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MINES BRANCH
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NATURAL GAS IN ALBERTA

By

R. T. Elworthy

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INTRODUCTION

Although natural gas occurs in many parts of the world it has been found in great amounts only in the United States and Canada. Since the first natural gas wells were drilled in the United States in the early part of the nineteenth century, the annual consumption in that country has grown to the enormous figure of over seven hundred thousand million cubic feet, valued at over one hundred and seventy-five million dollars.

The annual production in Canada is only about one-fortieth of this amount, valued approximately at five million dollars, but even with this quantity Canada stands second in the list of the world's producers.

The petroleum and natural gas resources of Canada were the subject of a thorough survey in 1912 and 1913, and an exhaustive report covering the results was issued in two volumes by the Mines Branch in 1914. The first volume of the report covered the technology and exploitation of oil and natural gas in a very complete manner; the second volume included the results of the investigation of the Canadian fields at that time. The report dealt with the individual fields, province by province, and gave a detailed account of the oil and gas industry in Canada up to 1914.

This investigation showed that, though natural gas occurs in many parts of Canada, Ontario and Alberta are the only provinces in which extensive resources have so far been found.

The Ontario fields have shown signs of exhaustion during the last few years and the provincial government has thought it necessary to take steps to regulate the distribution and use of the gas in order to conserve this valuable natural product in the best interests of the public. In Alberta the situation is different. In the search for oil, during the last decade, many large flows of natural gas have been struck, and the existence of extensive fields in several areas which were indicated in the earlier report has been confirmed.

Very little reliable information has been collected on these gas fields, however, especially as to the volume of the gases available, and their character. The product of some of the fields may not be required for domestic consumption for many years to come; but, in view of the develop-

ment of the natural gas gasoline and carbon black industries in the United States, it was thought desirable to obtain data regarding the volume, pressure, composition and gasoline content of gases from representative wells in the various fields.

This information should be of value to those who are interested in the establishment of the natural gas industry and in making regulations for the conservation of the natural gas resources.

The following report gives the results of this investigation. The situation of the chief fields is described with brief reference to the geological formations underlying them and the manner in which the gases may be used to the best advantage. The character of the field work is referred to, followed by a description of the chief gas fields. The possibilities of natural gas gasoline production, the manufacture of carbon black and the extraction of helium are also considered.

Brief mention only is made of subject matter which is treated more fully in other government publications to which full references are given.

THE LOCATION OF THE GAS FIELDS IN ALBERTA

The settled portion of Alberta, that is southern and central Alberta, roughly forms an irregular rectangle, bounded on the east by the fourth meridian (W longitude 110), on the west by the Rocky mountains, on the south by the International Boundary and on the north by latitude 54. This area is about two hundred miles wide at the south and four hundred at latitude 54, which is four hundred miles north of the United States boundary, and includes about 120,000 square miles.

Eight railways, approximately thirty to forty miles apart, cross this area from east to west, from Saskatchewan to the line running north and south from Calgary to Edmonton. The topography, geography, climate, and means of transportation are well described in a bulletin published by the Natural Resources Intelligence Branch in 1920 on "Oil and Gas in Western Canada".

The known gas fields lie to the east of the Calgary Edmonton line, with one exception—the Turner Valley field, forty miles southwest of Calgary—and the four chief fields are situated near the main railway lines; the Medicine Hat and Bow Island fields on the main line of the Canadian Pacific railway, and the Wainwright and Viking fields near the Canadian National railway.

The gas from these fields, with the exception of Wainwright, is used for domestic and industrial heating and lighting; Medicine Hat gas for the city of Medicine Hat, and Bow Island gas for Lethbridge, McLeod, Calgary, and the smaller towns in their vicinity. Edmonton has used its first gas this winter, supplied from the Viking field.

The new fields, Many Islands Lake, and Foremost, although within forty miles of Medicine Hat and Bow Island respectively are treated separately in this report.

Besides these fields many isolated wells have been drilled in various parts of Alberta, almost all in a search for oil, in which gas has been found and which give indications of large reservoirs in the neighbourhood.

Natural gas is also known to exist in great quantity in northern Alberta; the main areas, where wells have been drilled, being along Athabaska and Peace rivers, between latitudes 56 and 57.

These fields were not included in this year's investigation but the information now available is given in the report.

FIELD WORK

Although the main object of the field work was to make examinations of gas from representative wells in the newer fields, most of the older fields also were visited. A motor truck carrying the necessary apparatus and equipment was used for transport.

At the various wells, determinations were usually made of the open flow, rock pressure, gasoline content and specific gravity of the gas. Samples for analysis were also collected and information was obtained of the depth drilled, history of drilling, difficulties encountered, and of any other matters that seemed of interest and importance.

METHODS USED

For the measurement of the gasoline content, the Oberfell gas testing apparatus was used. In this apparatus a measured volume of the gas was passed through activated charcoal which took up the gasoline hydrocarbons. The charcoal was afterwards heated in glycerine and the absorbed gasoline distilled off, condensed, and the volume measured.

The results obtained by this method were compared on one occasion with those given by the older oil-absorption apparatus. Satisfactory agreement was shown. Although the gasoline content of a natural gas found by the charcoal method is probably a little greater than the result obtained with the usual type of oil absorption apparatus and certainly higher than would be obtained in commercial operations, this method is far more convenient for itinerant testing and gives comparable results for the different fields, which is the main consideration.

The open flow, pressure, specific gravity, etc., were measured by the standard methods. Duplicate samples for analysis were collected in one gallon glass bottles, usually by water displacement, though for comparison some samples were taken by air displacement, allowing the gas to pass through the bottle for at least ten minutes. Subsequent analysis of the samples collected by the air displacement method showed that this method did not give a pure sample.

Where larger quantities of gas were required, as for helium determinations, the samples were collected in small steel cylinders.

The cylinders were previously washed out five times by alternate filling with gas and blowing off, and were finally filled at well pressure, which was usually over 500 lbs. per square inch.

The gases were analysed in an improved type of Burrell gas analysis apparatus. Helium was determined by the usual method of first liquefying the hydrocarbons and then absorbing all other gases not liquefied by activated charcoal, cooled to the temperature of liquid air. Helium, the only gas not absorbed, was pumped into a burette and the volume measured.

Medicine Hat field[1]

Extent. The proved gas area at Medicine Hat covers about forty or fifty square miles and future drilling may open up new wells outside the borders of that area.

History. The first gas well was drilled in 1890 to a depth of 650 feet but it was not until 1905 that the main gas sand was located at a depth of about 1000 feet. By 1913, sixteen wells had been drilled by the city authorities and gas was supplied to 1,900 domestic consumers and sixteen industrial plants. The Canada Cement Company, in 1914, drilled several wells, the gas from which not being required by the company, is sold to the city. In 1919 the consumption was over 2,500,000,000 cubic feet, while in 1922 it amounted to nearly 3,200,000,000 cubic feet. There are today more than 68 miles of pipe of 4-inch and 6-inch diameters conveying the gas from the wells to the consumers.

There are two gas horizons in this field, one at 600 - 800 feet and the other, the larger reservoir, at 1000 - 1200 feet depth.

The gas pressure when these wells were first drilled was about 500 lbs. per square inch with open flows of up to 500,000 cubic feet a day. In 1914 the closed pressure had fallen to an average of 470 lbs. per square inch. In 1923 the only measurements obtainable were the gas pressures registered while gas was passing into the high pressure mains reduced from well pressure to 60 - 70 lbs. per square inch. Under these conditions the average pressure at 17 wells ranged from 300 - 400 lbs. per square inch.

Use. Medicine Hat early sought to attract industries to locate in its neighbourhood by offers of cheap gas, and the city undoubtedly owes its present development in great part to the establishment of several such plants.

The largest industrial consumers are three flour mills, the city power house, in which gas is used in boiler plants, the Alberta Clay Products Ltd., the largest manufacturer of sewer pipe and building tile in the west, and the Medalta Potteries, manufacturers of domestic stoneware. In the clay working plants, natural gas is used in large amount for firing the kilns. Several foundries and other smaller plants also use considerable quantities of gas.

Besides the supply that is obtained from their own wells, these plants consume about 1,500,000,000 cubic feet a year from the city's wells. The rate to the domestic consumer is 25 cents per thousand cubic feet. The total consumption reported to the Dominion Bureau of Statistics from the city's wells and from the privately owned wells of ten companies was 3,157,932,000 cubic feet in 1922.

Redcliff. There are six gas wells, giving a good flow of gas, in the town of Redcliff, two miles west of Medicine Hat. These wells are privately owned, and the gas is used in the glass melting furnaces of the Dominion Glass Company and in two or three brick plants. The gas comes from the same sands as the Medicine Hat gas.

The rock pressure of these wells was reported to be 450 lbs. per square inch in 1923. Over 300,000,000 cubic feet was used in 1922.

[1]Geo. Surv. Sum. Rep. 1916, pages 124-130.

Character of the Medicine Hat gas. When examined in October 1923, tests showed the gas to be a dry gas of specific gravity 0·565. This result was confirmed by the analysis given below. Previous results are also given for comparison.

	Gas from city main Mines Branch October 17, 1923	City gas*	Smith well*
Methane CH_4	97·8	99·5	76·6
Ethane C_2H_6	0·3	–	4·4
Carbon dioxide CO_2	0·4	–	2·0
Oxygen O_2	Nil	–	6·0
Nitrogen N_2	1·5	–	11·0
Sulphuretted hydrogen	—	0·5	—

*Mines Branch Bull. No. 31, p. 21.

The calorific value of the gas, calculated from the recent analysis, is 1046 B.Th.U. showing it to have a high fuel value.

The gas would be a valuable source of methane for future chemical manufacturing processes using natural gas as a raw material. Examples of such processes are the manufacture of methyl chloride by the regulated action of chlorine on methane, and the production of formaldehyde by partial oxidation of methane.

The Many Islands Lake field

Although this field is only 40 miles east of Medicine Hat and might be considered as within the Medicine Hat field, for the purpose of discussion it will be regarded as a separate area.

Six wells have been drilled or are being drilled in township 14, ranges 1 and 2, west of the fourth meridian. A considerable flow of gas has been discovered in the well of the Medicine Hat Development Co., but the other holes had not reached the gas sands (Sept. 1923), which are at a depth of 1300 to 1500 feet, except in the Community Oil well, in which the gas had been mudded off, and the Canadian American Oil Co's well.

The companies drilling wells are:—

Name	Location	Depth drilled in 1923
		feet
The Community Oil Wells, Ltd.	LSD 7, Sec.19, Tp.14, Rg. 1, W.4th.M.	2471
The Medicine Hat Development Co.	LSD 7, Sec.19, Tp.14, Rg. 1, W.4th.M.	1200
	LSD 7, Sec.20, Tp.14, Rg.1, W.4th.M.	70
The Many Islands Oil and Gas Co. Ltd.	LSD 13, Sec.26, Tp.13, Rg.2, W.4th.M.	1400
The Canadian American Oil and Gas Co., Ltd.	LSD 12, Sec.31, Tp.13, Rg.1, W.4th.M.	1350
Alberta Gas and Oil Co.	LSD 1, Sec.12, Tp.14, Rg.2, W.4th.M.	

Most geologists agree that there exists in this neighbourhood a favourable structure for the presence of oil and gas. The area was explored by an officer of the Geological Survey in 1923, and his report is awaited with interest.

The character of the gas. Two gases were examined in this field, from the wells of the Medicine Hat Development Co. and of the Canadian American Oil Co.

Medicine Hat Development Co. Owing to a defective casing in the Medicine Hat Development Co's well the gas could not be entirely closed off for a test of the rock pressure nor for a satisfactory open flow measurement. It was calculated, however, at 800,000 cubic feet a day. The specific gravity of the gas was 0·578.

Two tests for gasoline hydrocarbons were made, using the Oberfell apparatus. The tests were negative. This result is confirmed by the analysis, and by the low specific gravity of the gas.

Canadian American Oil Co's well. This well was reported to be 1350 feet deep. An hour after being blown off, the rock pressure was 350 lbs. per square inch. The flow was about half a million cubic feet per day.

The gas was a dry gas, of specific gravity 0·587. Two tests gave no evidence of the presence of gasoline hydrocarbons in the gas, a result confirmed by the analysis.

The Community Oil Well, Ltd. This is the deepest well in the field, but it has never been thoroughly tested. It was drilled to its present depth with a rotary drill, but the mud has never been entirely pumped off for a test. The driller believed that a heavy flow of wet gas was thus kept back.

Owing to an accident with the casing, the well could not be tested when it was visited in October 1923.

Analyses. The following are the results of analyses of the samples collected:—

	Medicine Hat Development Company	Canadian American Oil Company
	Per cent	Per cent
Methane CH_4	95·6	96·3
Ethane C_2H_6	Nil	0·5
Carbon dioxide CO_2	0·2	0·5
Oxygen O_2	0·1	0·3
Nitrogen N_2	4·1	2·4
Sp. Gr.	0·574	0·578
Calorific value B.Th.U., at 0°C. and 760 mm.	1017	1074
Gasoline content	Nil	Nil
Helium	Not examined	0·07

Although it is probable that large supplies of gas will be ultimately available, none of the wells yet drilled are in a position to supply large amounts to Medicine Hat or to any industrial plants in the neighbourhood. The erection of a gasoline extraction plant is not warranted as there is little gas and it is dry. Nor is the gas of the most suitable composition for a carbon black plant, as the ethane content is too low to give desirable yields of black.

Bow Island field[1]

The Bow Island field covers townships 10 and 11, ranges 11 and 12, west of 4th meridian, an area of about 20 square miles. The chief wells are situated along the south bank of the Saskatchewan river, ten miles north of Burdett station on the Medicine Hat—Lethbridge branch of the Canadian Pacific railway.

History. The first well was drilled in 1908 by the Canadian Pacific Railway Company, 12 miles from the present centre of production. The development of the field was subsequently carried out by the Canadian Western Natural Gas, Light, Heat and Power Co., Ltd., and in 1913, 16 wells producing 75,000,000 cubic feet per day were drilled. The present pipe line to Calgary, 160 miles long, was laid at that time. To date, twenty-five wells have been drilled in this field, several of which are now abandoned owing to the encroachment of water.

Present condition. The original rock pressures in this field were about 750 lbs. per square inch and open flows of seven and eight million cubic feet a day were common. The principal supply of gas comes from the Dakota sands at about 1900 feet, though a small amount is obtained at 800 - 1000 feet in the Belly River shales.

Unfortunately the field is showing signs of exhaustion and Calgary has suffered from a shortage of gas at times in the past few years. During the summer of 1923 many of the wells were cleaned out and the field was not drawn upon. A recent report based on an examination of the field in October 1923, made by engineers appointed by the Public Utilities Commission of Alberta, shows that this treatment has checked the decline of the field and the average rock pressure has increased slightly, to 210 lbs. per square inch. The open flow of all the wells was found by the Canadian Western Natural Gas Co's engineers to be about 17,000,000 cubic feet per day in September.

The minimum field pressure that will transmit gas through the pipe line to Calgary is 60 lbs. per square inch.

Character of the gas. The gas from the Bow Island field is of low specific gravity and is a dry gas, as the following analyses show:—

Analysis by	Mines Branch	G. A. Burrell, Pittsburgh		
	1914	1915	1916	1919
	p.c.	p.c.	p.c.	p.c.
Methane CH_4 / Ethane C_2H_6	91·6	92·3	91·1	90·3
Oxygen O_2	0·2	trace	0·1	0·0
Carbon dioxide CO_2	–	–	0·1	0·0
Nitrogen N_2	8·2	7·7	8·7	9·7
Specific gravity	0·59	0·58	0·59	0·60
Calorific value B.Th.U. at 0°C., 760 mm	946	983	970	962

[1]Geol. Sur. Sum. Rep. 1916, pp. 130-134.

Further analyses, reported[1] in 1917 by Mr. Patterson when examining the Bow Island gas for its helium content, were:—

	Barnwell			Bow Island		
	Well No. 25			Wells 1,2,3, 4,5,6,7,8, 12,13 and 23	No. 22	No. 9 and 10
	(I)	(II)	(III)	(I)	(I)	(I)
		p.c.		p.c.	p.c.	p.c.
Methane	86·2	91·6	87·0	87·6	90·1	89·2
Ethane	4·3	1·9	5·0	0·9	2·6	0·9
Nitrogen (including helium)	9·5	6·5	8·0	11·5	7·3	9·6
Helium	–	0·36	–	0·30	0·33	0·30

Other wells were drilled to the east of the Bow Island field, in township 12, range 13, at Taber, and near Lethbridge but no gas was found.

A number of wells have been drilled at various points on the Canadian Pacific Railway branch line from Medicine Hat to Suffield and Lomond. At Suffield, Alderson, Brooks, and Bassano small flows of gas were encountered, and are supplied to these towns for domestic use and for running gas engines and pumps at railway stations.

The supply from wells of this kind is usually less than five hundred thousand cubic feet a day and is of little importance from a domestic or industrial point of view except to the towns where the wells have been drilled.

The Foremost field

This area is eight miles south of Foremost station, on the Canadian Pacific Railway branch line from Lethbridge to Manyberries. A well drilled to a depth of 3705 feet by the United Oil Wells Ltd., on sec. 31, township 5, range 10, west of the 4th meridian, on the south bank of the Etzikom coulee first showed the possibilities of this region. Unfortunately a heavy flow of salt water drowned out this well.

Recently the Canadian Western Natural Gas, Light, Heat and Power Co., Ltd. put down a well on sec. 1, tp.6, range 11, west of 4th meridian. At a depth of 2180 to 2190 feet a strong flow of gas, reported to amount to 20 million cubic feet a day, was struck. The company is now drilling two other wells a mile to the south, and if, as is expected, equally good flows of gas are struck, a pipe line 40 miles long will be laid to connect this supply with the main pipe line of the company from the Bow Island field to Calgary.

This gas is found in the Dakota formation.

Character of gas. No measurements of the open flow were made when the well was visited. The rock pressure was 650 lbs. per square inch and cylinders were filled at this pressure. No gasoline hydrocarbons would be expected in a gas at this high pressure and no tests for them were made.

The report of the engineers appointed by the Public Utilities Commission of Alberta gives the rock pressure as 660 lbs. per square inch and

[1]Mines Branch Bulletin No. 31, p. 55.

the open flow 15,703,000 cubic feet per 24 hours. At 150 lbs. line pressure the well could flow at the rate of 12,660,000 cubic feet per day. This well is therefore the biggest gasser in Canada so far opened up.

The result of the analysis of the sample collected on October 20th, 1923, was:—

	Per cent
Methane CH_4	94·2
Ethane C_2H_6	0·8
Carbon dioxide CO_2	0·3
Oxygen O_2	0·3
Nitrogen N_2	4·4
Helium content	0·20
Specific gravity	0·610
Calorific value B.Th.U. at 0°C and 760 mm	1018·

The gas is free from odorous sulphur compounds and on account of its high calorific value is a very suitable gas for domestic use.

The Foremost area is undoubtedly a promising field and will be of great value in increasing the supply for Calgary and other towns fed by the Bow Island pipe line.

The Sweet Grass field[1]

Since the discovery of a new oil field in northern Montana, the Kevin Sunburst field, in which many producing oil wells have been drilled, 12 to 18 miles south of Coutts on the International Boundary, there has been great drilling activity in township 1, ranges 14 and 15 west of the 4th meridian. Many companies have commenced drilling during the last two years in the hope that the Kevin Sunburst field may be found to extend into Canada.

The following is a list of the chief companies operating:—

	L.S.D.	Sec.	Tp.	Rg.	Depth drilled up to Oct. 1923
					feet
Boundary Oils, Ltd	1	3	1	15	
Lethbridge Oils, Ltd	1	12	1	15	2040
Border Oil Co	1	6	1	14	2015
Wm. Livingstone	1	4, 11, 24	1	15	
Coutts Sweetgrass Oils, Ltd	1	2	1	15	2900
Oil Lands Exploration Co., Ltd	1	2	1	15	200
Stokes Stephens		22	2	14	
Anglo Indian Oil Co		14	1	15	Commencing
Snake River Oils	4	20	1	14	
Canadian Oil and Gas Co		29	1	11	1360

Two slight showings of oil have been reported but very little gas has been struck, and lately, following the decline of activity in the Sunburst field, many of the companies have suspended operations.

[1]The Geological Survey has commenced a detailed geological investigation in this field. See oil prospects Southern Alberta. M. Y. Williams, Canadian Mining Journal, Nov. 30, 1923, p. 949.

Other wells in the neighbourhood drilled by The North West Co., Ltd., on L.S.D. 6, sec. 5, tp. 1, range 16, west of 4th meridian, have furnished valuable geological information but, so far, have yielded no oil and little gas.

The Turner Valley field

This field, situated in the foothills, in townships 19, 20 and 21, range 2, west of 5th meridian, is the only one in western Canada where oil is being produced commercially at the present time. The Black Diamond field, the Sheep River district, the Dingman field and the Okotoks field, are other names by which this field is known. It lies to the southwest of Calgary and is reached by a good road through Okotoks, a distance of forty miles.

The formations in this neighbourhood are greatly disturbed and faulted and the difficulties of drilling are great. The geology and structural conditions are fully described in Geological Survey Memoir No. 122, Sheep River Gas and Oil Field, by S. E. Slipper.

History. Oil was first discovered in quantity in May 1914 at 2718 feet, in No. 1 Well of the Calgary Petroleum Products, Ltd., and at once a boom started in Calgary which is a vivid memory with many people. The failure to open up a large oil pool and the formation of worthless companies, coincident with the outbreak of war, led to much disappointment and loss of money.

A few companies, The Southern Alberta Oil Co., the Alberta Southern Oil and Refining Co., the Alberta Petroleum Consolidated Oil Co., and the Canada Southern Oil and Refining Co., produced some oil but only the first of these is in commercial operation today. The present production, about twenty barrels a day, is lower than the initial yield and the oil is heavier in character. An analysis is given below.

The chief wells producing gas in this field are:—

	L.S.D.	W. 5th Mer.			Depth	Gas volume cubic feet per day
		Sec.	Tp.	Rg.		
Southern Alberta	18	18	20	2	3575	1,000,000
Illinois-Alberta	14	12	20	3	3038	2,000,000
Royalite No. 1	6	20	20	2	3910	
Royalite No. 3	14—6		20	2	2830	3,000,000
Royalite No. 4	12—7		20	2	2890*	7,000,000

A list of wells drilled in this field and to the east, west, and south of Sheep river, giving the location, structure, depth, quantity of gas and oil found, is given on pp. 31, 32, and 33 of Memoir 122.

*Sept. 12, 1923, still being drilled.

Tests made. The field was visited on two occasions when samples for analysis were collected and tests made for the gasoline content of gas from five wells. The results are tabulated in the following columns:—

Constituents	Royalite Oil Company			Illinois-Alberta		Southern Alberta
	Well No. 1	Well No. 3	Well No. 4	Well No. 1		Well No. 2
	%	%	%	%	%	%
Methane (CH_4)	71·8	67·2	65·9	67·4	74·8*	52·0
Ethane (C_2H_6)	25·9	30·3	24·4	30·0	22·1	45·1
Carbon dioxide (CO_2)	2·1	1·7	1·2	1·0	2·1	1·4
Oxygen (O_2)	0·3	Nil	2·0	0·2	Nil	0·8
Nitrogen (N_2)	0·9	0·8	6·5	1·4	1·0	0·7
Helium (He)		0·06				
Specific gravity	0·70	0·71	0·73	0·72	0·77	0·86
Calorific value B. Th. U. at 0°C and 760 mm.	1274	1280	1156	1276	1201	1392
Gasoline hydrocarbons pints per 1000 cu. ft.		2,2	2·1	1·4		4·0
Open flow 1000 cu. ft.	2,000	3,000	8,000	2,000		800

The production of gasoline in the Turner Valley field. The Royalite Oil Co., in 1921 established a plant for the extraction of gasoline from the gas from wells of the Calgary Petroleum Products Ltd., which they had taken over.

The method used is an absorption process, operated under patents owned by the Hope Natural Gas Co. of Pittsburgh. The absorbing medium is a mineral oil, specific gravity 0·88 - 0·82, through which the gas is passed under pressure, first in spray absorbers and then through cylindrical absorbers. The oil, slightly lowered in gravity by taking up the gasoline hydrocarbons, is then distilled and the gasoline fraction separated. The oil is passed through heat exchangers, and then recirculated. The gas, after being stripped of the gasoline hydrocarbons, is piped through a 6-inch pipe to Okotoks, into the main Bow Island line, to supply Calgary.

The production from No. 4 well lately drilled, will increase the quantity of gas being treated in this plant and augment the Calgary supply. Recently six additional compressors, making twelve in all, have been installed. The pressure of delivery has been raised to about 300 lbs. per square inch at the intake end of the pipe line and the maximum volume that the line will convey at this pressure is about 8,000,000 cubic feet a day.

The production in 1922 was about 400,000 gallons gasoline and 1,250,000,000 cubic feet of gas. The plant is well arranged and efficiently managed.

The Jennings Refining Co., Ltd. This company has recently installed a plant to separate gasoline from gas from the Illinois-Alberta well. A small amount of oil in this well and the oil spray carried by the gas has undoubtedly accounted for the difficulty in getting concordant analyses of its gasoline content. The gas flow, according to recent reports, has increased to three million cubic feet since the measurements were made in September 1923, when it was only about one million. The method

*Analysis of sample collected April 1923.

employed for the recovery of gasoline is the usual absorption process; the gas passes up a tower, packed with special tiles affording a large surface over which the absorbing oil flows. The oil is then distilled and afterwards recirculated through the absorber. The plant had not commenced commercial production when visited, though trial runs were in progress. No arrangements had then been made for the utilization of the gas after the gasoline had been removed.

Analysis of gasoline obtained. A sample of the product obtained in this plant was examined in the oil laboratories of the Fuel Testing Division.

The specifications for aviation gasoline are included for comparison.

	Aviation gasoline	Lab. No. 2595
Specific gravity at 60°F	Less than 0·725	0·692
Colour	Water white	Water white
Water	None	None
Iodine number	Less than 7	4
Acidity	None	None
Sulphur content	Less than 0·01%	Less than 0·01%
Distillation range		
10 per cent must distill between	60–75°C	40% below 75°C
65 per cent must distill below	100°C	79% below 100
End point	150°C	178°C

Analysis by H.McD. Chantler, Jr. Chemist.

The comparison shows that the product contains too great a quantity of the more volatile hydrocarbons and would have to be blended with less volatile naphtha to produce a good fuel.

The gasoline would also require a purification treatment to remove the unpleasant smelling constituents.

The Alberta Southern Oil and Refining Co. This company has a small plant in which the oil obtained each day from the Southern Alberta Oil Co's well No. 1 is distilled. About 20 barrels a day of this oil is blown off into a 60-barrel tank and from there is pumped into a still.

The products obtained are gasoline, which forms about 65 per cent of the crude oil, kerosene about 15 per cent, and fuel oil which makes up the balance.

The following is a report of an analysis made on a sample of the crude oil collected in September:—

FUEL TESTING LABORATORIES

Ottawa, Feb. 29, 1924

REPORT OF ANALYSIS

Crude Oil from Southern Alberta Oil Company's Well,		Laboratory No. 2594 Black Diamond Field.
Specific Gravity of oil at 60°F		0·765
Distillation of oil.		Specific gravity
Fraction	*% Volume*	*at 60°F.*
Light (gasoline) fraction up to 150°C	52·5	0·723
Medium (illuminating) oil 150°—300°C	35·3	0·790
Heavy (lubricating) oil 300°C. up	10·0	0·864

Distillation range 49°C. to 391°C.

R. E. Gilmore (Sgd.)
Superintendent

Analysis by:
H. McD. Chantler, Jr. Chemist.

The Viking field

The Viking field covers townships 48 and 49, ranges 12 and 13, west of 4th meridian. The ten wells so far drilled are near the range line, six miles north of the town of Viking, which is on the main track of the Canadian National railway. The gas field probably extends to the north of Birch lake and leases have been taken up all over this area and for fifty miles to the west along the railway line to Wainwright.

The wells were drilled in 1914 by the Northern Alberta Natural Gas Development Co. but negotiations between this company and the city of Edmonton failed to reach any agreement. In 1923 a new company, the Northwestern Utilities, was formed and a contract to supply gas to the city was made.

Particulars of wells drilled. The following measurements were made by the company's engineer in 1923:—

No.	Location				Depth feet	Rock pres. lbs. per sq. in.	Open-flow M. cu ft. per day.
	L.S.D.	Sec.	Tp.	Rg.			
1	13	24	48	13	2435		9,000
2	5	19	48	12	2373	All	2,700
3	10	25	48	13	2365		5,000
4	3	30	48	12	2343	wells	1,350
5	8	36	48	13	2220		6,286
6	5	6	49	12	2203		7,617
7	1	6	49	12	2215	about	7,000
8	2	18	48	12	2430		2,000
9	8	24	49	13	2340	800	3,250
10	16	29	48	12	2220		3,000

The available supply in the immediate field is calculated to be over sixty billion cubic feet of gas and should be sufficient for many years if it is properly conserved and efficiently used.

Character of gas. The gas is a dry gas, with methane as the chief constituent as the following analyses show. It contains no sulphur compounds and therefore has little or no smell. It has a high calorific value and is of excellent quality for domestic heating and lighting.

Constituents	Mines Branch *1923	Provincial analyst 1919
	Per cent	Per cent
Methane CH_4	92·5	93·3
Ethane C_2H_6	3·5	–
Carbon dioxide CO_2	0·5	0·6
Carbon monoxide CO	–	0·6
Oxygen O_2	0·1	0·4
Nitrogen N_2	3·4	5·0
Sulphuretted hydrogen H_2S	Nil	Nil
Helium He	0·006	
Specific gravity	0·64	
Calorific value B.Th.U. at 0°C and 760 mm	1051	

*Sample taken from well No. 6.

The Edmonton Gas Supply. The pipe line from the Viking field to Edmonton is eighty miles long. Gas from the wells is piped to a central pressure reducing station, where it passes into the main 10-inch pipe line at about 300 lbs. pressure. At Clover Bar, just outside Edmonton, the pressure is again reduced to 20 lbs. per sq. in. and the gas passed into the high pressure belts in the city, from which it enters the supply line at a few ounces pressure.

The cost to consumers will be 46½ cents per thousand cubic feet for the first 60 thousand cubic feet with a reduction to 40 cents for the next 20 thousand cubic feet and a third reduction of 5 cents per thousand cubic feet for each additional 20 thousand cubic feet used, down to a minimum rate of 30 cents.

The Wainwright field

This field, sometimes known as the Irma field, lies between Irma and Wainwright along the Battle river, and near the main line of the Canadian National railway. At present it is attracting much notice because of the recent discovery of oil in No. 2 well of the British Petroleum Company, six miles north of the town of Wainwright. Leases have been taken out over six or seven townships adjoining and north of the railway line and there will be much drilling in this territory next year with the probability that large volumes of natural gas will be released.

The gas sands have been struck at 1700 to 2000 feet and are probably the beds of the Upper Cretaceous formation.

The first well in the neighbourhood was drilled by the Viking Battle Creek Syndicate, in 1920, on sec. 4, tp. 45, range 8, and a big gas flow was struck.

The Imperial Oil Company, subsequently taking over this company's interests, opened up another well, giving five million cubic feet of gas a day. This well has also been the subject of much notice on account of the spectacular display when the water which leaks into it is blown off, together with an oil-water emulsion which is formed.

The wells tested in this field were:

British Petroleum Ltd.

Well No. 1, L.S.D. 1, sec. 36, tp. 45, range 7 west 4th meridian. This well was drilled early in 1923, the gas sands being found at 1683 feet, at 1800 feet and at 2010-2015 feet, and six million cubic feet of gas was reported by the press[1] in May. It was said to be a wet gas containing several pints of gasoline per 1000 cubic feet.

However, when it was examined in September 1923, the flow had decreased to a few hundred thousand cubic feet per day and the well was flooded with water. The gasoline content of the gas was nil.

The analysis of the gas bubbling up through the water gave:—

	Per cent
Methane CH_4	87·3
Ethane C_2H_6	4·4
Carbon dioxide CO_2	0·3
Oxygen O_2	1·0
Nitrogen N_2	7·0
Specific gravity	0·62
Calorific value B.Th.U. at 0°C and 760 mm	1012

[1] Oil and Gas Journal, May 10, p. 48, 1923.

Well No. 2, L.S.D. 13, sec. 30, tp. 45, range 6 west 4th meridian. This well is situated on higher ground, about 200 yds. from Well No. 1. At the time of inspection it had been drilled to 2030 feet with a rotary drill, and the $8\frac{1}{4}$-inch casing was being cemented off for a test. On November 14th oil was struck. The flow was apparently not continuous but the oil was blown off by the gas when it was released periodically. The production was estimated at 60 to 100 barrels a day.

A report of analysis on a sample of this oil follows:—

FUEL TESTING LABORATORIES

Ottawa, March 3rd, 1924

REPORT OF ANALYSIS

Laboratory No. 2609.

Oil from Well No. 2 of British Petroleum Ltd., near Wainwright, Alberta, collected by Mr. C. Dingman.

The 4 oz. sample received consisted of an opaque brownish black emulsion of oil and water carrying a suspension of fine silt.

Approximate composition

Oil	70% Vol.
Water	20% Vol.
Sediment	10% Vol.

Sp. Gr. at 60°F. of oil after water had been separated	0·984
Sp. Gr. at 60°F. of oil filtered from silt	0·948

Distillation of the oil (water separated)	% Vol.	% Wt.
Total oil distillate	84·8	83·4
Coke residue		15·0
Loss by difference		1·6
Sp. Gr. at 60°F. of oil distillate	0·882	

Redistillation of oil distillate (Sp. Gr. 0·882)	% Vol.	Sp. Gr. at 60°F	% Total oil	Volume of original sample
Light oil (crude naphtha) up to 150°C	4·5	0·851	3·8	2·7
Medium oil (illuminants) 150°-300°C	36·6		31·1	21·8
Heavy oil (lubricating stock) 300°C. and up	54·8	0·916	46·5	32·5

Remarks. The sample submitted was too small to allow for determinations showing more than indications of the nature of oil as received and the proportion of light, medium and heavy oil fractions on a very small laboratory scale.

Analysis by: H. McD. Chantler
Jr. Chemist.

(Sgd.) R. E. Gilmore
Superintendent.

Imperial Oil Company.

As already mentioned this company drilled on the Gratton Oil Company's lease on L.S.D. sec. 18, tp. 45, range 7, to a depth of 2205 feet. A heavy gas flow of 10,000,000 cubic feet per day was struck but water was also encountered and proved difficult to case off. A sand at 1892 to 2205 feet gave a little heavy oil, reported as less than a barrel a day. Gas from this well was used in drilling a second well on L.S.D. 2, sec. 14, tp. 45, range 8.

Tests made. The well was visited on October 3rd. A few moments after the valve was opened a quantity of a dark brown heavy fluid shot up to a height of 60 to 80 feet, followed by a stream of water, mud and gas.

After ten or fifteen minutes the well had blown clear and tests for the gasoline content were carried out. Samples for analysis, including some of the heavy brown fluid, were collected. The results were as follows:—

Gas analysis

Constituents	Per cent
Methane CH_4	88·6
Ethane C_2H_6	2·6
Carbon dioxide CO_2	0·3
Oxygen O_2	0·8
Nitrogen N_2	7·7
Helium	0·06
Gasoline content	Nil
Specific gravity	0·61
Calorific value B.Th.U. at 0°C and 760 mm	992

Rock pressure after blowing off one hour 650 lbs. per square inch.

Analysis of dark viscous fluid. The examination was made by Mr. Kohl, chemist of the Fuel Testing Division, Mines Branch.

The report was as follows:—

The sample of black viscous material was contained in a quart sealer. A little greyish mineral matter had settled to the bottom of the jar, covered by water to a depth of about one inch. Above this was a dirty, dark brown emulsion.

The volume of the water was 180 cubic centimetres. The emulsion was drawn off, a measured volume put in a distilling flask and distilled.

The operation was carried out with great difficulty on account of the frothing and bubbling over of the material in the flask.

This treatment separated the water and oil forming the emulsion and the mineral matter suspended in it. A residue of coke remained in the flask after the distillation.

The quantities of these materials were:—

Mineral matter	2·1	per cent by vol.
Water	45·3	" "
Oil	40·0	" "
Petroleum coke	10·4	" "
Specific gravity of oil at 15·5°C	0·878	" "

The oil thus obtained was then redistilled with the following results:—

Temperature	Product	Per cent of initial volume	Per cent of volume of emulsion	Sp. Gr. at 15·5°C
25° — 150°C	(naphtha fraction)	20	8	0·765
150° — 300°C	(illuminating oils)	35	14	0·869
300° — 400°C	(lubricating oils and coke)	45	18	0·934

The quantity of the emulsion that could be obtained from this well is very small.

The Athabaska field

Some exploratory drilling for oil has been carried out in several localities along the Athabaska river. In 1897 the Geological Survey drilled a well on the banks of the Athabaska, two miles above the mouth of the Pelican river. This well encountered a large flow of gas in the Dakota sand at a depth of 800 feet. The well was allowed to blow off for fifteen years before it was finally capped. A few years later two other wells were drilled within a radius of two hundred feet by the Pelican Oil and Gas Company, and at a depth of 800 feet strong flows of gas were struck.

An analysis made on a sample collected in 1916 gave:—

Methane CH_4	83·5 per cent
Carbon dioxide CO_2	1·0 " "
Oxygen O_2	2·9 " "
Nitrogen N_2	12·6 " "

Calorific value, per cubic foot at 60°F and 760 mm..... 850 B.Th.U.

Undoubtedly large reservoirs of gas exist in this area.

Farther down the Athabaska river, especially north of McMurray, a number of wells have been drilled but no oil and little gas has been found.

The Peace River region

During the last ten years there has been spasmodic drilling in the Peace River field chiefly north of the town of Peace River. There have been slight showings of oil, usually a heavy asphaltic petroleum, in some of the wells, but no good gas sands free from heavy flows of water have been struck.

The water conditions cause much trouble in this locality and several drilling rigs have been completely destroyed by rushes of water at high pressure from water sands penetrated without the necessary precautions. Strong flows of gas have been struck in several of the wells drilled and rock pressures of 600 to 700 pounds per square inch are reported but the gas is seldom free from water. Little is known about the character of the gas, or the possibilities of extracting gasoline. The field is near the Edmonton, Dunvegan and British Columbia railway and is perhaps one of the best situated in Alberta for the establishment of carbon black plants if sufficient quantities of gas of a suitable composition can be found.

The chief companies operating are:—

	Location of well			Depth
	Sec.	Tp.	Rg.	
Peace River Oil Co., Ltd	4	85	20	1136
	31	85	21	1119
	24	85	21	1280
Canadian Petroleums Ltd	11	85	21	3000
	23	85	21	
P. M. Oil Co., Ltd	36	83	22	
Tar Island Oil and Gas Co	24	85	21	1087
North Pacific Oil Co	11	85	21	850

The following analyses have been reported:—

	Canadian Petroleums Ltd.,* Well No. 1			Spring on** Tar Island 25 miles below Peace River Crossing
	Sample 1	Sample 2	Sample 3	
Methane	71·6	65·6	73·6	77·2
Higher hydrocarbons	14·1	15·4	16·2	–
Illuminants	0·1	0·1	0·1	–
Carbon dioxide	0·2	0·2	0·3	1·8
Carbon monoxide	0·1	0·0	0·1	–
Oxygen	2·1	3·1	1·2	3·7
Nitrogen	10·3	14·2	7·2	17·3
Sulphuretted hydrogen	1·5	1·4	1·3	–

*Analysis by J. A. Kelso, University of Alberta.
**Fuel Testing Plant, Mines Branch, Ottawa.

Pouce Coupé field

The Imperial Oil Company, in 1922, drilled a well on L.S.D. 7, of sec. 26, tp. 80, range 13, 6th meridian, known as the Pouce Coupé well. This location is west of Peace River and about fifty miles from the railway.

At 1676 feet, 10,000,000 cubic feet of gas was struck. No information is available of its gasoline content or composition. The well after being drilled to 2733 feet was mudded off.

The Northern Alberta Oil Fields, Ltd., is now drilling on sec. 27, tp. 79, range 12, 6th meridian. It is evident that large supplies of gas are available in this neighbourhood.

The Prairie Oils, Ltd., is commencing to drill on L.S.D. 15, sec. 23, tp. 74, range 17, 5th meridian, near High Prairie.

Analysis of Alberta Natural Gas

Field	Well	Analysis						
		Sp. Gr.	CH_4	C_2H_6	CO_2	O_2	N_2	Gasoline gallons per 1000 cu. ft.
Medicine Hat	City Mains	0·56	97·8	0·3	0·4	0·0	1·5	
Many Islands Lake.	Medicine Hat Devel. Co.	0·57	95·6	0·0	0·2	0·1	4·1	
	Can. American Oil Co.	0·58	96·3	0·5	0·5	0·3	2·4	
Bow Island	Pipe line	0·59	91·6		0·0	0·2	8·2	
	Pipe line	0·60	90·3		0·0	0·0	9·7	
	Well No. 22		90·1	2·6	0·0	0·0	7·3	
	Well No. 9 and 10		89·2	0·9	0·0	0·0	9·6	
Barnwell	Well No. 25		86·2	4·3	0·0	0·0	9·5	
Foremost	Well No. 1	0·61	94·2	0·8	0·3	0·3	4·4	
Craigmyle	Ecklin well	0·57	95·4	0·0	0·3	0·0	3·7	
Turner Valley	Southern Alberta well No. 2	0·86	52·0	45·1	1·4	0·8	0·7	0·7
	Illinois Alberta, Well No. 1	0·72	67·4	30·0	1·0	0·2	1·4	0·3
	Royalite Oil Co. Well No. 1	0·70	71·8	25·9	2·1	0·3	0·9	0·2
	Well No. 3	0·71	67·2	30·3	1·7	0·0	0·8	0·3
	Well No. 4	0·73	65·9	24·4	1·2	2·0	6·5	0·2
Viking	Well No. 6	0·64	92·5	3·5	0·5	0·1	3·4	
Wainwright	British Petroleum Well No. 1	0·62	87·3	4·4	0·3	1·0	7·0	
	Imperial Oil Co., Fabyan No. 1	0·61	88·6	2·6	0·3	0·8	7·7	
Athabaska River	Pelican Rapids		83·5		1·0	2·9	12·6	
Peace River	Tar Island Spring	0·67	77·2		1·8	3·7	17·3	

Analyses of Some United States Natural Gases[1]

No.		Analysis						
		B.Th.U. net air free	CH_4	C_2H_6	CO_2	O_2	N_2	Gasoline gallons per 1,000 cu. ft.
3	Pennsylvania	929	75·79	11·33	0·00	0·00	12·00	0·10
7	Oklahoma	1007	71·00	18·54	0·16	0·61	9·82	0·11
10	West Virginia	1010	65·08	22·00	0·24	0·12	12·57	0·22
14	Oklahoma	1116	51·60	37·20	0·25	0·40	10·39	0·24
20	Texas	1136	72·60	25·10	0·12	0·00	2·18	0·40
23	California	1174	54·30	37·65	7·20	0·12	2·80	0·50
25	Oklahoma	1278	43·59	49·78	6·63	0·00	0·00	0·90

[1]Taken from table in U.S. Bureau of Mines Tech. Paper 253, 1920. Effect of gasoline removal on the heating value of natural gas by D. B. Dow.

THE USE OF NATURAL GAS IN ALBERTA

DOMESTIC AND INDUSTRIAL USE

Natural gas is the best fuel known; it has a high calorific value, it is clean to use and leaves no residue; it is easily piped to where it is required; and it can be burned with the maximum of control and efficiency.

The following table[1] shows the quantities and approximate costs in Alberta of other substances which might be used as fuels that have the same heat value as 1,000 cubic feet of natural gas.

Fuel	Amount required to equal calorific value of 1,000 cu. ft. natural gas	Rate per unit	Approximate cost
		$ cts.	$ cts.
Natural gas	1,000 cu. ft.	·50	·50
Manufactured gas	2,000 cu. ft.	1·50	3·00
Electricity	300 Kilowatt hours	1½	4·50
Gasoline	6 gallons	40	2·40
Coal oil	6 gallons	25	1·50
Soft coal	90 lbs.	8·00 ton	0·36

The efficiency obtainable in the use of these fuels is not taken into consideration in this table, though it is probable that most of them are burned with about the same efficiency excepting soft coal from which only about half its available heat is usually obtained. Considering the convenience of using natural gas, it is readily seen that it is the cheapest and best fuel obtainable.

Most of the natural gas at present available in Alberta is used for domestic purposes. It is supplied to all the larger cities—Calgary, Edmonton, Lethbridge, Medicine Hat, and more than half the population of Alberta may benefit from its use.

The chief companies supplying gas to domestic consumers are:—

	Wells at	Cities supplied
City of Medicine Hat	Medicine Hat	Medicine Hat
Dominion Glass Co	Redcliff	Redcliff
Canadian Western Natural Gas Light, Heat and Power Co., Ltd	Bow Island	Calgary
	Monarch	Lethbridge
	Barnwell	Macleod
	Foremost	Nanton
	Turner Valley	Okotoks etc.
North Western Utilities Ltd	Viking	Edmonton
City of Wetaskiwin	Wetaskiwin	Wetaskiwin

To conserve the supply in the best interests of the consumers, attention should be paid to the efficient distribution and use of the natural gas. The chief wastes are caused by leakage in the transmission and distribution of the gas, and inefficient and careless use by the consumer. The first cause of waste can be remedied by the installation of meters at various points in the pipe lines, so that the quantity of gas delivered from the wells

[1]Adapted from table by S. S. Wyer. 31st Annual Report Ontario Dept. of Mines, Vol. XXXI, Pt. V, 1922, p.32.

can be compared with that paid for by the consumers, and if serious discrepancies exist the leak can easily be found and repaired. Some loss in transmitting through a long pipe line is unavoidable and the limit allowed in many parts of the United States is 200,000 cubic feet per annum per mile of 3-inch pipe. This minimum can be secured by efficient management and control. The second great waste can be prevented by educating the consumers by close inspection and regulation[1] of all appliances used, and by keeping the price sufficiently high to prevent unnecessary consumption.

Much thought has been given to this subject in the United States[2] during the last few years, especially in those states where the natural gas supply is waning. The results of the many investigations and the remedies put forward can be applied to forestall similar conditions in Alberta.

Industrial use. It is a well recognised principle that the industrial use of natural gas should only be permitted where the supply is large and the field is proved to be of long life, and where it is certain that the establishment of the industry is of great economic importance to the district. Medicine Hat is the only place where natural gas is being used in this way in Alberta. As already mentioned, several flour mills, the largest glazed pipe factory in western Canada, a pottery, and several smaller plants have been established there, mainly attracted by the advantage of natural gas as a fuel.

The Wainwright field, situated close to the main line of the Canadian National railway, will doubtless attract similar industries in the near future, when more wells are drilled and greater supplies of gas are available.

The other fields, with the exception of those in northern Alberta, should be reserved solely for domestic consumption.

THE POSSIBILITIES OF EXTRACTING GASOLINE

The natural gas gasoline industry has become of considerable importance in the United States. The total output of gasoline in that country in 1921 was approximately 5,498,000,000 gallons of which 8·2 per cent or about 450,000,000 gallons valued at over $61,000,000 was obtained from natural gas. The quantity of natural gas gasoline recovered in Canada is less than 400,000 Imperial gallons, valued at about $85,000. Unfortunately, at present, there is not much prospect of this amount being greatly increased.

Dr. D. B. Dowling, of the Geological Survey, in 1917, examined many of the gases in the older fields. With the exception of the gas in the Turner Valley field, the tests showed that there were no gases in the Medicine Hat, Bow Island or Viking fields that contained gasoline hydrocarbons in commercial quantity.

[1] Wyer, S.S., Natural gas, its production, service, and conservation.
Smithsonian Inst. Bull. 102, part 7, 1918, p.42.
Natural gas manual for the home. R.A. Cattell.
Tech. Paper 325 ,U.S. Bureau of Mines, 1922.
Natural gas in 1919-1921. R. S. McBride and E. G. Sievers.
Mineral Resources of the United States, 1921.
Part II, pp. 335-36. U.S. Geological Survey.
Natural gas in 1921. 31st annual report Ontario Department of Mines, 1922, especially report by Samuel S. Wyer on the situation in Western Ontario, pp. 29-34.

[2] Op. ci

The results obtained in the investigation carried out by the Mines Branch during 1923 confirm the report then made. At many natural gas wells no tests were carried out, because preliminary measurements of the specific gravity and of the rock pressure showed that no gasoline hydrocarbons were likely to be present, a condition afterwards confirmed by the analyses of the gases.

Three gases in the Turner Valley field were found to contain about two pints per 1,000 cubic feet and one approximately four pints; even these would be considered hardly worthy of treatment in the United States. Two plants[1] are established to recover gasoline from these gases, however, both using an oil absorption process.

The existence of gasoline in gases in the Many Islands Lake and Wainwright fields has been reported but the tests made this summer failed to confirm these reports. One of the wells, however, has filled with water and may not have been yielding gas of the same character or from the same sand as that in which several pints of gasoline per 1,000 cubic feet were reported to be present. Further investigations in this field should be made. It cannot be too strongly emphasized that before any capital is invested in the erection or operation of a gasoline extraction plant an exhaustive series of tests of the gases to be treated should be carried out. The possibilities of the establishment of gasoline extraction plants in Alberta are greatly dependent on the possibilities of finding oil. The richest gasoline containing natural gases are those which are found with oil, and oil in abundance has not yet been discovered in western Canada.

THE MANUFACTURE OF CARBON BLACK IN ALBERTA

Carbon black is the fluffy black substance formed by the deposition of the solid products of incomplete combustion of natural gas. It is thus differentiated from other blacks such as lampblack, vine black, ivory black, bone black, acetylene black, etc., which are formed by the combustion of oil or similar hydrocarbons of high molecular weight or of such other carbonaceous materials as the names imply. Each of these blacks has its own specific uses, lampblack for paints and pigments, ivory black for high class varnishes, bone black for decolorizing purposes. With the exception of ivory black, carbon black has the highest average value because of its fineness and intense blackness, properties which make it indispensable in some industries.

The chief demand for carbon black is in the manufacture of printing ink and as a filler in automobile tires and other rubber goods, in which in certain cases it may be mixed in quantities up to 20 per cent of the total weight. The most complete account of the methods of manufacture, composition, properties and uses of carbon black yet published, is given in the U.S. Bureau of Mines Bulletin 192, by R. O. Neal and G. St. J. Perrott.

The usual type of plant consists of long, steel frame buildings covered with sheet iron. In these sheds the gas is burned at hundreds of small steatite burners set in rows of pipe. The draughts are carefully controlled and the products of incomplete combustion deposited on parallel

[1] A more detailed description of these plants is given in the section on the Turner Valley field, p. 14.

sheet iron trays or channels set above the burners. These channels slowly move back and forward. Scrapers are arranged so that the carbon black is automatically removed from the channels, dropped into hoppers beneath and transported by screw conveyers to packing houses where it is bolted and packed in paper sacks.

The process is very inefficient, an average of about one pound of carbon black being formed from the combustion of 1,000 cubic feet of gas, while the theoretical yield is about forty pounds. But no process giving a higher yield of the same high quality of black has yet been devised.

It is due to this inefficiency that the process is looked upon with disfavour and regarded as a wasteful use of natural gas, but the product is so indispensable to the printing and newspaper publishing industries that it is difficult to prohibit its manufacture and no satisfactory substitute for it has yet been found.

Imports. The imports of all forms of blacks into Canada during the last three years were as follows:—

		Twelve months ending March		
		1921	1922	1923
From—				
United Kingdom	Lb.	73,070	3,856	12,128
	$	10,951	501	1,304
United States	Lb.	3,444,416	2,296,984	708,660
	$	445,470	256,551	443,932
Other countries	Lb.		12,300	22,621
	$		1,621	1,576
Total		3,567,486	2,313,140	3,743,409
	$	456,421	258,673	446,812

There is no import duty on any form of black.

It is probable that carbon black importations constitute at least three quarters of these quantities and certainly account for more than half of the values. Great Britain imports 8,000,000 to 10,000,000 lbs. of carbon black, principally from America. The European countries also take large quantities and Japan and China are becoming large consumers.

Canadian market. There are about twenty plants manufacturing rubber goods in Ontario and Quebec in which probably two-thirds of the carbon black imported into Canada is used. Most of these plants are situated in or near Toronto.

The rubber industry does not require as high a grade of material as the printing ink manufacturers, the chief requirement being freedom from grit. The present price for carload lots is from 10 to 12 cents per pound, f.o.b. Louisiana.

The freight rate is about one to one and a half cents per lb.

The printing and lithographic ink manufacturers use between a half and one million pounds a year, these requirements covering a number of grades, the prices of which range from 15-35 cents a pound. In addition there are between thirty and forty manufacturers of japans and varnishes

chiefly located in Toronto and Montreal, many of whom require quantities of gas black. Carbon paper and typewriter ribbon manufacturers in Toronto and Montreal also use a considerable quantity of the finer grades of carbon black.

It is evident therefore that if two or three plants were established in Canada, they could find a ready market for their product if they could compete in price with manufacturers in the United States.

Freight charges. The freight charges constitute one of the chief items of cost that must be taken into account by any company considering the establishment of a carbon black plant in western Canada.

Carbon black is usually shipped in paper bags. The standard bag contains 12½ pounds and is 21 inches long, 11 inches wide and 8 inches thick. Frequently the bags are compressed, when they are reduced in volume by thirty or forty per cent. The usual carload consists of 1600 bags weighing about 20,000 lbs. The rates in the United States are fourth class in carload lots or first class in less than carload lots.

The chief producing centres in Louisiana are about 1500 miles from Toronto, and the freight rate is from one to one and a half cents per pound. The Peace River district, probably the most favourable location for a plant in Canada, is about 2,300 miles from Toronto. There is no provision for gas or carbon black in the Canadian class rates but assuming it to be classed with lampblack the rate from the west to Toronto would be about $3.50 or $3 per hundred pounds.

Under present conditions, the industry would therefore be under the handicap of an extra freight cost of two cents, besides the extra capital charges for the freight on plant and equipment.

Factors governing location of plant. There are several factors which enter into the choice of a location for the establishment of a carbon black plant. They may be summarized as follows.

1. At least five million cubic feet a day of cheap gas should be available, and there should be good evidence in favour of a long life for the field.

2. The gas should be relatively rich in ethane. It has been found that the higher the ethane and higher hydrocarbon content the greater the yield of carbon black as shown by the following table.[1]

Carbon content and quantity of carbon black recovered:—

	A Louisiana	B West Virginia	C West Virginia	D Wyoming
Methane (a) p.c.	94·12	70·75	65·23	46·45
Ethane, p.c.	3·44	24·14	30·07	43·10
Carbon dioxide	·50	·28	1·56	·96
Nitrogen, p.c.	1·94	4·83	3·14	9·49
Heating value (b)	962	1,086	1,134	1,176
Carbon per 1,000 cu.ft. of gas (c) Lb.	33·8	39·9	42·3	44·3
Carbon black per 1,000 cu.ft. of gas reported obtained	·80	1·00	1·10	1·40
Per cent recovery	2·4	2·5	2·6	3·1

(a) Analyses were made by D. B. Dow, junior chemist of Bartlesville station, United States Bureau of Mines.
(b) Net heating value in B.Th.U. per cubic foot at 0°C, and 760 mm. pressure.
(c) Calculated from carbon content of methane and ethane.

[1] U.S. Bureau of Mines Bulletin No. 192, p. 12.

3. There should be reasonably good transportation facilities by railway or by water. The materials for the construction of the plant have to be brought in and the product though not particularly bulky must be shipped out regularly. This can not be done profitably except by railway or barge.

4. There should be no immediately prospective demand for the gas by domestic consumers.

Possible locations in Alberta

When the various gas fields in Alberta are regarded in the light of the preceding paragraph it is at once apparent that there are only four areas which can be considered, with the possible exception of one or two areas where shallow wells may provide for local production. The four are the Many Island Lake field, the Wainwright field, and the two areas in northern Alberta, Athabaska River and the Peace River. All the other fields are now used to supply domestic requirements or will soon be utilized for that purpose.

Many Island Lake field. Although comparatively small amounts of gas are immediately available in this field, large supplies exist, which will be soon opened up in the search for oil in that neighbourhood. The gas from the sands so far struck is of poor quality for the production of carbon black, and contains little or no gasoline, therefore the yield would be small. Transportation facilities in this field are good. On the other hand the field is only forty miles from Medicine Hat, whose supply is showing signs of depletion.

It is most probable that in a few years, gas from the Many Islands field will be required to supplement the Medicine Hat supply.

Wainwright field. In this field also the present available supply is comparatively small. Much gas exists however in the sands and many large flows will be struck during the activity that is bound to result from the recent announcement of the discovery of oil in the neighbourhood. There are no cities or towns where the gas is required and consequently no prospect of a domestic demand for many years, Edmonton being assured of a supply for a long period from the Viking field. If the gas is not used for the purpose there is bound to be much waste, unless drilling in this area is restricted and carefully regulated. This part of the country is sparsely settled and not as suitable for wheat growing as many parts of Alberta. Over 100 square miles immediately south of the gas field forms the Canadian National Park buffalo reserve. The gas at present available is mostly methane and would not give very high yields of carbon black. Neither would it warrant the erection of a plant for the extraction of gasoline, though richer gases may presently be found.

The field is close to the main line of the Canadian National railway and transportation facilities would be good.

If the establishment of a carbon black plant or plants in this field is economically possible, many people consider there are no valid arguments to be advanced against it from the point of view of conservation.

The Craigmyle field. This area lies about thirty miles northeast of Drumheller, in the Hand Hills district, covering tp. 32, range 17, W. 4th meridian.

There have been a number of shallow wells drilled in the district, notably at Castor and on the Ecklin farm near Delia, and in most of these wells small flows of gas are encountered.

The Prairie Natural Gas Company plans to manufacture carbon black near Craigmyle, but in September 1923 the only well drilled had the small flow of 40,000 cubic feet per day. An analysis of the gas is given in the table following. The territory is unproved and it is doubtful if sufficient gas can be found to warrant the erection of a plant large enough to be a commercial success.

There would be no considerable domestic demand for gas in this field. If large supplies can be found, the question of using some of the gas for the manufacture of carbon black must be considered.

The Canadian National railway runs through this district and the roads are good.

The Peace River region. A large amount of gas is available in this district, though drilling is difficult on account of the water conditions, and there is danger of flooding the gas sands unless great care is exercised. Insufficient analyses have been made to make a statement on the suitability of the gas for the manufacture of carbon black or for gasoline extraction. No argument for conserving the gas for future domestic use can be reasonably advanced.

The great drawback to the location of a plant in this field is the difficulty and high cost of transportation. It is connected by the Edmonton, Dunvegan and British Columbia railway with Edmonton, a distance of 312 miles. It should be repeated that the freight charges on the product from Peace River to the east or to the coast would be an important item in the costs, so long as the price of carbon black from the United States remains at the present level.

The Pelican Rapids field. Although little information exists of the quality and quantity of the gas available in the Pelican Rapids field, every condition would seem favourable for the location of a plant except the difficulty of transportation. It is even greater than in the Peace River field, as the only means would be by barge on Peace river. The distance to Athabaska Landing, the nearest railway point, is about 100 miles, and from there to Edmonton about another 100 miles. The river is navigable for a few months in the year only, on account of low water and ice.

The quality of the natural gas available. It has been found from experience in the United States that the most suitable natural gases for the manufacture of carbon black are those with a high ethane content.

As the following analyses show, the gases so far available in Canadian fields where plants might be established, are low in ethane and the higher hydrocarbons. This does not mean that no carbon black could be obtained from them, but rather that the yields would be relatively small.

Typical analyses from the following fields are:—

	Many Islands		Wainwright		Craigmyle	Peace River	Pelican Rapids
Methane	95·6	96·3	87·3	88·6	95·4	77·2	83·5
Ethane	Nil	0·5	4·5	2·6	Nil		
Carbon dioxide	0·2	0·5	0·3	0·3	0·3	1·8	1·0
Oxygen	0·1	0·3	1·0	0·8	Nil	3·7	2·9
Nitrogen	4·1	2·4	7·0	7·7	3·7	17·3	12·6
Specific gravity	0·57	0·58	0·62	0·61	0·57	0·67	
Calorific value	1017	1074	1012	992	1016	785	850
Gasoline content pints per 1000 cu.ft.	Nil	Nil	Trace	Nil	Nil		

Regulations governing the use of natural gas for the manufacture of carbon black. Regulations governing the use of natural gas for the manufacture of carbon black have been recently issued. The main points in these regulations are that the permission of the Minister of the Interior must be obtained for the gas to be so used, that gasoline if present in commercial amount must first be extracted, and that if any or all of the gas is subsequently required for domestic consumption that demand must first be supplied at a rate to be fixed by arbitration.

The general regulations under which natural gas leases may be granted, the carbon black regulations and all necessary information relating to such matters can be obtained from the Deputy Minister, Department of the Interior.

HELIUM FROM NATURAL GAS

The commercial production of helium during the later stage of the war, a substance that in 1916 was almost a scientific curiosity and of which only a few cubic feet were in existence in scientific laboratories in Europe, is one of the many recent spectacular achievements of scientists.

Helium is a light non-inflammable gas which is a most valuable substitute for hydrogen for the inflation of the gas bags of airships. The inflammability of hydrogen and the explosive nature of its mixture with air was, to mention only a few recent accidents, the cause of destruction of the U.S. airships Roma, the U.S. Z.R. 2, in England, the British airship R. 34, and the French dirigible Dixmude.

The story of the early development and later large scale production of helium in Canada and the United States has been frequently related. The most recent achievement in the United States was the inflation of the U.S. airship Shenandoah with helium and its survival after being blown from its mooring mast in a heavy gale.

Helium is also of great importance to the scientist because of its relation to the phenomenon of radioactivity and the part it plays in modern theories of the structure of matter.

The results of a survey of the helium resources of the British Empire, carried out in 1916-1917 under the direction of Prof. J. C. McLennan of the University of Toronto, have already been published by the Department of Mines, Mines Branch Bull. No. 31. This survey showed that the Bow Island natural gas field in Alberta was the best source for the commercial production of helium in Canada.

Several natural gases in Ontario contained as large a per cent of helium, but the supplies available were small and the difficulties of extraction considerably greater.

A small experimental plant was built at Calgary in December 1919 and operated for four months. About 60,000 cubic feet of helium of varying degrees of purity were separated in experimental runs and from the experience gained a large scale plant was designed. Lack of means prevented the continuation of this investigation. Since that time no further work on the separation of helium has been carried out, although research on the liquefaction and solidification of this gas is being most successfully followed at the University of Toronto.

Progress in the production of helium in the United States. Much greater progress has been made in the United States chiefly owing to the large resources of helium available but also to their belief in the value of the development of the dirigible balloon. More than five million dollars have been spent on this work, and a similar sum will probably be available for future work. The two plants built during the war have been shut down, but a third, based on the design of the better of these has produced several million cubic feet of 95 per cent pure helium. The United States Bureau of Mines is actively engaged in perfecting a new process, in building repurification plants at airship stations and in carrying out many scientific investigations relative to helium.

The helium resources of the United States. A complete survey has been made of all the natural gas fields in the United States. The results of this extensive survey show that helium is a common constituent in small amounts of many gases, although relatively few samples contained more than 0·5 per cent, which the Bureau of Mines considers to be the minimum amount to justify commercial operation. It was shown that over 500,000,000 cubic feet of helium were going to waste annually, and that of this amount 50,000,000 cubic feet could be readily extracted, if plants were available.

Helium in Alberta

The chief gas fields in Alberta are the Medicine Hat area, the Bow Island field, the Turner Valley field and the Viking and Wainwright fields. Samples of gas from the chief wells in these areas were examined for their helium content in 1916 and 1923 with the following results. Analyses of a few of the chief helium bearing gases in the United States are added for comparison.

Alberta

Field	Well	Depth of gas sand in feet	Open flow M. cu. ft. per day	Helium content per cent
Medicine Hat	Cousins and Sissons	1075	3,000	0·13
	Central Park	1300	3,000	0·11
	Electric Park	1300	3,000	0·12
	C. P. R.	1020		0·11
Many Islands Lake	Canadian American	1350	500	0·07*
Bow Island	No. 4	1879	2,000	0·29
	Nos. 3,11 and 14	2200—2500	3,000	0·29
	No. 16	2218		0·34
	Nos. 9 and 10	1910	2,300	0·30
	No. 22	2151	538	0·33
	Barnwell, No. 25	2166	1,000	0·36
Turner Valley	Dingman	400—800		0·03
	Dingman	3900	3,000	0·01
	Royalite No. 3	2830	3,000	0·06*
Foremost	No. 1	2180	15,000	0·20*
Viking	No. 9 (?)	2300	3,000	0·05
	No. 6	2203	7,617	0·07*
Wainwright	Imperial Gratton No. 1	2205	10,000	0·09*
Athabaska River	Pelican River			0·002
Peace River	Tar Island Spring			0·10

United States

Eldorado	Butler Co., Kansas mean of 19.	900		1·12
Augusta	Butler Co., mean of 13	1200		1·01
	Butler Co., mean of 2	450—650		2·04
	Butler Co., mean of 2	1200—1400		1·09
	Butler Co., mean of 22	1200—1500		0·43
Petrolea	Clay Co., Texas	1500—1750		0·93

*Tested in 1923. Others in 1916.

These figures show the lower helium content of the Alberta gases. Extensive investigation has shown in the United States that the gases from the shallower sands are usually richest in helium and that gases of low thermal value, high in nitrogen (20-40 per cent), usually have a higher helium content than those having a lower nitrogen percentage, although the presence of much nitrogen is not always an indication of helium. So far as known no gas of this character has ever been found in Alberta, though it must be said that little attention has been paid to the small flows of gas which have been struck at shallow depths in several of the fields.

Another factor that may be of importance is the difference in the geological ages of the formations in which the gas deposits are found. Most of the gases in the United States are found in formations of the Pennsylvanian (Carboniferous) age, while the gas sands in Alberta belong to the Cretaceous age, and are therefore much younger. Several gases in the United States, known to come from formations of the Cretaceous age, have a low helium content like the Alberta gases.

The Bow Island field. It has often been stated in the newspapers that ten million cubic feet of helium escape annually from the chimneys in Calgary alone. This is not correct today, however true it may have been ten years ago.

The Bow Island field in the last few years has been fast declining and in the future it is likely to be drawn upon only in winter to supplement gas now obtained from the Turner Valley, and soon to be obtained from the Foremost field south of Bow Island.

The original open flow of the Bow Island field was 75,000,000 cubic feet in 1913. Today it is about 17,000,000 and the rock pressure has declined from 800 to 210 lbs. per square inch. The daily capacity of the field when gas is passed into the pipe line at 60 lbs. pressure is about 12,000,000 cubic feet. Probably this amount could not be taken out for more than six months of the year, on account of water encroachment, if the pressure is greatly lowered. Taking the mean helium content as 0·30 and assuming the high efficiency of 80 per cent obtainable in the extraction process the quantity of helium recoverable would now be under six million cubic feet per annum.

The original experimental plant established by the British Admiralty under the direction of Prof. J. C. McLennan of the University of Toronto was put up in Calgary in 1919. As already stated, Calgary is now supplied with a mixture of gases from the Turner Valley field, the Chin Coulee field and the Bow Island field, much of which has a low helium content. A more suitable location today for an extraction plant would be in the Bow Island field itself. The early experiments showed that the recovery of helium is possible from a low percentage helium gas, and the estimates of the cost in a large scale plant based on experience gained from the experimental plant were $50 per 1000 cubic feet of 95 per cent pure helium. In the opinion of engineers with practical experience of commercial production in the United States this figure is too low.

The Foremost field. A well recently drilled to a depth of 2190 feet which opened up a flow of over 15,000,000 cubic feet a day has proved the presence of a large gas reservoir at Foremost, forty miles south of Bow Island.

Other wells now being drilled give promise of providing a large quantity of gas, which will be available for Calgary and the other cities supplied from the Bow Island pipe line. A sample of the gas from No. 1 well recently tested, contained 0·20 per cent helium. This gas was probably from the main gas sands at 2181-2191 feet. It was not possible to make a test of the gas which was encountered at 1068 feet. If the other wells now being drilled give as large flows as No. 1 well, a conservative estimate of the gas available per day, piped at 100 lbs. pressure would be 20,000,000 cubic feet and the helium recoverable, allowing an 80 per cent efficiency in extraction, would amount to about 30,000 cubic feet per day, or about ten million cubic feet annually.

The difficulties of recovering helium from a gas containing as low a percentage as 0·2 would be great and the cost might prove prohibitive, valuable as helium undoubtedly will become if the development of commercial airships now projected in Great Britain is carried out. In time of war it would be indispensable.

Other gas fields in Alberta. Preliminary investigations so far made have not brought to light any other Canadian gases which might be sources of helium. As already pointed out, previous examinations have been of a more or less hurried character to meet the requirements of the hour. Additional and more intensive investigations may bring to light natural gases containing larger amounts of helium, especially in view of the activity in the Wainwright area, and in the practically undeveloped gas fields in the north, at Pouce Coupé, along the Peace river and in the Athabaska area.

Summary. The two fields, Bow Island and Foremost, might yield from ten to fifteen million cubic feet of helium a year if an efficient process was developed to treat gases with the low helium content of 0·3 to 0·2 per cent. The cost might be estimated at $50 to $100 per 1000 cubic feet.

The recovery of the helium now going to waste in Alberta would seem to be a true measure of conservation and of the greatest importance to the empire even in face of the present great need for economy and restriction of public expenditure. No private corporation could be expected to engage in such an enterprise and it is a work entirely for the state to develop.