Report No. 64

THIRTY-THIRD

ANNUAL REPORT

OF THE

RESEARCH COUNCIL OF ALBERTA

1952

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The following report, the Thirty-Third Annual Report of the Research Council of Alberta, was submitted in March, 1953, by Dr. N. H. Grace, Director of Research, to the Chairman of the Council, The Honourable Dr. J. L. Robinson, Minister of Industries and Labour. The Chairman submitted the report to the Premier of Alberta, The Honourable E. C. Manning, who tabled it in the Legislature.

The offices and laboratories of the Council are situated in the buildings of the University of Alberta. Requests for information and reports should be addressed to the Secretary, Research Council of Alberta, University of Alberta, Edmonton, Canada.

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The Council operates under the Research Council Act of 1930 as amended 1943, 1945 and 1950.

The offices and laboratories of the Council are in the University of Alberta. The Secretary of Council is W. A. Lang.

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   Mr. J. A. Davidson, representing The Coal Operators' Association of Western Canada.

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Mr. Hugh Miller, representing the Alberta Section of the Prairie Road Builders' Association.

STAFF OF THE RESEARCH COUNCIL

Administration and Office Services:

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Mrs. S. M. Stewart, Technical Stenographer.
Mrs. J. K. Vander Velde, Stenographer.
Mrs. B. Johnson (part), Stenographer.
Mrs. M. J. Edwards, Stenographer, May 2—September 20.
S. J. Groot, Draftsman-Compiler.

Coal:

W. A. Lang, Senior Research Chemist.
N. Berkowitz, Research Chemist, from July 15.
J. S. C. Dunn, Assistant Research Engineer.
T. E. Morimoto, Assistant Research Engineer, to May 10.
J. F. Fryer, Assistant Chemist.
J. L. Carveth, Assistant Research Engineer.
B. O. Krueger,, Research Assistant, from April 14.
H. Rempis, Laboratory Assistant.

Oil Sands:

K. A. Clark (part), Research Engineer.
D. S. Pasternack, Senior Research Chemist.
G. W. Hodgson, Research Chemist.
Miss J. Scott, Junior Research Chemist, from May 1.
R. Wandio, Laboratory Assistant, from December 8.

Gasoline and Oil Testing:

J. S. Charlesworth, Chemist.
E. Tipman, Assistant Chemist.
Miss G. M. Rymer, Laboratory Assistant.
Miss M. Stevenson, Laboratory Assistant, June 2—September 15.

Natural Gas:

D. Quon (part), Research Engineer.
W. K. Schmidt, Assistant Research Engineer, from June 2.

Industrial Projects:

J. Gregory, Industrial Engineer.

Geology:

G. A. Collins, Assistant Geologist.
A. G. Swan, Assistant Geologist.
P. J. S. Byrne, Assistant Geologist, June 7—September 19.
H. Hominiuk, Field Assistant, April 24—September 9.
V. Sweetnam, Field Assistant, April 24—August 31.

Soil Survey:

Wm. Odynsky, Soil Surveyor.
A. Wynnyk, Assistant Soil Surveyor.
M. D. Scheelar, Assistant Soil Surveyor.
A. M. F. Hennig, Assistant Soil Surveyor.

A. W. Henley, Assistant Soil Surveyor, from May 1.
F. J. Disney, Cook, May 19—September 24.
M. G. Morin, Field Assistant, May 6—September 30.
K. C. Stewart, Field Assistant, May 1—September 30 .
Wm. F. Van Tyen, Field Assistant, from May 6.

Irrigation and Solonetzic Soils:

A. L. Mathieu, Research Assistant, from May 2.

Highway Research:

P. Yurkiw, Civil Engineer, from June 16—November 30.

Biological Cycles:

D. Stelfox, Assistant Zoologist, from October 1.

Hatchability of Turkey Eggs:

Miss R. O. A. Renner, Research Assistant, from April 1.

The following members of the Faculty of the University of Alberta assisted in the work of the Council.

Dr. K. A. Clark, Oil Sands.
Dr. E. H. Gowan and Dr. K. B. Newbound, Ultra-violet Solar Radiation.
Dr. G. W. Govier, Natural Gas Research.
Dean R. M. Hardy, Highway Research.
Dr. J. D. Newton, Soils Survey, and with Dr. T. A. Toogood, Irrigation of Solonetzic Soils.
Dr. Wm. Rowan, Biological Cycles.
Dr. D. R. Clandinin and Dr. A. R. Robblee on Hatchability of Turkey Eggs.

ANNUAL REPORT

of the

Research Council of Alberta

1952

This report summarizes the work of Council for the calendar year 1952. There has been encouraging progress in the broad research program which is directed to the effective utilization and conservation of Alberta's natural resources. The chief projects under study in 1951 were continued although changes were made in certain problems and in specific objectives; several new projects were undertaken. The industrial expansion and development taking place in the Province had a direct bearing on several projects during 1952. For example, years of steady work on basic and applied phases of oil sands research have now led to marked interest in the Alberta oil sands on the part of industry, with consequent leasing of large acreages in the oil sand area for detailed core drilling and assaying. Furthermore, the coal industry is now faced with shrinking markets as a result of competition from natural gas and oil. The Advisory Committees of the Council have endeavoured to modify the program to meet the opportunities and challenges of the changing situation, insofar as existing facilitiies would permit.

The program on coal has included studies on coal cleaning, water retention by coal, domestic coal-fired stokers, and a fundamental investigation of the colloidal properties of selected coals for the purpose of studying the preparation of self-bonded and bonded briquets and carbonized products obtained from the briquets. Chemical and engineering aspects of the oil sands project have dealt with trace metals in Athabasca oil sands, a general study of the 'heavy oils' of Alberta, and studies on the hydraulic transportation of oil-sand tailings. The Gasoline and Oil Testing Laboratory made surveys of gasoline quality, tested a wide variety of petroleum products, co-operated with various government departments, completed a research project on the viscosity of aviation lubricating oils, and continued long term work on the storage of aviation gasoline. Natural gas investigations have been concerned with the pyrolysis of natural gas, the partial oxidation of butane, and the production of carbon black. The Industrial Projects section has rendered technical assistance to government and industry; its service to the Province is to be enlarged through taking over the Alberta activities of the Technical Information Service of the National Research Council.. The Geological program included completion of the mapping of surface deposits in the Lake St. Ann map area (Pleistocene survey), investigations on limestone (including differential thermal analysis), investigations on sphalerite in reefal Devonian rocks of the plains area, and studies on clays and bentonites. The Geological section is also co-ordinating the results

of core-drilling programs in the oil sand area. The Soil Survey section has participated in the Alberta soil survey, being primarily concerned with a reconnaissance survey of the Sturgeon Lake and Grande Prairie sheets and an exploratory survey of the area adjacent to the new Whitecourt-Valleyview highway. The Highway research program continued work related to frost heaving and frost boils by injecting "lignosol" into the soil; it now appears that the action of lignosol is to increase the viscosity of the soil moisture and thus reduce the rate of movement of soil moisture to the frost line. Work has been continued on the study of Biological cycles; the current periodic peak in wild life population has been vigorously followed and upwards of 700 upland game birds and rabbits have been post-mortemed. Two conditions—hitherto not reported—were recorded, one relating presumably to a virus infection of rabbits' eyes and the other to a skin condition in sharp-tailed grouse. Solar Ultra-violet measurements which have been made during the past six years are being brought to a common standard; the accumulation of these measurements is continuing.

Two problems were recommended to the Minister of Agriculture by an Advisory Committee appointed by him to advise on the merits of practical agricultural research projects. The problems were suggested by staff members of the University of Alberta and were financed through the Research Council. These projects were: (1) studies on the irrigation of solonetzic soils using field plots near Youngstown in the projected Red Deer irrigation area; (2) study of the factors affecting the percentage hatch of turkey eggs.

The research program of the Council owes much to the co-operation received from government and university departments and from various industrial concerns. This help is gratefully acknowledged.

Members of the staff contributed a number of technical papers to the scientific literature during the year. A list of the major publications of the Council, since its establishment, is shown at the end of this report.

The following reports describe the work carried on under the various projects.

COAL

The investigations on coal carried out in 1952 were those recommended by the Technical Advisory Committee and approved by Council in December 1951. Satisfactory progress is reported for most of the studies although it was not possible to complete all of the program planned, because of changes in staff and because of the unsatisfactory nature of the laboratory space and lack of pilot plant facilities. It was necessary from time to time to dismantle and rearrange equipment in order to provide space for all of the investigations in progress. Considerable time was also wasted through the staff having to commute between the main laboratory in the Mining building and the preparation laboratory under the kitchen of Athabasca Hall.

Chemical and Physical Tests

The analysis of channel samples of coal was continued. This is an important part of the coal program since it provides a catalogue of the rank, type, physical and chemical characteristics of the coals occuring within the province. This information is invaluable to the Council in supplying data with respect to markets for coal, and

possible new uses of coal. It is presently being used in the revision of Report 35.—a standard reference on Alberta coals. In addition to the channel samples, Provincial Mines Inspectors submitted samples of coal dust from a number of mines for the determination of their explosion hazard, and the Department of National Defence a number of samples representative of the coals purchased for army, navy and airforce installations. A large number of miscellaneous samples of coal, or products from coal, were analysed in connection with other investigations of Council.

Assistance was rendered the International Standards Organization and the American Society for Testing Materials, Coal Division, in connection with studies these organizations are making in relation to possible modifications of procedures used for analysing coal and coal products. A member of the coal staff of Council has been appointed a member of Subcommittee XXI of Committee D5 "Coal and Coke" of the A.S.T.M.

Constitution of Coal

The work on the chemical constitution of coal had to be suspended when the research assistant working on this project resigned in December 1951 to take a position with a large industrial concern. Some of the results of the investigation were presented as a paper entitled "Oxidation Studies of Some Alberta Subbituminous Coals" at the Western Regional Meeting of the Chemical Institute of Canada held at Saskatoon in October 1952. Studies relating to the origin and constitution of coal are being reorganized and will be recommenced in 1953.

Cleaning of Coal

The cleaning work outlined in the 1951 Annual Report was continued. Data have been obtained for two bituminous coals following a standard procedure with a Driessen cyclone, when using a mixture of magnetite and water as the dense medium. In addition a study was made of methods for evaluating the analytical data. The results of these investigations were submitted in May 1952 to the University of Alberta as the Thesis requirement for a Master of Science Degree.

In the work with magnetite as medium considerable difficulty was experienced in obtaining material balances because of degradation of the coal during processing and since the equipment available for removing the magnetite from the products was unsatisfactory. An investigation was then undertaken to test the feasibility of using a coal-water slurry as medium. Preliminary work indicated that a mixture of 66 parts of coal, 34 parts of water, with approximately 35 percent of the coal of minus 100 mesh size was necessary for obtaining a good separation. Some modifications of the equipment had to be made before satisfactory results were obtained. However after considerable experimentation it was possible to clean a coal with an ash content of 17.7 percent to 11.8 percent, and with an 81 percent recovery of clean coal. Because of the high coal to water ratio, the throughput was increased over what it was when magnetite was used as the dense medium. More work will be required before the results are conclusive.

Water Retention Studies

The aims of this investigation were given in the Annual Report for 1951. Good progress has been made in determining the water retained by various sizes of untreated and oil-treated coal after

immersion in water, followed by drainage under specified conditions. A method has been devised for oil-treating coal. The building of equipment by which small quantities of coal could be oil treated, using proportions that might be employed in commercial operation was a difficult job, but has been accomplished.

Coals of varying sizes, and containing varying amounts of surface moisture, have been frozen at —10°, —20°, and —30° C. Cylinders of the frozen coals have been subjected to a compression test to determine their resistance to fracture. It now appears as if a test to give tensile strength rather than a determination of compression might give more useful information.

Immersion tests indicated little degradation of coal due to the absorption of water, particularly when the coal was immersed for short periods as would be the case when it is wet washed in a number of modern processes. Shales and bentonitic materials, on the other hand, absorb water rapidly and tend to break up. This would tend to affect the density and viscosity of the medium in wet washing processes. The amount of water adhering to coal after immersion is dependent to a large extent on the sizing of the coal, probably to a lesser extent on the rank of the coal. Pretreating the coal with oil reduces materially the amount of water that is retained by the coal when it is subsequently immersed in water and drained by the standard procedure. The amount of reduction is related to the amount of oil added, the completeness of coverage of the surface of the coal particles with oil, and also the screen analysis of the sample.

Stoker Investigation

A rotating self-cleaning grate domestic stoker, hot-water boiler, and accessory control and recording equipment were set up in the coal preparation laboratory and test work begun to determine the burning characteristics of a number of typical Alberta coals, and of blends of coking and noncoking coals in this equipment. The test procedure used is similar to that developed jointly by the Stoker Manufacturers' Association and Bituminous Coal Research. It is designed to measure, for the coals tested, the completeness of combustion, uniformity of combustion, the ability of the fire to ignite rapidly when the stoker goes on, and the extent to which the coal continues to burn after the stoker has shut off. Each test lasts approximately three days and includes five firing periods, namely, separate intervals at which the stoker is on for 3, 15, 30, 45 minutes out of each hour, and when it is on continously. The sizing of the coal and the rate at which the coal is fed are also varied. Tests have been completed on three typical coals. The data are being compared and when sufficient runs have been completed an analysis of the results will be made and a report prepared.

Briquetting and Balling

The briquetting investigation was inactive during most of the year. Visits were made to three briquetting plants in the province and recommendations given as to processing techniques. In connection with briquetting a fundamental investigation has been commenced in which the colloidal properties of selected Alberta coals will be studied and the results thus obtained will be used to investigate methods for preparing self-bonded and bonded briquets, and carbonized products from these briquets. It was not possible to carry out the pilot-plant investigation on balling that had been

recommended by the Fourth Dominion-Provincial Meeting on Coal Research since no suitable space was available for the work.

Information on Coal

Progress has been made in completing the analytical data necessary for the revision of Report 35 "Coals of Alberta, Their Occurrence, Analysis and Utilization" and consideration has been given to the rewriting of certain sections of the report. Members of the Research Council staff, in co-operation with personnel of the Mines Branch, Department of Mines and Technical Surveys and the Dominion Coal Board, prepared a number of draft copies of a pamphlet giving recommended procedures for the combustion of Alberta coals. These were submitted to the Alberta Coal Operators for their consideration and approval and it is hoped the pamphlet will be published shortly. A paper "Gasification and Chemical Utilization" was published in Trans. C.I.M & M. Vol. LV, 1952, pp. 118-122.

Miscellaneous

Visits were made to a number of coal mines and coal preparation plants in the province. A member of the staff attended a meeting of personnel of the Federal Mines Branch and the Dominion Coal Board in Ottawa in February, the Fourth Dominion-Provincial Meeting on Coal Research in Ottawa in June, and the Second Conference on the Origin and Constitution of Coal at Crystal Cliffs, N.S. in June, the Western Annual Meeting of the Canadian Institute of Mining in Winnipeg in October, and the Western Regional Meeting of the Chemical Institute of Canada in Saskatoon in October. In addition, visits were made to a number of government laboratories, research institutions and industrial plants in the United States. This trip provided an opportunity to study many phases of the coal industry, particularly recent advances in coal research. Close liaison was maintained with the Coal Operators' Association of Western Canada, the Provincial Mines Branch, the Federal Mines Branch and the Dominion Coal Board.

OIL SANDS

The Athabasca oil sand story continues to unfold. The operation of the separation plant at Bitumount during 1949 followed by the Blair Report in 1950 and the Oil Sands Conference in 1951 directed the attention of the oil industry to the possibilities of oil sand development. The plant operation demonstrated that the oil could be extracted from the oil sands in a practical manner. The Blair Report showed that a complete sequence of operations for oil sand development could be put together by a proper choice from among established processes; that a marginal profit from development was indicated under present economic conditions; and that the margin of profit should increase with time and with further study of the problem. The Conference laid this and other information before a large gathering of representatives of the oil companies. The question then was whether there would be any positive response from the oil industry. The answer came during the past year. Exploration permits on eleven 50,000 acre areas were taken out by nine oil companies, three of them majors, and a twelfth area that had already been taken out became active. In addition to the search for favorable locations for development that is being made in the oil sand area along the Athabasca River by core drilling, the research departments of an indefinite number of large oil companies are at work

on various phases of the general problem. Thus, a general movement toward the commercial development of the Athabasca oil sands is under way.

The quickening march of events in the oil sand story is a satisfaction to the Research Council of Alberta which has had the oil sands on its program of studies since its inception. But the contributions of other government organizations should not be overlooked. The Federal Department of Mines and Technical Surveys, including the Geological Survey of Canada, over a long period of years has carried out and has published the results of many oil sand studies of varied character. During the last few years the National Research Council has been doing important work. The efforts of these federal organizations and of the Research Council of Alberta are co-ordinated through friendly liaison between their workers. A number of meetings of representatives of the three have been held.

Such a meeting took place during the past summer to review the progress of oil sand studies. The undertaking, by the oil companies that have taken out exploration permits, of a wide-spread program of core drilling was noted. It was realized that this work would uncover a great amount of fundamental information about the oil sand resource and that it was of great importance that this information should be gathered up for publication in due course of time. A recommendation was made to the Board of Trustees, Oil Sands Project that steps should be taken to assure that the various oil companies would collect and report to the Government of Alberta, the data that was wanted and that could be got from their core-drilling operations. This recommendation was acted upon and the Research Council of Alberta was given the responsibility of keeping in touch with the core-drilling in the north and of receiving company reports. A member of its geological staff has been assigned to this work. Reference to it will be found in the Geological Section of this report. The Geological Survey of Canada is co-operating by making needed fossil examinations of core samples.

As interest in oil sand development grows, the need for more and more information about the oil sands increases. The Research Council of Alberta is using its laboratory facilities to capacity in making contributions to further knowledge. This capacity is not large as only one room is available to it for oil sand studies. During the year further study was given to the flow of water suspensions of oil sand tailings through pipes. Knowledge about the occurrence and distribution of iron, nickel and vanadium in the oil sands has been advanced. The search for useful methods of examining very heavy oils like the oil-sand oil, for comparative and other purposes, has been continued.

Laboratory Studies

Hydraulic Transportation of Oil-Sand Tailings in Small-Diameter Pipes

Any plant processing mined Athabasca oil sand for the recovery of oil produces as a waste material about one ton of sand tailings for every barrel of oil recovered. A disposal operation of major proportions is thus indicated. Of the many known ways of conveying solids on a large scale, the hydraulic transfer method is becoming increasingly important because of convenience and economy operation. However in pipelining suspensions consideration must be given to the stability of the suspension, and while it would be simple merely to maintain the linear flow rate well above some 'safe' value,

to so do might well be prohibitively expensive because of excessive power demands. Attention has therefore been directed to a study of the friction factor and the conditions affecting the stability of sand-in-water suspensions in pipeline transfer. The scale of operations selected for study was as large as could be used satisfactorily in the laboratory. Pipe sizes were one, one-and-one-half, and two-inch diameters, flow rates ranged from 10 to 110 gallons per minute. Temperatures from 100° to 160° F. were used, and solids concentrations of the suspensions varied from about 25% to 55%.

Results of the frictions factor determinations showed that there exists a critical velocity for each suspension—a velocity above which the suspension resembles the suspending water in its flow characteristics, and below which it differs markedly from the water in that the observed friction factor is considerably greater than that for water. The reason for the change in flow characteristics at the critical velocity is the settling out of solids from the suspension.

This laboratory study of the hydraulic transportation of oil-sand tailings has shown that the 'stability' of the sand suspension in the pipeline is satisfactorily predicted by the solution of the bed-load problem—that the mean space velocity must be about twenty times the free fall velocity of the particles under consideration—subject to the over-riding effects of sand concentration, pipe size, and temperature of flow. At flow rates greater than the critical velocity, the flow of a suspension is identical, superficially, with that of water insofar as power demands are concerned.

Some Trace Metals in Athabasca Oil Sands

The presence of trace metals in catalyst charging stocks leads to a change in the activity of the catalyst. Vanadium, nickel, and iron are the most objectionable metals—leading to increased coke and gas yields at the expense of lowered gasoline yields. A second objection to the presence of vanadium in a crude oil is that vanadium oxide produced in the combustion of a fuel oil is very reactive with most furnace refractories. An investigation has therefore been undertaken to determine the extent and distribution of vanadium and the other two metals in oil-sand oil with the object of defining the occurrence of the metals so that steps might be taken in refining processes to cope with them.

Colorimetric methods were used to determine metals concentrations, following conventional dry-ashing techniques.

Attention was first directed to the mineral aggregate. Two classes of samples were examined: one was the McMurray formation which had not been impregnated with oil-sand oil, and the other was McMurray sand from which the oil had been extracted. Nickel and vanadium oxide contents of the two classes of sand were essentially identical at 1.5 and 35 p.p.m. respectively. It is apparent, then, that the nickel and vanadium found in the impregnated sand are a true part of the sand, and were not introduced into the McMurray formation by the oil-sand oil. A further examination of the distribution of the three metals in the mineral aggregate showed that the metals are more concentrated in the more finely divided material, and there is reason to believe that both nickel and vanadium exist therein as substitution atoms in magnetite crystal structure. The iron content of the mineral aggregate is quite variable, ranging from a 'normal' value of about 1,500 p.p.m. up to about 4,000 p.p.m.

The second phase of the investigation was concerned with the metals content of the oil extracted from the impregnated McMurray formation. All of the samples analysed were from surface exposures of the sand and as a result the iron content of the oils was quite variable, falling in the range of 100 to 2,000 p.p.m. The nickel oxide values were quite constant at 94 p.p.m., and vanadium oxide concentrations were about 374 p.p.m.

Extracted oil-sand oil was divided into its Marcusson components, and the distribution of the metals in the three components measured. The oily constituents have very little iron, nickel, and vanadium. The asphaltenes have the major proportions of the metals, but it is significant that the intermediate material, the resins, do have considerable metal content. The resins account for 38% of the vanadium in the oil, 41% of the nickel and only 5% of the iron.

The presence of the vanadium and nickel in the resins fraction may be attributed to the existence of both vanadium and nickel complexes of porphyrin compounds. Purification of the vanadium porphyrin and subsequent examination showed strong evidence that it was similar to the vanadium complex of desoxyphyllerythroetioporphyrin. A paper on this work was presented to the Western Regional Conference of the Chemical Institute of Canada, Saskatoon, Sask. 1953

Study of the "Heavy Oils" of Alberta

The origin of oil-sand oil and its relationship to the other Alberta oils—especially its relationship to the so-called "heavy oils"— is of fundamental interest. The usual approach to the comparative study of oils is to examine the distillation fractions which can be obtained from them. However, so little of the oil-sand oil can be distilled off without cracking taking place that this approach did not appear useful in this case.

Fortunately, the oil in Alberta oil sand is readily cracked. A complete cracking operation yields light oil, coke and gas, whereas partial cracking yields light oil, bunker fuel and gas. A method of comparison that appeared to hold out more promise was the characterization of the bunker fuel obtained from partial cracking of oil-sand oil and similar characterization of the bunker fuel produced from oils from the "heavy oil" fields.

The investigation was started by making a study of the effect of varying the temperature and the rate of heating during the partial cracking of oil-sand oil on the resulting bunker fuel. The bunker fuel produced in each experiment was split up into a number of fractions by means of solvent extraction. Work is underway to split some of these fractions into still narrower cuts by means of mixed solvents, following which various analyses—such as determination of sulphur, ultimate analysis, degree of unsaturation, and molecular weight—will be carried out. Comparison will then be made with similar fractions obtained from the "heavy oils" of Alberta.

It should be pointed out that up to the present, bunker fuel has represented a very important part of the market for heavy crude. The opinion has been expressed that in five or ten years, if not sooner, the market for this product will decline, especially as the trend of the Canadian railways is towards the use of Diesel locomotives and that of industry to use natural gas. Other markets for that portion of the bunker fuel will then be necessary. The work outlined above

may show the way to the production of other useful specialty products from the bunker fuel.

GASOLINE AND OIL TESTING LABORATORY

The Gasoline and Oil Testing Laboratory dealt with a wide variety of petroleum products handling approximately 600 samples during the year. Samples were received from the Department of National Defence, both Air Force and Army, Alberta Motor Gasoline Surveys, various Provincial Government Departments and a number of general commercial accounts.

Two surveys of the quality of motor gasoline sold within the Province were made, covering the winter period 1951-52 and the summer of 1952. Samples for this work were obtained through the co-operation of the Inspection Service Branch of the Attorney General's Department. To ensure that the gasoline samples were representative they were purchased from retail outlets throughout the Province. The results have been reported in the Research Council of Alberta mimeographed circular No. 14, "Alberta Gasoline Surveys 1952". The survey data indicated that, on the average, the level of quality of the gasoline manufactured and sold in the Province was well above the minimum requirements as set forth in the Fuel Oil Licensing Act. Since 1949 the anti-knock quality or octane number of gasolines has been substantially increased.

Two research projects were undertaken for the Defence Research Board. The first of these, now complete and shortly to be published by the Board, dealt with the viscosity of aviation lubricating oils at low temperatures. The second concerns the storage of aviation gasoline, a long term project which will continue for several years. Although also classified as research, but of a minor nature, many cases of engine operational difficulties were investigated with assistance and advice given. Service was also rendered to various Provincial Government departments. An explosion in a rural residence was investigated for the Provincial Fire Commissioner; samples of material taken as evidence in a case of suspected arson were analysed for the Fire Commissioner. The marking and identification of Government stocks of anti-freeze were studied for the Department of Public Works, and samples of anti-freeze were inspected for the Government Purchasing Agent. Many tests were made for the presence of purple dye in marked gasoline in samples taken for possible prosecution under provision of the Fuel Oil Tax Act.

Through official membership, an active part was also taken in the work of two National Research Council Committees, the Associate Committee on Petroleum and the Petroleum Specification Committee of the Canadian Government Specification Board. During June of 1952 the Specifications Committee held one meeting in Edmonton to familiarize the membership with petroleum developments in Western Canada.

NATURAL GAS

One of the primary objectives of this program is to keep in close touch with recent advances in the field of petrochemicals. A rather comprehensive report entitled "The Chemical Utilization of Natural Gas" was published. This received a wide distribution and was apparently well-received. Developments in the field have been so

rapid that early revision of this report is deemed desirable. Publication of the report on "The Manufacture of Carbon Black from Natural Gas" and its significance to Alberta will be finished and distributed shortly.

The program included study of the pyrolysis of natural gas, the partial oxidation of butane and evaluation of a process for the manufacture of carbon black; research effort was concentrated on the butane oxidation and carbon black projects.

The Partial Oxidation of Butane

A study has been made of the kinetics of the homogeneous gas phase partial oxidation of butane in the presence of large quantities of inert diluent gas. Oxygen concentrations were in the range 1.5% to 6.0%; butane concentrations also varied from 1.5% to 6.0%; the rest was nitrogen. The reaction pressure varied from 50 to 150 psia and contact times ranged from 0.8 to 4.5 seconds. All the runs were carried out under ambient temperatures of 725° F.

Despite an attempt to design a reactor having a high surface to volume ratio and with high heat transfer coefficients from the gas to the wall most of the reactions were of the "run-away" type, i.e. the gas temperature reached a peak some 59 to 100 Fahrenheit degrees higher than the surroundings in a short length of the reactor. The effect of mass velocity in the heat transfer properties of the reactor was masked by the change in contact times. A new reactor, with better instrumentation to record the temperature traverse at the reaction peak, and of the variable length type to change contact times without changing mass velocities is now being designed.

Efforts have also been made to develop quick analytical methods for the liquid products (aldehydes, ketones, acids and alcohols). However, it was later decided that in the long run, it would be more economical to send the samples to a commercial laboratory for analysis by the mass spectrometer.

The problem is a complex one and is of considerable interest not only from the chemical viewpoint (involving reaction kinetics and mechanism of chain reactions) but also from the viewpoint of engineering reactor design.

Pilot Plant Evaluation of the Pidgeon Process for Producing Carbon Black from Natural Gas

The purpose of this project was to extend Pidgeon's Laboratory scale work to a pilot plant scale to permit an evaluation of the commercial possibilities. Alundum tubes failed to withstand the severe thermal requirements of the process and cracked before any significant data could be gathered. A silicon tube, with much better thermal properties but also a far smaller permeability than the alundum tubes, was then installed. However, the flue gas diffusion rate was so low that it was not found possible to operate continously; the tube exit invariably plugged with carbon black after about an hour's operation. Fortunately, the runs were of sufficient duration that useful basic natural gas decomposition data could be obtained.

In summary, the flow rates covered a range of space velocities (defined as the volume of feed gas, measured under standard conditions, passed through per unit volume of reactor per unit time) of 0.1 to 0.6 sec^{-1}; reactions were carried out at two temperatures, 2,500° F and 2,200° F. The feed gas, taken from the city gas mains, was practically entirely taken from the Viking-Kinsella fields and is typical "dry" gas.

The data appear to be consistent with theoretical considerations. Material balances on the hydrogen check within 5% but on the carbon show consistent losses of around 10%. It is possible that some of the finer carbon blacks formed are not being recovered by the present bag filter system in which case either an electrostatic precipitator or an ultrasonic agglomerator may be the answer. Preliminary tests are being made on these blacks to determine their quality. However, a thorough evaluation can only be done in a rubber compounding laboratory, and arrangements are being made with commercial rubber companies to have this done.

Another type of alumdum tube, believed to have better thermal properties than the ones originally tried and found unsatisfactory, is now being installed. It is hoped that operation over an extended period of time will be possible and sufficient data made available so that the advisability of further work on this project can be considered.

INDUSTRIAL PROJECTS

The handling of inquiries and interviews from industry and government departments constituted the major phase of work of the industrial engineer for the past year. The services of this office are becoming increasingly known to industry and, in addition, many inquiries submitted to the University or to other government departments are channelled through the Industrial Projects section. Letters of inquiry received from the Industrial Development Branch of the Department of Economic Affairs are frequently passed on to this office for consideration. Some examples of the types of inquiries received are: questionnaires pertaining to tungsten carbide manufacture, porous cement manufacture, candy making, manufacture of plywood, installation of propane storage tanks, etc. Information is obtained from personal experience, office files, the University library, the facilities of the Technical Information Service, Ottawa and any other possible source. About one hundred such inquiries were handled during the year.

In addition to specific requests for technical information, considerable time is devoted to interviews dealing with industrial development and general conditions in Alberta. Other government departments dealing with industrial development often suggest visiting industrialists to call at this office. About fifty-five such interviews were held.

The Alberta Industrial Corporation, to facilitate investigations of applications for monetary loans, maintains an advisory committee of which the Industrial Engineer is a member. Several applications were studied during the past year. Periodic inspections were made of industries that had previously received financial assistance from the government.

The Industrial Engineer assisted the Provincial Marketing Board in two special investigations of a small plant producing insulating material and of a small refinery.

As technical adviser to the Industrial Development Board the Industrial Engineer attended their meetings at Drumheller and Brooks. A paper on coal was presented at the first meeting and one on "Agriculture and Industry" at the latter. An outline of the functions and activities of the Research Council of Alberta was presented at the meetings; technical questions were answered.

The Industrial Engineer has served the past year on a Provincial Committee to assist the Department of Defence Production Numerous inspections were made of plants in the province to assess their capabilities for defence production. In this connection two trips were made to Calgary, one to the Lethbridge-Medicine Hat area as well as periodic inspections at Edmonton. Close relations were maintained with the Liaison Officer, Prairie Area, Small Industries Division, Department of Defence Production at Winnipeg.

The Industrial Engineer is requested periodically to perform laboratory tests on various materials. Considerable testing has been done on the clays in the Edmonton area for bloating characteristics to determine the suitability of the clays for the production of light weight aggregate. A plant is presently under construction in Edmonton for the manufacture of this material. Indentation tests on asphalt plank made in Alberta enabled the manufacturer to obtain a sizable contract in British Columbia. Other tests included the recording of furnace temperatures in Alberta-made domestic furnaces, testing of license plates and safety stickers and the examination of insulation material.

A paper entitled "Industrial Minerals in Alberta" was prepared in co-operation with the Geological section and presented at the convention of the Canadian Institute of Mining and Metallurgy at Winnipeg, October 17, 1952 .

Tecvhnical Information Service

During 1952 the National Research Council approached the Research Council of Alberta in regard to the Technical Information Service in Alberta. It was proposed that the Province assume the local responsibility for the service under grant from the National Research Council. Discussion indicated that such an arrangement would enable integration of the field service into the operations of the Industrial Projects section of Council. A close liaison thereby should be possible between sources of information, laboratory research, and developing Alberta industry. At the same time the National Research Council indicated that it would maintain the central information service at Ottawa. This is available to supply information requested through Provincial field men.

Arrangements for assumption of the field responsibilities of the Alberta Technical Information Service by the Research Council of Alberta were made in December. The Research Council of Alberta has assumed this responsibility as of January 1953, and receives a grant from the National Research Council to meet the expenses of the service.

GEOLOGY

A field mapping program and several laboratory projects were carried forward during 1952. As the year progressed the changing situation made it desirable to undertake a survey of bentonite clays and to assist in the co-ordination of results from the core-drilling programs in the oil sands area.

Pleistocene Survey

The detailed survey of the Lake St. Ann area has been completed and a report and map are being prepared for limited distribution to those interested in Pleistocene geology and in the economic aspects of the surface deposits.

The map of the Edmonton area presented in a Master's thesis to the University of Alberta in 1951 has been amplified by further field work. This map will, it is expected be incorporated in an overall report on the glacial geology of the Edmonton area.

Limestone Sampling—Cadomin

Sampling of carbonate rock near Cadomin was undertaken upon the recommendation of the Industrial Engineer that a lime deposit in the area west of Edmonton would be desirable to meet industrial needs. Twelve samples were taken to represent a lime pit at Cadomin, one mile south of Cadomin, on the railway to Mountain Park. On the basis of these samples this lime property has been reactivated and a new plant is being considered for the site.

The Study of Carbonate Rock Systems

A study of the fine-grained sediments characteristic of much of the surface and subsurface deposits of the province has been undertaken as part of a general program on the minerals of Alberta. It was decided to use the differential thermal analysis technique as the first step of a more comprehensive investigation that ultimately should include the use of X-ray spectroscopy. Flexibility in the mechanical and electrical arrangement of the equipment was retained to allow for a study of the fundamentals upon which standard procedures have been adopted by other workers.

After operating techniques were acquired, two problems were brought under investigation: 1. to reconcile the chemisty of the $PbCO_3$-PbO and $MgCO_3$-MgO systems with the published results of differential thermal investigation, and 2. to relate the chemical analysis of certain carbonates to their mineral assemblages where optical methods fail and physical property contrasts are negligible.

Sphalerite in Reefal Devonian Rocks of the Plains Area

The geological staff of the Socony Vacuum Company intimated to Council geologists that sphalerite, the sulphide of zinc, had been described from an oil well in the Duhamel oil field. Further investigation found that the geological staff of the Sun Oil Company had described sphalerite in a well in the New Norway field. To obtain quantitative data rather than mere description the Division undertook to sample the core which amounted to obtaining chips that represented the values of the core. Assaying was completed in this case through the co-operation of the staff of the Consolidated Mining and Smelting Company, Trail, and the results are as follows:

Assay Results for Zinc*

Footage depth	Feet	Percent Zn	Feet/Percent
4,819.0-4,823.0	4.0	0.7	2.80
4,823.0-4,827.0	4.0	0.1	.....
4,827.0-4,832.5	5.5	0.8	4.40
4,832.5-4,838.5	6.0	7.2	43.20
4,838.5-4,843.3	4.8	4.7	22.56
4,843.5-4,851.0	7.5	15.3	114.75
4,855.0-4,859.0	4.0	1.9	7.60
4,859.0-4,864.0	5.0	0.1	.....
4,864.0-4,878.0	14.0	0.1	.....
4,878.0-4.885.5	7.5	0.3	2.25
4,885.0-4,890.0	5.0	0.1	.....

*From Sun-Orr well, No. 2-1, New Norway, Alberta.

As a result of the sphalerite investigation there was interest in obtaining samples and firsthand information of other metallic sulphides known to occur in Alberta or in deposits that had structures capable of being traced into the province. Therefore, a suite of samples was obtained from Pine Point, N.W.T., and a list of occurrences of heavy metal sulphides has been made from the files of the Imperial Oil Company.

Investigation of Clays

During the past year inquires have been answered regarding the general geology of Alberta—and especially with regard to distribution of clays, carbonate rocks and petroleum.

One major new company has entered the brick manufacturing field in the Edmonton district and its technical representatives were given all the information known as to distribution of raw materials. Core samples have been taken that indicate that the common lake clays known to exist north-east of Edmonton occur in 20-foot sections as far west as Big Lake. The opinion has been expressed that the recent survey of the Whitemud formation of the Cypress Hills area should be followed by more detailed work with special note being taken of economic deposits.

Investigation of Alberta Bentonites

A summer survey of Alberta bentonites was made by a student who expected to make use of some of the bentonite samples in studies for the Ph.D. degree at a leading United States institution. There follows a short summary of the results of the survey.

Beds of bentonite were examined and sampled at Busby, Camrose, Dorothy, Drumheller, Edson, Irvine, Medicine Hat and Rosebud. The thickness of the bentonite seams ranged from a few inches to as much as 30 feet, with wide variation in the amount of overburden and in the quality of the clay. Some of these bentonites would probably be suitable for bonding agents in foundry sand and as bleaching agents if a suitable market should develop for such products. However, no bentonite suitable for use in drilling fluids was found. With chemical beneficiation a suitable product for drilling fluids might well be developed from one or more of the bentonite deposits of Alberta.

Oil Sands

The Geological section has undertaken the correlation of geological data from the present core-drilling program in the oil sands area. Two routine trips have been made to McMurray to obtain geological samples of stratigraphic and mineralogical value to further a study of the oil sands. Samples sent to the Geological Survey of Canada, Calgary, have determined that the massive dark grey clays overlying the oil sand section north of Mildred-Ruth Lakes area is part of the Clearwater formation of Lower Cretaceous age. Detailed study of the lithology of the basal contact of the Oil Sands-McMurray formation with the Waterway formation indicates that a residual clay has developed upon the Devonian surface and a kaolinitic clay has been formed in a terrestial environment.

In September Council staff traversed the Clearwater River east to a point 15 miles above the Christina River. On this traverse samples of unimpregnated sands of the McMurray formation, the carbonate rocks of the Waterways and the seepage oil from the

outcrop area of the McMurray formation at Bitumount were obtained.

Uranium Propects in Alberta

Prospectors claims have been staked in north-eastern Alberta, an area underlain by rocks of Precambrian age. Rocks of a similar structure and age in the adjacent area of Saskatchewan are known to contain economic deposits of uranium. Aerial photographs of selected regions in the Alberta area have been acquired by the geological section for photo interpretation of regional geological structures and the relationship of the structures to the uranium mineralization.

In the Leyland Lake area a zone of parallel fractures running east-west, and a regional line of dislocation trending north-east, are evident from the photographs. Claims have been staked at Leyland Lake and at Fidler Point on Lake Athabasca during the current year. It is proposed that each of these areas be surveyed next year to map the prospects and to discover the extent of the mineralization.

SOILS

Soil surveys were continued as a co-operative undertaking by the Research Council of Alberta, the Department of Soils of the University and the Dominion Experimental Farm Services, and the following is a summary of the 1952 surveys:

Irrigation Soil Surveys

Sage Creek Flood Irrigation Project—Detailed Survey

At the request of the International Joint Commission a survey was made of the Sage Creek area, covering approximately 10,000 acres.

St. Mary Project—Detailed Survey

In The Grassy Lake district 9,000 acres were surveyed and rated These were areas that had been added because of canal relocation, or on which only reconnaissance survey information was available. This work completed in detail all areas that will be offered for settlement in 1952.

William Pearce (Red Deer) Irrigation Project—Detailed Survey

In the Cessford-Pollockville area 83,000 acres were surveyed, and in the Youngstown-Coronation area the survey of the plane-tabled area is almost complete. More than 50% of the soil is Hemaruka heavy loam (brown solodized solonetzic hard pan soil).

Reconnaissance Soil Surveys

Rocky Mountain House Sheet

An additional 700,000 acres were surveyed in this area in 1952. Due to pressure of other work and wet weather not as much was done as expected, but preliminary surveying has now been completed on the Brazeau-Rocky Mountain House sheets. Considerable checking has yet to be done.

Edmonton Sheet

In the spring and at convenient intervals during the summer about 350,000 acres of the Edmonton sheet were mapped, mainly in the Spruce Grove-Devon areas.

Sturgeon Lake and Grande Prairie Sheets

The survey was resumed on the Sturgeon Lake sheet and a start made on the Grande Prairie sheet. Due to delays from wet weather and very wet working conditions in the area only about 500,000 acres were surveyed in 1952. Good roads are scarce in parts of these sheets and many areas were surveyed on foot. Except for checking, most of the area east of the Smoky River has been completed.

Exploratory Surveys

Area Adjacent to New Whitecourt-Valleyview Highway

An exploratory soil survey of this area was started in 1952 The area under consideration consists of townships 61 to 68 inclusive, in ranges 14 to 26 inclusive, west of the fifth meridian. Surveys with pack horses were completed in about 50 townships or approximately half of the area. This survey is being done in anticipation of many requests for information regarding the agricultural possibilities of the area adjacent to the highway.

Other Activities

A survey correlation trip was made in various parts of the Peace River area by the Senior Research Council surveyor in company with the senior soil surveyor from Ottawa and representatives of the British Columbia and Saskatchewan soil surveys. As a result of such co-operation similar soils in the Peace River district of B.C and Alberta are given the same series names. Inspection trips were made also by the Director of Research and the Head of the University Department of Soils with Research Council and Dominion surveyors in the Peace River and Rocky Mountain House districts.

A field trip was made by Research Council surveyors in an area north-east of Edmonton for the purpose of ascertaining the characteristics of the public lands that are still available for settlement. This is part of an undertaking by which it is hoped to collect sufficient information for the publication of a report on public lands open for settlement in the central and western parts of Alberta. Such a publication has been requested by the Department of Lands and Forests.

In connection with the Alberta Land Clearing Project the senior Research Council surveyor made several field trips into the Valleyview and Blueberry Mountain districts in order to select suitable areas.

Seven monoliths and some 120 samples of soil were obtained in the Peace River area, representing profiles typical of the land surveyed in this district, for exhibition and analysis.

Reports

(1) "Soil Survey of Red Deer Sheet." Report No. 16 of the Alberta Soil Survey. This report was distributed in 1952 following receipts of maps from printers.

(2) The soil survey report of the High Prairie and McLennan sheets is in the hands of the printers, and the soil maps are also in the printer's hands.

IRRIGATION AND SOLONETZIC SOILS

More than half of the projected Red Deer irrigation area consists of hard-pan (solonetzic) soil, and we have had practically no experience with this type of hard-pan (Hemaruka) soil under irrigat-

ion. The limited areas of hard-pan soil previously brought under irrigation in Alberta were not of this extreme character. It was therefore deemed desirable and very necessary to carry out experimental work on this hard-pan soil to see if it can be made to produce crops successfully under irrigation, before spending large sums of money on irrigation development.

Experimental irrigation plots were established southwest of Youngstown in the spring of 1952, by the Research Council of Alberta and the University Department of Soils in co-operation with Dominion Experimental Farm at Lethbridge.

The project is carried on in close co-operation by provincial and federal workers. The experimental set-up was agreed upon following a discussion between the staffs of the Dominion Experimental Station at Lethbridge, the Alberta Soil Survey and the University Department of Soils. It was decided: (1) that the Dominion Experimental Station plots at Youngstown would be devoted chiefly to a study of consumptive use of water on Hemaruka soils under varying cropping conditions; (2) that the Research Council of Alberta and University Soils Department plots and other experiments would be devoted chiefly to a study of the physical characteristics of the soil and methods of correcting if possible any undesirable features of the soil when subjected to irrigation. The site near Youngstown was chosen because it is close to a stock watering dam previously constructed by the P.F.R.A., and adjacent to poor hard-pan (Hemaruka) soil. The dam contains sufficient water of suitable quality for the irrigation plots.

Work Done in 1925

Plots were laid out as follows:

A. Continuous grain. One series of 7 plots each 16′×45′, and each plot receiving a different treatment.

B. Grains and sweet clover rotation. Two series of 7 plots, each plot receiving a different treatment.

Treatments were as follows: (1) dry check, (2) irrigated check, (3) deep cultivation, (4) barnyard manure, (5) sulphur, (6) krilium at lower rate, (7) krilium at higher rate. Quadruplicate replication was obtained by using four ranges of each series of plots. Within each series the plots were randomized.

The land was plowed, cultivated, and treated according to plan. All plots were seeded to barley in June, and first irrigated July 16. This was not early enough to produce a good crop, and the growth was uneven, masking effects of soil amendments or treatments. However, the plot crops were sampled, threshed, and the yields recorded.

A detailed soil survey of the plot area was completed by the soil survey staff. A complete set of soil samples was taken of all the plots during the summer for future reference and analysis.

During the summer the plot area was fenced and a dugout water reservoir constructed on the higher land above the plots. A weather station was maintained in co-operation with the Lethbridge station. Also, more land was worked up in preparation for expansion of experiments in 1953.

A start was made using a soil core sampler to study porosity and permeability in the Hemaruka soils, apparatus being secured and equipment set up in the Soil Laboratory to expand this study.

The Lethbridge Station plots at Youngstown were designed to include one series in continuous grass, one series in continuous alfalfa, and four series in a rotation. A standard fertilizer, ammonium phosphate 11-48-0, is applied to half of each plot each year, and different numbers of irrigations are applied to different plots each year. In 1952 all plots were seeded down to barley.

HIGHWAY RESEARCH

For the past six years research work has been underway in the Department of Civil Engineering of the University dealing with the prevention of frost heaving and frost boils by the injection of a chemical called "lignosol" into the soil. Lignosol is a waste product of the paper industry. The results on a laboratory scale were so successful that a field program was undertaken in the fall of 1950.

The purposes of the field program were:

(a) to develop satisfactory methods for the injection of the lignosol;

(b) to secure data from which the cost of a treatment could be estimated;

(c) to acquire information on the permanence of a treatment.

A considerable degree of success was achieved in the field program.

In view of the extensive damage caused on the Alberta main highway system, particularly in the southern part of the Province, last spring during the break-up due to frost action it was decided that it would be worthwhile to establish the usefulness of the method on the Provincial highways.

The original assumption was that the action of the lignosol would be to alter the capillarity properties of the soil moisture in view of the fact that the lignosol is a wetting agent. However, the work conducted during the past summer has shown that the wetting agent theory is incorrect. It was found that other wetting agents did not prevent the formation of ice lenses and the migration of water to the frost line to anywhere near the extent that lignosol does. In now appears that the action of the lignosol is to greatly increase the viscosity of the soil moisture in the treated zone. This has the effect of reducing the rate of movement of the soil moisture to the frost line.

This new explanation of the fundamental action of the lignosol opened up the possibility of securing equally satisfactory results from other chemicals that might be more economical to use in Alberta than lignosol. Several have been found to be satisfactory including locally produced products.

BIOLOGICAL CYCLES

The ten-year cycle now appears to have reached the "crash" stage, i.e. a definite decline of some species has evidently set in, including particularly the snowshoe hare, ruffed and sharp-tailed grouse, and apparently magpies. Hunters reported a great diminution of Hungarian partridges throughout central Alberta in October, an observation that agreed with our own but with the somewhat belated advent of snow Hungarians have become more evident again and have, during the past month, been reported as unusually plentiful instead of scarce over at least limited areas, including both

northern and southern ends of their range within the Province. The explanation of this is not obvious; large-scale movements in this species are not known to occur but, unfortunately, what we do not know still exceeds what we do know on this topic and the situation must rest here till 1953 has passed.

Pheasants have shown no signs of diminution anywhere up to date and appear to be at their numerical peak in central Alberta at the moment. Ten years ago, this species was the last to collapse.

One interesting phase of the present situation is the patchy nature of the start of the decline, with local concentrations holding out after the general drop has set in. This applied equally to rabbits which are now on the whole scare yet in a few localities, the Athabasca district being one, extraordinary concentrations have maintained themselves. Here we have attempted to keep one particular site under close observation through the winter. When first discovered through reports of observers, local concentrations at the rate 38,000 to the square mile were discovered (actual counts made by shooting and trapping rabbits off small patches of one or two acres) but during the winter a change of sex ratio (males dropping to about 50% of the females) suggests that the die-off is in progress.

Except for restricted localities such as this, rabbit numbers have nowhere attained the usual peak proportions but the consensus of local opinion almost everywhere is nevertheless that numbers have substantially dropped.

Epidemiology

Some 700 specimens of various species have been autopsied either by ourselves or at the Provincial Veterinary Laboratory during the past year. Nothing that could sweep the population of any species has been discovered, but two hitherto unrecorded maladies, with the organism unidentified, have appeared. One is an eye infection of snowshoe hares, the other a fungal skin infection of grouse. Tuleraemia, despite injection of scores of rabbit bloods into guinea pigs, has not occurred. Coccidiosis so far has proved the main scourge and has persistently depleted our supply of captive rabbits, of which we have had over 100, trapped without injury during the winter. One case of rabies has been definitely determined in the snowshoe. An outbreak of tuleraemia among beavers and muskrats in the Waterton area has just been reported and we have now arranged to get rabbits from the same zone.

The enclosure at Cooking Lake has suffered no leakages this fall and winter and there have been three survivors of last year's population. One of these was shot for examination and found to be free of any infection, including the ubiquitous tapeworm, *Taenia serrata*. It was in flourishing condition and weighed 3½ lbs., a substantial weight for this species.

This enclosure has now been restocked with 5 males and 5 females, all of them earmarked and treated in various ways for three weeks before liberation in an attempt to eradicate coccidiosis and other possible infections.

In addition to these, we have rabbits caged in Edmonton and being fed a balanced ration, professionally mixed and standardized. Despite this, the mortality remains high and we have recently had three deaths that resembles Green's shock disease, the malady—

the cause of which is still unknown—to which Green attributed the rabbit crash in Minnesota.

At Anzac, a collaborator's records of rabbit movements and reproductive rates have been continued. Owing to the scarcity of hares, his figures have taken a serious drop but are sufficiently extensive to indicate marked diminution in litter sizes and number of litters for the season.

In addition to the large accumulation of pathological reports, weight, sexes, ages, food, etc, have been obtained from hundreds of samples of snowshoe hares, jack rabbits, grouse, Hungarian partridges and pheasants, as well as crop and gizzard contents through most of the year except (in the case of game birds) during the breeding season. This collection of material, when finally analysed, promises to produce not only information that is entirely new, but some of it of considerable significance.

In addition, vitamin A assays are now being made on scores of livers while calcium tests on the femurs of all rabbits obtained have been run for a matter of months.

HATCHABILITY OF TURKEY EGGS

The effect of the addition of known vitamins to turkey breeder diets

The percentage hatch of turkey eggs is low. Records of the last few years show that more than fifty percent of all turkey eggs set in hatcheries in Alberta failed to hatch. It has also been observed that there is a decline in percentage hatch as the breeding season progresses. It seemed possible that the low percentage hatch and the subsequent decline in hatch as the breeding season advanced might be associated with vitamin reserves in th turkey breeder. Consequently an experiment was conducted to study the effect, on the percentage hatch of turkey eggs, of the addition of known vitamins to the turkey breeding ration.

In the experiment the performance of two lots, of twenty turkey hans each, receiving a practical turkey breeding ration was compared to that of two lots, of twenty turkey hens each, receiving the same ration plus vitamins. The vitamins added were thiamine, pyridoxine, choline, folic acid, biotin and vitamins C, E and K. The practical breeding ration used was already supplemented with vitamins A and D, riboflavin, niacin, pantothenic acid and vitamin B_{12}

The experiment was continued for an 18 week period which corresponded with the normal turkey hatching season. Records were kept on rate of production, fertility and hatchability of eggs produced. All eggs that failed to hatch were broken open and classifed either as infertile or dead germs. In the case of the dead germs the age at which death occurred was recorded.

The results obtained are summarized in the following table.

The Effect of Vitamin Supplementation on Reproduction

Lot	Treatment	% production	% fertility	% hatchability	% hatch
1	none	47.7	84.5	60.9	51.4
2	plus vitamins	45.1	89.2	68.7	61.3
3	none	45.5	58.9	65.3	38.5
4	plus vitamins	38.5	82.3	61.8	50.9

Examination of the results indicated that the addition of a number of vitamins not usually added to turkey breeder rations had no effect on rate of production or fertility, hatchability and percentage hatch of eggs produced. The variability that occurred in rate of production could not be explained. The low fertility noted in pen 3 could be attributed to the males used. Initially fertility was high, but declined as the breeding season progressed. When fertility was at a low ebb the males were changed and fertility immediately improved. The percentage hatch of fertile eggs (% hatchability) was not affected by the addition of vitamins to the breeder ration. It was also noted that the addition of vitamins had no apparent effect on embryonic mortality.

Since the addition of known vitamins failed to show any effect on the hatch of turkey eggs it is proposed during 1953 to study the effect of variations in management on the percentage hatch of turkey eggs. Two aspects will be studied. The first will deal with selection of breeders. The second will deal with the condition of the breeders entering the breeding season.

ULTRA-VIOLET SOLAR RADIATION

A report on the solar ultra-violet measurements made in Edmonton since 1946 was made before the Radiation Section of the International Union of Geodesy and Geophysics, meeting in Brussels during August, 1951. The measuring methods were presented in a paper to the Canadian Association of physicists meeting in Montreal the same summer. During the discussion there was some interest shown in these measurements. As a result of this, and later talks with Dr. C. H. Robinson of the British Meteorological Service, similar equipment was ordered for the observatory at Kew, in the suburbs of London. A further result of these talks with Dr. Robinson was a communication from a research team in Nigeria, Africa. They are measuring the solar ultra-violet in the longer region that is also being studied in Alberta. They were enough interested in our methods for shorter regions that an order was placed for the same type of photocell as we have in continuous use.

During a trip through the United States the subject of ultra-violet measurement was discussed with Dr. Stair of the Bureau of Standards, and with several people at the Washington office of the U.S. Weather Bureau. They expressed the opinion that more of such observations should be taken. In similar vein a most positive endorsement was given by Dr. F. W. Wendt, California Institute of Technology. He thinks that botanists and biologists are in great need of measurements in various ranges of the whole solar spectrum, and hopes the Alberta methods will continue and develop.

(The above-mentioned contacts were made by Dr. E. H. Gowan while he was on sabbatical leave from the University of Alberta during the 1951-52 session.)

The records of nearly six year are being brought to a common standard and detailed study is under way of the relations among the three wave length ranges being observed, (2,900 to 3,150, 2,900 to 3,675 and 2,900 to 4,000 Angstrom units).

LIST OF PUBLICATIONS

of

RESEARCH COUNCIL OF ALBERTA

EDMONTON, ALBERTA

ANNUAL REPORTS OF COUNCIL

No. 3 (for the calendar year 1920); pp. 36. **(Out of print.)**
No. 5 (for the calendar year 1921); pp. 86. **(Out of print.)**
No. 8 (for the calendar year 1922); pp. 64. **(Out of print.)**
No. 10 (for the calendar year 1923); pp. 76. **(Out of print.)**
No. 12 (for the calendar year 1924); pp. 66. **Price 35 cents.**
No. 16 (for the calendar year 1925); pp. 65. **Price 35 cents.**
No. 20 (for the calendar year 1926); pp. 53. **Price 25 cents.**
No. 22 (for the calendar year 1927); pp. 49. **Price 25 cents.**
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