ANALYSES OF CANADIAN CRUDE OILS, NAPHTHAS, SHALE OIL, AND BITUMEN

P. V. ROSEWARNE, H. McD. CHANTLER, AND A. A. SWINNERTON

SER
622(21)
C212r

MINES BRANCH
DEPARTMENT OF MINES
OTTAWA
1936

NO. 765

SER
622(21)
C212r

CANADA
DEPARTMENT OF MINES
HON. T. A. CRERAR, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

MINES BRANCH
JOHN MCLEISH, DIRECTOR

Analyses of Canadian Crude Oils, Naphthas, Shale Oil, and Bitumen

BY

P. V. Rosewarne, H. McD. Chantler, and A. A. Swinnerton

OTTAWA
J. O. PATENAUDE, I.S.O.
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1936

Price, 10 cents

No. 765

CONTENTS

TABLES

ILLUSTRATIONS

Photographs

Drawings

PREFACE

By R. E. Gilmore

The analysis survey of Canadian crude petroleum oils, naphthas, shale oil, and bitumen reported herewith was conducted by technical officers of the Division of Fuels and Fuel Testing to supplement field work on petroleum, natural gas, shale oil, and bitumen. The officials of the Department of the Interior, of the provincial governments of Ontario and Alberta, and of the oil companies mentioned in the acknowledgments, co-operated in the collection of the samples. The crude oil samples were collected mostly during the four-year period 1927 to 1930, and the Turner Valley naphthas during the years 1929 to 1932.

As a result of increasing interest in petroleum developments in Canada, and of many outstanding improvements in the technology of petroleum refining during recent years, it was decided that the information on crude oils from the various producing fields in Canada that had been accumulated at the Fuel Research Laboratories should be compiled for publication. The present report, containing a comprehensive reference list in addition to the make-up outlined in the introduction, greatly augments previous published information on Canadian crude oils.

The details of the Hempel and Engler distillations are reported in Tables I and II. These tables, together with a map of Canada showing the location of the oil fields from which the samples originated, are to be found in the pocket attached to the back cover page. The yields of the gasoline-naphtha, kerosene, gas oil, and the non-viscous lubricating oil distillates obtained by the Hempel method, introduced and employed by the U. S. Bureau of Mines for the comparison of crude oils, are considered to approximate fairly closely the average refinery yields by straight run distillation. However, this does not apply to the medium and viscous lub-distillates, and inasmuch as refinery practice is not standardized, the laboratory yields of products are to be accepted as comparative only. Pressure cracking technique to increase the yield of motor fuel varies considerably in different refineries, and both the yield and quality of the lubricating oil products depend on the nature of the crude, and on the refiners' equipment and skill.

As is to be expected, the Canadian crude oils resemble the crude oils found in the northern part of the United States. The crude oils from Gaspe in eastern Quebec and from Stony Creek in New Brunswick are similar to those from Pennsylvania; the oils from southwestern Ontario are similar to those from Ohio; and the light crudes from Alberta, which are characterized by a high percentage of gasoline and naphtha, are similar to those from certain Montana and Wyoming fields. A classification according to base, together with a more comprehenisve comparison of the base and of the different distillates from typical oils from Canada and the United States, is given on pages 11 and 12, and in Table VI.

The weathered naphthas from the Turner Valley field, it is to be noted, are crude gasolines and are considered separately from the crude oils from this and other fields in Alberta. The crude shale oil was obtained by destructive distillation of oil shale from New Brunswick and Nova Scotia, and apparently the method of distillation has an effect on the type, or character, of the recovered oil. The bitumen separated from the bituminous sands of northern Alberta contains practically no light oils, in which respect it resembles Trinidad asphalt. Distillation of it in the laboratory yielded a distillate boiling at high temperature and a large proportion of residuum. The crude bitumen is quite amenable to pressure cracking and hydrogenation for the production of high yields of motor fuel.

The present annual production of crude oil and naphtha in Canada is nearly one and a half million barrels, which represents only about three per cent of the annual consumption. This means that, except for a small area in Alberta, which produces nearly 90 per cent of the total, Canada is at present dependent almost wholly on imported crude oil for its motor fuel and other petroleum products. The discovery of new productive oil fields in Canada would tend to decrease this dependence. The enormous deposits of bituminous sands in Alberta and of oil shale in the Maritime Provinces are highly valuable potential sources of oil. When increased crude oil prices in this country direct serious attention to a domestic supply of motor fuel and associated oil products from raw material other than crude petroleum from wells, they will become attractive for commercial development.

Analyses of Canadian Crude Oils, Naphthas, Shale Oil, and Bitumen

INTRODUCTION

This report contains the detailed analyses of one hundred and forty-three samples of crude oil from Canadian sources, a short description of the methods employed for their examination, an interpretation of the results obtained, and a comparison of a typical oil from each field with oils from other fields. In addition, the report gives some brief statistics of the petroleum industry in Canada, a short description of the main producing oil fields, a summary of the production from each field during recent years, and an outline map of Canada showing the location of the different fields and the samples that were obtained from them.

The writers wish to express their thanks for much valuable assistance in the field during the collection of the samples. Special mention should be made of: Col. R. B. Harkness, Commissioner of Petroleum and Natural Gas for Ontario; W. Calder, Director of Petroleum and Natural Gas Division of the Department of Lands, Forests, and Mines for Alberta; C. C. Ross, formerly Supervisory Mining Engineer for the Department of the Interior; T. G. Madgwick and C. W. Dingman, formerly of the Office of the Supervisory Mining Engineer; A. Crichton and R. H. Findlater, of the New Brunswick Gas and Oilfields, Limited. To these, to those companies and individuals who supplied samples and information, and to all others who helped in the work, grateful acknowledgment is made.

STATISTICS OF THE PETROLEUM INDUSTRY

Statistics concerning the petroleum industry in Canada are compiled by the Dominion Bureau of Statistics,[1, 2] and reports thereon are prepared and published by the Mining, Metallurgical, and Chemical Branch of the Bureau. These reports cover production, imports, exports, value of products, costs, labour, etc., and copies may be obtained on application to the Bureau.

For convenience of reference the production of crude oil in Canada by fields has been compiled from these reports for the years from 1929 to 1934, and is shown in Table A. A curve showing the total production in Canada from 1880 to 1934, and also that of the provinces of Ontario and Alberta, is given in Figure 1.

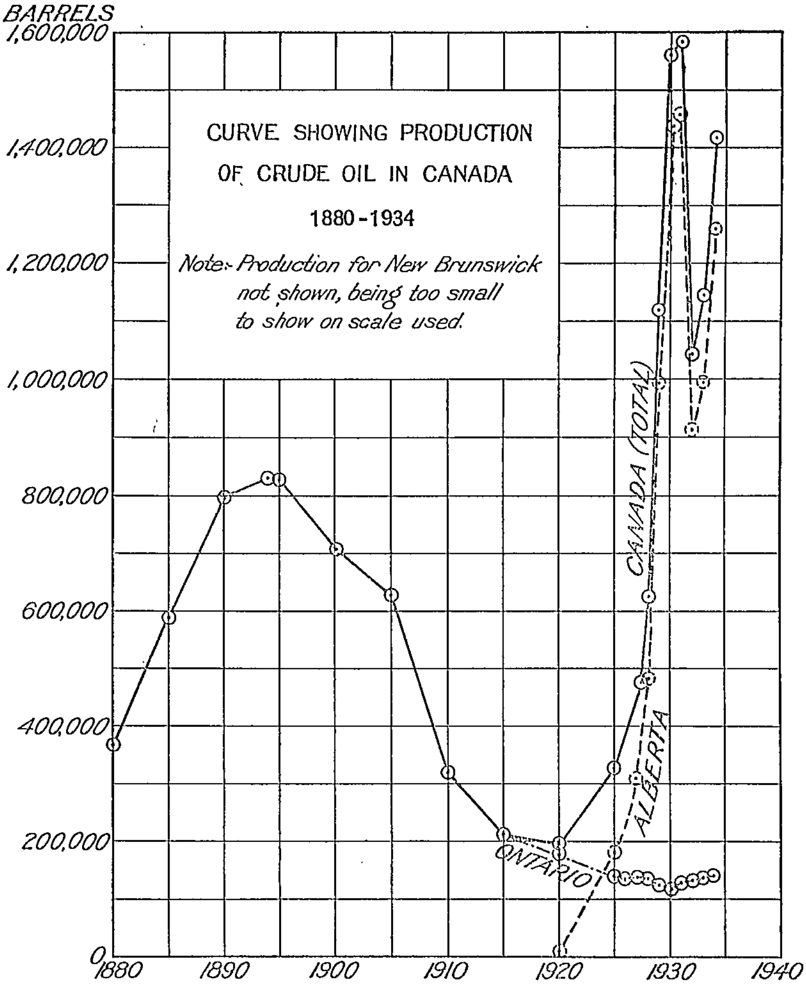


Figure 1. Curve showing production of crude oil in Canada, 1880 to 1934.

TABLE A

Production of Crude Oil in Canada, Calendar Years 1929 to 1934

(Barrels of 35 Imperial gallons)

Field	1929	1930	1931	1932	1933	1934[1]
ALBERTA—						
Turner Valley..........	971,821	1,340,428	1,334,039	868,812	968,055	1,227,486
*Wainwright............	14,093	57,732	15,392	4,683	4,472	12,189
**Red Coulee and Skiff...	2,761		64,200	33,256	23,305	20,325
	988,675	1,398,160	1,413,631	906,751	995,832	1,260,000
ONTARIO—						
†Petrolia.................	56,284	55,126	57,515	58,871	57,298	55,924
Oil Springs..............	30,789	29,160	30,792	31,438	31,343	29,863
Bothwell tp.............	23,236	21,177	18,024	19,460	22,935	32,133
Mosa tp.................	6,851	7,166	8,517	8,429	8,168	9,031
††Dawn tp................	....	....	121	5,557	8,589	4,169
All others...............	4,034	4,673	7,396	6,588	7,725	10,265
	121,194	117,302	122,365	130,343	136,058	141,385
NEW BRUNSWICK—						
Stony Creek............	7,499	6,758	6,577	6,408	8,835	11,545
NORTHWEST TERRITORIES—						
Fort Norman...........	....	....	....	910	4,608	4,438
CANADA...........	1,117,368	1,522,220	1,542,573	1,044,412	1,145,333	1,417,368

[1] The 1934 data are subject to revision.

† Includes Enniskillen tp. †† Includes Euphemia tp.

* Includes Ribstone from 1929 to 1932, and Keho in 1933-1934. ** Includes Fuego from 1929 to 1931.

METHODS USED FOR EXAMINATION OF THE SAMPLES

The characteristics of the samples of crude oil that were determined included specific gravity, colour, viscosity, pour point, cloud test, calorific value, sulphur content, distillation range, and carbon residue. The methods of analysis that were used to determine these properties are stated below and, as far as possible, reference is made to the publication in which the method is described in detail.

The *specific gravity* of the oils was determined by the Chainomatic Specific Gravity Balance at room temperature and corrected to 60° F. The equivalent on the gravity scale of the American Petroleum Institute, which is in general use in the petroleum industry[3] is also given.

The *colour* of the oils that were transparent was determined by the Union colorimeter according to method D155-23T of the American Society for Testing Materials.[4] For oils that were opaque the apparent colour by reflected light is stated.

Viscosity was determined in the standard Saybolt viscosimeter[4, 5] at 100° F. and also at 70° F., if the oil was reasonably fluid at that temperature. The pipette viscosimeter was used for those fractions that were too small to be used in the Saybolt instrument.

The *pour point* was determined according to method D97-27T of the American Society for Testing Materials[4, 5], which consists briefly of cooling the oil slowly in a 4-ounce sample bottle and noting the temperature at which the oil does not flow when the bottle is held in a horizontal position for 5 seconds.

The *cloud test* was also determined according to method D97-27T of the American Society for Testing Materials[4, 5] and consists essentially of gradually cooling the oil and noting the temperature at which crystals of paraffin begin to appear.

The *calorific value* was determined in an Emerson bomb calorimeter using oxygen at 600 pounds pressure.

The *sulphur content* was determined by oxidizing the oil with sodium peroxide in a Parr calorimeter bomb, precipitating the sulphate with barium chloride, and calculating the amount of sulphur present from the weight of barium sulphate obtained.

The *carbon residue* determination was made by heating a part of the residuum of the distillation in such a way as to drive off and burn all the volatile matter. The weight of the solid carbonaceous residue was determined and calculated as a percentage of the original sample.

The *distillation range of the crude oils* was determined by the Engler method, and by the modified Hempel method advocated by the United States Bureau of Mines[6]. By this latter method about 300 c.c. of the sample of crude oil is distilled at atmospheric pressure till the temperature rises to 275° C., and the pressure is then reduced to 40 mm. in order to avoid cracking the heavier fractions. The distillation under reduced pressure is continued till a temperature of 300° C. is reached. Cuts are made at every 25° C. increase in temperature, and these fractions are examined separately.

The determination of the distillation range by the Engler method consists in distilling 100 c.c. of the sample from a glass flask of 125 c.c. capacity, and recording the temperature at which successive fractions of the distillate are recovered in the receiver. The fractions are not separated but are all bulked together.

The *distillation range of crude naphthas* was determined according to method D216-30[7] of the American Society for Testing Materials. By this method 100 c.c. of the sample are distilled from a suitable glass flask and a record made of the rise in temperature as successive fractions are recovered. The method is similar to the Engler, or to the approved method for gasoline, except that the receiver is surrounded by an ice bath in order to minimize loss through evaporation of the lighter constituents during the distillation.

Fractionation of Crude Condensate and Naphtha

In addition to the distillation range, a few samples were subjected to a fractional distillation in a Podbielniak column in order to show the relative amounts of the lighter hydrocarbons present.

The Podbielniak fractionation column for the distillation of liquids is similar in appearance to the columns used for the fractionation of natural gas[8, 9, 10] except that the distillation bulb is larger and the sample to be tested is admitted in a different manner. The apparatus consists of a fractionation tube for liquids, with attachments for admitting and withdrawing the sample, a thermocouple and millivoltmeter for indicating the temperature of the distillation, a receiver for the distillate, a vacuum pump, two manometers, one for indicating the pressure in the distilling tube and one for indicating the pressure in the receiver. The distillation is made at reduced pressure and the distillate is not condensed but is measured in the vapour phase by its vapour pressure in a closed receiver of known capacity. A diagram of the apparatus is shown in Figure 2.

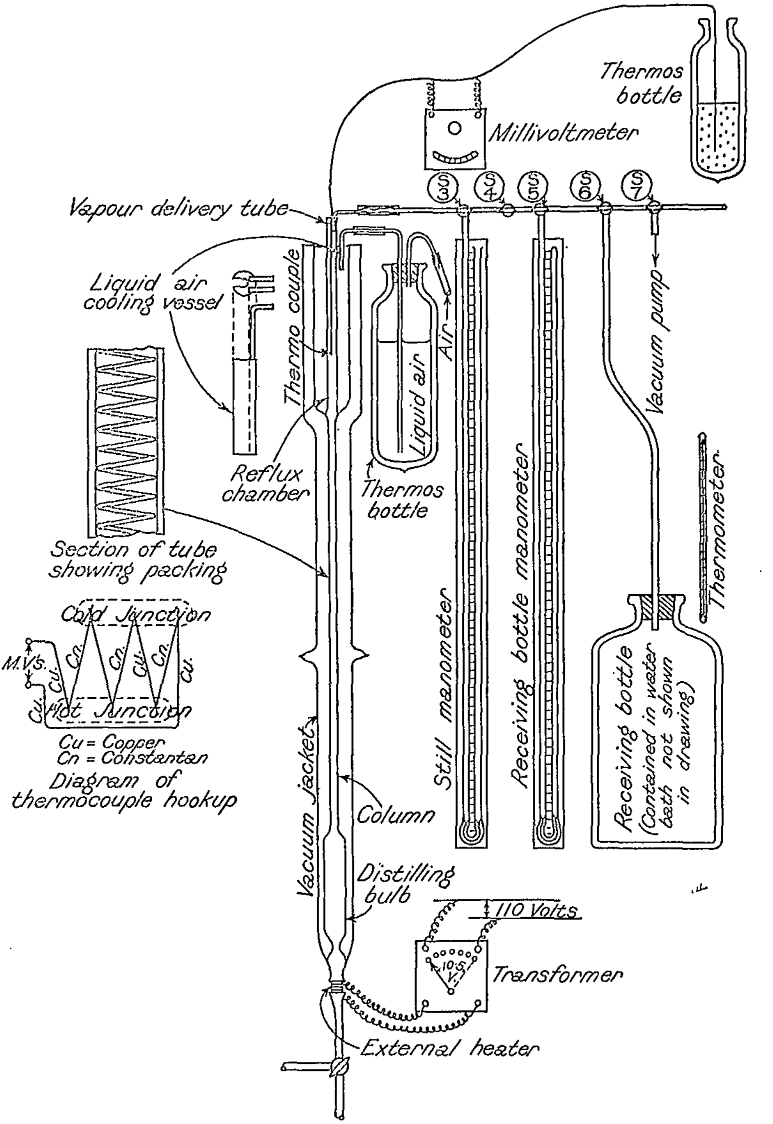


Figure 2. Apparatus for fractional distillation analysis of natural gas gasoline.

Procedure for Fractionating a Liquid Sample. The entire apparatus is first evacuated and tested to make sure that there are no air leaks, the upper reflux chamber is cooled with the refrigerant,—in this case liquid air was used—and the sample container connected to the inlet tube*. When the sample being analysed is relatively stable at normal atmospheric pressures, the valves can then be carefully opened and a portion of the sample admitted to the distillation bulb without trouble. However, when the sample is so volatile that it must be taken and kept under considerable pressure, precautions must be taken to avoid too sudden an opening of the valve and a consequent wrecking of the apparatus. After the sample is admitted, the rate of distillation is regulated by adjusting the heat input at the distillation bulb and the cooling of the reflux chamber so that a slow and steady stream of vapour is fractionated and admitted to the receiver for measurement. When it becomes necessary to re-evacuate the receiver, the distillation is checked by increasing the amount of reflux and maintaining the increased rate until the receiver is pumped out after which the fractionation may be continued. It is necessary to maintain low pressures in the receiver system in order to prevent a partial condensation of the distillate that would interfere with the measurement.

Difficulty has been experienced in fractionating some samples owing to the presence of water or of paraffin wax in the sample. It was found possible to remove water by allowing the sample to stand in contact with anhydrous calcium chloride before being admitted to the distilling tube. Very volatile samples were dehydrated by the same method in a specially designed bomb into which the sample was introduced without the pressure on the sample being materially reduced. No remedy has so far been found for trouble with wax. The wax crystallizes out on the spiral wire packing in the fractionation tube and interferes with the reflux liquid so that flooding occurs. It is possible that the use of a refrigerant having a boiling point not so low as that of liquid air might avoid some of the difficulty.

The analyses shown in Tables IV and V indicate that the apparatus and method used give results that are in satisfactory agreement. Also, from the same tables it will be observed that from time to time the composition of the product of some of the wells varies considerably, that is, the results obtained from samples collected from the same well at different times vary more than is indicated by the experimental error of the apparatus and method.

The term "crude naphtha" is used in Turner Valley in a general way, and has been so used in the discussion above. However, there are two types of liquid involved; one, a very volatile material that must be handled under pressure to avoid loss of some of the constituents, and the other a relatively stable liquid at ordinary atmospheric pressures. The former is the liquid which is collected in the separators in the field under pressure, and the latter is the residue of the same liquid after the pressure has been reduced to atmospheric and the liquid has been exposed to the

---

*In some of the earlier samples trouble was experienced in transferring a portion of the sample from the sampling tube to the distillation bulb. Rubber connexions were found to slip off too easily and finally were replaced with a metal connexion using asbestos cord as packing in a gland nut. This was found to be entirely satisfactory but great care had to be taken in joining the tubes to avoid breaking the glass parts of the apparatus.

TABLE III

Residues from Weathered Turner Valley Naphthas †

Sample No.	Well	Well pressure	Separator pressure	Weathering, Nat. or Art.	Degrees A.P.I.	Sp. gr. 60° F.	Distillation Range													
							First drop	5 %	10 %	20 %	30 %	40 %	50 %	60 %	70 %	80 %	90 %	95 %	End point	Recovery, %
		pounds per sq. inch						°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	
69	Advance No. 5A.	500	265	Artificial....	63·7	0·725	88	121	139	164	181	198	212	230	254	296	401	......	468	98·0
70	“ No. 5A.	750–770	300	“	....	....	*85	104	115	138	153	171	189	209	235	281	......	......	471	93·0
71	“ No. 5A.	....	....	Nat. and Art.	....	....	*85	108	117	133	151	168	185	204	227	264	404	......	459	94·0
72	“ No. 5A.	1,150	270	Artificial....	58·7	0·744	106	148	166	186	202	217	234	250	273	308	404	......	462	99·5
73	“ No. 5A.	1,150	300	“	61·8	0·732	100	124	152	172	192	208	223	239	259	290	374	......	438	99·2
74	“ No. 5A.	....	....	Nat. and Art.	68·1	0·709	85	112	124	142	160	178	194	212	232	264	336	......	420	98·2
75	Dalhousie No. 7.	960	300	Artificial....	72·1	0·695	86	105	116	130	144	158	174	190	206	230	270	312	322	97·3
76	“ No. 7.	....	....	Nat. and Art.	73·0	0·692	82	104	115	130	144	159	174	190	206	228	264	313	333	98·0
77	East Crest No. 3.	1,160	185	Artificial....	76·6	0·680	82	96	103	114	124	136	150	164	180	202	242	......	321	97·4
78	“ No. 3.	....	....	Nat. and Art.	73·9	0·689	84	101	110	124	138	153	168	186	205	251	274	331	343	97·0
79	Foothills No. 1..	1,200	280–300	Artificial....	66·7	0·714	83	107	117	135	152	170	187	207	227	256	308	......	380	96·6
80	“ No. 1..	....	....	Nat. and Art.	69·5	0·704	90	109	121	141	158	175	194	212	236	263	322	......	386	96·4
81	Home No. 4.....	625	300	Artificial....	....	....	*79	105	118	139	154	169	183	198	214	235	315	......	344	94·5
82	“ No. 4.....	....	....	Nat. and Art.	....	....	*83	109	121	141	156	171	183	197	213	229	273	......	313	95·5
83	Lowery Pet. No. 1	665	300	Artificial....	70·1	0·702	84	109	120	142	158	174	190	205	218	240	286	......	336	96·4
84	“ No. 1	665	300	“	70·4	0·701	86	110	122	141	158	174	188	201	218	238	286	......	330	96·3
85	“ No. 1	675	300	“	70·6	0·700	86	114	126	144	160	177	192	206	220	240	279	......	327	96·0
86	“ No. 1	....	....	Nat. and Art.	68·9	0·706	86	118	131	151	167	180	195	208	223	242	274	......	336	97·0
87	Mayland No. 6.	1,080	280	Artificial....	74·2	0·688	81	100	109	125	139	154	170	189	207	231	284	......	335	96·1
88	“ No. 6.	....	....	Nat. and Art.	74·5	0·687	81	98	107	122	138	154	168	186	204	229	277	......	334	96·0
89	Merland No. 1...	1,700	250	Artificial....	70·1	0·702	86	103	113	130	148	168	188	208	234	268	328	......	378	97·3
90	“ No. 1...	....	....	Nat. and Art.	73·0	0·692	86	105	115	130	144	158	175	191	210	234	277	......	355	96·1
91	Mercury No. 1..	1,200	285	Artificial....	70·9	0·699	88	116	122	139	151	164	181	197	217	232	279	327	350	97·2
92	“ No. 1..	1,200	265	“	72·4	0·694	83	104	113	127	141	156	171	189	206	228	268	308	334	97·6
93	“ No. 1..	....	....	Nat. and Art.	69·2	0·705	90	122	138	153	162	172	192	212	234	265	320	394	396	97·3
94	Mercury No. 2..	1,180	250	Artificial....	70·6	0·700	82	105	116	134	150	165	181	200	221	246	293	344	370	98·4
95	“ No. 2..	....	....	Nat. and Art.	73·0	0·692	81	104	114	130	146	163	180	198	218	244	295	360	363	96·6
96	Miracle No. 1...	1,220	250	Artificial....	69·6	0·707	92	110	123	136	152	169	189	208	229	261	327	......	342	97·0
97	“ No. 1...	....	....	Nat. and Art.	73·3	0·691	81	102	110	126	141	157	175	194	214	240	298	348	361	97·2
98	Model No. 1....	600	90	Artificial....	53·5	0·765	96	125	140	178	209	240	276	323	398	484	......	......	501	99·5
99	“ No. 1....	700	200±	“	54·0	0·763	97	120	142	177	210	244	284	338	423	......	......	......	470	98·0
100	“ No. 1....	....	....	Nat. and Art.	53·5	0·765	94	125	146	182	213	245	282	334	418	......	......	......	494	98·2
101	“ No. 1....	800	195±	Artificial....	55·4	0·757	92	124	144	176	210	244	286	336	432	......	......	......	496	96·4
102	“ No. 1....	900	300	“	55·9	0·755	87	113	134	170	202	240	277	334	418	......	......	......	480	96·4
103	“ No. 1....	1,000	300±	“	56·9	0·751	86	114	131	162	194	225	259	304	382	......	......	......	458	97·5
104	“ No. 1....	....	....	Nat. and Art.	54·9	0·759	88	123	142	175	206	237	278	326	406	......	......	......	492	96·0
105	“ No. 1....	1,100	250	Artificial....	55·2	0·758	111	130	147	178	200	238	263	314	406	540	......	......	582	93·5
106	Okalta No. 1....	815	200	“	70·1	0·702	85	110	122	144	160	178	192	208	225	251	298	......	366	96·5
107	“ No. 1....	....	....	Nat. and Art.	70·6	0·700	88	112	124	143	158	172	186	200	216	255	284	318	329	98·0
108	Richfield No. 1..	870	230	Artificial....	70·4	0·701	86	110	123	142	159	174	189	204	221	245	290	......	328	95·0
109	“ No. 1..	....	....	Nat. and Art.	71·8	0·696	81	107	118	135	148	163	180	194	210	228	262	......	326	96·8
110	Royalite No. 23..	850	300	Artificial....	71·8	0·696	84	106	116	133	149	164	181	197	216	240	293	......	352	96·3
111	“ No. 23..	....	....	Nat. and Art.	73·9	0·698	91	102	116	132	147	160	177	190	206	239	269	325	348	97·8
112	Sterling Pac. No. 2	1,520	270	Artificial....	70·1	0·702	86	101	112	126	146	166	187	209	236	280	331	......	385	96·5
113	“ No. 2	....	....	Nat. and Art.	70·9	0·699	84	101	113	130	147	167	189	209	234	267	338	......	401	96·5
114	Structure No. 1..	1,010±	220±	Artificial....	....	....	*89	123	139	161	178	193	208	223	243	266	318	......	366	95·0
115	“ No. 1..	....	....	Nat. and Art.	....	....	*87	109	120	135	150	167	181	196	214	238	293	......	335	95·0
116	Wellington No. 1.	700	200	Artificial....	70·9	0·699	89	112	124	142	156	170	184	196	210	226	256	310	316	97·0
117	“ No. 1.	....	....	Nat. and Art.	69·5	0·704	90	117	129	144	161	176	189	202	216	233	265	308	334	97·9

† All samples were collected in 1932.

* Distillations were made at Turner Valley. Temperatures shown are corrected for difference in barometric pressure between Turner Valley and Ottawa.

open air for an indefinite time. In some cases the storage tanks are fitted with steam coils in order to hasten or to control the evaporation of the more volatile constituents. This process is known as "weathering" irrespective of whether the evaporation is assisted by artificial heating or not. In order to avoid confusion in this report, the writers have used the term "crude naphtha" to designate the weathered product only, and have selected the term "crude condensate" to indicate the total liquid collected in the separator under pressure before it is weathered.

RESULTS OF ANALYSES

The results of the analyses are given in tabular form. Table I (in pocket) shows the origin of the samples and the general characteristics of the crude oils as received, the results of the Hempel distillation, the analytical data obtained from the examination of the separate fractions, and a summary calculated from these results showing the approximate amount of gasoline, kerosene, gas oil, lubricating distillate, and residue that may be expected from each sample. The specific gravity of the fractions and the carbon residue of the residuum are also given. In addition, the samples are classified as paraffin-, intermediate-, hybrid-, or naphthene-base crude oils. Table II (also in pocket) shows the results of an ordinary Engler distillation of each sample at atmospheric pressure, which results have been included in this report so that the samples may be conveniently compared with others reported throughout the literature in that way. Tables III, IV, and V show the results obtained by distillation of samples of naphtha and crude condensate produced at Turner Valley in Alberta.

TABLE IV

Fractionation of Naphthas

Sample No.	Name and No. of well	Description of sample	Date sampled	Methane (plus), %	Ethane, %	Propane, %	Butanes, %	Pentanes (plus), %
129	Composite........	Imperial Refinery, Calgary	9–13–29	......	......	2·4	10·0	87·6
130	"	Duplicate analysis test....	9–13–29	......	......	2·2	10·1	87·7
131	"	Storage tank, Turner Valley	10–16–29	......	......	2·0	8·8	89·2
132	"	From Stabilizer Plant....	9–19–30	......	......	1·8	5·1	93·2
133	Lowery Pet. No.1	After weathering..........	8–24–31	......	......	1·6	10·6	87·8
134	"	"	9– 5–31	0·2	0·5	4·3	12·1	83·1
135	"	"	9–25–31	0·1	0·3	4·6	15·6	79·4
136	"	"	9–25–31	0·1	0·2	5·1	14·0	80·5
137	McDougall-Segur No. 2	"	9–27–30	......	......	2·2	13·7	84·1
138	"	"	9–12–30	......	0·9	4·1	16·3	78·7
139	Royalite No. 6..	Before steaming	9–19–30	......	0·2	1·8	7·7	90·3
140	" 6..	After steaming	9–19–30	......	......	0·7	9·6	89·7
141	" 23..	After weathering	9–24–32	0·2	0·1	1·9	8·8	89·0
142	Ster.-Pac. No. 2..	"	9–24–32	......	......	4·6	17·6	77·9

TABLE V

Fractionation of Condensates

Sample No.	Name and No. of well	Date sampled	Methane (plus), %	Ethane, %	Propane, %	Butanes, %	Pentanes (plus), %	Index book	Sample mark
118	Brit. Dom. No. 3....	11- 2-31	Wax present					11201a	
119	Lowery Pet. No. 1...	8-25-31	2·1	2·9	6·3	13·2	75·7	....	2A
120	" " ..	9-10-31	1·6	3·2	6·9	16·6	71·7	10714B	3A
121	Model No. 1.........	11- 2-31	0·6	1·6	4·5	9·0	84·3	11203	....
122	Royalite No. 14.....	11- 2-31	Wax present					11201b	....
123	" No. 17.....	9-17-30	4·1	4·4	9·4	16·6	65·5	8098	3003
124	" No. 17.....	9-17-30	4·2	4·6	9·7	17·3	64·3	8098	3003
125	" No. 19.....	9-17-30	5·1	4·8	10·8	17·9	61·4	8100	3005
126	" No. 23.....	9-17-30	0·2	2·5	9·0	18·0	70·3	8099	3004
127	" No. 23.....	9-17-30	3·0	4·8	9·7	20·3	62·2	8099	3004
128	" No. 23.....	9-24-32	4·5	3·4	5·6	11·7	75·0	11333	....

INTERPRETATION OF RESULTS

The physical characteristics of a crude oil are shown by the specific gravity, colour, pour point, and viscosity. The specific gravity of a crude has usually been accepted as a fair measure of its quality, and this is justified to a certain extent insofar as a crude oil having a low specific gravity (high A.P.I. gravity) generally yields large proportions of gasoline, and has a low viscosity which indicates ease in handling, providing the pour point is not too high. In the early days of the petroleum industry when production was limited to a few fields yielding crudes of known quality, the specific gravity was used as an indication of the sources of the crude, but it is not so valuable an indicator today, as, owing to the large number of producing fields and the complexity of their products, the identity of a crude cannot be established by specific gravity alone. The colour of a crude ranges from very light yellow to brownish black by transmitted light. The darker coloured ones are rather opaque and the colour by reflected light is generally reported, e.g. green, dark green, brown, or brownish black. The pour point of a crude indicates to some extent how it will behave in transportation or storage. Oils with pour points higher than 50° F. are likely to solidify in storage tanks and pipe lines in cold weather. The viscosity of a crude oil indicates its general character, as oils having large amounts of asphalt in solution, or that are deficient in low boiling fractions, have high viscosities.

Chemically, crude oils consist of a complex mixture of hydrocarbons with a small amount of inorganic material, which may or may not be combined with the hydrocarbon molecule. The paraffins and naphthenes are the principal hydrocarbons present. A comparatively small amount of aromatic compounds is present also. The relative proportions of these three classes of hydrocarbons vary rather widely when crude petroleums from different fields are compared. Sulphur is an objectionable impurity in a crude oil from a refinery standpoint, as the amount of this element present and the way it is combined, determine to a large extent the corrosive properties of the crude and the ease, or difficulty, with which it may be refined to a satisfactory commercial product. The total sulphur content is usually determined rather than the amount of the different sulphur compounds, and as their corrosive properties vary greatly, the total sulphur determination indicates the corrosive properties only in a general way. For instance 0·3 per cent total sulphur in an oil would not be considered unduly high if the sulphur compound were not highly corrosive, but 0·3 per cent total sulphur in another oil would be considered a "high sulphur" crude if it were corrosive. It has been noticed that crude oils having a large amount of asphalt in solution usually contain the highest percentage of sulphur.

CLASSIFICATION OF THE DISTILLATES

A crude oil is separated into commercial products mainly by means of distillation and it is therefore logical that the distillation range of a crude is the most important laboratory determination. The difficulty is that, although a laboratory method may be devised which will compare favourably with a cycle of operations in any particular refinery, it is impossible, owing to variations in refinery practice, to adopt one that will absolutely parallel the results of actual operations in all refineries. The modified Hempel method of distillation, advocated by the United States Bureau of Mines,[6] was selected as the most suitable for the examination of the samples reported herewith, since it facilitates a comparison of these samples with a large number of different crude oils produced and tested[11] in the United States, and also since it furnishes a more satisfactory summary in terms of commercial products than does the older Engler method. As has been stated above, the samples which are the basis of this report have been distilled by the Engler method also and the results included in order to serve as a basis of comparison with others examined and reported in that way.

The summary of the modified Hempel distillation method indicates a percentage of different products which may be obtained and are classified as follows:—

1. Light gasoline.
2. Total gasoline and naphtha.
3. Kerosene distillate.
4. Gas oil.
5. Non-viscous distillate.
6. Medium lubricating distillate.
7. Viscous lubricating distillate.

The above nomenclature is not suggested as the only possible one, nor perhaps as that most desirable, but it has been adopted by the United States Bureau of Mines in its reports and has been followed here in order to avoid ambiguity in comparing results. The reader will, of course, modify it to conform as far as possible with local practice.

It is perhaps advisable to add a few words of explanation and comment regarding the different fractions shown in the summaries.

Light Gasoline. The total percentage of all fractions distilling below 212° F. (100° C.), is reported as light gasoline.

Total Gasoline and Naphtha. The total percentage of all fractions distilling at atmospheric pressure below 392° F. (200° C.), is reported as total gasoline and naphtha if no fraction in this range has a gravity heavier than 40° A.P.I. (specific gravity 0·825). Fractions boiling below 392° F. and having gravities heavier than 40° A.P.I. are classed as gas oils. The total gasoline and naphtha percentage obtained as above approximates that of a fraction having a maximum boiling point, or "end point", of

419° F. (215° C.), when redistilled alone. The average end point of the gasoline sold in Canada during 1934 was 395° F.[12] Consequently the percentage of total gasoline and naphtha obtained from the Hempel distillation of a crude oil corresponds fairly closely with the percentage of untreated gasoline that could be obtained from it by straight distillation without cracking.

Kerosene Distillate. The total percentage of all fractions distilling at atmospheric pressure between 392° F. (200° C.) and 527° F. (275° C.), and having gravities lighter than 40° A.P.I. (specific gravity 0·825), is reported as kerosene distillate. This is believed to be fairly in accord with the average refinery yield. It is, of course, possible by careful fractionation to increase or decrease the refinery yield of kerosene to meet the demands of the market to a certain extent.

Gas Oil Fraction. The total percentage of all fractions distilling at atmospheric pressure below 527° F. (275° C.), and having gravities heavier than 40° A.P.I. (specific gravity 0·825), together with all vacuum distillates having viscosities less than 50 seconds at 100° F. by Saybolt Universal viscosimeter is reported as gas oil. This percentage is believed to be equivalent to the average refinery yield. It is from this fraction that the lighter grades of fuel oil are prepared.

Non-viscous Lubricating Distillate. All fractions having viscosities between 50 and 100 seconds at 100° F. by the Saybolt Universal viscosimeter are reported as non-viscous distillates. This percentage also is believed to be equivalent to the average refinery yield.

Medium Lubricating Distillate. All fractions having viscosities between 100 and 200 seconds at 100° F. by the Saybolt Universal viscosimeter are reported as medium lubricating distillates. The percentage of medium and viscous lubricating distillates is more or less an arbitrary one and is not thought to approximate average refinery yields, as a great deal depends on the presence or absence of waxes of different types, the kind of refinery equipment available, and particularly the refiner's skill in the manufacture of lubricating oils.

Viscous Lubricating Distillate. All fractions having viscosities greater than 200 seconds at 100° F. by the Saybolt Universal viscosimeter are reported as viscous lubricating distillate. As has been stated above this is a more or less arbitrary distinction.

The percentages of the three lubricating distillates described above are calculated by plotting the gravities and viscosities of the individual fractions separately against "volume-sum percentages" and noting where the 50-second, 100-second, and 200-second points on the viscosity curve intercept the volume-sum percentage co-ordinate. The gravities corresponding to these intercepts give the gravity ranges of the distillates.

A few additional figures are included in the summary. The "total distillate" is self-explanatory. After the distillation of a crude oil a certain amount of "residuum" is left in the flask. The "carbon residue", or "fixed carbon", of this residuum is of interest as it indicates roughly the presence or absence of asphalt. Oils with high carbon residues are usually considered less desirable for refining than lubricating stock, and crudes containing large amounts of sulphur generally have high carbon residues. The figure for the carbon residue of the crude is obtained by multiplying the carbon residue of the residuum by the percentage of residuum and dividing by 100. Most crudes contain so much volatile matter that it would be almost an impossibility to make this determination on the original crude oil, consequently a calculated figure is included in the summary. It is generally assumed that the carbon residue of the crude is roughly proportional to the percentage of asphalt dissolved in the crudes, the conversion factor used being 2·5, i.e. the carbon residue of the crude multiplied by 2·5 equals the percentage of asphalt.

THE BASE OF A CRUDE OIL

In describing a crude oil, reference is often made to the base of the oil, as, for instance, "paraffin-base", "asphaltic- or naphthene-base", "intermediate-base", and "hybrid-base". In the early days of the petroleum industry crude oils were grouped in this way and the terms are still used. Most of the oils which were discovered first in the United States deposited a waxy material, paraffin wax, when slowly cooled and were therefore called paraffin-base oils; others however contained no wax but did contain asphaltic materials, and came to be known as asphaltic-base oils. Other oils were found which contained neither paraffin wax nor asphalt although in other respects they resembled the crude which had come to be called asphaltic-base oils. It appeared therefore that the term asphaltic-base was somewhat of a misnomer and the term naphthene-base came into use as being a more correct and descriptive name for these oils. Other oils were found that partook of the character of both the paraffin and naphthenic groups and are usually classed as intermediate-base crudes. These intermediate-base oils more closely resemble the paraffin-base type than the naphthene type. There appears to be a fourth type which resembles a true naphthene-base crude except that it contains a small amount of paraffin wax and to this type the term hybrid base has been applied.

Several methods may be used for determining the base of a crude oil from the analytical data, but one of the simplest is as follows[13]: If the gravity of the fraction distilling between 482° F. and 527° F. (250-275° C.), at atmospheric pressure is lighter than 40° A.P.I. (specific gravity 0·825), the crude can be considered to be a definite paraffin-base oil. If the gravity of this fraction is between 33° and 40° A.P.I. the oil is an intermediate base crude, and if the gravity is heavier than 33° A.P.I. it may be either a naphthene- or hybrid-base. The cloud point of the fraction distilling between 527° F. and 572° F. (275-300° C.), at 40 mm. pressure is useful in supplementing the conclusions reached from the gravity determinations. If the cloud point of the above fraction is below 5° F. it indicates that little or no wax is present and that the oil can be classed as a naphthene-base crude. If the cloud point is above 5° F., wax is present and the oil may be either paraffin-, intermediate-, or hybrid-base. As explained above the gravity of the 482-527° F. fraction at atmospheric pressure serves to differentiate between these three classes.

Most crude oils can be easily assigned to one or other of the four classes by means of the above method, but some oils are found which lack either the light or the heavy end of a normal crude oil. Oils that lack the heavy ends are found in many parts of the world but the production is relatively small. The crude naphtha produced in Turner Valley may be considered as falling into this class. Another class of oil of peculiar interest to Canadians is heavy oils from which the light ends have evaporated. The bituminous, or "tar", sand deposits of northern Alberta are an example of this type of crude petroleum. Such oils are hard to classify definitely as the 482-527° F. fraction at atmospheric pressure is generally missing. A study of the gravity and viscosity curves of the distillates obtained under a pressure of 40 mm., together with the presence or absence of wax, can usually be relied upon to assign these crudes to their proper class.

COMPARISON OF TYPICAL CRUDE OILS

The heavy oil produced in Stony Creek field resembles very closely some of the oils from Pennsylvania and West Virginia[11] as is shown in Table VI in which the analysis of a typical Pennsylvania oil is included. In 1929 when deepening one of the older wells in this field a light oil was struck which was quite different from the heavy oil previously obtained. Two grades of oil are also recognized[20] in the Gaspe field, the lighter of which resembles the heavy oil from Stony Creek, except that it contains larger proportions of gasoline, naphtha, and kerosene distillates. The heavy oil from the Gaspe field is considerably heavier and seems to resemble the oils of Ontario except that it is deficient in the lighter fractions. The Ontario crude oils are similar to crude oil from the Lima field[11] in the state of Ohio with which they are generally compared, the main difference being the higher sulphur content of the Ontario crudes. This applies to oil from the Petrolia, Oil Springs, Bothwell, and Glencoe fields.

Three different classes of petroleum products are recognized in Alberta and the Northwest Territories, and have been classified arbitrarily by gravity. Oil of 60° A.P.I. (specific gravity 0·739), or lighter, is called naphtha; oil between 59·9° A.P.I. and 30° A.P.I. (specific gravity 0·876), is called light crude; and oil of 29·9° A.P.I. or heavier is called heavy crude. This classification was adopted by the Supervisory Mining Engineer's Branch of the Department of the Interior and by the Petroleum and Natural Gas Division of the province of Alberta. The greater part of the production from Turner Valley field is accordingly classified as naphtha. The remainder is a light crude obtained from oil sands above the limestone. The oil from Red Coulee and Fort Norman is also classed as light crude, whereas that from Wainwright, Ribstone, and Skiff fields is classed as heavy crude oil. Specific difference in the character of these oils is apparent from the results given in Table VI.

The character of the oil obtained from shale depends to a large extent upon the manner in which it is recovered as is shown by the results of the analysis of oil obtained from an externally heated retort and an internally heated one. The oil obtained from the bituminous sand deposits is quite distinct from any other oil produced in Canada.

DESCRIPTION OF THE OIL FIELDS IN CANADA

Petroleum has been found in Canada in the provinces of New Brunswick, Quebec, Ontario, Alberta, and in the Northwest Territories. The history and geology of the fields have been covered in considerable detail by reports published by the Mines Branch,[14,15,16] and by the Geological

TABLE VI

Comparison of Typical Crude Oils

—	Colour	Gravity, 60° F.		Sul-phur, % by wt.	Saybolt† viscosity, sec.	Pour point, °F.	B.T.U. per pound	Gasoline and naphtha			Kerosene distillate			Gas oil distillate			Non-viscous lub. distillate			Medium lub. distillate			Viscous lub. distillate			Residuum, % by weight	Petroleum base
								Per cent by vol.	Gravity, 60° F.		Per cent by vol.	Gravity, 60° F.		Per cent by vol.	Gravity, 60° F.		Per cent by vol.	Gravity, 60° F.		Per cent by vol.	Gravity, 60° F.		Per cent by vol.	Gravity, 60° F.			
		Specific	A.P.I.°						Specific	A.P.I.°		Specific	A.P.I.°		Specific	A.P.I.°		Specific	A.P.I.°		Specific	A.P.I.°		Specific	A.P.I.°		
Stony Creek—																											
Light oil..........	Light red........	0·751	56·9	0·06	31	Below 5	....	76·2	0·728	62·9	6·4	0·795	43·8	2·3	0·824	40·2	3·2	0·850	35·0	1·4	0·873	30·6	......	....	......	7·1	Paraffin.
Heavy oil..........	Dark green......	0·839	37·1	0·08	127	Below 0	19,550	18·5	0·732	61·8	13·4	0·797	46·0	9·0	0·822	40·6	12·1	0·843	36·4	5·2	0·860	33·0	......	....	......	39·9	Paraffin.
Pennsylvania.......	Dark red........	0·817	41·7	0·19	62	30	....	23·8	0·736	60·8	16·8	0·792	47·2	11·5	0·828	39·4	17·8	0·845	36·0	2·0	0·858	33·4	......	....	......	25·1	Paraffin.
Gaspe—																											
Light oil..........	Amber...........	0·800	45·4	0·07	42	30	19,550	37·5	0·738	60·2	22·4	0·796	46·3	11·0	0·825	40·0	12·5	0·845	36·0	3·6	0·860	33·0	......	....	......	12·0	Paraffin.
Heavy oil..........	Dark green......	0·884	28·6	......	227	55	....	1·5	0·784	49·0	8·6	0·812	42·8	26·8	0·840	37·0	19·8	0·867	31·7	11·7	0·886	28·2	2·7	0·894	26·8	28·5	Intermediate.
Oil Springs.........	Brownish green...	0·845	36·0	0·71	71	Below 0	19,240	26·9	0·752	56·7	18·1	0·814	42·3	8·5	0·843	36·4	11·3	0·859	33·2	8·2	0·876	30·0	......	....	......	25·5	Paraffin.
Lima (**Ohio**)........	Dark green......	0·835	38·0	0·55	50	Below 5	....	31·0	0·749	57·4	19·2	0·815	42·1	12·0	0·846	35·8	7·6	0·870	31·1	6·5	0·889	27·7	......	....	......	20·7	Paraffin.
Petrolia............	Brownish green...	0·855	34·0	0·82	104	5	19,290	22·8	0·755	55·9	10·3	0·812	42·8	14·7	0·835	38·0	11·5	0·861	32·8	6·6	0·880	29·3	......	....	......	34·0	Intermediate.
Bothwell...........	Greenish black...	0·837	37·3	0·91	64	Below 0	....	27·3	....	......	18·7	....	......	10·5	....	......	12·3	....	......	7·5	....	......	......	....	......	22·9	Paraffin.
Turner Valley—																											
Light oil..........	Dark red........	0·758	55·2	0·15	30	Below 0	....	74·2	0·737	60·5	9·4	0·809	43·4	7·2	0·842	36·6	3·1	0·878	29·7	1·3	0·905	24·9	......	....	......	2·9	Intermediate.
Wainwright.........	Brownish black...	0·945	18·2	......	1,476	Below 0	....	9·2	0·786	48·5	......	....	......	21·6	0·860	33·0	10·8	0·900	25·7	5·7	0·918	22·6	7·1	0·927	21·1	43·9	Hybrid.
Ribstone...........	Brownish black...	0·981	12·7	......	4,170	Below 5	....	......	....	......	......	....	......	25·1	0·869	31·3	9·1	0·906	24·7	7·5	0·922	22·0	11·5	0·938	19·4	42·8	Hybrid.
Skiff..............	Brownish black...	0·939	19·2	2·82	1,384	Below 0	....	12·8	0·750	57·2	3·1	0·807	43·8	15·9	0·852	34·6	8·7	0·901	25·6	6·4	0·929	20·8	......	....	......	45·3	Intermediate.
Red Coulee.........	Dark green......	0·871	31·0	......	70	Below 0	....	21·8	0·761	54·4	5·6	0·821	41·1	24·0	0·857	33·6	13·0	0·894	26·8	9·6	0·908	24·3	2·9	0·911	23·8	21·0	Intermediate.
Fort Norman.......	Brownish green...	0·862	32·6	0·38	66	Below 0	19,110	32·0	0·759	54·9	5·2	0·816	41·9	21·1	0·844	36·2	9·7	0·877	29·9	5·9	0·894	26·8	4·7	0·906	24·7	20·4	Intermediate.
Pictou Shale Oil—																											
Ext. heated retort...	Brown-black.....	0·900	25·7	......	60	60	....	15·4	0·777	50·6	......	....	......	36·8	0·865	32·1	12·0	0·913	23·5	7·2	0·931	20·5	11·9	0·955	16·7	15·6	Hybrid.
Int. heated retort...	Brown-black.....	0·893	27·0	......	91‡	70	....	5·1	0·800	45·4	5·9	0·824	40·2	28·4	0·852	34·6	18·0	0·883	28·8	10·8	0·907	24·5	......	....	......	30·8	Intermediate.
Rosevale Shale Oil..	Brown-black.....	0·895	26·6	0·48	74	45	....	20·3	....	......	......	....	......	31·1	....	......	11·3	....	......	7·1	....	......	11·3	....	......	18·2	Hybrid.
Bitumen...........	Black...........	1·030	......	5·0	820*	....	....	2·8	0·818	41·5	......	....	......	19·0	0·867	31·7	4·3	0·920	22·3	8·5	0·950	17·5	13·2	0·970	14·4	49·5	Naphthene.

† Saybolt Universal Viscosimeter at 70° F. * Saybolt Furol Viscosimeter at 210° F. ‡Saybolt Universal Viscosimeter at 100° F.

Survey,[17,18,19,20] of the Department of Mines of Canada, and, in some cases, by an administrative department of those provinces in which crude petroleum is found. Particular mention should be made of the annual reports [21,22] of the Department of Mines of Ontario and of the annual reports [23,24] of the Bureau of Mines of Quebec. These departmental reports of the Dominion and of the provinces form the chief sources of information for the very brief description of the principal oil fields in Canada that has been included in this report for convenience of reference. Additional information regarding the fields that have been developed more recently has been gathered from technical journals and periodicals and included in the discussion in order that it may be brought up to date.

New Brunswick

In New Brunswick, natural gas and petroleum have been found in commercial quantities only in the counties of Albert and Westmorland at the head of the bay of Fundy. Oil seepages in these two counties attracted attention as early as 1859,[14] and a few shallow wells being drilled about that time yielded a considerable amount of gas and small quantities of oil. In 1876 further drilling was done and larger quantities of oil were obtained. Twenty years later the New Brunswick Petroleum Company, Limited was organized and between 1903 and 1905 considerable drilling took place, several thousand barrels of oil being produced and marketed. In 1906, the Maritime Oil Fields, Limited was formed to take over the drilling rights of the New Brunswick Petroleum Company. A little later the company was reorganized as the New Brunswick Gas and Oilfields, Limited, and this latter company has been steadily improving and developing the area ever since, at the same time supplying and distributing natural gas in the city of Moncton and the town of Hillsborough. At the present time all the producing wells are in the Stony Creek field.

Stony Creek Field

This field is situated on a dome-shaped hill in Albert county on the west bank of Petitcodiac river about nine miles south of the Moncton. The area in which most of the wells have been drilled is about four miles long from east to west and about two miles wide. The district is well wooded and unlike the oil and gas fields of Ontario and Alberta, clearings have to be made for the erection of derricks. Up to the end of 1934 over 100 wells have been drilled in this field approximately half of which produce gas, and from others oil can be obtained [25]. The wells are drilled to a depth of from 2,000 to 3,000 feet, four or five oil sands being struck. A small topping plant has been built by the company for the recovery of gasoline from the crude oil [26]. The residual fuel oil is sold to the Canadian National Railways for use in their shops at Moncton.

Quebec

Oil has been found only in Gaspe county. The oil-bearing region, approximately thirty miles long and eight miles wide, lies in an easterly and westerly direction, and comprises the lower part of the area drained by York and St. John rivers.

It has been stated [23] that the first published reference to the occurrence of petroleum in Gaspe was in 1836, and in 1844 Sir William Logan [27] noted the occurrence of more than 20 seepages of petroleum and bituminous matter. In 1860 two wells were drilled by the Gaspe Mining Company, [17] but only traces of oil were obtained. In 1865 and 1866 the Gaspe Petroleum Company drilled a well, known as the Conant, near Sandy Beach, which produced a small quantity of dark oil and continues to yield a similar product at the present time (end of 1934). Between 1889 and 1901 some fifty wells were drilled by the Petroleum Oil Trust, [19] a company that had been organized in England, and by its subsidiary, the Canada Petroleum Company. These wells were drilled to depths of 1,500 to 3,700 feet, [14] some obtaining a production of oil; and a small refinery was built [28] in 1900 and 1901, about eight miles west of Gaspe. The company went into liquidation early in 1903. According to Dr. Parks, this district [23] "must still be regarded as a possible source of oil on a commercial scale". There would appear to be no record of the quantity of oil produced, but the best well is said to have produced about 2,000 barrels of oil, and in 1902 the average output was about two gallons per day per well from a few wells that were still producing, so that five thousand barrels would probably be a fair estimate of the total oil produced in Gaspe.

Ontario

The principal oil fields in Ontario are to be found in Lambton and Middlesex counties, and in those counties bordering on Lake Erie. There are a few non-commercial wells, in addition, in Brant county, on the south shore of Georgian bay, and on Manitoulin island. The wells vary in depth from 400 to 3,600 feet, and the producing formations range from the Devonian to the Lower Ordovician in age. Oil springs and asphalt deposits in Ontario were known to the Indians and settlers at an early date. A detailed account of some of the occurrences was given by Sir William Logan in 1863, [29] the most pronounced of which was in Lambton county where a deposit varying in depth from a few inches to two feet thick had accumulated along the shores of Black creek in Enniskillen township.

Oil Springs Field

Development of the Oil Springs field began as early as 1857, [17] when a Mr. W. H. Williams of Hamilton undertook the distillation of oil from this deposit at the present site of the village of Oil Springs, and in so doing laid the foundation of the present petroleum refining industry in Canada. It was soon discovered that the material became more fluid on penetrating deeper into the deposit, and wells were dug to depths of 40 or 50 feet, from which a heavy oil more suitable for distillation was obtained. In 1858, Williams sunk a well down to the gravel above bed rock. It will be seen that this preceded the drilling of the Drake well in Pennsylvania, which occurred in the following year. However, the Drake well was drilled through the bed rock and obtained a flowing production at the surface which Williams' well did not do. The success of the Drake well encouraged drilling into the rock at Oil Springs, and in 1861 Shaw [21] drilled a well through the rock to a depth of 160 feet, and obtained a gusher that flowed uncontrolled for several days. Great drilling activity in the district followed, and Oil Springs became a bustling town. Several of the early wells yielded between 2,000 and 5,000 barrels of oil per day, and on the basis of initial flow, the flush production of this field has been estimated at several million barrels, very little of which was saved owing to lack of storage facilities at that time. The field has produced oil continuously ever since.

Petrolia and Bothwell Fields

The success in obtaining oil at Oil Springs encouraged exploratory drilling elsewhere, with the result that the Petrolia field, about seven miles north of Oil Springs, and the Bothwell field in Kent county, about 18 miles to the southeast, were discovered in 1862. The Petrolia field has been, and is at the present time the largest producer of crude oil in Ontario. The pool is irregular in shape and is located in parts of Enniskillen, Moore, and Sarnia townships. It is about 10 miles long from east to west and about 5 miles wide at the widest part. The Bothwell field was largely abandoned in 1866, but was reopened in 1895 and has been producing oil ever since. The field is a series of small pools extending east and west from the Thames river above Moraviantown through Zone township into Camden township, a distance of about 10 miles. It is about midway between the towns of Bothwell and Thamesville, either of which names is used to designate the field. The fourth largest producing oil field in Ontario is near the town of Glencoe, in the township of Mosa, county of Middlesex. It was discovered at an early date, partially drilled, and abandoned. It was reopened in 1917, and although some trouble with salt-water had been experienced it has been producing fairly steadily ever since. A small production is obtained from Onondaga township in Brant county, a few miles to the south of the city of Brantford. This field also produces natural gas which is piped into the city.

Alberta

The first record of finding oil in Alberta was shortly before 1890 when seepages were reported in the bed of Cameron brook, Waterton Lake Park. In 1891, samples from these seepages were collected [30] by Dr. Selwyn of the Geological Survey, Dawson's report of 1898 [35] again calling attention to the oil in that district. In 1902, in a well drilled by a company formed [31] by John Lineham, oil was struck at 1,080 feet and the well was carried on to 1,400 feet. Several other wells were drilled in that neighbourhood without getting a large production. As early as 1899, A. W. Dingman was engaged in prospecting for oil. He obtained gas, but apparently no oil until he drilled the Discovery well at Turner Valley in 1913, [32] when Alberta's contribution to the petroleum output of Canada started, although it took some years to develop any considerable production. In 1919, 16,437 barrels was produced, but during the next few years, production declined until in 1924 only 844 barrels was produced. After the bringing in of the famous Royalite No. 4 well in 1924, the output increased rapidly until, in 1931, Alberta contributed more than 90 per cent of the petroleum produced in Canada.

Turner Valley Field

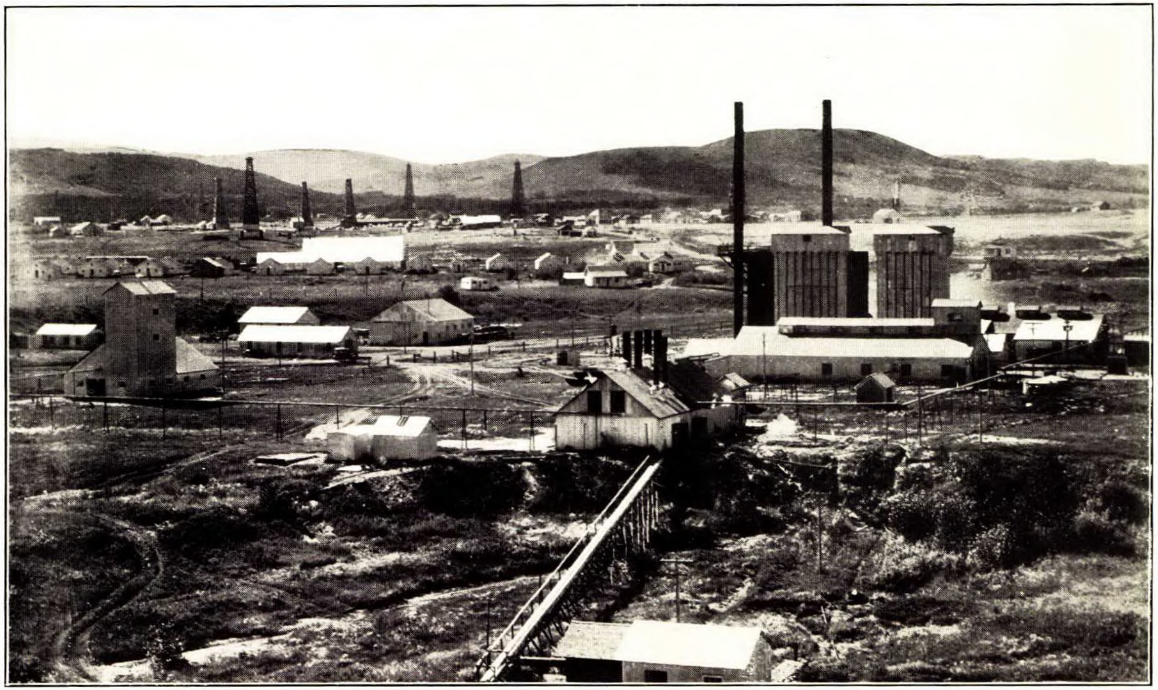
Turner Valley field, located in the foothills of the Rocky mountains about 40 miles southwest of Calgary, is an area about 15 miles long and 2 miles wide. It is the most highly developed field in Alberta at the present time, and is responsible for the bulk of the production of that province. The first well drilled in Turner Valley was started near a gas seepage [33] just north of the Sheep river by the Calgary Petroleum Products Company, the company organized by Mr. A. W. Dingman. A showing of oil was obtained in 1913 at a depth of 1,557 feet, and in the following year a much larger flow at 2,718 feet. This discovery stimulated drilling [34] in Turner Valley and several other wells obtained small production but, no large flows being struck, development came nearly to a standstill during the war.

The Dingman well produced an extremely light crude oil, a small sample received by the Fuel Research Laboratories in 1914 giving the following results when examined:—

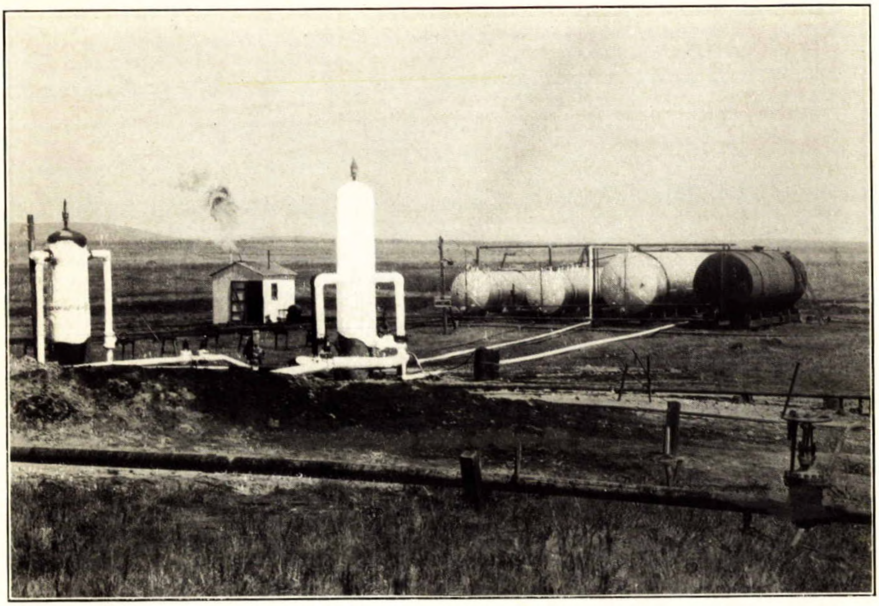
Specific gravity at 60° F.	0·756
Equivalent A.P.I. degrees	55·7
Colour	yellow
Distillation range,	
First drop	169° F.
10%	199
20%	216
50%	255
70%	298
90%	421

Early in 1921 the Imperial Oil Company formed the Royalite Oil Company to take over the properties of the Calgary Petroleum Products Company, the discovery well being re-named Royalite No. 1. The possibilities of the field were not realized until Royalite No. 4, after drilling for over two years and penetrating 310 feet into the Palæozoic limestone, "blew in" on October 24, 1924 with a measured production of 21,500,000 cubic feet of gas and an estimated 500 barrels of naphtha per day. The first official statement of production was for the month of June, 1925, when 14,049 barrels of naphtha was shipped, or an average of 450 barrels per day. The gas pressure in the well was very high and although it was not tested during the early days of its production there is good reason to believe [36] that originally it was about 2,500 pounds per square inch. When an attempt was made to close the well, the casing was blown apart and the liberated gas caught fire. After the fire was extinguished, the well was not entirely closed in until some years later when the pressure had diminished considerably, although the well became plugged at times owing to "freezing". In spite of these difficulties the well has a record of a production of over 400 barrels per day for a period of five years, and was still reported producing as late as 1932. During 1934 the well was cleaned out, but it was not brought back into production, and was finally abandoned during the summer of that year.

The second well in Turner Valley to come in with a production comparable to that of Royalite No. 4 was Dalhousie No. 1, [34] completed in April, 1928, with a reported yield of 350 barrels per day. In June of the same year Royalite No. 6 extended the area of limestone production



Looking northwest across Turner Valley, Alberta.



A. Separators and storage tanks at Home No. 1, Turner Valley, Alberta (1929)

B. Imperial Oil Well No. 1, Fort Norman, N.W.T. (1921)

nearly two miles to the southeast of Royalite No. 4; and in October, Foothills No. 1 did the same to the northwest, these two wells being nearly five miles apart. In November, Okalta No. 1 came in with a production of 400 barrels per day.

During 1929 much drilling was done, an outstanding development being the bringing in of the famous Home group of three wells, thus extending the southeastern limits of production another two and a half miles and bringing the daily production of the field up to 3,000 barrels.

The year 1930 saw the greatest development of the Turner Valley field, 48 producing wells having been completed during the year. Although a number were in the northern and the central part of the field, the greater number were to the south, notable producers being Mercury, East Crest, Miracle, and Sterling Pacific.

In the following years the southern limit of the field continued to be pushed still farther to the south. In 1931, sixteen new producing wells were reported; in 1932, four; in 1933, six more; and in 1934, seven were brought in.

From the time that Royalite No. 4 was brought into production in 1924, the main objective of the oil companies operating in Turner Valley was to reach the naphtha-producing horizon in the limestone, few stopping to take light crude oil production from upper horizons, although a number of wells passed good showings. In November, 1924, McLeod well No. 1 obtained a production of 20 barrels per day of 54° A.P.I. crude from a depth of 2,937 feet. A little over two years later, McDougall-Segur No. 1 obtained a flow of 62 barrels a day from the same horizon, which came to be known as the McDougall-Segur sand.[34] In 1927, Home No. 1 started producing 30 barrels per day of 45° A.P.I. crude from a lower sand at 4,560 feet, which is now called the Home sand. Early in 1928, Dalhousie No. 5 after taking some production from the Home sand was deepened to 4,901 feet and obtained a production of 57 barrels per day of 52° A.P.I. oil from a sand that now bears its name. Although these three sands have been definitely located, the production of light crude in Turner Valley has been small in comparison with that of the naphtha.

Wainwright and Ribstone Fields

These two fields, situated close together near the Alberta-Saskatchewan boundary, about 160 miles east of Edmonton, have been undergoing development since 1926, and several wells have been drilled, Wainwright now having a small production of heavy oil.[37] The character of the oil produced is indicated in Table VI.

Skiff

This area, situated near Skiff in southern Alberta, was discovered in 1927 when oil was struck in the Devenish well. The character of the oil then produced is indicated in Table VI.

Red Coulee Field

This field, situated near Coutts in southern Alberta close to the International Boundary, has been actively developed since 1929, and produces a lighter crude than the Skiff area. The character of the oil produced is indicated in Table VI.

Northwest Territories

Drilling for oil has been attempted in only two areas in the Northwest Territories, namely, near Fort Norman and around Great Slave lake, although large areas, within Mackenzie River basin, are underlain by rocks presumably oil bearing.[38]

Fort Norman

This field is situated on the lower Mackenzie river about 50 miles north of the Hudson's Bay post of Fort Norman at approximately 65° North latitude and 127° West longitude. Two productive wells were drilled on the east bank of the river by the North West Oil Company, a subsidiary of the Imperial Oil Company. The first was drilled in 1920, and oil was obtained at 783 feet. In 1922, and 1923, the well was deepened. The second was drilled in 1924 and 1925, oil being obtained at 936 feet and 1,063 feet. A third well gave a small flow of gas, but three others which were drilled yielded neither oil nor gas. The two wells first mentioned each produced about 100 barrels of crude oil per day.

As a result of the recent mining activities at Great Bear Lake these wells were opened up in 1932 and a small refinery was built near Fort Norman for the production of gasoline and Diesel fuel oil. Production was taken chiefly from well No. 2.

OIL SHALE DEPOSITS

Occurrences of bituminous shales in Canada have been known for many years,[15] and have been found in almost every province.[39] These deposits represent a large aggregate tonnage, constituting a national asset of great possible potential value, when the supply of petroleum begins to approach exhaustion. Up to the present the deposits in Nova Scotia and New Brunswick have received the most attention.

The most promising deposits in Nova Scotia so far investigated are those found in Pictou county[40]. The shales occur as bands in the productive coal measures underlying an area of approximately 20 square miles in the vicinity of New Glasgow, and outcrop at several places. The thickness of the bands and the oil content of the shale have been found to vary considerably[42]. The beds were worked shortly after their discovery in 1859,[41] but little has been done since in a commercial way, although two experimental plants were built about 1929 to investigate their treatment[42].

The principal areas in New Brunswick in which oil shales of commercial value have been recognized lie in Albert and Westmorland counties.[43] The extent of the beds has not been determined definitely, but outcrops occur at several places, notably at Albert Mines and Rosevale[44,45]. Experimental plants were built and operated at Rosevale in 1921 and in 1929[46]. The analyses of oils from the Pictou shales and from the Rosevale shales are included in the tables for comparison.

BITUMINOUS SAND DEPOSITS

Sand which has become saturated with a heavy asphaltic oil or a semi-liquid bitumen is exposed at frequent intervals along the Athabaska river and its tributaries near McMurray in northern Alberta.[16] The area over which exposures have been noted measures about 115 miles in a north and south direction, and approximately 55 miles from east to west. These exposures, over 300 of which have been measured and examined, represent portions of an almost continuous deposit.

Much investigational work has been done to encourage the commercial development of this bituminous sand. The depth of the deposit has been tested in many places by drilling[47] and by sinking shafts.[48] The bituminous content of the material has been tested at different localities and at different depths.[47,49] The aggregate, practically as mined, has been used for the experimental surfacing of streets and highways.[50] Processes have been developed for separating the bitumen from the sand economically,[51] and for dehydrating the separated bitumen.[52,53] The bitumen has been subjected to cracking processes and the yield and quality of the motor fuel so produced determined.[54] The material has also been hydrogenated and the characteristics of the resulting products determined.[55,56,57,58] As a result of this and other work commercial development is being attempted at the present time.

The analyses given in the tables are those of the separated, water-free bitumen without treatment of any other kind.

LIST OF REFERENCES

1. Dominion Bureau of Statistics. The Petroleum Industry in Canada, 1933. *(Issued yearly).*
2. Dominion Bureau of Statistics. The Petroleum Products Industry in Canada, 1933. *(Issued yearly).*
3. National Standard Petroleum Oil Tables. Circular No. 154, United States Bureau of Standards.
4. Tentative Methods of Analyses. Proceedings of the American Society for Testing Materials, Vol. 32, Part I (1932).
5. Methods of Testing Petroleum and its Products. Institution of Petroleum Technologists.
6. Analytical Distillation of Petroleum and its Products. E. W. Dean, H. H. Hill, N. A. C. Smith and W. A. Jacobs; Bull. No. 207, United States Bureau of Mines.
7. A. S. T. M. Standards, American Society for Testing Materials, 1930, Part II.
8. The Analysis of Natural Gas from the Turner Valley Field in Alberta. P. V. Rosewarne and R. J. Offord; Report No. 721, Mines Branch, Department of Mines, Canada.
9. Method of Natural Gasoline Analysis. Walter J. Podbielniak; Oil and Gas Jour., January 17, 1929.
10. Apparatus and Methods for Precise Fractional-Distillation Analysis. Walter J. Podbielniak; Jour. of Ind. and Eng. Chem., Analytical Edition, Vol. 3, No. 2. (April 15, 1931.)
11. Tabulated Analyses of Representative Crude Petroleums of the United States N. A. C. Smith and E. C. Lane; Bull. No. 291, United States Bureau of Mines.
    See also—Properties of Typical Crude Oils from the Producing Fields of the Western Hemisphere. A. J. Kraemer and L. P. Calkin; Technical Paper 346, United States Bureau of Mines.
12. Gasoline Survey for 1934. H. McD. Chantler; Report of Investigations of Fuels and Fuel Testing, 1934. Mines Branch, Department of Mines, Canada.
13. The Interpretation of Crude Oil Analyses. N. A. C. Smith; Report of Investigations, Ser. No. 2806, United States Bureau of Mines.
14. Petroleum and Natural Gas Resources of Canada. F. G. Clapp and others; Report No. 291, Mines Branch, Department of Mines, Canada.
15. Oil Shales of Canada. S. C. Ells; Report No. 586, Mines Branch, Department of Mines, Canada.

16. Bituminous Sands of Northern Alberta. S. C. Ells; Report No. 632, Mines Branch, Department of Mines, Canada.
17. Oil and Gas in Eastern Canada. G. S. Hume; Econ. Geol. Series No. 9, Geological Survey, Department of Mines, Canada.
18. Oil and Gas in Western Canada. G. S. Hume; Econ. Geol. Series No. 5, Geological Survey, Department of Mines, Canada.
19. The Oil and Gas Fields of Ontario and Quebec. Wyatt Malcolm; Memoir 81, Geological Survey, Department of Mines, Canada.
20. The Oil Fields of Gaspe. R. W. Ells; Summary Report for 1902, Geological Survey, Department of Mines, Canada.
21. Oil and Gas Fields of Ontario. R. B. Harkness; Annual Report of the Ontario Department of Mines, Vol. XXXVII, Part V, 1928.
22. Petroleum in 1932. R. B. Harkness; Annual Report of the Ontario Department of Mines, Vol. XLII, Part V, 1933.
23. Report on the Oil and Gas Resources of the Province of Quebec. Wm. A. Parks; Annual Report of the Quebec Bureau of Mines for 1929, Part B.
24. Natural Gas in the St. Lawrence Valley, Quebec. Wm. A. Parks; Annual Report of the Quebec Bureau of Mines for 1930, Part D.
25. Natural Gas in New Brunswick. R. T. Elworthy; Report No. 669, Mines Branch, Department of Mines, Canada.
26. Private communication from R. H. Findlater, New Brunswick Gas and Oilfields Ltd., Moncton, N.B.
27. On the Geology of the Chat and Cascapedia Rivers, Gaspe, and part of Chaleur Bay. Sir Wm. Logan; Report of Progress for 1844, Pub. No. 2, Geological Survey, Department of Mines, Canada.
28. Mining Operations in the Province of Quebec, 1901.
29. Geology of Canada, 1863. Sir Wm. Logan; Report of Progress from its commencement to 1863; Pub. No. 52, Geological Survey, Department of Mines, Canada.
30. Notes on the Reported Discoveries of Oil in the Vicinity of Pincher Creek, and in the South Kootenay Pass, Alberta; and in the Flathead Valley, British Columbia. A. R. C. Selwyn; Summary Report for the year 1891, Pub. No. 321, Geological Survey, Department of Mines, Canada.
31. Waterton Lakes-Flathead Valley Area, Alberta and British Columbia. G. S. Hume; Report of the Minister of Mines of the province of British Columbia, Canada, for the year 1932.
32. Sheep River Gas and Oil Field, Alberta. S. E. Slipper; Memoir 122, Geological Survey, Department of Mines, Canada.
33. Geological Notes to Accompany Map of Sheep River Gas and Oil Field, Alberta. D. B. Dowling; Memoir 52, Geological Survey, Department of Mines, Canada.
34. The Turner Valley Oil Field. G. R. Elliott; Bull. Canadian Mining and Metallurgical Inst. No. 214, February 1930, pages 259-283.
35. Summary Report of the Operations of the Geological Survey for the year 1898. G. M. Dawson; Pub. No. 674, Geological Survey, Department of Mines, Canada.
36. Petroleum and Natural Gas Development in Alberta. Charles C. Ross; Bull. No. 168, Can. Min. and Met. Inst., April 1926, pages 466-495.
37. Oil and Gas Prospects of the Wainwright-Vermilion Area, Alberta. G. S. Hume; Summary Report, 1924, Part B. Geological Survey, Department of Mines, Canada.
38. The Mackenzie River Area. G. S. Hume; Trans. of the Can. Inst. of Min. and Met., 1927, pp. 671-679.
39. The Mineral Industries of Canada, 1933. A. H. A. Robinson; Report No. 749, Mines Branch, Department of Mines, Canada.
40. Joint Report on the Bituminous Shales of New Brunswick and Nova Scotia, also on the Oil Shale Industry of Scotland. R. W. Ells; Repts. 55 and 1107, Department of Mines, Canada (1909).
41. Bituminous Shales of Nova Scotia and New Brunswick. R. W. Ells; Summary Report, 1908. Pub. No. 1072, Geological Survey, Department of Mines, Canada.

42. Report on Oil Shales from New Glasgow Area, Pictou County, N.S., and from Port Daniel, Bonaventure County, Que. A. A. Swinnerton; Investigations of Fuels and Fuel Testing, 1930 and 1931, Report No. 725, pp. 136-148, Mines Branch, Department of Mines, Canada.
43. The Albert Shale Deposits of Albert and Westmorland Counties, New Brunswick. R. W. Ells; Summary Report, 1902, Pub. No. 816, Geological Survey, Department of Mines, Canada.
44. Geology of the Moncton Map-Area. W. J. Wright; Mem. 129, Geological Survey, Department of Mines, Canada.
45. Preliminary Report on the Investigation of Oil Shales. A. A. Swinnerton; Report No. 586, pp. 239-252, Summary Report of the Mines Branch, Department of Mines, Canada, 1921.
46. A World Survey of Recent Oil Shale Developments. A. A. Swinnerton; Memorandum Series No. 53, Mines Branch, Department of Mines, Canada.
47. Core Drilling Bituminous Sands of Northern Alberta. S. C. Ells; Report of Investigations of Mineral Resources, 1928; Report No. 710, Mines Branch, Department of Mines, Canada.
48. Bituminous Sand of Northern Alberta. S. C. Ells; Report No. 625, Mines Branch, Department of Mines, Canada.
49. The Assay of Bituminous Sands. R. E. Gilmore, A. A. Swinnerton, and G. P. Connell; Report No. 696-2, Mines Branch, Department of Mines, Canada.
50. Use of Alberta Bituminous Sands for Surfacing of Highways. S. C. Ells; Report No. 684, Mines Branch, Department of Mines, Canada.
51. The Bituminous Sands of Alberta. K. A. Clark and S. M. Blair; Report No. 18, Scientific and Industrial Research Council of Alberta.
52. Report of Experiments on the Dehydration of Bitumen Emulsion from Alberta Bituminous Sands. P. V. Rosewarne and G. P. Connell; Report of Investigations of Fuels and Fuel Testing, 1926, Report No. 689, Mines Branch, Department of Mines, Canada.
53. Report of the Road Materials Division. K. A. Clark and D. S. Pasternack; Report No. 26, Eleventh Annual Report of the Research Council of Alberta.
54. Canadian Shale Oil, and Bitumen from Bituminous Sands, as Sources of Gasoline and Fuel Oil, by Pressure Cracking. R. E. Gilmore, P. V. Rosewarne, and A. A. Swinnerton; Report No. 689, Mines Branch, Department of Mines, Canada.
55. Hydrogenation, or Berginisation, of Tar and Coal. E. H. Boomer; Report No. 25, Tenth Annual Report of the Research Council of Alberta, 1929.
56. On the Hydrogenation of Bitumen from the Bituminous Sands of Alberta. E. H. Boomer and A. W. Saddington, Can. Jour. of Research, Vol. 2, No. 6 (June 1930) and Vol. 4, No. 5 (May 1931).
57. Experiments on the Hydrogenation of Alberta Bitumen. T. E. Warren; Report No. 725-1, Mines Branch, Department of Mines, Canada.
58. Report of Experimental Work on the Hydrogenation of Canadian Coal, Coal Tar, and Bitumen, for the Production of Motor Fuel. T. E. Warren, A. R. Williams and K. W. Bowles; Report No. 737-3, Mines Branch, Department of Mines, Canada.

622(21~~(06~~) 765,c.1 C212

SER

Canada, mines branch reports.

765, analysis of crude oils. ,
1936, c. 1.

~~GT Smiley (ERL)~~ ~~29-2-80~~

LOWE-MARTIN CO.—67-4026

A *Fort Norman* 55
B *McMurray* 63,65,68
C *Ribstone* 44,45
D *Wainwright* 30,32,43,46,47,59,62
E *Bow River and Moose Dome* 51, 52
F *Turner Valley* 31,33,34,35,36,37.38,48,49,54
G *Skiff* 39.42
H *Red Coulee* 50
J *Collingwood* 67
K *Oil Springs and Petrolia* 25,26,40,60
L *Dover and Tilbury* 27, 28, 29
M *Bothwell and Thamesville* 18,19,20,21,22.23,24
N *Mosa, Wallacetown and Dunwich Tp.* 14,15,16,17
O *Brant* 13
P *Gaspé* 8,11,12,56,57,58
Q *Sandy Beach* 7
R *Stony Creek* 1,2,3,4,5,6,61,66
S *Rosevale* 41
T *Pictou* 53,64,69,70,71

Figure 3. Map showing location of oil fields in Canada.

TABLE I

Analytical Comparison of Canadian Crude Oils

ORIGIN AND CHARACTERISTICS

Sample No.	Field	Location	Owner or Operator	Well number	Depth (feet)	Formation	Collector	Date	Colour	Specific gravity
		New Brunswick								
1	Stony Creek	Hillsborough parish, Albert co	N.B. Gas and Oilfields, Ltd	Storage Tank (gen. average)			N.B. Gas and Oilfields, Ltd	Aug., 1927	Dark green	0·842
2	“	“ “	“ “	81. (Group 3 oil sands)	2,592–2,606	Pay sand	“ “	“	Brownish black	0·842
3	“	“ “	“ “	81. (Group 4 oil sands)	2,617–2,630	“	“ “	“	Greenish black	0·837
4	“	“ “	“ “	18. (Group 6 oil sands)	2,647–2,653	“	“ “	“	Dark green	0·839
5	“	“ “	“ “	70. (Group 6 oil sands)	2,554–2,640	Oil pay	“ “	“	Dark green	0·833
6	“	“ “	“ “	20. (Group 6 oil sands)	2,514–2,528	“	“ “	“	Dark green	0·838
61	“	“ “	“ “	Composite sample from all producing wells			Mines Branch	Sept., 1925	Dark green	0·838
66	“	“ “	“ “	48A. (Group 5 oil sands)	2,881–2,884	Pay sand	N.B. Gas and Oilfields, Ltd	Sept., 1930	Light red	0·751
		Quebec								
7	Gaspe	Lot A6, R.1, Sandy Beach, Douglas tp	Gaspe Oil Co	Conant well	684	Gaspe	Mines Branch	July, 1927	Brownish green	0·875
8	“	Lot 31, R.1, Gaspe Bay South	Canadian Petroleum Co	Canadian Petroleum No. 9	2,360	“	“	“	Greenish black	0·861
11	“	Block 41, Galt tp		Oil Spring		“	“	“	Brownish black	0·929
12	“	Block 40, Larocque tp	Petroleum Oil Trust	Petroleum Oil Trust No. 20	2,173	“	“	“	Light red	0·800
56	“	Lots 30, 34, and 35, R.1, Gaspe Bay South	“	Composite sample from wells 10, 7, and 11		“	“	July, 1923	Brownish green	0·884
57	“	Block 40, Larocque tp	“	Petroleum Oil Trust No. 20	2,173	“	“	“	Claret red	0·811
58	“	“	“	Petroleum Oil Trust No. 34	1,677	“	“	“	Claret red	0·793
		Ontario								
13	Brant	Lot 18, Con. III, Onondaga tp., Brant co	Onondaga Oil and Gas Co	Onondaga No. 1 (Fearman Farm)	470	White Medina	J. F. Carmody	April, 1928	Dark green	0·859
14	Dunwich Township	Lot 24, Con. V (north of A), Dunwich tp., Elgin co	Peace River Development Co	Peace River No. 3	330	Onondaga	Ontario Dept. of Mines	Dec., 1927	Brownish green	0·897
15	Wallacetown	Lot 14, Con. XI, Dunwich tp., Elgin co	G. H. Lidster	Lidster No. 1	305	“	G. H. Lidster	“	Brownish green	0·837
16	Mosa Township	Lot 6, Con. VI, Mosa tp., Middlesex co	J. A. Walker	Walker No. 17	350	“	Mines Branch	Oct., 1927	Brownish green	0·854
17	“	Gillies Siding, Mosa tp., Middlesex co		Composite sample		“	Imperial Oil Co	“	Brownish green	0·857
18	Bothwell	Zone tp., Kent co		Composite sample from tank		Onondaga	Mines Branch	Oct., 1927	Greenish black	0·844
19	“	“		Composite sample		“	Imperial Oil Co	“	Greenish black	0·838
20	Thamesville	Lot 5, Con. III, Zone tp., Kent co	Colchester Oil Co	‘Deep well’	3,960	Trenton	Ontario Dept. of Mines	May, 1928	Brownish green	0·827
21	“	Lot 5, Con. XIII, Gore of Camden tp., Kent co	Ajax Oil and Gas Co	Ajax No. 1 (Earl Smith Farm)	345	Onondaga	Ajax Oil and Gas Co	Jan., 1928	Greenish black	0·838
22	“	Lot 4, Con. III, Zone tp., Kent co	Colchester Oil Co	Barclay well	278	Delaware	Colchester Oil Co	“	Dark green	0·823
23	Thamesville	Zone tp., Kent co		Composite sample		Onondaga	Imperial Oil Co	Oct., 1927	Dark green	0·831
24	“	“	Vacuum Gas and Oil Co	Composite sample from tank		“	Vacuum Gas and Oil Co	“	Dark green	0·833
25	Oil Springs	Lot 18, Con. II, Enniskillen tp., Lambton co	Fairbank Estate	Fairbank No. 157	390	“	Mines Branch	“	Brownish green	0·845
26	Petrolia	Lot 11, Con. XI, Enniskillen tp., Lambton co	E. Kelly	Kelly No. 2	465	“	“	“	Brownish green	0·855
27	Dover Township	Lot 1, Con. II, Dover West tp., Kent co	Petrol Oil and Gas Co		3,280	Trenton	Petrol Oil and Gas Co	“	Dark green	0·826
28	Tilbury	Glenwood, Kent co		Composite sample		Guelph	Imperial Oil Co	Oct., 1927	Brownish green	0·844
29	Dover Township	Prairie Siding, Kent co	Petrol Oil and Gas Co	Composite sample	3,000–3,300	Trenton	“	“	Dark green	0·836
40	Oil Springs	Lot 16, Con. II, Enniskillen tp., Lambton co	Hillis & Son	“Old Well”	280	Onondaga	Ontario Dept. of Mines	Dec., 1928	Brownish green	0·845
60	“	Lambton co		Oil seepage			A. W. Dewar	1924	Brownish green	0·842
67		Southeast of Collingwood, Simcoe co		Oil seepage			R. Cherry	Aug., 1930	Brownish green	0·838
		Alberta								
30	Wainwright	L.S. 9, sec. 36, tp. 44, R. 7, W. 4th mer	Wainwell Oils, Ltd	Wainwell No. 1	2,065–2,072	Wainwell	Wainwell Oils, Ltd	Aug., 1928	Brownish black	0·971
31	Turner Valley	L.S. 14, sec. 12, tp. 20, R. 3, W. 5th mer	McDougall-Segur Oil Co	New McDougall-Segur No. 1	2,512	Blairmore	Dept. of Interior	“	Dark red	0·758
32	Wainwright	S.W. ¼, sec. 29, tp. 45, R. 6, W. 4th mer	Gipsy Oils, Ltd	British Petroleums No. 3B	2,233–2,256	Brit. Pet. 3B	Gypsy Oils, Ltd	“	Brownish black	0·945
33	Turner Valley	L.S. 10, sec. 12, tp. 20, R. 3, W. 5th mer	Royalite Oil Co	Royalite No. 10	2,332	New McDougall-Segur	Dept. of Interior	“	Pale red	0·750
34	“	L.S. 14, sec. 20, tp. 19, R. 2, W. 5th mer	Home Oils, Ltd	Home No. 2	5,158	Home	“	“	Dark red	0·793
35	Turner Valley	L.S. 8, sec. 1, tp. 20, R. 3, W. 5th mer	Foothills Oil and Gas Co	Foothills No. 2	2,840	New McDougall-Segur	Dept. of Interior	Aug., 1928	Very dark red	0·772
36	“	L.S. 16, sec. 30, tp. 19, R. 2, W. 5th mer	Dalhousie Oil Co	Dalhousie No. 5	4,900	Home	“	“	Light red	0·772
37	“	L.S. 8, sec. 1, tp. 20, R. 3, W. 5th mer	Okalta Oils, Ltd	Okalta No. 2	3,058	New McDougall-Segur	“	Sept., 1928	Very dark red	0·773
38	“	L.S. 2, sec. 1, tp. 20, R. 3, W. 5th mer	Calmont Oils, Ltd	Calmont No. 1	3,735	Benton. ?	“	Nov., 1928	Extra pale	0·777
39	Skiff	L.S. 5, sec. 27, tp. 5, R. 14, W. 4th mer	Devenish Petroleum, Ltd	Devenish No. 1	3,080	Ellis	Devenish Petroleum, Ltd	April, 1929	Brownish black	0·939
42	Skiff	L.S. 4, sec. 27, tp. 5, R. 14, W. 4th mer	Devenish Petroleum, Ltd	Devenish No. 3	3,054–3,067	Ellis	Devenish Petroleum, Ltd	April, 1929	Brownish black	0·943
43	Wainwright	L.S. 1, sec. 19, tp. 45, R. 6, W. 4th mer	Sasko-Wainwright Oil Co., Ltd	Sasko-Wainwright No. 1	2,239–2,250	Brit. Pet. 3B	Sasko-Wainwright Oil Co., Ltd	“	Brownish black	0·929
44	Ribstone	L.S. 14, sec. 10, tp. 43, R. 3, W. 4th mer	London-Ribstone Pet., Ltd	London-Ribstone No. 1	2,149–2,158		London-Ribstone Pet., Ltd	May, 1929	Brownish black	0·954
45	“	L.S. 1, sec. 16, tp. 45, R. 1, W. 4th mer	Ribstone Oils, Ltd	Meridian No. 1	1,822–1,833		Ribstone Oils, Ltd	“	Brownish black	0·981
46	Wainwright	L.S. 4, sec. 22, tp. 45, R. 6, W. 4th mer	Brit. Wainwright Oil and Dev. Co. Ltd	British Wainwright No. 1	2,230–2,238	Brit. Pet. 3B	Brit. Wainwright Oil and Dev. Co	June, 1929	Brownish black	0·929
47	Wainwright	L.S. 15, sec. 36, tp. 44, R. 7, W. 4th mer	Wainwell Oils, Ltd	Wainwell No. 4	2,046–2,052	Wainwell	Wainwell Oils, Ltd	June, 1929	Brownish black	0·957
48	Turner Valley	L.S. 8, sec. 22, tp. 20, R. 3, W. 5th mer	Model Oils, Ltd	Model No. 1	5,200–5,206	Home	Model Oils, Ltd	Aug., 1929	Brownish green	0·875
49	“	L.S. 6, sec. 12, tp. 20, R. 3, W. 5th mer	British Dominion Oil Co	British Dominion No. 2	4,820–4,900	Dalhousie	British Dominion Oil Co	“	Extra pale	0·763
50	Red Coulee	L.S. 3, sec. 4, tp. 1, R. 16, W. 4th mer	Alberta Pacific Consol. Oils, Ltd	Vanalta No. 1	2,467–2,491	Vanalta	Dept. of Interior	Sept., 1929	Dark green	0·871
51	Moose Dome	L.S. 16, sec. 29, tp. 22, R. 6, W. 5th mer	Moose Oils, Ltd	Moose No. 1	2,220–2,236	Devonian	Moose Oils, Ltd	Mar., 1930	Extra pale	0·795
52	Bow River	L.S. 19, sec. 34, tp. 23, R. 5, W. 5th mer	Signal Hill Oil Co	Signal Hill No. 2	3,905–3,907	Dalhousie ?	Signal Hill Oil Co	April, 1930	Green	0·799
54	Turner Valley	L.S. 14, sec. 6, tp. 20, R. 2, W. 5th mer	Royalite Oil Co	Royalite No. 1 (Dingman No. 1)	3,924	Blairmore	Calgary Petroleum Prod. Co	Oct., 1914	Lemon pale	0·759
59	Wainwright	L.S. 13, sec. 30, tp. 45, R. 6, W. 4th mer	British Petroleums, Ltd	British Petroleums No. 4	2,025–2,036	Wainwell ?	Geological Survey	Sept., 1924	Brownish black	0·969
62	“	S.W. ¼, sec. 29, tp. 45, R. 6, W. 4th mer	“	British Petroleums No. 3B	2,233–2,256	Brit. Pet. 3B	“	Oct., 1925	Brownish black	0·944
		Northwest Territories								
55	Fort Norman	Oil Creek, 45 m. north Fort Norman	Imperial Oil Co	Discovery No. 1	260–272	Fort Creek	Geological Survey	Sept., 1920	Brownish green	0·862
		Miscellaneous—*Shale Oil*								
41	Rosevale, N.B.	Rosevale, Albert co., N.B.	Shale oil obtained by distillation in Pritchard Retort, Toronto (Runs 1, 2 and 3)			Albert	Mines Branch	Sept., 1925	Brownish black	0·895
64	Pictou, N.S.	Pictou co., N.S.	Shale oil obtained by distillation of core drill samples, Pictou co. (composite)				Geological Survey	Feb., 1930	Brownish black	0·881
69	“	New Glasgow, N.S.	Shale oil obtained by distillation Bed “A”, New Glasgow			Stellarton	Mines Branch	Aug., 1929	Brownish black	0·913
53	“	McLellan brook, New Glasgow, N.S.	Can. Torbanite and Oil Prod., Ltd	Shale oil from Exp. plant		Thorburn	Can. Torb. and Oil Prod., Ltd	Oct., 1930	Brownish black	0·893
70	“	New Glasgow, N.S.	Torbanite Products, Ltd	“		Stellarton	Torbanite Prod., Ltd	July, 1930	Brownish black	0·900
71	“	“	“	“		“	“	“	Brownish black	0·899
		Bitumen								
63	McMurray	Athabaska river near McMurray, Alta	Research Council, Alberta	Bitumen from Exp. plant, Edmonton			Research Council, Alberta	Oct., 1925	Black	1·061
65	“	“ “	“	Bitumen from Clearwater separation plant (1930)			“	July, 1930	Black	1·030
68	“	“ “	International Bitumens, Ltd	Bitumen from Exp. separation plant			Mines Branch	Oct., 1930	Black	1·035

(a) Gravity, American Petroleum Institute degrees. (b) Per cent weight of original crude. (c) Per cent volume of original crude. (d) Saybolt 'Furol' at 210° F. (e) Saybolt 'Furol' at 250° F. * Water in sample.

TABLE II

Analytical Comparison of Canadian Crude Oils—Engler Distillations

Sample No.	Field	Owner or Operator	Well number	Specific gravity	Distillation Range—100 c.c.—at atmospheric pressure													Re-covery, c.c.	Specific gravity of dis-tillate	Weight coke residue, grm.	Loss by differ-ence, grm.	Sample No.
					First drop.	5 %	10 %	20 %	30 %	40 %	50 %	60 %	70 %	80 %	90 %	95 %	End point					
	New Brunswick				°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.					
1	Stony Creek	N.B. Gas and Oilfields, Ltd.	Storage Tank (gen. average)	0·842	142	252	310	428	539	622	640	645	647	649	658	680	721	99·0	0·807	2·0	2·7	1
2	“	“ “	81. (Group 3 oil sands)	0·842	141	247	317	453	565	626	630	633	635	637	650	669	708	98·0	0·806	2·8	2·9	2
3	“	“ “	81. (Group 4 oil sands)	0·837	160	247	314	435	547	623	651	661	667	672	677	686	716	99·0	0·806	1·9	2·7	3
4	“	“ “	18. (Group 6 oil sands)	0·839	135	248	307	425	538	617	637	646	650	657	670	686	709	98·5	0·809	1·9	2·8	4
5	“	“ “	70. (Group 6 oil sands)	0·833	122	227	295	408	531	612	633	636	639	648	660	674	705	98·0	0·803	2·0	3·0	5
6	“	“ “	20. (Group 6 oil sands)	0·838	150	243	300	407	522	608	643	663	670	672	692	711	729	98·5	0·811	1·8	2·5	6
61	“	“ “	Composite sample from all producing wells	0·838	162	248	305	414	538	600	640	660	670	690	707	710	720	97·5	0·809	1·1	3·0	61
66	“	“ “	48A. (Group 5 oil sands)	0·751	140	201	218	238	251	262	282	297	326	428	672	680	680	98·0	0·744	......	1·4	66
	Quebec																					
7	Gaspe	Gaspe Oil Co.	Conant well	0·875	310	389	442	496	566	626	670	694	700	702	704	......	706	94·0	0·840	1·2	2·6	7
8	“	Canadian Petroleum Co.	Canadian Petroleum No. 9	0·861	290	350	387	442	496	548	608	658	694	723	730	734	735	98·0	0·844	1·3	1·1	8
11	“		Oil Spring	0·929	520	548	570	640	678	688	690	694	696	698	698	......	702	95·8	0·890	5·3	3·9	11
12	“	Petroleum Oil Trust	Petroleum Oil Trust No. 20	0·800	186	243	269	314	364	423	487	549	621	676	706	713	726	99·0	0·792	0·2	0·7	12
56	“	“	Composite sample from wells 10, 7, and 11	0·884	420	480	509	548	583	614	650	665	670	690	702	718	720	97·0	0·861	2·3	3·0	56
57	“	“	Petroleum Oil Trust No. 20	0·811	240	280	298	343	391	448	507	563	638	706	720	730	752	99·5	0·802	0·1	0·6	57
58	“	“	Petroleum Oil Trust No. 34	0·793	174	220	246	286	328	394	458	530	606	672	734	756	770	99·0	0·787	0·1	0·7	58
	Ontario																					
13	Brant	Onondaga Oil and Gas Co.	Onondaga No. 1 (Fearman Farm)	0·859	236	337	397	484	556	616	648	669	697	709	726	746	764	97·5	0·832	1·3	2·4	13
14	Dunwich Township	Peace River Development Co.	Peace River No. 3	0·897	400	471	505	564	615	639	656	671	685	700	720	725	738	96·5	0·850	3·4	3·5	14
15	Wallacetown	G. H. Lidster	Lidster No. 1	0·837	150	228	261	330	414	494	580	638	664	674	698	708	712	97·5	0·810	1·6	2·4	15
16	Mosa Township	J. A. Walker	Walker No. 17	0·854	200	276	315	420	500	571	619	641	660	668	683	709	742	97·5	0·828	2·4	1·9	16
17	“		Composite sample	0·857	196	297	346	443	517	587	633	654	661	683	708	722	744	98·0	0·831	2·3	2·0	17
18	Bothwell		Composite sample from tank	0·844	206	276	313	380	450	529	600	648	662	670	697	711	737	98·5	0·822	1·6	1·7	18
19	“		Composite sample	0·838	175	250	285	346	426	507	576	639	650	664	699	709	741	99·0	0·815	1·8	1·7	19
20	Thamesville	Colchester Oil Co.	“Deep well”	0·827	140	227	271	341	421	499	572	626	666	684	705	717	726	98·5	0·810	1·3	1·6	20
21	“	Ajax Oil and Gas Co.	Ajax No. 1 (Earl Smith Farm)	0·838	176	276	306	365	440	505	578	622	649	672	690	698	720	98·3	0·818	1·6	1·8	21
22	“	Colchester Oil Co.	Barclay well	0·823	152	219	250	304	364	442	511	601	646	661	673	688	697	98·2	0·807	1·3	1·4	22
23	“		Composite sample	0·831	190	251	282	337	407	482	556	618	652	667	684	709	726	99·0	0·811	1·1	1·6	23
24	“	Vacuum Gas and Oil Co.	Composite sample from tank	0·833	193	257	289	348	417	487	563	628	655	674	694	708	737	98·5	0·813	1·4	1·6	24
25	Oil Springs	Fairbank Estate	Fairbank No. 157	0·845	178	254	291	352	437	526	602	643	659	669	693	701	729	97·8	0·819	2·5	2·2	25
26	Petrolia	E. Kelly	Kelly No. 2	0·855	174	256	304	381	480	564	631	652	657	663	677	700	723	97·5	0·823	3·2	2·6	26
27	Dover Township	Petrol Oil and Gas Co.		0·826	134	226	270	329	400	483	558	627	668	692	711	723	730	97·8	0·814	1·2	1·7	27
28	Tilbury		Composite sample	0·844	297	364	408	457	496	551	605	651	678	694	709	713	723	98·5	0·826	1·3	1·5	28
29	Dover Township	Petrol Oil and Gas Co.	Composite sample	0·836	199	278	311	371	440	513	581	646	678	688	692	700	750	99·0	0·818	1·5	1·4	29
40	Oil Springs	Hillis & Son	“Old Well”	0·845	175	247	283	352	437	523	607	652	666	680	689	694	737	98·0	0·819	2·3	2·3	40
60	“		Oil seepage	0·842	170	230	265	336	424	494	590	636	680	703	730	736	740	97·5	0·820	1·2	2·2	60
67			Oil seepage	0·838	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	67
	Alberta																					
30	Wainwright	Wainwell Oils, Ltd.	Wainwell No. 1	0·971	290	533	564	604	632	648	670	687	705	720	......	......	724	82·0	0·908	0·2	2·9	30
31	Turner Valley	McDougall-Segur Oil Co.	New McDougall-Segur No. 1	0·758	124	162	184	206	228	254	280	312	360	432	562	......	712	98·0	0·759	0·1	0·8	31
32	Wainwright	Gipsy Oils, Ltd.	British Petroleums No. 3B	0·945	208	362	432	538	602	634	648	651	622	636	......	......	651	84·0	0·866	0·6	2·8	32
33	Turner Valley	Royalite Oil Co.	Royalite No. 10	0·750	117	152	169	198	220	246	270	300	342	411	557	708	724	97·0	0·750	0·1	1·4	33
34	“	Home Oils, Ltd.	Home No. 2	0·793	154	208	227	254	284	318	366	417	485	575	682	720	740	96·0	0·786	0·1	2·6	34
35	“	Foothills Oil and Gas Co.	Foothills No. 2	0·772	129	182	195	222	248	278	308	351	412	501	668	714	744	98·0	0·771	0·1	0·8	35
36	“	Dalhousie Oil Co.	Dalhousie No. 5	0·772	117	163	186	220	252	284	328	378	447	540	695	730	758	97·5	0·771	0·1	2·0	36
37	“	Okalta Oils, Ltd.	Okalta No. 2	0·773	135	180	200	227	252	282	314	355	411	497	652	710	747	97·0	0·769	0·2	1·9	37
38	“	Calmont Oils, Ltd.	Calmont No. 1	0·777	158	242	262	286	303	327	350	367	390	414	452	491	561	98·7	0·775	......	1·2	38
39	Skiff	Devenish Petroleum, Ltd.	Devenish No. 1	0·939	209	290	375	503	602	638	650	662	656	......	......	......	677	79·0	0·862	Trace	1·1	39
42	“	“	Devenish No. 3	0·943	228	280	344	491	586	623	645	659	659	......	......	......	680	79·0	0·859	0·5	3·6	42
43	Wainwright	Sasko-Wainwright Oil Co., Ltd.	Sasko-Wainwright No. 1	0·929	196	309	390	510	593	632	644	666	678	692	......	......	719	90·0	0·880	5·2	4·6	43
44	Ribstone	London-Ribstone Pet., Ltd.	London-Ribstone No. 1	0·954	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	44
45	“	Ribstone Oils, Ltd.	Meridian No. 1	0·981	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	45
46	Wainwright	Brit. Wainwright Oil and Dev. Co., Ltd.	British Wainwright No. 1	0·929	205	295	400	518	592	642	655	665	670	683	......	......	683	88·0	0·876	1·0	4·2	46
47	“	Wainwell Oils, Ltd.	Wainwell No. 4	0·957	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	47
48	Turner Valley	Model Oils, Ltd.	Model No. 1	0·875	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	48
49	“	British Dominion Oil Co.	British Dominion No. 2	0·763	130	175	194	218	241	266	290	328	370	446	575	......	737	98·5	0·762	Trace	0·9	49
50	Red Coulee	Alberta Pacific Consol. Oils, Ltd.	Vanalta No. 1	0·871	155	281	327	406	479	556	612	673	700	710	723	722	750	97·0	0·854	2·1	2·1	50
51	Moose Dome	Moose Oils, Ltd.	Moose No. 1	0·795	163	208	222	246	269	293	318	354	402	467	564	652	710	99·0	0·791	0·1	0·5	51
52	Bow River	Signal Hill Oil Co.	Signal Hill No. 2	0·799	139	196	215	263	316	383	465	529	599	677	754	767	767	98·0	0·798	0·6	1·5	52
54	Turner Valley	Royalite Oil Co.	Royalite No. 1 (Dingman No. 1)	0·759	166	200	210	223	238	253	268	290	314	347	447	564	670	98·5	0·755	Trace	0·4	54
59	Wainwright	British Petroleums, Ltd.	British Petroleums No. 4	0·969	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	59
62	“	“	British Petroleums No. 3B	0·944	250	383	459	545	599	637	660	674	680	694	......	......	698	86·7	0·886	0·1	5·6	62
	Northwest Territories																					
55	Fort Norman	Imperial Oil Co.	Discovery No. 1	0·862	222	268	299	356	418	495	566	640	676	696	710	742	746	97·5	0·844	2·5	2·2	55
	Miscellaneous																					
	Shale Oil																					
41	Rosevale, N.B.	Shale oil obtained by distillation in Pritchard Retort, Toronto (Runs 1, 2 and 3)		0·895	210	308	342	424	475	535	590	642	676	690	732	......	750	96·0	0·871	4·2	0·9	41
64	Pictou, N.S.	Shale oil obtained by distillation of core drill samples, Pictou co. (composite)		0·881	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	64
69	“	Shale oil obtained by distillation Bed “A”, New Glasgow		0·913	237	332	340	424	492	561	622	660	684	692	707	......	739	93·0	0·878	5·4	4·2	69
53	“	Can. Torbanite and Oil Prod., Ltd.	Shale oil from Exp. plant	0·893	......	437	472	521	568	617	653	678	709	732	724	745	745	97·0	0·875	3·8	2·0	53
70	“	Torbanite Products, Ltd.	“	0·900	210	302	342	407	464	522	587	635	672	692	722	740	740	96·5	0·881	2·3	2·6	70
71	“	“	“	0·899	253	338	379	433	481	533	574	627	668	732	752	758	758	98·0	0·888	2·1	0·9	71
	Bitumen																					
63	McMurray	Research Council, Alberta	Bitumen from Exp. plant, Edmonton	1·061	455	539	563	590	602	611	629	644	......	......	......	......	644	61·0	0·901	5·0	10·5	63
65	“	“	Bitumen from Clearwater separation plant (1930)	1·030	437	487	514	554	581	626	633	644	......	......	......	......	644	60·0	0·906	2·0	2·5	65
68	“	International Bitumens, Ltd.	Bitumen from Exp. separation plant	1·035	......	496	542	616	652	664	692	712	720	......	......	......	720	79·0	0·922	1·1	5·1	68