JOURNAL OF THE NEW ZEALAND INSTITUTE OF CHEMISTRY

VOL. XV. JUNE, 1951. No. 3.

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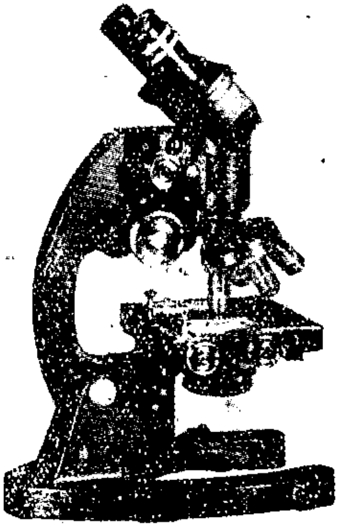

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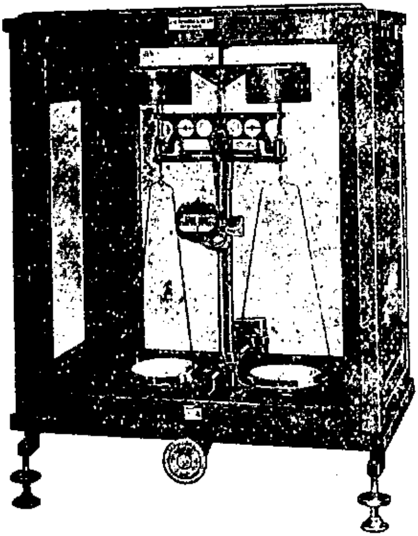

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WIDNES — ENGLAND

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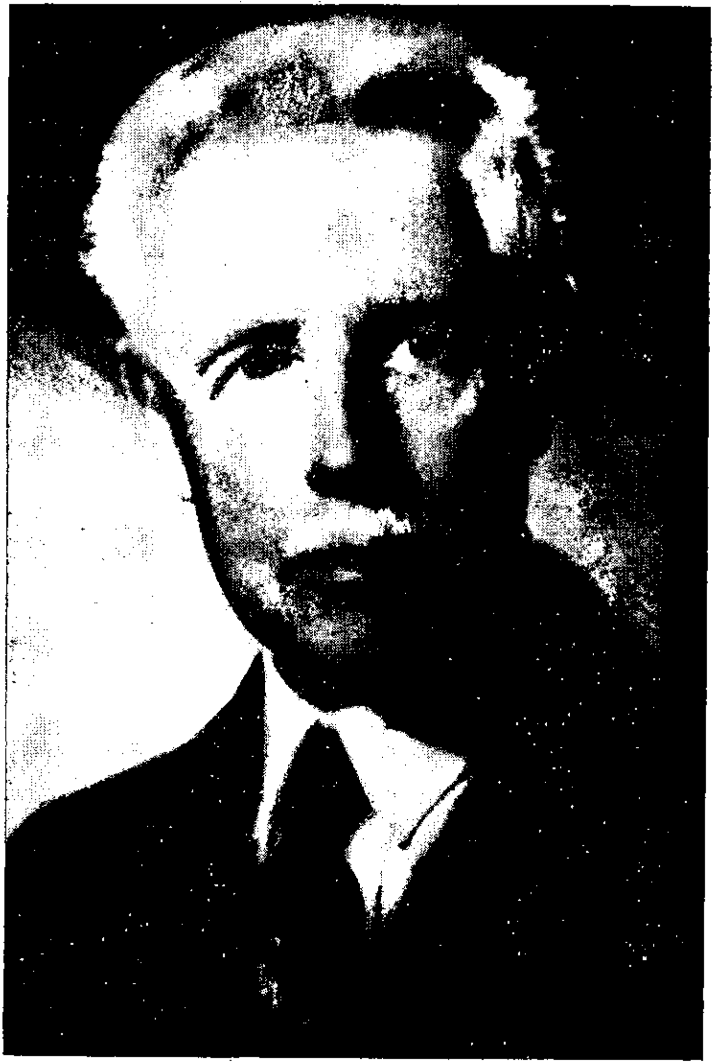

WILLIAM DONAVON

WILLIAM DONOVAN

A Tribute

William Donovan, Honorary Fellow and a foundation member of this Institute, died at his home, 51 Washington Avenue, Brooklyn, Wellington, on December 4th, 1950.

He was born at Thames in 1879, his father being a well-known builder and contractor in the then important goldfield town.

He received his primary education at Kaueranga Girls' School, which, contrary to its title, was a mixed school. However, it was still directed by a headmistress, Miss Haselden, a most efficient teacher, and it was due to her and to his exceptional capacity for learning that he was through his standards in his eleventh year. He was then successful in winning one of the few district scholarships offered annually and tenable for three years.

On this he attended the Thames High School. There also he was among the outstanding scholars, winning a senior district scholarship which gave him a further two years at the school.

The headmaster, James Adams, was a man of strong personality, a sound classical scholar, having a passion for science. Unfortunately he was limited by the small numbers at the school and no university scholarships were won by his pupils. However, he enthused a number of his best boys to take up, for their life work, science as applied to mining and metallurgy. Donovan was among these and accordingly in his eighteenth year he commenced a three-year course at the Thames School of Mines.

He was most successful at this school. The Director, Mr. F. B. Allen, said of him (in his final year, 1898) that "in addition to gaining first-class certificates in all his subjects, he won the President's Medal for the best student, the Director's Prize for assaying and chemistry, and the University Mining Scholarship. Besides showing a marked ability in the theoretical work, he attained a high degree of proficiency in the practical operations of assaying, chemistry, metallurgy and surveying, and assisted in the school battery in the treatment of various classes of ore by the amalgamation and cyanide processes."

Donovan looked back with pleasure to his period at this school, and used to say that he was there taught the principles and importance of what is now known as "chemical engineering," and to appreciate the value of the chemist in industry. He also associated with practical men, which broadened his outlook, and he particularly valued friendships made with several who afterwards attained eminence in the mining world outside New Zealand.

As a mining man he was proud that the School of Mines were pioneers in bringing science into industry in New Zealand, and he was always ready to pay tribute to the memory of Dr. James Gower Black, Professor of Chemistry at the University of Otago, whose series of science lectures to audiences of mining men on the various fields led to the setting-up of the schools in the middle eighties. He believed that these lectures, delivered and received at the time with the utmost enthusiasm, were probably the most fruitful scientific lectures given in New Zealand, and that for this alone Black should be worthily remembered.

As required by the terms of the university mining scholarship, he studied at the University of Otago for three sessions (1899-1901), taking a science course and specialising in chemistry and geology. Unfortunately, while on a vacation tour of the gold-dredging areas, he spent a night in the snow, which resulted in a serious attack of rheumatic fever. This had a disastrous effect on his university work for that year, and blasted his hope of finally obtaining double first-class honours.

The sessions for 1902 and 1903 were taken at Auckland University College. At the end of the former year he completed B.Sc., won the college prize for chemistry, and a Senior University Scholarship in Chemistry. In the next year he qualified for M.Sc. with second-class honours in Chemistry and Geology. His chemistry thesis was on the sulphides, selenides and tellurides of gold, which piece of work was highly commended by the examiner, Sir William Ramsay.

His university course completed, he joined the staff of the Victoria Mill of the Waihi Gold Mining Company at Waihi, and was employed as assayer and in the cyanide works. He had previously worked during a vacation in the same mill. He there gained valuable experience in organised systems of process control and in the large-scale plant operations connected with the cyanide process, which was most useful to him in subsequent years.

During 1904 he qualified by examination for a battery-manager's certificate, as he then expected, either in New Zealand or more probably overseas, to remain permanently in the gold-mining industry. This was not to be, for in January, 1905, he accepted the offer of a position as assistant analyst in the Mines Laboratory, Wellington, where Dr. J. S. Maclaurin was Analyst to the Mines Department and Colonial Analyst.

It should here be explained that this laboratory really had its origin in Dunedin in 1862, when the Provincial Government of Otago set up a Geological Survey of which Dr. James Hector was Director and Wm. Skey analyst. In 1865 the General Government instituted a Geological Survey for the whole of New Zealand, and Hector was appointed director. Skey had charge of the laboratory as analyst to the Geological Survey of New Zealand, but in addition carried out general analytical work for the Government. To cover this, Skey was designated Colonial Analyst and the laboratory the Colonial Laboratory. Thus both analyst and laboratory had dual designations.

In 1893 the Geological Survey and the Laboratory were taken over by the Mines Department, Skey then becoming Analyst to the Mines Department, but was still also Colonial Analyst. Skey died in 1900. Dr. J. S. Maclaurin succeeded him and carried on with one cadet until increasing work led to further appointments of which Donovan's was the first.

This arose mainly because the Geological Survey had recently been reorganised with Dr. James Mackintosh Bell as Director and a most efficient staff appointed. A comprehensive scheme was laid down for the general survey of the country and the work was taken up with much enthusiasm. Special attention was given to known metalliferous areas and very many samples of a wide variety of ore were submitted for analysis. Donovan's training and outlook made him particularly efficient in dealing with this class of work and in the training and supervision of junior staff. It was a very busy time for him as well as for others. Space will not permit of a full account of his work during this period (1905-1910) of intensive activity by the Geological Survey in the metalliferous and coal-bearing areas, but the following may be of interest.

The Mines Department had a large set of exhibits at the Christchurch Exhibition of 1906-07 and among them a laboratory to demonstrate the fire-assaying of gold and silver ores and the analysis of coals. A small laboratory building was erected in the exhibition grounds, reasonably well equipped, and Donovan placed in charge. He made the six months by no means a pleasure jaunt, as the writer who was his assistant can testify. The periodical demonstrations to the public called for considerable preparation and maybe were of some value, but they were really a side issue as far as work was concerned.

Many assays of gold and silver were made but the values found were small indeed. There was, fortunately, some compensation, as Donovan was able to initiate his assistant into the latest methods for determining trace quantities of gold and silver in ores. The most useful job was the analysis of a representative set of coal samples from all the main working mines in the country. Donovan gave much attention to the standardisation of the method for fixed carbon. One most important advance was the determination of calorific values by the then new oxygen bomb calorimeter. Sulphur was determined by Eschka's method, and he soon proposed that for checks we determine the sulphur in the combustion products from the bomb. This was done with satisfactory results. Bromine water was used for oxidising. The writer can look back to hot Christchurch afternoons, when we worked behind doors close shut to keep out intruders, traces of bromine in the air quite appreciable to the senses, struggling with improvised connections for charging the bomb, keeping an eye on odds and ends, while from outside came the happy screams of water-chute patrons and, above all, the maddening boom of beaten tom-toms from the Fijian compound just next door.

It spoke volumes for Donovan's devotion to duty that good laboratory work was done under such distracting conditions. However, it was a pleasant episode in retrospect, but he agreed that maybe we worked too hard. The job was completed on his return to Wellington, and the results, published by the Mines Department in 1907, were the first comprehensive and reliable set of analyses of New Zealand coals. They were of great value for reference, and formed a basis for future work.

The other aspect of his work at this period was the tradition established for the accuracy of reports made by the laboratory, and to ensure this continuous investigation was made of methods of analysis, both as to accuracy and speed of working. Dr. Maclaurin took the lead in this matter, but Donovan saw to it that it became a fundamental part of laboratory procedure.

Owing to staff being so busily employed, little of this work was written up for publication. An exception was a paper entitled "A Rapid and Accurate Method for Estimating Iron in Iron Ores," published jointly by Maclaurin and Donovan in Trans. N.Z. Inst., Vol. XLI, 1908. It occupies only three pages, but is a model paper and gives some indication of the high standard of work considered essential by the two men directing the laboratory.

The depression of 1909 and the resulting retrenchment brought changes. The staff was not reduced, but it was a close call, so close that Donovan got his testimonials up to date. The Geological Survey was severely reduced, being blamed by the selfstyled practical man for not discovering the unlimited mineral wealth which the said practical man declared must exist. What the Geological Survey had finally established was that, with the possible exception of iron ores, the metallic-mineral resources of New Zealand are limited.

Donovan with others saw this very clearly, and that accordingly, apart from iron ores, the emphasis regarding mineral resources should be on the non-metallics. With the retrenchment there was some reorganisation of Departments, the laboratory being taken over by the Internal Affairs, the designation Mines Laboratory was dropped, and it was from this time known only as the Dominion Laboratory, which had been one of its designations since 1907, when New Zealand was given Dominion status.

Although for some time a reduced volume of samples was submitted by the Geological Survey, the total work of the laboratory increased rather than diminished. At this time the Department of Health commenced its serious administration of the Sale of Food and Drugs Act of 1908, which called for much investigational and routine work by the laboratory. Donovan showed much interest in this section of the work and to some extent directed it, but the duties were undertaken by others under the leadership of Dr. Maclaurin.

The Customs Department also made increasing use of the laboratory facilities. Donovan undertook most of this very varied work, which called for a wide knowledge of materials and for keen judgment as to when enough had been done to determine the nature of the sample for its classification for tariff purposes.

The most far-reaching advance was due to the growing recognition by Government Departments of the value of the scientific aid which could be given by a laboratory, and that better service could be expected from a well-organised central institution than from small laboratories attached to specific departments. This led finally to the laboratory undertaking, as a regular activity, a very wide range of investigations connected with failures of materials and other problems. Attention was given to the testing of materials to ascertain if they complied with specifications. This was most important, and in a few years the desirability of purchasing to specification, and requiring the use of materials complying with specifications, became fully recognised by the Departments concerned. The increasing volume of this work made it necessary as the years passed to set up well-equipped special sections to deal with materials. That such facilities should be available seems axiomatic to-day, but in 1908 this was by no means so—indeed some thought that specifications in themselves were sufficient. Donovan was much amused when informed that an erring painter whose paint failed to comply said that he did not know the specification mattered. No one supplying paint to a Government Department would say that to-day. The laboratory thus ceased to be primarily concerned with the needs of the Geological Survey and of the Mining Industry, and had become, except for Agriculture, a general service laboratory for Government Departments.

One special feature connected with this development was the building up of a good library. Donovan saw clearly that there would be increasing demands for service from the laboratory, and that if these demands were to be effectively met a good library was essential. He was most insistent on this, and had arguments ready when expenditure on books was questioned, and it is mainly to his efforts and foresight that the present laboratory owes its fine library.

Donovan was first assistant from his appointment in 1905 until 1930, when Dr. Maclaurin retired. Part of the time his designation was Mining Chemist and then Assistant Dominion Analyst. The exacting and varied duties of this position made it impossible for him to embark on prolonged special investigations, the publication of which might have brought academic honours. He would have appreciated such an opportunity, but it never came. However, there were compensations, as in the course of his work he followed up some lines of special interest to him and in which he became an authority. These, as would be expected from one with his background, dealt with the mineral resources of the country, and of these most attention was given to clays, coal, and ironsand.

Clays had been analysed by Skey during his time as Colonial Analyst (1865-1900) and the results published in the Annual Reports of the Colonial Laboratory. This was continued by Dr. J. S. Maclaurin, but nothing in the way of a systematic survey was attempted. Donovan advocated such a survey, as he saw that clays were among our most valuable mineral resources.

A modest beginning was made about 1912, when more thorough analyses were undertaken, and in addition test tiles were burnt over a range of temperatures. The analyses were carefully tabulated and the test tiles kept for reference, together with all available particulars as to the locality and size of deposits. By 1924 sufficient data were available to warrant their publication as an appendix to the 57th Annual Report of the laboratory.

In 1926 Donovan read a paper entitled "Clay Resources of New Zealand," to a Mining Conference at Dunedin. As the years went by the work was extended and an inter-Departmental Committee was set up to co-ordinate fully both field and laboratory work. Finally a Pottery and Ceramic Research Association was formed by the industry and the Department of Scientific and Industrial Research. It has set up a well-equipped and efficiently staffed laboratory which works closely with the Dominion Laboratory. In addition, several pottery firms have chemists on their staffs, so that one can say that with the Government work on clays and that of the chemists in the pottery industry, New Zealand is well provided for as regards research in ceramics.

Although Donovan took no active part in recent developments, this most desirable state of affairs is in a large measure due to his quiet and effective work over many years, and to his ready and unostentatious co-operation with others interested in various phases of clay utilization. It was fitting, therefore, that he was given the honour of delivering the first "Mellor Memorial Lecture" to our Wellington Branch at the August meeting, 1945.

Coal: Although the desirability of extended research was recognised, little was undertaken from 1907-1914 except analyses of bunker coal then supplied to the Royal Navy and of samples submitted on behalf of the Mines Department and others. In 1914, as the result of the disastrous explosion in the Huntly coal mine, with the loss of 43 lives, attention was focused on safety in mines. The question of the comparative inflammability of coal dusts was investigated and the results published by the Mines Department in a bulletin entitled "A Laboratory Study of the Inflammability of New Zealand Coal Dusts, by W. Donovan." Research on the inflammability of coal dusts had already been carried out overseas, but the procedure followed required special apparatus which could not be obtained owing to war conditions. Donovan improvised apparatus by which the comparative inflammability of the dusts was ascertained, by blowing a sample through a bunsen flame and measuring the distance which the flame of the ignited dust carried beyond the bunsen, as indicated by the ignition of a piece of cotton wool. He acknowledged helpful suggestions from Dr. Maclaurin, and from the literature cited one sees that he had a thorough knowledge of British and American research on coal-dust explosions. The paper illustrates Donovan's grasp of the essential when investigating a practical problem and his skill in improvisation. It merited the high praise given by P. G. Morgan, Director of the Geological Survey, who said, *inter alia,* "deductions of immediate value in lessening the dangers of our coal mines can safely be drawn from the experiments made by Mr. Donovan."

In 1926 Donovan was granted leave of absence and visited Great Britain, the Continent of Europe and the U.S.A. It was mainly for personal reasons, but he visited laboratories wherever possible. He met many eminent chemists, among them J. S. Haldane, the great authority on hazards due to gases in coal mines. Although the tour was for personal reasons, he agreed when in Germany to arrange for the purchase, on behalf of the Mines Department, of a Fischer experimental low-temperature coal-carbonisation plant, and also to obtain information as to the briquetting of coal and lignite.

After his return to New Zealand a comprehensive investigation of the low-temperature carbonisation of New Zealand coals was put in hand, and also experimental work on briquetting of the char. This latter was a continuation of work on the briquetting of coal previously carried out for the Mines Department.

These investigations were made for the Mines Department and the New Zealand Fuel Research Association. This was one of the first Research Associations organised by the then newly-formed Department of Scientific and Industrial Research. Valuable results were obtained, which were of much assistance to the Waikato Coal Carbonisation Company, when establishing their Lurgi Plant at Rotowaro. In this connection, because of his special knowledge, Donovan was in 1929 sent to Canada at the request of the company to report for them on the operation of a Lurgi Plant, then in production in Alberta.

Unfortunately, owing to slump conditions and the withdrawal of support by the mine-owners, the Fuel Research Association disbanded and the research was discontinued. The desirability of again taking up the research was persistently advocated by Donovan and others, and in 1936 a wholly Departmental organisation, the Coal Survey, was set up and controlled by officers of the Mines Department, Geological Survey and Dominion Laboratory. A special laboratory was equipped with the latest apparatus, and staff appointed. Although Donovan played a most active part in organising the Coal Survey, a long illness in 1937, followed by his retirement in 1940, prevented his taking up the direction of the laboratory work. However, his keen interest in the work of the survey continued, and in his official position as one of the three gas referees he strongly advocated research with a view to the utilization of our brown coals and high-sulphur bituminous coals in gas making.

As in the case of ceramic research, Donovan's work on coal was effective largely because of his ready co-operation with others interested in the various coal problems. This is exemplified in a joint paper prepared by him with J. A. C. Bayne, Instructing Engineer of Mines, and F. W. J. Belton, Engineer to the Christchurch Gas Company (N.Z. Journal of Science and Tech., Vol. XIII, pp. 353-70, 1932), which was part of a joint report to the Government in 1931.

Ironsands.—Although he was of the opinion that large-scale working of our ironsands was in the distant future, he thought they were worth continuous investigation and that attention should be given to any work undertaken on similar ores overseas. In 1916 he published a paper on the distribution of titanium, phosphorus and vanadium in Taranaki ironsand, and in 1923 a further paper which dealt with suggested processes for their reduction, and included very full analyses of Patea and New Plymouth sand. The subject continued to interest him to the end, and in 1944 he published a paper entitled "Possible Use of Pumice as a Flux in Smelting Iron Sand." The paper concludes with suggestions as to lines of investigation which show that his enthusiasm was still keen and that he had not lost his facility for grasping the essentials of a practical problem.

It is usual to assess a worker's contribution to the advancement of his science by a consideration of his published work. Donovan's published papers were not numerous, although of a high standard in their several fields; but important as the papers may be, they are not his outstanding contribution to the progress of applied chemistry in this country.

This is to be found in his work (as sketched above), for the Government, over a period of 36 years from 1905, first as second in charge and finally, for ten years, as Director of the Dominion Laboratory and Dominion Analyst. This covered a period of great progress in the application of chemistry in New Zealand and was an epoch, following a time when few chemists were employed by Government or by industry and when the tendency was to regard the chemist as a being apart or as a kind of magician. The changed attitude developed at the turn of the century. When Donovan joined the Colonial Laboratory in 1905 the staff was two; at his retirement it was 50, and at his death 150; and a corresponding increase had taken place in other Government Laboratories and in industry. The various factors leading to this development cannot be dealt with here, except that it was due in large measure to a number of far-seeing and devoted workers, in the University, research institutions, industry and Government Service, but to none of these workers is more credit due than to Donovan.

He took no narrow view of his professional duties and held that they included a responsibility to the profession as a whole. He therefore associated himself with the early chemical organisations sponsored by Victoria University College and by the Wellington Branch of the Royal Society of N.Z. In 1926 he was made a Fellow of the Royal Institute of Chemistry and became an active member of the newly-formed New Zealand section of that Institute. He was a foundation member of our Institute, and he took a leading part in its formation and until failing health prevented him, he regularly attended meetings of the Wellington Branch. He did not apply for the Fellowship until 1941, as he thought that the Institute should not grant Fellowships until it was well established, and also, he did not accept nomination for President, as he felt that his official position might hamper him in carrying out the duties of that office.

However, he took the keenest interest in the progress of the Institute and was much gratified at his election as an Honorary Fellow in 1946.

One remembers some of his personal characteristics which illustrate the man. In his student days he memorised the table of elements and atomic weights. He said he must have done this by will power, as his memory was not exceptional. He had not studied higher mathematics, but he did know his arithmetic, and to one plodding through calculations in the hard way, his short methods and ingenious checks were a matter for wonder. In attacking a problem he held that the simplest solution should first be looked for. The soundness of this attitude was exemplified when some round seeds found in stomach contents could not be identified, even with the help of two botanical experts. When consulted, he said, "Now what common seedy food could be eaten?" and suggested dried figs, and fig seeds they were. His favourite approach to a discussion of a doubtful project was by what he used to call the "Euclidian" method—"Suppose it done, what then?" He did not believe in work for no reasonably well-defined objective. Although diplomatic in dealing with others, he quickly resented what appeared to him to be unfair criticism of the laboratory or of the profession, and to a highly-placed official, who told him that chemists could be picked up anywhere, he answered: "That might apply even to men for your position."

He was a shy man, sensitive and apparently stand-offish in manner. This impression disappeared on close acquaintance, and to those who knew him he was eminently a man whom one could implicitly trust.

His will power has been mentioned: it enabled him to overcome a stammer, and he became a forceful and clear lecturer. In his younger days he was a keen cricketer and always retained his interest in the game.

His interest in athletics was general, for he was a runner, played hockey and football and knew something about boxing. The last he learnt, just in case. In his latter years he was a keen bowler. He was a lover of flowers and had a fine garden at his home in Brooklyn, cared for by Mrs. Donovan and himself. They grew very fine dahlias and flowers were a joy to him to the last.

He was deeply religious, was a leading member of the Baptist Church of New Zealand, and for many years a much-loved and valued worker in the Brooklyn (Wellington) congregation. The closing 12 years of his life made plain to those who knew him what manner of man he was. An illness of two years, attended with much suffering, was endured with uncomplaining hope. He recovered and returned to the laboratory, but when he felt he could not "pull his weight" he resigned his position. Although his state of health would have warranted it, he did not take things easy, but continued whatever activities he could in connection with his church and garden, and kept up his general interests. He saw to many of the usually neglected small things which matter so much. For instance, he wrote long letters regularly for many years to a crippled relative in hospital, and this continued even when he himself lay for months on his back in a frame. The letters were always happy and brought cheer to the recipient.

Until failing health kept him to his home, he for some years visited week by week otherwise friendless old men and women in the Silverstream Hospital, 18 miles from Wellington city.

During the last two years his health again seriously failed and he had once more to face hospital and major operations.

However, he retained his serenity of spirit and clearness of mind, and was to the last interested in the affairs of the laboratory and in the progress of our Institute and his many friends in it. His death came ten years after retirement.

It can truly be said that by his passing our profession has lost one of its most valued members and the community a wise, good man.

R. L. ANDREW.

FURFURAL: POTENTIAL USES AND POSSIBLE MANUFACTURE IN NEW ZEALAND

(Industrial Chemical Essay Prize—1950)

By H. A. L. Morris, Dominion Laboratory, Dunedin.

It has been said that the scientist should be like the explorer —during his journey he should pause at some vantage-point and gaze back on the tracks he has made. Not only would he see the well-defined paths of his achievements to help him plan his advances, but he would see those paths bestrewn with waste-products which he should periodically reconsider in the light of scientific advances, and changes in economic and geographical factors within the world. The chemist interested in the utilization of waste-products is, in a sense, performing difficult gymnastics by mainly looking backwards into the past, but keeping one eye on the future.

In a world of increasing populations and decreasing resources, the profitable utilization of waste-products is of singular importance, and no country in this modern age can afford to neglect opportunities in this field. This essay is a contribution towards progress in the utilization of waste-products in New Zealand, and it is intended to demonstrate how certain local agricultural wastes (principally oat hulls) may be profitably used for the manufacture of furfural, a versatile compound which, it is predicted, will fulfil some role in future New Zealand industry.

No established market for this compound exists in New Zealand, but it is claimed that locally produced furfural could (a) replace certain imported materials, (b) stimulate the manufacture of new products and the establishment of new industries, and (c) increase the efficiency of certain established processes, and the quality of many products.

A detailed account of the manufacture and uses of furfural could not be presented in an essay of this type. Rather has the purpose been to focus attention on the product itself, to show its possible uses in New Zealand, and to study prospects for its manufacture.

The Overseas Development of the Furfural Industry

Furfural was first prepared by Dobereiner in 1832, but it remained a laboratory product until prepared on a small scale industrially in the early 1890's.

The possibility of industrial preparation was first apparent as the result of investigations in 1920, when the Quaker Oats Company of U.S.A. was faced with the disposal of inconvenient quantities of oat-hulls, the waste product from milling. Only about 50% digestible, the hulls were of little use as stock feed, and research was undertaken as to means of improving their nutritive value. Little success was achieved; digestibility was improved but the product was unpalatable. During the study, however, it was noticed that acid treatment of the oat-hulls produced substantial quantities of furfural, a fact which appeared to be of little importance at the time, since one ton of hulls would have produced sufficient furfural to cover the current world demand. Subsequent research into uses and applications went hand-in-hand with the development of industrial preparation, and the industry progressed from delivery in cans to steel drums, and ultimately to delivery in tank cars and tank steamers. To-day in the U.S.A., approximately 500 million pounds of agricultural by-products are utilized in its production. The demand for furfural has far outstripped the supply of oat-hulls, whose limited utilization furnished the impetus responsible for the birth of the industry. Expansion has led to the use of corn cobs and cottonseed hulls; bagasse, rice hulls and peanut hulls must be considered in the near future.

Uses of Furfural

A study of the rapid and successful technological development of furfural could not fail to inspire any chemist. Since the compound first became available on an industrial scale, some twenty years ago (at one dollar per pound), about 3,200 patents have been issued covering furfural and its derivatives.

Recently a production plant has been established in Britain, while Australia in the last two or three years has been actively investigating the possible setting up of a production unit there. A quantity of 50 tons or so a year of furfural was previously imported into Australia, with the market showing obvious signs of increasing. It was also generally realized that reasonably priced, locally prepared furfural would lead to a much greater usage.

As one views an imposing list of uses increasing rapidly year by year, the still youthful furfural industry initially arising from the creation of its own markets shows prospects of entering a host of fields of application. It is felt that the potentialities of the compound (industrially unknown in New Zealand) have been long overlooked here. U.S.A. has been virtually the world source, and during the war supply scarcely met demand. This condition continued after the war and impeded the apparently logical extension of the market to other countries such as New Zealand.

From the vast number of reported uses and applications, an attempt is made here to provide a glimpse of those uses of possible importance in New Zealand now, or within the next few years.

Furfural as a Solvent

The physical constants are reported as follows:

Specific Gravity	20 deg. C.	1.1593
Refractive Index		1.5261
Boiling Point		162 deg. C.
Flash Point (open cup)		56 deg. C.

The straw-coloured liquid, which darkens on standing, is miscible in all proportions with most organic solvents excepting petroleum derivatives.

The darkening on standing, which is due to autoxidation, can be prevented by inhibitors (usually basic substances) such as tertiary amines, or aqueous sodium carbonate.

Furfural's success as a solvent is due to a number of factors, some of which are (a) high degree of selectivity, (b) ease and economy of recovery of solvent, (c) relative freedom from fire and explosion hazards, (d) non-toxicity to humans under normal operating conditions.

Furfural dissolves nearly all the known cellulose esters and ethers, and although in certain cases it is somewhat slow in action, its solvent power is increased by admixture with alcohols and benzene. Its importance in the cellulose-ester lacquer industry may therefore be appreciated. It has been extensively used as a solvent for phenolic-resins, dyes, gums, metallic soaps, and complex organic materials. Furfural as a solvent has excellent penetrating power, and has been used for leather dyeing (in the shoe industry) and for dying of wood.

As a paint and varnish remover it has established several large companies in the U.S.A. One of the most effective paint removers reported consists of a mixture of furfural and acetone, whilst furfural with 1% of cellulose acetate to help spreading has also been used extensively. Furfural has also been used as an effective dispersant for tar in supply pipes by overseas gas companies.

The scope for furfural as a solvent in New Zealand is considerable. One further interesting possibility is in the field of timber preservation. Apart from possessing effective fungicidal powers itself, and possessing excellent penetrative properties, furfural has good solvent power for metallic soaps, and will dissolve appreciable quantities of purely inorganic salts such as copper nitrate (0.03%).

The great bulk of solvents used in New Zealand is imported and the estimated cost of production of furfural indicates that it could compete quite favourably, on a basis of cost, with most imported solvents.

Furfural as a Selective Solvent

(a) One of the largest and best established uses of furfural is in the field of refining petroleum lubricating oils. To-day more lubricating oil is refined by furfural than any other solvent.

(b) Another outstanding application has been its use as a selective solvent in the purification of butadiene for the synthetic rubber programme in U.S.A.

Neither of these two uses is of likely significance in New Zealand, although if an oil-shale project were to eventuate furfural as a refining medium might well be considered. In addition it is not unlikely that recovery of used lubricating oil which is established on a small scale in some parts of New Zealand could be extended.

(c) The application of furfural in the rosin industry has caused revolutionary developments in this field. In the U.S.A. to-day more than half of the total rosin produced is derived by extraction of the wood (chiefly the pine). This achievement, accomplished in a space of a few years, has been attributed to the use of furfural in the refining process.

Wood rosin as distinct from gum rosin is obtained, by extraction, from the *dead* timber, usually the stump, after timber has been removed from wooded areas. The tree stump, which is removed by dynamiting or by a type of tractor termed a "nutcracker," is transported to the factory and there reduced to chips. The chips are then treated to recover volatiles such as turpentine, which was formerly obtained by steam distillation, but now by a method of extraction with light solvent, yielding about 12 gallons per ton of wood.

The wood rosin is then extracted from the residue with petroleum naphtha and is partitioned with furfural—the furfural layer separating with the more aromatic and more oxidised rosin fraction dissolved in it. Distillation of the petroleum naphtha and of the furfural yields refined rosin and dark rosin respectively. Even the impure rosin fraction extracted by the furfural has been developed to find application as a modifier for plastics and cement, and as an emulsifier for asphalt.

The loss of furfural in the process has been found to represent less than 1% by weight of the refined rosin produced.

At present much emphasis is being placed on the future importance of forest products to New Zealand. Plans for the establishment of a large pulping industry are proceeding, and furfural might well find application in relation to this project. Depending on the type of pulping process employed, furfural could be used in the extraction of excess rosin from the wood, or in the recovery of rosin from waste-liquors in the form of tall oils, etc.

It is also possible that, associated with the pulping industry, a plant could be established for the extraction of rosin from the unused tree stumps. The rosin recovered would find a ready market and such a plant would provide a valuable industrial contribution.

(d) The overseas application of furfural to the selective extraction of high iodine value fractions of vegetable and animal glyceride oils has assumed some importance. During a four-year period in U.S.A. over six million gallons of linseed oil were fractionated with furfural to yield a high iodine value extract similar to perilla oil in its properties.

Furfural extraction has also been employed in the concentration of Vitamin A from fish-liver oils and, for example, a concentrate in 19% yield, containing 82,000 units of Vitamin A per gram has been obtained from dog-fish liver oil with an average potency of 17,500 units per gram. These concentrates also had lost much of the fishy odour and taste associated with the original oil.

These applications are of possible industrial importance in New Zealand.

Furfural as a Chemical Intermediate

Many compounds are prepared on an industrial scale using furfural as starting material, one of the more recent and impressive examples being that of its use in the manufacture of nylon. The du Pont Co. in the U.S.A. has actually established a plant using furfural as the starting material for the prparation of hexamethylene diamine, one of the main ingredients of nylon.

In the pharmaceutical field a number of derivatives have been prepared and their use as disinfectants, antiseptics, mydriatics and anaesthetics is reported.

A discussion of the derivatives of furfural and their preparation would be lengthy, and this description will be confined to furfuryl alcohol and tetrahydrofurfuryl alcohol, two compounds which are readily prepared and offer potentially immediate application to New Zealand industry.

Furfuryl Alcohol: Furfural can be smoothly and rapidly converted by reduction with hydrogen into furfuryl alcohol in virtually quantitative yields. Commercially the reduction is carried out in 110-gallon autoclaves at 1,000-1,500 lb. per sq. inch, and 175 deg. C., in the presence of copper-chromium oxide catalyst.

Furfuryl alcohol is an amber mobile liquid of boiling point 169 deg. C., and is extremely sensitive to acids, which cause it to resinify readily. This property has led to the use of furfuryl alcohol in the synthetic resin field. Controlled resinification, using an acid catalyst, produces resins of any desired viscosity from thin liquids to thick gels. These liquid resins are thermo-setting and are readily converted into the infusible form.

Partially polymerized furfuryl alcohol has had widespread use as a protective coating against acid-alkali conditions, in food, battery, dairy and soap industries, etc. Application can be made by brush, and the finished coat may be sanded and machined without chipping. One such type of protective coating is furfuryl alcohol (diluted with acetone, etc.) containing 2% by volume of catalyst, which is 33% by volume aqueous sulphuric acid. Similar types of resins have been used as mortar for bricks where high temperatures and acid-alkali conditions exist.

Many other furfuryl alcohol resins prepared by reaction with phenol, urea, and formaldehyde are of industrial application.

Furfuryl alcohol (as is furfural) is a reactive solvent for phenolic resins and is used, for example, in the manufacture of resinoid-bonded abrasive wheels. It wets the abrasive surface and partially dissolves the resin binder to make the mix bondable, and then in part reacts with the resin and with itself during the curing cycle.

An 80% reduction during the last ten years, of grinding costs incidental to the manufacturing of automobile bodies in the U.S.A., has been attributed to the use of furfural and furfuryl alcohol resinoid-bonded abrasives.

As a solvent furfuryl alcohol dissolves cellulose nitrate and acetate, shellac, kauri and mastic gums, and is used industrially in the varnish industry, while it has also been used as an effective paint remover, and solvent for dyes. It has been found to be an excellent solvent for carbon removal in petrol and diesel motors.

Stated to be non-poisonous, furfuryl alcohol is miscible with water and most organic solvents except petrol.

Tetrahydrofurfuryl Alcohol

By merely changing the catalyst, in the process for the preparation of furfuryl alcohol, furfural may be reduced with hydrogen to terahydrofurfuryl alcohol. The catalyst used is Raney nickel, and yields are given as from 70% to 80%, although it is claimed that low temperature operation over an extended period of time gives 95% yield. This compound is a pale yellow liquid of boiling range 170-178 deg. C., and is completeley miscible with water. It is an excellent resin and dye solvent and dissolves, for example, rubber hydrochloride, cellulose esters, ethyl cellulose, rosin, shellac, kauri and copal gums.

It can be seen from the above brief account of these two readily prepared derivatives that the preparation of furfuryl alcohol and tetrahydrofurfuryl alcohol, with their many potential uses, could be a valuable adjunct to a furfural industry.

Furfural in the Synthetic Resin Field

The details available concerning furfural application in this field are enormous and here again an attempt is made to provide a glimpse of the potentialities this compond holds for application in the developing plastic industries of New Zealand.

Furfural (as does furfuryl alcohol) undergoes ready polymerization with acid or alkali catalysts, either with itself or with phenol, aldehydes, ketones, etc. Uncontrolled acid catalysis of furfural tends to give insoluble, infusible resins as a result of fast reactions, but careful control of conditions yield dense, hard resins of glossy finish and lustrous fracture.

Acid-produced liquid thermosetting resins, indefinitely stable at room temperatures, are also available; the addition of a catalyst converts them into the solid cured state. Such resins can be used for casting and laminating purposes, or in the impregnation of porous materials.

A porous product said to be non-resinous is obtained by treating 60 parts furfural with 15 parts hydrochloric acid and 25 parts of water for a seven-day period at room temperature. The product is claimed to be an adsorbent and suitable for use in artists' crayons, etc.

Alkaline catalysts tend to give more controllable polymerization of furfural and the products (generally soluble in alcohol) when used for coating purposes give firm, glossy surfaces on drying.

Phenol-furfural resins are of later development than phenol-formaldehyde resins, but the former type have reached considerable volume output. Phenol-formaldehyde resins (usually base catalysed) pass through intermediate rubbery stages in formation before setting to rigid and infusible masses, while phenol-furfural resins yield moulding products which flow freely into the desired form and set rapidly to infusibility. Completeness of cure, low moisture absorption, good finish and excellent acid-alkali resistance and electrical properties, are typical of the phenol-furfural type.

An important advantage over formaledhyde types is that in the case of furfural no water of reaction requires removal during the reaction. Another advantage arises from the excellent solvent power of furfural, which enables it to react more readily with substituted amines and phenols, etc., which react only with difficulty in the aqueous medium of formalin.

Furfural-ketone resins (chiefly with acetone) are light in colour and have been utilized in lacquers and impregnating lacquers, while heating them with linseed oil produces oil varnishes. Furfural-amine types have been developed and furfural-aniline resins (soluble in organic solvents) have been used as dark varnish coatings. Furfural-phenol resins are applicable to much the same range of products as are the phenol-formaldehyde types, and uses vary from mouldings, laminates, to bonds; the resins are applicable alone or combined with such fillers as wood flour, etc. A host of uses are described and articles produced include radio-cabinets, ornaments, various fittings, parts of electric equipment and toys, abrasive wheels, safety helmets, paints, lacquers, sealing compounds and containers for products of industry. Special wartime uses such as bonding of ammunition boxes, bonding of aircraft flooring and preparation of containers are reported.

Furfural-casein resins have been used as substitutes for ivory and horn and for the preparation of insulating materials, while furfural-amine and acetone resins are light sensitive, and have been used in photography, lithography, and etching of metals.

In Australia, imported furfural has been used increasingly in the plastics field over a matter of a few years, and in 1947 a consumption approaching 100 tons per year was estimated for the near future.

For every 100 lb. of resin made, 55 lb. each of phenol and furfural are required as compared with 90lb. of phenol and 7½ gallons of 40% formalin. On this basis the cost of the furfural-phenol types compares more than satisfactorily with that of the phenol formdehyde type.

A limitation of the furfural resins that must be emphasised is that the greater proportion of them are dark in colour, frequently brown and black. Exceptions have been mentioned, such as the furfural-acetone resins.

Furfural as a Fungicide and Bactericide and Other Miscellaneous Uses

Furfural, although said to be relatively non-toxic to humans, is an effective fungicide and bactericide. It has a phenol coefficient of 0.26 and is regarded as about half as toxic to bacteria as phenol.

It has been used as a fungicide for seed treatment, as a preservative for glue and starch and biological preparations, as a fumigant for poultry houses and as a fly repellant.

As a weed-killer (5-10% in kerosene), a large railroad company in U.S.A. used furfural to kill weeds on its right-of-way. The compound has also been used to prevent slime growth in water supply lines. At present in New Zealand slime growth in irrigation races is a problem because it restricts water flow. The problem has been met somewhat inadequately by the use of copper sulphate. Trials with furfural would be worth while, because stock would be unaffected by even large doses.

Furfural has a strong but somewhat pleasant odour, and it has been used as an odorant in "germicidal" soaps, as an odorant for church candles and as an embalming fluid.

Sawdust: The disposal of sawdust in New Zealand creates many difficulties and entails much cost when carried out efficiently. To-day in New Zealand sawdust causes serious pollution of many rivers. Quantities are dumped, involving costly transport, and either left as noxious piles "breeding" insects and disfiguring the landscape, or burnt, frequently involving costly procedures. It is possible that furfural could help progress in the economic utilization of this waste material.

Acid hydrolysis of wood-waste yields ligneous residue with plastic properties when subjected to heat and pressure. One process involves digestion of sawdust with dilute sulphuric acid for 30 minutes at 135 lb. per square inch, the ratio of lignin to cellulose determining the properties of the finished moulded product. After washing and drying the material may be moulded at 190 deg. C., but the addition of aniline and furfural reduces the required moulding temperature to 150 deg. C. and improves the properties of the product. Lignin (in situ) in sawdust will condense with certain chemicals to give mouldable products. A process has been developed whereby sawdust is digested at 160 lb. per sq. inch for 3 hours with water and aniline. An aniline-lignin complex is formed, and when furfural is added as plasticizer, the material yields a mouldable composition of good strength and water resistance. Likely applications include manufacture of materials such as wallboard, etc.

Industrial Preparation of Furfural

Raw Materials: Furfural is produced in aqueous solution by steam distillation under pressure (in the presence of a catalyst) of a wide variety of pentosan containing agricultural wastes, such as oat hulls, maize cores, rice hulls, flax shives, straw and wood. Economically, however, the production of low-cost furfural is limited and only the higher pentosan-containing material such as oat hulls, corn cobs and cottonseed hulls are utilized. The industry in U.S.A., until recent years, was based on the use of oat hulls, which were available in large quantities within a convenient shipping radius of the furural-producing plant.

In New Zealand, some 96% of the oat crop is grown in the South Island. The variety of oats grown specifically for milling is "white oats," grown predominantly in Southland, with smaller quantities being grown in Otago and Canterbury. More than 500,000 bushels of "white oats" are grown in Southland yearly, and this grain passes almost entirely through the milling factory at Gore.

Assuming, however, that the mill throughput is 450,000 bushels yearly (18,000,000lb.), and the average hull weight represents 30% of the total grain weight, the above represents 5,400,000lb. of oat hulls per annum.

Representative samples of "white oats" oat hulls have been found to have a potential furfural yield of 23% by weight, which is comparable with that found overseas. Industrially, however, it is found that only 10% by weight of furfural is recoverable.

It appears that in New Zealand oat hulls available from the one factory site would yield approximately 240 tons per year of furfural.

Other agricultural wastes available in New Zealand, of possible value as raw materials, are flax shives, sawdust, and the residue obtained from grass seed milling.

Flax shives were investigated in Australia as a raw material, but were found to be unsatisfactory because of the relatively poor yield obtainable, due to their low bulk density, of 7lb. per cubic foot, and the difficulty encountered in manipulating this long-fibred material. The best yield obtainable was 6-7lb. furfural per 100lb. In New Zealand, linen flax shives are unlikely to be of significance. The linen flax industry has dwindled in size, and relatively small quantities are available at only widely-dispersed points, such as Timaru and Winton.

Seed-dressing residues, obtained predominantly in the South Island, are a possible supplementary raw material, and an estimated 1,200 tons of such material are obtainable (on a basis of 20 per cent. residue from the unmilled seed) at the plants situated at Dunedin, Gore and Invercargill. A further 1,600 tons or so are available in Canterbury. The residues vary considerably in composition, but analyses of certain mixtures indicate a potential yield of about 11 per cent. of furfural (about half that of oat hulls).

Although it has been stated that sawdust has been used overseas as a raw material, the low potential furfural yield of less than 7lb. per 100lb. as compared with approximately 23lb. per 100lb. for oat hulls, indicates that only processing on a vast scale would be economic. In New Zealand it is possible that if quantities of sawdust were available close at hand to a furfural unit admixture with oat hulls as a digestion charge could be considered, particularly if a two-stage digestion for the simultaneous production of ligno-cellulose was planned.

As far as raw materials are concerned it is apparent that the setting up of a furfural preparation plant in New Zealand should aim (initially, in any case) at the utilization of oat hulls as a raw material, although it is equally apparent that expansion of the industry could lead to utilization of other wastes, which, however, will lead to the problem of low-cost transportation to the preparation factory.

Processes for the Preparation of Furfural

Most of the detailed information given concerning the process for the production of furfural is based on data obtained from pilot plant studies and examination of plant required under Australian conditions. This in general must be deemed directly applicable to New Zealand conditions, where the same main raw materials would be used and the production unit would be of similar size to that considered by the Australian workers.

The formation of furfural from pentosan containing materials involves two main reactions, the hydrolysis of pentosans to pentoses and the dehydration of pentoses to furfural, the two reactions occurring almost simultaneously at high pressure. In general the process consists of steam distillation under pressure of the raw material in the presence of sulphuric acid as catalyst, the furfural being recovered from the distillate by fractional distillation.

This process (as used in U.S.A.) consists of pentosan hydrolysis and dehydration of pentoses to furfural in a single stage using high-pressure or superheated steam. European processes, on the other hand, employ a two-stage digestion, consisting of a low-temperature pentosan hydrolysis, followed by dehydration of pentoses at elevated temperatures after their separation from the cellulose. The advantages and disadvantages of the two-stage digestion process are discussed later.

Plant has been designed in the U.S.A. to achieve a continuous digestion procedure, oat hulls being forced into the digester against continuous pressure. This development was later abandoned, however, because of the considerable abrasion and corrosion of the feeder system and the difficulty of discharging the semi-solid mass from the digester.

Optimum conditions for the production of furfural by single stage digestion of oat hulls are quoted as follows:—

Catalyst Concentration—1.25 to 1.50% (i.e., 1.25 to 1.50lb. 93% sulphuric acid per 100lb. dilute acid charged).

Working Pressure—120-130lb. per sq. inch.
Liquid to Solid Ratio—1.25 to 1.50.
Steam Throughput—65 to 75lb. per hour per 100lb. hulls.
Time of Digestion—To Working Pressure, 30-40mins.
At Working Pressure, 3-4hrs.
Blow Down, 30-45mins.

The addition of metallic salts to the digestion mixture to increase the yield due to their tendency to increase the critical solution temperature of furfural—water mixtures was investigated, and it was shown that the addition of sodium sulphate to the sulphuric acid solution gave a slight increase of about 0.5 to 1.0 lb. (per 100lb. of hulls) in furfural yield, over a range of concentration from 1.45 to 4.35lb. of sodium sulphate per 100lb. of solution. It is thus doubtful whether addition of metallic salts would be of economic value.

Effective agitation is an important factor in digestion, it having been found that the agitating effect of live steam was small, even at relatively high throughputs. In the Quaker Oats Company's plant the digesters used are of circular design, and the digester itself is rotated to maintain agitation. From the Australian data, a fixed vertical cylindrical digester, with a paddle stirring device, is satisfactory, and doubtless of cheaper construction. One of the principal functions of effective stirring was found to be that of overcoming the channelling of steam. Stirring power requirements were the same for most raw materials (oat hulls, sawdust, maize cores, etc.), and stirring in the early stages of digestion appeared to be unnecessary. The stirrer required starting just before working pressure was reached.

Recovery of Furfural from the Digestion Product

Furfural is most readily recoverable from aqueous solutions obtained from the digestion product, by means of distillation, although a solvent extraction method has been reported as of likely economic value for more dilute solutions.

Distillation methods are attractive because the furfural-water azeotrope separates on cooling into two layers, the lower of which contains 95% furfural at ordinary temperatures. Pure furfural can be obtained by subsequent distillation of the 95% product under reduced pressure.

The aqueous furfural solution obtained by the digestion of oat hulls normally contains 2-5% furfural, 0.5-1.5% of acids (chiefly acetic), and about 0.05% of volatiles (chiefly methyl alcohol). When the mixture is continuously distilled in a suitable column the furfural-water azeotrope containing about 35% furfural and boiling at 208 deg. F. is obtained as a two-phase distillate, which when cooled to 72 deg. F. gives two layers containing 95% and 8.4% of furfural respectively. The aqueous layers can be returned to a suitable point in the column above the feed inlet, but if this is done, it is necessary to remove the volatiles which would otherwise accumulate in the upper part of the column and in the decanter, thereby increasing the mutual solubility of the two layers. Almost all the acetic acid is contained in the aqueous waste from the column.

The use of the digestion product as a direct vapour feed to the column has been employed as an alternative to the condensed product as a liquid feed, but a comparison of the two methods has shown that, although vapour feed slightly decreases steam and condenser water consumption, and decreases the necessary condenser surface area, it increases the necessary diameter of the column and also requires the careful removal of fatty materials (chiefly oleic and palmitic acids) by the use of an additional scrubbing column. On a cost basis there appears to be little difference between the two methods, but it has been suggested that liquid feed operation would be better because of greater flexibility and ease of operation.

A reduction in cooling surface area and cooling water requirements can be effected by decantation in two stages. The 35% furfural distillate is first decanted at 210 deg. F. to yield a decant containing 18.4% furfural, which is returned to the column, and an 84% product which is cooled to atmospheric temperature and again decanted. The quantity of 8% decant from this second operation is small and it can be returned cold to the column without affecting its operation.

The volatiles of the order of 0.05% have been assessed as being of the following approximate composition:—

Methanol	80%
Acetone	15%
Acetaldehyde	2%
Furan	2%
Methyl Furans	1%

The most satisfactory means of removing volatiles, which tend to accumulate in the upper portions of the column and in the decanter, is by stripping them from the aqueous decanter layer in a small auxiliary column, before returning the dilute furfural solution to the main column. This smaller process may yield impure methanol as a by-product. The problem concerning the utilization of the residue from the digestion process has been extensively examined in the U.S.A. The residue consists of about 70% of the original weight of hulls, in a finely divided, slightly carbonized condition. Efforts to utilize this residue in carbon black production, as a filler for plastics, dextrose production, etc., were unavailing and the material was until recently burnt as a boiler fuel; lately, however, the residue has found a market as a soil conditioner.

In the case of a New Zealand furfural industry situated at Gore, dumping of the residue may probably be necessary, for the area required for air drying, cost of handling, etc., would suggest that it would be of doubtful economy to utilize the residue as fuel, when cheap local lignite coal is readily obtainable.

Investigations carried out in Australia have shown that hydroylsis of oat hulls under mild conditions produces a form of ligno-cellulose with similar properties to wood flour.

Mention has already been made of a two-stage digestion process which is commonly employed in European production of furfural, and the Australian workers have suggested the use of a modified two-stage process for the purpose of a simultaneous yield of ligno-cellulose and furfural.

Oat hulls would be digested under milder conditions, a portion of the furfural recovered, the residue centrifuged and the solid ligno-cellulose residue dried and milled. The remainder of the furfural is recovered from the centrifuged liquor by autoclaving and passing the vapour through a column. Alternatively the ligno-cellulose may be converted with dilute sulphuric acid to a dextrose solution from which the insoluble lignin may be filtered and dried, while the dextrose solution may be crystallized to give pure sugar, or it may be fermented to alcohol or otherwise processed.

This two-stage process would produce from 2,000lb. of oat hulls, 880lb. of ligno-cellulose and 150lb. of furfural as compared with the yield of 200lb. of furfural in the normal one-stage process. The ligno-cellulose obtained in this way is said to be satisfactory as a filler for plastics, and application to the manufacture of linoleum and wallboard has been suggested.

In the U.S.A. lignin-furfural resins are being investigated as a possible large-scale source of prefabricated building materials.

Much experimental work would be required to investigate the conditions under which the best type of ligno-cellulose for various purposes would be produced, and the advantage, or otherwise, of the two-stage digestion process in a New Zealand furfural preparation unit would obviously depend on the relative demand for furfural and ligno-cellulose.

Cost of Production

The present minimum economic scale for furfural production would appear to be of the order of 100 to 200 tons per year. As has been mentioned already, most of the details concerning the process have been taken from a report in the "Journal of the Council for Scientific and Industrial Research (Australia)," 1947. Details of plant and basis of costing have also been obtained from this source, and this latter data has been translated into New Zealand equivalents as far as possible, at the time or writing—March, 1950.

Plant

The plant designed was based on a production of 200 short tons of furfural per year (400,000lb.), with an operation of three eight-hour shifts per day for 250 days per year, and assuming a yield of 10lb. per 100lb. of air-dried hulls.

Capital Expenditure

It is considered that ideally in New Zealand the furfural unit should be operated as an adjunct to the existing oat-milling plant at Gore. If excess boiler capacity was already available there, capital cost would be thereby reduced.

The Australian estimate for the boiler installation of required output, 58,200lb. of steam per day, is £6,000. A New Zealand estimate based on the recent installation of a standard type of boiler of the same output is £4,500, complete with fittings, etc.

Details of the plant cost grouped in units (Australia, 1947) is quoted as follows:—

Digestion unit	£1,300
Distillation unit	900
Hull storage and handling	3,300
Tanks and fittings	1,100
Residue handling equipment	1,450
Pipes and fittings	700
Erection and installation	1,000
Instruments	500
Design costs	500
	£10,850

It has not been possible to obtain comparable quotes for the various units of plant (most of which are unfamiliar to New Zealand engineering practice) were they constructed here to-day. It does appear, however, that Australian engineering costs, as reflected by the estimates, were higher in 1947 than New Zealand engineering costs are to-day. This is shown, for example, by the contrast in Australian and New Zealand estimates for the boiler installation, although it is realised that the Australian design may have been more elaborate than the local installation.

It does appear that improvisation for equipment can be carried out in the furfural plant without great loss of efficiency.

To quote Miner & Brownlee, Ind. Eng. Chem. (1948): "In line with the policy of keeping costs down, a rectifying column was developed which consisted of an iron pipe filled with gravel from a nearby river. It worked efficiently for a considerable length of time and is recommended for use in emergencies where more satisfactory equipment is not available."

For capital expenditure on plant and boiler for a furfural industry in New Zealand, a figure of approximately £17,000 should be adequate for conditions to-day. Improvisation for certain equipment is possible.

Cost of Production of Furfural

A table with details of cost (Australia, 1947) is quoted and New Zealand equivalents are inserted.

Oat Hulls: The cost of oat hulls, which are at present burnt as fuel, has been assessed on a basis of replacing oat hulls ton for ton with lignite coal, which is readily obtainable in close proximity to Gore. Oat hulls are an unsatisfactory fuel.

Steam: With efficient boiler practice, it is said that in New Zealand steam generation costs approximately one penny for 20lb. The Australian quote of five shillings per thousand lb. has been retained as an adequate figure.

Electric Power: This quotation of an average 1.3 pence per unit (Kw. hr.) is based on standard rate quotations from the Southland Electric Power Board. This figure might be reduced by bulk contract quotation for the particular industry, and items such as power factor correction, etc., would also influence it.

Labour: The figures given are in proximate conformity with award rates in New Zealand for workers in similar industries. The market price for labour, however, is variable and difficult to assess.

Waste Disposal: With the industry established in a somewhat rural area in New Zealand, the disposal of residue by dumping would not involve transport over more than small distances. The

Australian figure has been reduced, therefore—perhaps the figure given is still somewhat high.

Water: Water charge in New Zealand is generally of the order of one shilling per thousand gallons. Water cost amounts to only some 2% of the total production cost per lb. of furfural. Variation about this estimate will therefore affect the total but little.

Sulphuric Acid: Fortunately this material constitutes only about 3% of the total cost. Sulphuric acid obtained locally is considerably dearer than the price quoted for Australian acid. It is possible that more dilute acid could be obtained at less than proportionately smaller cost by arrangement with a superphosphate works (e.g., in Dunedin), although the greater bulk to handle would be a disadvantage. Sulphuric acid 94% as quoted is available ex works at Burnside, near Dunedin.

It appears that furfural could be produced in New Zealand (with suitable location of unit, say at Gore) at a cost of about eleven-pence per pound. The price of furfural imported to New Zealand is quoted locally on an indent basis ex Australia, the original source being the Quaker Oats Co., U.S.A. Prior to exchange alterations, and alteration in dollar equivalents of sterling (1949), furfural was available on wharf at Sydney at 1/4 lb. and was therefore available to the New Zealand market at 1/4 plus transport, plus indent charges (44-gallon lots). It cost in New Zealand, therefore, more than 1/6 per lb. To-day Australia pays approximately 2/3 per lb. for furfural, and this on the New Zealand market would be 1/10 per lb. plus transport from Sydney plus indent charges. The expected costs to a New Zealand buyer would exceed 2/- per lb.

The estimated cost per pound of furfural, produced locally, would therefore be very much less than the available product ex Quaker Oats Co., U.S.A., via Australia, and doubtless much less than if it were available by importation direct from U.S.A. This difference in cost allows a good margin for contingencies.

Furfural, apart from consideration of its particular properties, uses and versatility, may be produced at a cost which compares favourably with the cost of various imported solvents such as acetone, amyl acetate, methyl ethyl ketone, etc.

Conclusions:

(A) Furfural would appear to have numerous potentialities with respect to New Zealand industries.

(B) Many uses, such as in the preparation or modification of synthetic resins, as a solvent in the paint and varnish industries, and as a paint and varnish remover, would appear to be immediately applicable to New Zealand conditions.

(C) Oat hulls (at present a waste product and burnt as a fuel) are available in quantities more than sufficient to maintain an "economic unit" for the manufacture of furfural in New Zealand. This quantity of raw material is available from the one factory site, a noteworthy advantage.

(D) Production costs indicate that such an industry would be economically sound.

(E) As well as replacing other imported chemicals, furfural produced locally would doubtless lead to an extension of many industries, and perhaps the creating of new industries.

(F) The ease of preparation of many valuable derivatives opens up a further wide field for furfural in the role of chemical intermediate.

Proposals

(1) It is suggested that the Scientific Liaison Officer for the New Zealand Government in Washington, U.S.A., should be asked to prepare a report based on the observation of representative types of industries utilizing furfural and its more easily prepared derivatives, and provide his opinion on the potentialities of the compound within New Zealand.

(2) A committee comprising, for example, representatives of the Department of Scientific and Industrial Research, Department of Industries and Commerce, and manufacturers' organizations, should examine the question of furfural utilization and production in all its aspects, and also approach and interest those industrial concerns to whom the compound could be of immediate use and advantage. A quantity of the compound could be imported and samples allocated for trial utilization.

(3) The Department of Scientific and Industrial Research should publish regular bulletins, from data already available, and from data obtained from planned research within New Zealand. This would foster the use of furfural and its derivatives, either as a solution to present-day problems, as a stimulus to the widening of the industrial potentialities of New Zealand, or as an encouragement to the use of more efficient and economic methods and processes.

(4) If local production of the compound and possibly certain derivatives is deemed desirable, the Government should promote and encourage the setting up of a production plant rendering assistance similar to that given the grass-seed, tobacco, and hop industries. Pilot plant studies would be unnecessary, as published work on such studies recently made in Australia provides data which can be deemed directly applicable to New Zealand conditions.

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Mr. H. A. L. Morris received his secondary education at Wellington College and is a graduate of Otago University. He has served for ten years in the Dominion Laboratory, four in Wellington and six in Dunedin, where he is now stationed. His experience has been mainly in food and water analysis, and he hopes to specialise later in food research. He was admitted as an Associate in 1949.

Item	Quantity per day	Bulk Cost.		Cost per unit Pence		Units per lb. Furfural.	Furfural Cost per lb. Pence.	
		Australia 1947	N.Z. 1950	Australia 1947	N.Z. 1950		Australia 1947	N.Z. 1950
Oat hulls	7.21 tons	£1/14/-/ton	15/-	0.183/lb.	0.084	10.11	1.853	0.849
Steam	58,200 lb.	5/-/1000 lb.	5/-	0.06/lb.	0.06	36.35	2.181	2.181
Water cooling	44,300 gal.	6d/1000 gal.	1/-	0.006/gal.	0.012	27.70	0.166	0.332
Water charge	2,400 gal.	6d/1000 gal.	1/-	0.006/gal.	0.012	1.50	0.009	0.018
Sulphuric acid 94%	303 lb.	£9/16/6/ton	£25/2/6	1.05/lb.	2.69	0.189	0.198	0.509
Electric power per Kw. hr.	161	0.98d.	1.3d.	0.98	1.3	0.101	0.099	0.131
Labour: per week—								
Process workers	6 (2 per shift)	£6/10/-	£7/10/-				1.170	1.350
Labourers	6 (2 per shift)	£5/10/-	£6/15/-				0.990	1.215
Truck-driver	1	£6/10/-	£7/16/-				0.195	0.234
Fitters	2	£7/10/-	£8/7/-				0.450	0.501
Technical control	1	£12/-/-	£12/-/-				0.360	0.360
Running costs of waste disposal truck	65 miles (Aust.) 40 miles (N.Z.)	1/-/mile	1/-				0.488	0.300
Containers (200 returnable drums)	3 x 44 gal.	£3/-/- each	£3/-/-				0.180	0.180
Boiler attendants	3 (1 per shift)	£6/10/-	£7/10/-				0.585	0.675
							8.924d.	8.835d.
Depreciation on £17,000 (plant & boiler): @ 10% = £6/8/-							1.020	1.020
Interest on £17,000 @ 5% = £3/4/-							0.510	0.510
Maintenance on plant (say £11,000) @ 10% = £4/4/-							0.660	0.660
							2.190d.	2.190d.
						Total Cost	11.114d.	11.025d.

On a basis of 200 short tons per annum.

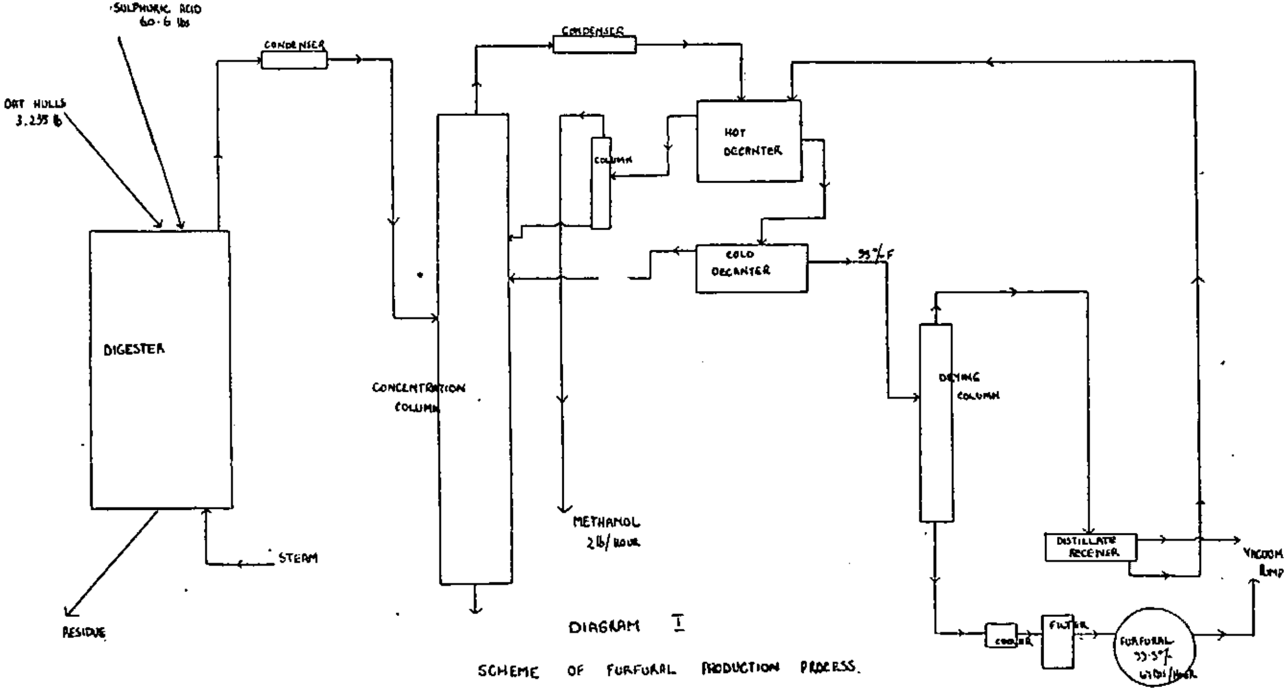

DIAGRAM I

SCHEME OF FURFURAL PRODUCTION PROCESS.

RUTHERFORD MEMORIAL FUND

The following is an extract from the Anniversary address of the President of the Royal Society, Sir Robert Robinson, delivered at the end of last year:—

> The Rutherford Memorial Committee, which was reconstituted in 1948, has advised the Council of the Royal Society to issue without further delay an appeal for financial support of its plans. This is being done, and generous contributions are solicited to enable us to show our gratitude for the life and work of one of the greatest experimental scientists of all time. He was not a theoretician, but a discoverer, and he found in unexplored regions that the actual facts were much more wonderful than anything ever imagined by man. Some of his components were buoyant energy, insatiable curiosity, lively and infectious enthusiasm, a remarkable capacity for the devising of suitable experiments, and inspired genius in the interpretation of results. We can justly claim that he was the father of nuclear physics. For one thing, he discovered the nucleus of the atom, and I well remember at Manchester how we all, physicists and chemists alike, engineers and even biologists, crowded his colloquia during that development, partly because we sensed that something quite unique was happening, but also because we felt that attraction of Rutherford's magnetic personality.
>
> After demonstrating the existence of the nucleus through its concentrated positive charge he next, at Cambridge, showed that it could be disintegrated by bombardment with atomic projectiles and thus achieved the transmutation of the elements.
>
> Following his inspired leadership, a notable succession of brilliant physicists, one of whom, Sir James Chadwick, has to-day received the highest honour which it is in the Society's power to bestow, made a series of discoveries of the most fundamental importance. Each and every one of them pays his grateful tribute to Rutherford.

Among the various forms which it is hoped the memorial will take, special importance is attached to the creation of Rutherford Memorial Scholarships, tenable for three years at a University or other approved institution in some part of the British Commonwealth other than that in which the holder graduated. The intention is thus to establish travelling scholarships. Recalling that Rutherford once held an Overseas Scholarship offered in New Zealand by the Royal Commissioners of the Exhibition of 1851, the proposal seems particularly appropriate, and it is one which we feel confident he would himself have approved. Contributions amounting to more than £30,000 have already been received; but in order to carry out the suggestions we have made, a sum of at least £100,000 will be required.

The Memorial Committee is reported to have made two other suggestions. The first is that all Lord Rutherford's correspondence be collected and bound, and the second that there be a Rutherford Memorial Lecture to be delivered at intervals at selected University centres in the British Commonwealth overseas, at least one in three to be given in New Zealand.

While any form of memorial to the greatest personality New Zealand has yet produced would be gratifying to the scientists of this country, the proposals for travelling scholarships and memorial lectures seem to us to be very happily inspired, not only for the specific recognition of New Zealand and the opportunity there will be of offering hospitality to eminent scientists from overseas, but also because of the recognition, at the highest level of scientific endeavour, of the value of an interchange of research inspiration within the Commonwealth, and because they foreshadow the establishment at various points within the Empire of schools of research producing results comparable with and complementary to those of the great University centres of Britain.

Owing to rising costs of production, due largely to the greatly increased volume of original publication since the war, the American Chemical Society has had to increase the price of "Chemical Abstracts" very considerably. Members of the Society who are prepared to swear that they are required only for their own personal use, can obtain the Abstracts, including index, for $15.00 as against the old price of $10.00; for non-members and those not prepared to make this affirmation the price is $60.00, or at the present rate of exchange almost £1 per issue. This figure does not include postage, which is charged extra to members and subscribers outside the Pan-American Union. We do not know if this large increase is justified or not, but we do agree with "The South African Industrial Chemist" that there is an urgent need to see if the work of the three great abstracting bodies, "British Abstracts," "Chemical Abstracts" and "Zentrallblatt," cannot in some way be combined, so that a better service and fuller abstracts could be made available to all concerned at lower cost.

BOOK REVIEWS

BOOKS ON NUCLEAR CHEMISTRY.—Following the articles by Prof. Dalton and Mr. T. A. Rafter, in our February issue, our readers will be interested in these three volumes. *New Atoms,* by Otto Hahn (Cleaver-Hume Press, London, 184 pages, 1950, 12/6), is a collection of four papers by the co-discoverer of uranium fission, entitled: (1) From the natural transmutation of uranium to its artificial fission; (2) The chain reaction of uranium; (3) Artificial new elements; (4) Some personal reminiscences from the history of natural radioactivity. These papers give a very readable and clear account of nuclear science by an authority, and justice is done to all countries. The translators, a group of British scientists, have done their work well, and the only obvious slip noted was "chinoline" for "quinoline" on page 109. For New Zealanders the picture of Rutherford in Montreal will be most interesting, but the whole volume is an attractive if rather small-scale discussion of nuclear chemistry and physics.

The *Trilinear Chart of Nuclear Species,* by William H. Sullivan (John Wiley and Sons, 1949, $2.50) is a successful and ingenious attempt to portray most of the information available in 1949 about the various isotopes of the elements. It consists of a number of large pages which, when stuck together, give a chart 10½ inches wide and about 14 feet long. Each isotope is represented by a hexagon fitting in with its neighbours in the nuclear series. From the chart the isotopic abundance, mass, nuclear charge, half-life value, modes of disintegration (if any), modes of production of artificial elements, fission yield values and much other information may readily be found. The chart should be useful to anyone interested in the new developments.

The *Pocket Encyclopedia of Atomic Energy,* edited by Frank Gaynor (Philosophical Library, New York, 1950; 204 pages, $7.50), is a ready reference work on nucleonics and contains much useful information in short articles and tables.There are also cameo biographies of workers in the field. However, it contains much information easily found elsewhere, such as the Greek alphabet and the statement of Charles' law, and this space could have been used to expand other articles where the information is so inadequate as to be worthless, e.g., "Crookes' Radiometer—An apparatus to show the intensity of radiation." There is no reference to radioactive indicators either under "I" or "R." Rutherford's proper title is not "Sir Ernest" but "Lord." The printing and binding are more commensurate with the high price than is the text.

TRAITE DE CHIMIE ORGANIQUE. Published under the direction of V. Grignard, G. Dupont, R. Loquin and Paul Baud. Vol. VII, 1529 pages; 1950. Paris: Masson et Cie; 6400 francs.—With this volume the series is complete up to Vol. XIX, leaving only two further volumes on heterocyclics and an index volume still to come. The volume under review covers aldehydes and ketones, with certain exceptions. Quinones and ketens are dealt with in Volume XIII, oxo compounds of fused benzene rings in Volume XVII, but glyoxal, phthalaldehydes and other polyaldehydes, with the single exception of hexenedial, could not be located. Vol. VII includes oxo derivatives of the monoterpenes, which are thus separated from the general discussion of terpenes in Vol. XVI. There are very good general reviews of the aldehydes and ketones, which in the main are dealt with exhaustively. An excellent feature is the very full bibliography with over 11,000 references, the latest being 1949. A useful author index covers about one-tenth of the more important references. Both these features are unfortunately marred by numerous minor errors, such as "Heilbronn" and "Shopper." As we have pointed out before, this treatise deserves to be better known than it is. Apart from Beilstein, to which, in a sense, it is complementary, it is the largest treatise of organic chemistry published and contains a great deal of well-organised information at a very reasonable price.

COLORIMETRIC METHODS OF ANALYSIS. By F. D. Snell and C. T. Snell. Vol. II: Inorganic. 3rd Edition; 1949 950 pages. London: Macmillan & Co., 90/-; New York: Van Nostrand, $12.00.—The first volume of this work (discussed in our issue for October, 1949) discussed colorimetric methods in general: this volume gives their application to the determination of the elements in various media. Though labelled "inorganic," it includes the determination of elements in organic media such as blood and milk, and it also covers the determination of cyanides, carbon monoxide and peroxides of organic compounds. The authors have adopted a middle-of-the-road procedure between a highly-critical attitude which would debar all but a few methods, and an uncritical inclusion of all methods and sundry. There are, however, brief indications of methods which are now out of date or not well established. It will be recognised that this covers the field more than adequately, and here the analyst has a very useful compendium of colorimetric methods. The increasing use of these enhances the value of this book. Comparison with a recent English book on micro-methods shows that in the main the same methods are used, but there are many differences in detail. The book is well-referenced and has an author and subject index.

GENERAL CHEMISTRY FOR COLLEGES. By Herman T. Briscoe. 4th edn., 1949; 773 pages. Boston: Houghton-Mifflin Co.; $5.00.—There are few English equivalents of the many American text-books of general chemistry designed to cover the requirements of those taking a general course without specialising in chemistry. This is one of the most impressive of these American texts. By the use of a fairly large page size (7 x 9.5 inches) a great amount of material has been included, covering physical, inorganic and organic chemistry. The work is well up-to-date and a good deal of stress is laid on technical developments. Each chapter is followed by a number of questions and a series of references to books and to original literature. There are many illustrations and some very good photographs of chemical plant. On the other hand, the drawings of a burette and a pipette, on page 452, would be unacceptable in a schoolboy's notebook in this country, and the photographs on pages 539 and 589 do not carry conviction. The author (or printer) is inconsistent in the shape of the benzene ring, frequently using an elongated hexagon, seen at its worst on page 594. The formula for methyl orange on page 622 appears to have an extra carbon. Despite these weaknesses, the book should be of interest to teachers of chemistry in secondary schools and at stage I.

The Editor would be pleased to hear from any readers wishing to dispose of back issues of the Annual Reports of the Chemical Society.

CONFERENCE, 1951

Hamilton, August 20th-22nd

The programme is taking shape satisfactorily and in outline is as follows:—On the Monday morning there will be a session on "Problems Connected with Food and Agriculture," three speakers dealing with Soil, Plant and Animal aspects respectively. Thereafter two parallel sections will be run, one devoted to Industrial and Academic subjects and the other to Agriculture. A symposium on pH will constitute the final session—a combined one.

Current University research will be discussed on Monday evening, while the presidential address on "The Chemist and Food" will be delivered on Tuesday evening. Visits to Ruakura Animal Research Station, the chemical laboratories and other places of interest will be arranged for Monday afternoon. Throughout Tuesday there will be a display of instruments by various firms and it is hoped that outstanding features will be highlighted by a member of the Institute. The annual general meeting of the Royal and New Zealand Institutes of Chemistry will be held on Tuesday afternoon.

The presidential address will be preceded by a social gathering. This will be a buffet meal with appropriate stimulants, and will be continued after the address with further practical exercises in nutrition.

MINUTES OF INAUGURAL MEETING

Waikato Branch—N.Z.I.C. (Inc.)

The minutes of the inaugural meeting of the Waikato Branch are published for their general and historical interest.

Held in the Welding Club Rooms, Hamilton, on Thursday, April 5th, 1951, at 8 p.m.

Present: 16 members of the Institute and several visitors.

Apologies: Apologies were received from Dr. H. E. Annett and Dr. R. H. Jackman.

Chairman: Pending the election of branch Chairman, Mr. R. E. R. Grimmett was elected to chair this meeting.

Branch Formation: Mr. J. L. Grigg outlined the steps that had been taken to constitute a Waikato branch and read letters from the President of the Institute and Dr. J. K. Dixon (proxy by invitation at last meeting of Council) outlining the boundaries of our area.

Election of Officers: The following were elected as the Branch Committee:—

Branch Chairman: Mr. Grimmett moved, seconded by Mr. Whittleston, that Dr. H. E. Annett be elected Branch Chairman.—Carried.

Secretary-Treasurer: Mr. E. P. White. (Dr. Davies/Mr. Coup.)

Committee: Mr. N. T. Clare (Mr. Thompson/Dr. Davies); Mrs. D. R. Perrin (Mr. Lancaster/Mr. Grigg); Mr. R. E. R. Grimmett (Mr. Whittleston/Mr. Coup); Mr. J. L. Grigg (Mr. Clare/Dr. Davies).

Delegate to Council: Dr. H. E. Annett. (Mr. Clare/Dr. Perrin.)

Meetings: It was resolved that monthly meetings be held on Thursday evenings, depending on the availability of hall accommodation.

The progress made by the 1951 Conference Committee is to be outlined at the next meeting.

This concluded the formal business of the evening and the remainder of the time was occupied by Mr. C. H. Williams, Plant Chemist of the Division of Plant Industry, C.S.I.R.O., Canberra, who gave an interesting address on the C.S.I.R.O. and the work of the Division of Plant Industry.

THE OCCURRENCE OF BRANCHED CHAIN ACIDS IN BUTTERFAT

R. P. Hansen & F. B. Shorland, Fats Research Laboratory,
Department of Scientific & Industrial Research, Wellington.
(Received 19:3:51.)

In a previous communication (this journal, 1950, *14*, 142) the occurrence of branched chain acids in butterfat was suspected. Probably many types of branched chain acids of varying molecular weight are present. In the acids in the C_{17} series, for example, which have been intensively purified by fractional distillation, it has been possible by subsequent repeated crystallization to separate two fractions m.p., 54.4° and 39.8° respectively. X-ray diffraction data are consistent with the view that these acids are saturated fatty acids with a methyl side chain. The detailed results will be reported elsewhere.

NEWS AND NOTES

A refresher course is being arranged for Auckland members in the month of July, and will take the form of a number of lectures by members of the organic chemistry department of A.U.C., on various modern developments in pure and applied organic chemistry. These lectures will be held at 4 p.m. in each case, and deserve to be well attended.

Mr. P. Lever-Naylor, of N.Z. Milk Products, Ltd., Invercargill, has been transferred to Sydney.

Miss M. Whiteside, a local member of the Otago Branch, has left the Travers Research Laboratory and is now at the Wallaceville Animal Research Station.

In his chairman's address to the Otago Branch, Dr. G. M. Richardson spoke on "Problems of Food Production and Food Preservation." He began with a general discussion of proteins—including reference to specific amino acids which the body cannot synthesise—carbohydrates, fats and vitamins, and the relative availability of these in different foodstuffs. He then went on to show that the maximum protein productivity of the soil could only be obtained by cultivating such relatively unpalatable foods as soybeans and peanuts, and there was a much lower efficiency when animals such as the cow, pig, sheep, hen, etc., were used to convert plant foods to the more acceptable forms, milk, butter, cheese, meat, eggs, etc. The speaker pointed out that it was by no means a coincidence that such densely-populated countries as China depended almost totally on crops for their food supplies, and that with increasing population this state of affairs was becoming more general throughout the world. It was shown that where communities depended too exclusively on a particular food, e.g., Lathyrus pea or maize, there was a considerable risk of disease either due to diet deficiencies or to cumulative poisons, and this opened up a wide field for further research. The increasing demand for food also emphasised the importance of storing excess from good harvests to cover bad ones. Dr. Richardson discussed various methods of food preservation, such as tinning, chilling, quick freeze, dehydration, and the use of anti-oxidants. He concluded a most stimulating address by pointing out some of the practical difficulties to be met and overcome in the field of preserving food.

On 12th March, Dr. R. Hurst, a past student and demonstrator at C.U.C., and now Principal Scientific Officer and Leader of the Plutonic Group at the Harwell Research Station, addressed a large gathering on "The Trans-Uranium Elements."

Mr. N. P. Alcorn chose as the subject for his Chairman's address to the Canterbury Branch "Some Aspects of the Work of the Dominion Laboratory." He outlined the type of work being done from water analysis and milk-testing to forensic chemistry (poisoned chocolates).

Professor G. A. S. Smith, B.Sc. (Calif.), Ph.D. (Michigan), Assistant Professor of Chemistry, University of Michigan, is working on the chemistry of New Zealand plant products at Auckland University College, under a Fullbright Fellowship. Professor Smith recently addressed the staff and students of O.U.C. and members of the Institute on "Carbon-Nitrogen Migration."

Dr. J. C. Andrews, Fellow, previously works superintendent, Challenge Phosphate Co. Ltd., Auckland, is now works manager, Brown, Barrett Ltd., coffee and condiment manufacturers, Auckland.

Mr. G. S. Lambert, Associate, metallurgist and works manager, Hayes Metal Refineries Ltd., Auckland, was a member of a party of New Zealand manufacturers which recently made a three weeks' tour of Australian industries.

Mr. E. H. Schache, Associate, has resigned from the position of factory manager, Reid N.Z. Rubber Mills Ltd., Auckland, to join the firm of Harvey Sims Ltd., latex specialists, Auckland.

Dr. H. O. Askew, Fellow, chief of the biochemical department of Cawthron Institute, left New Zealand on a study tour of Great Britain, having been awarded a visiting lectureship by the Nuffield Foundation. Subjects of special interest will be those connected with mineral deficiencies in pip fruits, hops and small fruits. Dr. Askew will also represent the Government of New Zealand at the World Tobacco Congress in Amsterdam next September, and will visit agricultural research stations in Belgium and Holland. He will be away from Nelson for seven months.

Mr. E. P. White, of Ruakura Animal Research Station, has been appointed Branch Editor in addition to his duties as Branch Secretary of the Waikato Branch.

Mr. O. K. Sewell has resigned from his position as Biochemist at the Ruakura Animal Research Station and intends to proceed to England for post-graduate study.

The following notes are from the Wellington Branch:—

On 29th March, Dr. R. Hurst, of Harwell Atomic Research Station, delivered an address on the "Trans-Uranium Elements," to a record audience. Photographs of the Harwell laboratories were shown and questions answered with unusual frankness. Prof. A. D. Monro moved the vote of thanks to the speaker, stressing the importance of the lanthanum and actinium groups in the elucidation of element structure.

Prof. F. J. Llewellyn, of Auckland, delivered six well-attended lectures at Victoria College during the second week in April. The theme was crystal structure with, special treatment of X-ray measurements. The lectures were intended in the first place for stage III and Honours students, but many chemists and physicists from outside availed themselves of the opportunity of hearing Prof. Llewellyn, who combines expert knowledge with a rare gift as a lecturer. Prof. Slater, of Victoria College, is to be congratulated on arranging this series of lectures, and the idea of such exchanges between colleges is an extremely happy one.

The very lively Wellington Branch of the N.Z. Association of Scientific Workers has arranged a course of lectures on the preparation of scientific papers. Up till now four lectures have been held:

"The Reader's View of Scientific Writing," by Mr. C. M. Smith, Director, Botany Division, D.S.I.R.

"Planning the Scientific Paper," by Mr. L. W. Tiller, Deputy-Assistant-Secretary, D.S.I.R.

"English for the Scientist," by Prof. I. A. Gordon, Vice-Chancellor of the University of N.Z.

"A Symposium on Illustrations" (Photographic and Drawing Techniques), by members of the D.S.I.R.

The importance of this course need not be stressed, and it is hoped that the Wellington members will put their newly-acquired knowledge to full use during the approaching Conference, though the difference between written papers and those to be read should not be forgotten.

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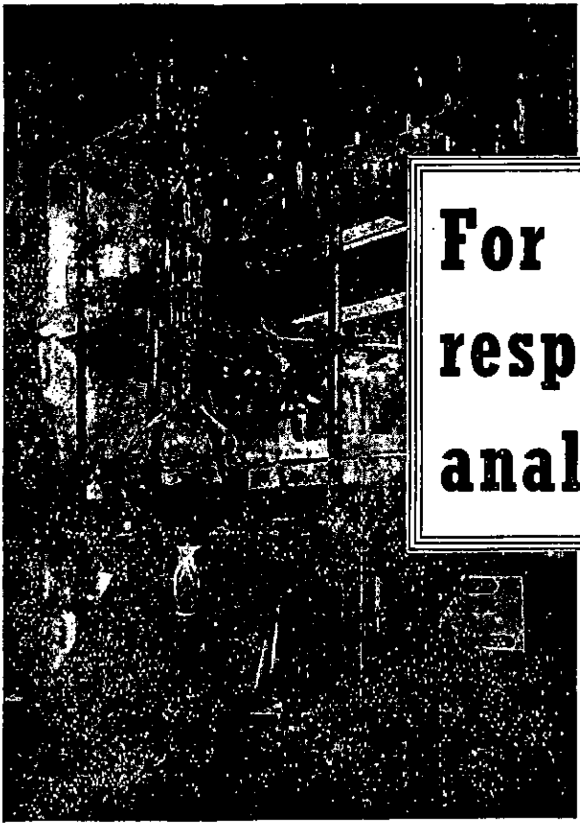

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