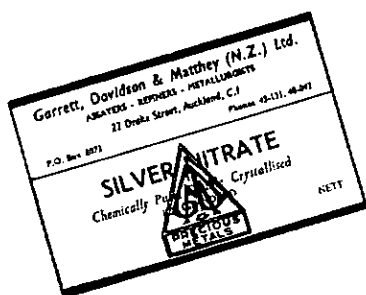
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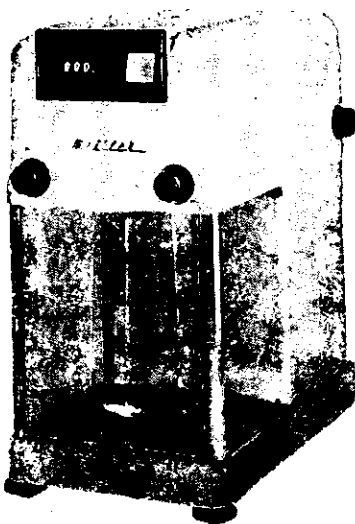
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