

B. F. Haanel
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CANADA
DEPARTMENT OF MINES

HON. W. A. GORDON, MINISTER

CHARLES CAMSELL, DEPUTY MINISTER

MINES BRANCH
JOHN MCLEISH, *Director*

DIVISION OF FUELS AND FUEL TESTING
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Gasoline Survey for 1934

BY

H. McD. Chantler



OTTAWA
J. O. PATENAUDE, I.S.O.
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1935

Price, 10 cents.

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GASOLINE SURVEY FOR 1934

The Division of Fuels and Fuel Testing of the Mines Branch has made at the Fuel Research Laboratories, a continuous study of the gasoline sold in Canada in the past eleven years, and annual reports have been prepared from the results obtained. This report contains the results in detail of the analyses of 117 samples of gasoline from wholesale dealers and distributors in fifteen cities during July 1934. The hearty support and co-operation of the Department of Pensions and National Health in collecting the samples is gratefully acknowledged.

It was found that the average gasoline sold in Canada was of good quality, with a higher volatility than that sold during any previous year and that the variation in quality was less than in any previous year, when judged by the volatility. The knock rating of the average gasoline sold in 1934 was 66 octane number, as compared with the average knocking ratings of 65 octane number in 1933 and the estimated 62 octane number in 1932. According to their knock ratings, the samples may be divided into three groups. These groups in 1934 would have average octane numbers of 77, 68, and 56 respectively; corresponding groups in 1933 had average octane numbers of 76, 69, and 60. The average Reid vapour pressure of the samples in 1934 was 7.5 pounds per square inch. Less than five per cent of the gasoline samples contained more than 10 milligrams of gum per 100 millilitres. All but one of the gasolines gave a negative corrosion test with a copper strip. Seventy per cent of the gasoline samples were artificially coloured. The retail price and the provincial tax at the time each sample was taken are shown in Table I. It should be noted, however, that at this time a "price war" was stated to affect the prices in Ottawa and Toronto.

METHODS OF ANALYSIS USED

The distillation range was determined according to the American Society for Testing Materials method D86-30.¹ The specific gravity was obtained by the use of the chainomatic specific gravity balance at room temperature and the result calculated to 60°F. according to the National Standard Petroleum Oil Tables.² The degrees A.P.I. were obtained by converting the specific gravity according to the above tables. The knock ratings of the gasoline were expressed in octane numbers, and were determined at 345°F. and 900 r.p.m. in a Series 30B knock-testing engine³, manufactured by the Ethyl Gasoline Corporation. The Reid vapour pressure was determined according to the A.S.T.M. tentative method D323-32T. The gum content of all of the samples collected was determined according to the A.S.T.M. tentative method D381-34T. In addition the gum content of some of the samples was determined according to the A.S.T.M. proposed⁴ method B. The corrosion test was made according to the A.S.T.M. method

D130-30. The colour was determined according to the A.S.T.M. tentative method D156-23T, except when the samples were artificially coloured, when the apparent colour is reported.

RESULTS OF LABORATORY EXAMINATION

The results of the laboratory examination of the gasoline tested in 1934 are shown by cities in Table I, and the average analyses are summarized in Table II. The average results obtained by examination of samples for the twelve years 1923 to 1934 are shown in Table III, and Figure 1 shows graphically the ranges of average distillation temperatures for the same twelve years. Table IV shows the average analysis of the three groups of gasoline sold in Canada in July 1934. In order to determine the variation in quality of the gasoline, the average of the 10 per cent of samples having the highest index numbers and the average of the 10 per cent having the lowest index numbers were calculated for 1934, and the results are given in Tables V and VI. Table VII shows the difference between the average index numbers of the maximum and minimum 10 per cent of the samples collected in the twelve years 1923 to 1934. Table VIII gives a classification of the samples collected in 1934 arranged according to arbitrary octane number groups. Table IX shows the average knock rating of 50 brands of gasoline. Table X shows the average knock rating of the samples of 21 different brands of gasoline sold by eight oil companies in 1934, arranged according to groups. Table XI gives a classification of the samples taken in 1934 according to the results of the Reid vapour pressure determination. A classification of the samples collected in 1934 according to their gum content is shown in Table XII. A comparison of the gum content of some of the 1934 samples, when determined by two different methods is recorded in Table XIII. The percentage of artificially coloured gasolines in the past eight years is shown in Table XIV.

A general discussion of the significance of the laboratory tests, together with the relationship between these tests and the actual operation of the fuel in the engine will be found in the report on Gasoline Surveys for 1930 and 1931.⁵ Owing to the rapid advancement in design and construction of new motors, the average compression ratio⁶ of automobile motors has steadily increased in recent years. This has required a corresponding change in the knock rating of the motor fuels for these new automobiles. Knock rating has, therefore, become a significant factor in the marketing of motor fuels for these new automobiles, although volatility is still the primary requisite for all automobiles. In order to meet the requirements of all automobiles, the major oil companies, generally speaking, are now marketing three grades of motor fuels and these grades differ principally in knock ratings. These three grades are usually known in the oil industry as "Premium", "Regular" brand, and "Third Grade" gasoline. Corresponding approximately to these three grades, the gasoline samples collected in Canada in 1934 have been divided into three groups. It should be noted that these groups are arbitrary octane number groups selected by the Fuel Research Laboratories and defined as:—

- Group I. Gasolines with octane numbers of 75 and above.
- Group II. Gasolines with octane numbers between 74 and 65.
- Group III. Gasolines with octane numbers of 64 and below.

VOLATILITY

It is interesting to compare the results of the laboratory analysis obtained in 1934 with those obtained in previous years. In Table III are given the average results of the samples collected in Canada in successive years from 1923 to 1934 inclusive. When judged by the distillation range which has been the ordinarily accepted standard, it will be observed that the gasoline sold in Canada in 1934 shows an average of good quality, with a higher volatility than that sold in the past eleven years. It should be noted that the average gasoline sold in Canada in 1933 and 1934 has shown a marked increase in volatility. When compared with the average volatility of the gasoline sold in 1933, increased volatility in 1934 is shown by approximately a 4°F. drop in the average temperature of the 10, 20, 50 and 70 per cent points in the distillation range, as shown graphically in Figure 1.

Table VII shows the difference between the average index numbers of the 10 per cent having maximum index numbers and the 10 per cent having minimum index numbers, of the samples collected in Canada in the twelve years 1923 to 1934. The difference between the two averages has been used previously for the purpose of comparison, as a measure of the variation in quality. It will be observed that the variation in quality during 1934 was less than in any previous year. This decrease in the difference of the average volatility in the higher and lower groups in the past four years indicates the growing tendency towards a more uniform grade of gasoline.

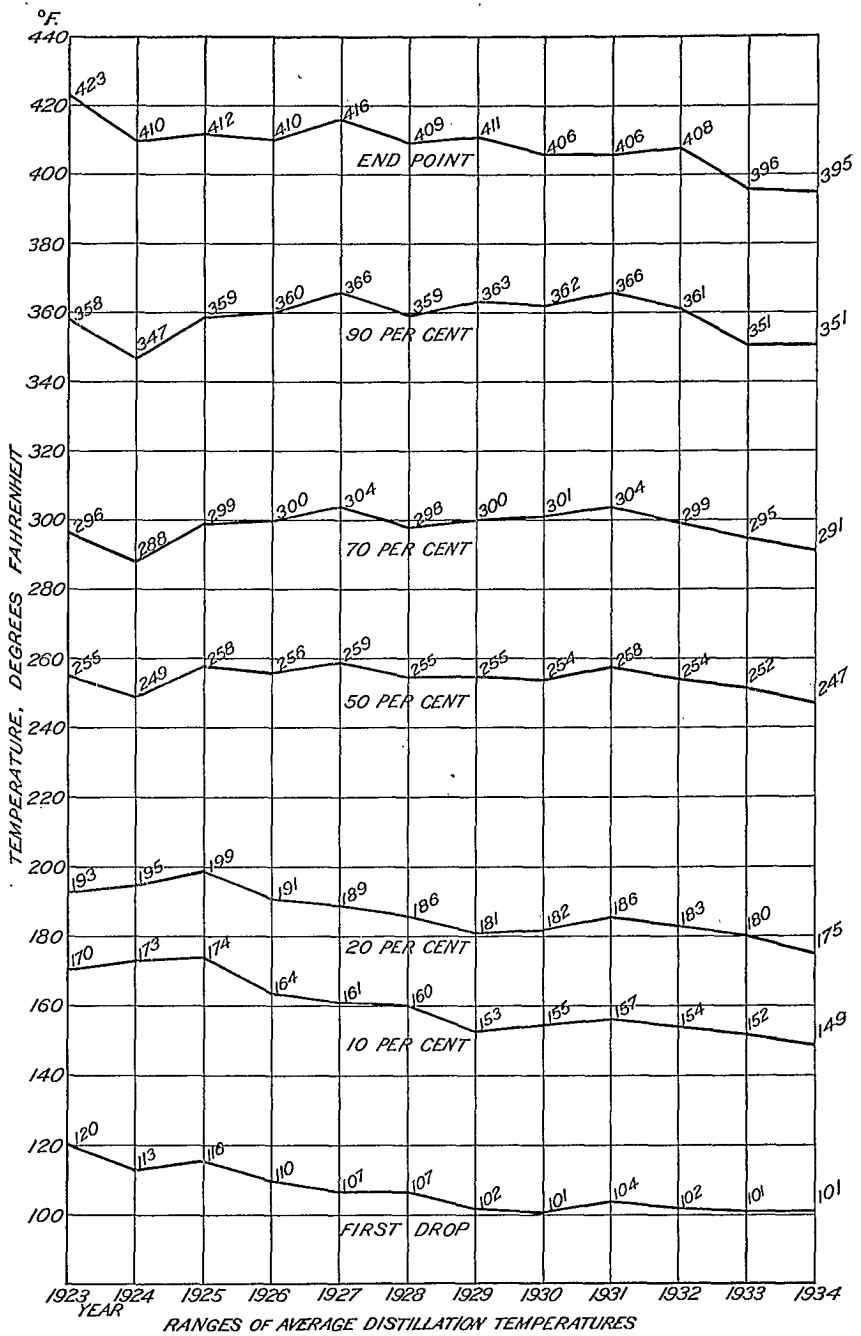
In 1934, the group having the higher volatility has an average volatility greater than the corresponding groups examined in 1931, 1932, and 1933. The group having the lower volatility has an average volatility greater than the corresponding groups examined in any previous year. This indicates that there is a tendency to market a more volatile grade of gasoline.

Table IV shows the average analysis of the three arbitrary octane number groups of gasoline sold in Canada in July 1934. It will be noted that these three groups have almost the same volatility. This indicates the tendency for all grades of gasoline to have the same volatility.

KNOCK RATINGS

In 1934, the knock ratings of the gasoline were determined in a knock-testing engine known as Series 30B, manufactured by the Ethyl Gasoline Corporation. The operating conditions³ were a speed of 900 r.p.m., a jacket temperature of 345°F., and a spark advance 15 degrees below top dead centre. The knock ratings were expressed in octane numbers.

The knock ratings expressed in octane numbers for individual samples are given in Table I. The highest knock rating was 78 octane number and the lowest was 41 octane number. The average knock rating of the 117 samples was 66 octane number. The average knock rating of the gasoline collected in 1933 was 65 octane number and the average knock rating in 1932 was estimated, from knock ratings determined at 212°F. and 600 r.p.m., to be 62 octane number. This indicates a gradual improvement in the knock rating of the average gasoline being sold in Canada.



According to knock ratings only, the 1934 samples may be divided into three groups as follows:—

Group I. Gasolines of high knock ratings with octane numbers of 75 and above.

Group II. Gasolines of medium knock ratings with octane numbers between 74 and 65.

Group III. Gasolines of low knock ratings with octane numbers of 64 and below.

According to the above three arbitrary octane number groups, selected by the Fuel Research Laboratories, the group in which each sample logically falls is noted in Table I. As shown in Table VIII, 15 samples, or 12·8 per cent of all the samples collected, were in Group I with an average octane number of 77; 66 samples, or 56·4 per cent, were in Group II, with an average octane number of 68; and 36 samples, or 30·8 per cent, were in Group III, with an average octane number of 56. The average octane number of corresponding groups of gasoline in 1933 was 76 for Group I, 69 for Group II, and 60 for Group III. Table IX shows the average knock ratings of 50 brands of gasoline.

In Table X is given the average knock rating of 21 different brands of gasoline sold by 8 oil companies in 1934 arranged according to groups. It will be observed that the brands of gasoline sold by these major oil companies fall logically in the groups defined above. These three groups are usually known in the oil industry as "Premium", "Regular" brand, and "Third Grade" gasoline. For the gasoline sold by these 8 companies, the average octane number for Group I ("Premium") is 77 octane number, for Group II ("Regular" brand) is 67 octane number, and for Group III ("Third Grade") is 58 octane number. The average octane number of corresponding groups of gasoline sold by the same companies in 1933 was 76 for Group I, 67 for Group II, and 59 for Group III. It will be noted that the average octane number of these three groups has been fairly uniformly maintained in the past two years.

Tetra-ethyl lead was blended with the majority of the gasoline samples in Group I and Group II, in order to increase their knock ratings; benzol was added for a similar purpose to one sample in Group I, one sample in Group II, and two samples in Group III.

Gasolines burn more smoothly the higher the octane number. Knock ratings, determined by the Series 30B engine at 345°F. and 900 r.p.m., are in fair agreement with grading of fuels by automobiles.³ The petroleum industry in Canada and the United States now generally uses an engine and method⁷ developed by the Co-operative Fuel Research Committee and usually denoted by the initials C.F.R.

VAPOUR PRESSURE

The average Reid vapour pressure of the gasoline samples collected in Canada during 1934 was 7·5 pounds per square inch. This is an increase of 0·6 pound per square inch in average vapour pressure from that observed for samples collected in 1933. The average Reid vapour pressure of the gasoline samples in 1932 was 7·4 pounds per square inch, in 1933 was 6·9

and in 1934 was 7.5 pounds per square inch. A classification of the 1934 samples according to the results of the Reid vapour pressure determination is shown in Table XI. This table shows that 7.7 per cent of the samples had Reid vapour pressures of 6 pounds or less per square inch, 65.0 per cent had between 8 and 6.1 pounds, 26.4 per cent had between 10 and 8.1 pounds, and only 0.9 per cent had over 10 pounds per square inch. The average Reid vapour pressure of the three grades of gasoline in Canada in July 1934 was 7.6 pounds per square inch for Group I, 7.5 pounds for Group II, and 7.4 pounds for Group III, as shown in Table IV. The Reid vapour pressure is used to indicate the temperatures at which vapour lock may occur. Vapour lock⁸ does not occur in all engines under similar conditions with fuels of the same vapour pressure, and on that account, in the writer's opinion, the Reid vapour pressure should not exceed 10 pounds per square inch. It is to be noted that only one of the 117 samples collected in 1934 had a Reid vapour pressure over 10 pounds per square inch.

GUM

The gum content of motor fuels is determined by evaporating a quantity of the gasoline under an air jet. Two methods were used to determine the gum content of the samples of gasoline collected in 1934. A.S.T.M. tentative method D381-34T determines the gum content by evaporating a known volume of the sample in a glass beaker under a hot air jet at 320°F. and weighing the residue. The result is expressed in milligrams per 100 millilitres. A.S.T.M. proposed method B differs from A.S.T.M. tentative method D381-34T only in that the evaporation is made at 374°F. instead of 320°F. The gum content was first determined on all samples at 320°F. and only those samples that were "oily" and had 10 milligrams or more of gum at 320°F. were, also, tested at 374°F. The determinations were made in duplicate and the average reported to the nearest five milligrams. Those samples that averaged less than 2 milligrams were reported as "nil", since that amount is considered to be negligible. The results shown in Table I are those obtained by the method, which, in the writer's opinion, gave the most accurate result for any particular sample. The results are indicative of the amount of gum that may be deposited, if the fuel is used immediately.

As shown in Table XII, the gum content of 64 samples or 54.7 per cent of the 117 samples was less than 2 milligrams per 100 millilitres and has, therefore, been reported as "nil", 53 samples, or 45.3 per cent of the total number collected, were found to contain an appreciable amount of gum. Of these, 40 samples, or 34 per cent of all samples, had 5 milligrams of gum, 8 samples, or 6.8 per cent, had 10 milligrams, 1 sample had 15; and 4 samples had residues of 20, 40, 60 and 110 milligrams respectively, and were reported as "oily" to indicate that the residues had the appearance of lubricating oil and did not dry to a hard varnish-like or gummy coating, as is usually the case. These four samples appeared to contain lubricating oil, which could not be separated from the gum by either method.

Table XIII shows the gum content, as determined by two methods, of sixteen of the 117 samples collected in 1934. It will be observed that all of these samples were "oily" after evaporation at 320°F. and that only 6 of the 16 samples remained "oily" after evaporation at 374°F. This indicates

that the oil may be separated from the gum in some samples by evaporation at a higher temperature. In the writer's opinion, 14 samples, or 12 per cent of all the samples collected in 1934 contained lubricating oil, presumably added as a "top lubricant".

The limit of tolerance for multi-cylinder engines has been stated⁴ to be not over 10 milligrams per 100 millilitres. The above results show that only 4.5 per cent of the samples tested in 1934 had a gum content above this limit of 10 milligrams.

CORROSION

The corrosion test for motor fuels is made by immersing a strip of polished copper for three hours in a sample of the gasoline heated to 122°F., according to A.S.T.M. method D130-30, and observing the tarnishing or corrosion that takes place. The copper strip should not show more than a "slight discoloration". The test is intended to show the possible corrosive effect of the gasoline on the metal in the fuel and induction systems of internal combustion engines. As shown in Table I all but one of the 117 samples collected in 1934 gave a negative test for corrosion, which indicates that little fear of corrosion need be felt with these gasolines at atmospheric temperatures.

The acidity of the gasoline was, also, tested, according to the U.S. Bureau of Mines method 510.2⁹. This test involves extracting the distillation residue with water and testing the extract for acidity with an indicator. All of the gasoline samples collected in 1934 gave a negative test for acidity. This indicates that the gasolines had been properly treated at the refinery to remove free acid, such as sulphuric acid, before being released to the consumer.

The doctor test was also made on all the 1934 gasoline samples, according to the U.S. Bureau of Mines method 520.3⁹. Gasolines are reported as "negative" or "sweet" when they pass the doctor test and "positive" or "sour" when they fail to pass. The test is essentially a very sensitive chemical test for such sulphur compounds as hydrogen sulphide and mercaptans. The test is primarily a refiner's test and probably the main reason¹⁰ that gasolines are rendered negative to the doctor test is to improve their odour. Of the 117 samples of gasoline collected in 1934, only nine samples—namely, laboratory numbers 20, 23, 27, 56, 57, 84, 94, 95 and 96,—were positive or failed to pass the doctor test. However, in the writer's opinion, only four of the samples that failed to pass the doctor test had a very bad odour.

However, the tendency of a motor fuel to be corrosive is, in the writer's opinion, indicated more definitely by the copper strip corrosion test than by the acidity or doctor tests, and for this reason the results of the acidity and doctor tests are not shown in Table I.

COLOUR

Gasoline is a clear, water-white liquid when freshly distilled. The Saybolt colour number was determined for all the samples that were not artificially coloured. The higher the Saybolt number, the lighter, or "whiter" is the colour of the gasoline. It will be noted that all of the 35 samples had colour numbers lighter than +19 Saybolt; but it is difficult to draw any clear-cut distinctions between motor fuels on the basis of colour.

Many gasolines on the market have small quantities of various dyes dissolved in them, in order to make them more attractive, to distinguish readily between different brands or groups, or to indicate the presence of tetra-ethyl lead, so that the gasoline shall not be used for any other purpose than as a motor fuel. Since 1927, there has been an increasing tendency to dye the motor fuels being put on the market. As indicated in Table XIV, according to the samples examined in the annual survey, the percentage of artificially coloured gasoline sold in Canada has increased in eight years from 10 per cent in 1927 to 70 per cent in 1934. The apparent colour of the samples containing dye is reported in Table I. As shown in Table IV, of the samples collected in 1934, 100 per cent of the Group I and 89 per cent of the Group II gasolines were coloured, and only 22 per cent of the Group III gasolines were coloured. This indicates that the oil companies and distributors are colouring their motor fuels in order to distinguish between their different brands or grades. But it should be noted that the addition of a dye has no effect on the quality of the motor fuel, nor has it any effect on the operation of the engine. Deposits in the carburetor and engine parts are frequently coloured with the dye from the motor fuel; but these deposits cannot be properly attributed to the dye itself. It is very difficult to draw any clear cut distinctions between dyed motor fuels on the basis of their colour. The artificial or natural colour of a motor fuel cannot be used, at the present time, as a definite indication of quality.

GRAVITY

The specific gravity and the gravity in degrees A.P.I. is shown in Table I. Gravity has been used in the petroleum industry for many years as an easy and convenient method of refinery control, but it should not be used as an indicator of quality, and it is only of value, when used in conjunction with the distillation range, to indicate the probable source of the fuel or the treatment it has received. It is reported here for comparison with the gravity obtained in previous surveys and for the information it may give. As indicated by the results of these surveys, the specific gravity of the gasoline sold in summer usually varies from about 0.720 to 0.755, with a corresponding variation in degrees A.P.I. from about 65 to 56. When motor fuels contain an appreciable amount of benzol the specific gravity may be as heavy or heavier than 0.790, equivalent to about 47 degrees A.P.I.

PRICE

The samples were collected during the first week of July, 1934 and the retail price and the provincial tax at the time each sample was taken is shown in Table I. Except in Ottawa, usually only one brand or "group" of gasoline was collected in a city from an individual company or distributor, and therefore a comparison of the price of different brands or groups of gasoline sold by an individual company cannot be made for Canada. In Ottawa all the brands or groups of gasoline sold by an individual company were collected. Generally speaking, in Ottawa, the retail price of the "Premium" or Group I gasoline was two cents higher than the retail price of the "Regular" brand or Group II gasoline, and the retail price of the "Third Grade" brand or Group III gasoline was one to two cents lower than the

retail price of the "Regular" brand gasoline. As shown in Table I, in Canada in July 1934, the highest retail price excluding tax was 28 cents and the lowest retail price was 13 cents per gallon, but it should be noted that at this time a price war was stated to affect the price in Toronto and Ottawa. The provincial tax varied from 6 to 8 cents per gallon depending on the province in which the gasoline was purchased.

SUMMARY AND CONCLUSIONS

In July 1934, 117 samples of gasoline were collected from fifteen different cities. As these cities are widely separated and are distribution centres throughout the country, the samples taken may be accepted as representative of the gasoline sold in Canada at that time. The samples consisted of 50 different brands of motor fuel sold by 32 wholesalers or distributors.

The analysis of the samples has shown that the average gasoline sold during 1934 was of good quality. The average gasoline in 1934 was more volatile than the average gasoline sold in any previous year.

The variation in quality of the average gasoline in 1934 was less than in any preceding year. This indicates a growing tendency towards a more uniform and more volatile grade of gasoline.

In 1934, as in 1933, the knock ratings of the gasoline were determined in a Series 30B engine at 900 r.p.m. and 345°F., as this method gives knock ratings which are in fair agreement with the actual ratings of gasoline in automobiles. The knock rating of the average gasoline collected in 1934 was 66 octane number. When compared on the same basis of test procedure, the knock rating of the average gasoline in 1932 was estimated to be 62 octane number and in 1933 was 65 octane number. This indicates a gradual improvement in the knock rating of the average gasoline being sold in Canada.

A table is included which shows the average knock ratings of fifty different brands of gasoline. There are three groups of gasoline being sold in Canada, according to the analysis of the 1934 gasoline samples. These groups differ principally in knock ratings, as the average volatility of all groups is practically the same. These groups of gasoline are usually known as "Premium" or Group I, "Regular" brand or Group II, and "Third Grade" or Group III. In 1934, the average knock rating of Group I gasoline was 77 octane number, of Group II was 68 octane number, and of Group III gasoline was 56 octane number. The average octane number of corresponding groups of gasoline in 1933 was 76 for Group I, 69 for Group II, and 60 for Group III.

Tetra-ethyl lead was blended with the majority of the 1934 gasoline samples in Groups I and II, and benzol was added to 4 samples in order to increase their knock ratings.

The average Reid vapour pressure of the 1934 gasoline samples was 7.5 pounds per square inch, an increase of 0.6 pound from the average Reid vapour pressure of the 1933 gasoline samples. All but one of the samples collected in 1934 had Reid vapour pressures less than 10 pounds.

Less than five per cent of the 1934 samples contained more than 10 milligrams of gum per 100 millilitres, which is considered the usual limit of tolerance for gum in gasoline for use in automobiles. Twelve per cent of the gasoline samples contained lubricating oil, presumably added as a "top lubricant".

All but one of the 1934 gasoline samples gave a negative test for corrosion with a copper strip.

All of the clear, or "white" gasoline samples had a Saybolt colour number lighter than +19. Seventy per cent of the 1934 gasoline samples were artificially coloured.

The retail price and tax during the first week in July 1934 is shown for each sample of gasoline. The highest retail price shown is 28 cents per Imperial gallon and the lowest retail price shown is 13 cents per Imperial gallon. The provincial tax varies from 6 to 8 cents per gallon depending on the province in which the gasoline is sold. In the city of Ottawa, generally speaking, the retail price of the "Premium" gasoline was two cents higher, and the retail price of the "Third Grade" gasoline was one to two cents lower than the retail price of the "Regular" brand gasoline.

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TABLE I
Gasoline Survey Analyses for 1934 by Cities

Sample No.	Price, cents per gallon		Group*	Octane number at 345 °F. and 900 r.p.m.	Distillation Range						Recovery	Residue	Distillation loss	Index No. °F.	Specific gravity	Degrees A.P.I.	Vapour pressure	Gum milli-grams per 100 milli-litres	Corrosion test	Colour Saybolt	
	Gasoline	Tax			1st drop °F.	10% °F.	20% °F.	50% °F.	70% °F.	90% °F.											End point °F.
HALIFAX, N.S.																					
1	24	8	1	77	105	151	177	250	288	350	398	97.5	1.4	1.1	1614	0.738	60.2	6.8	5	No	Red
2	22	8	2	70	105	150	177	246	288	346	398	98.0	1.2	0.9	1603	0.737	60.5	7.4	5	No	Green
3	23	8	1	77	105	149	176	246	288	346	404	98.0	1.2	0.8	1609	0.737	60.5	7.0	5	No	Red
4	22	8	2	71	104	146	178	240	285	348	404	97.5	1.2	1.3	1610	0.736	60.8	7.4	5	No	Blue
5	22	8	2	68	104	151	175	242	280	342	381	98.0	1.2	0.8	1571	0.739	60.0	7.9	5	No	Blue
Average..					105	149	177	247	285	346	397	97.8	1.2	1.0	1601	0.737	60.5	7.3			
SAINT JOHN, N.B.																					
6	22	8	3	60	110	157	181	252	291	346	401	98.0	1.2	0.8	1628	0.737	60.5	5.8	Nil	No	+27
7	22	8	2	70	100	144	173	256	300	361	408	97.5	1.3	1.2	1642	0.740	59.7	7.6	60	No	Green
8	22	8	2	71	100	147	173	250	288	348	399	97.0	1.2	1.8	1605	0.734	61.3	8.0	Nil	No	Blue
9	22	8	2	67	104	154	184	256	298	351	405	97.5	1.2	1.3	1648	0.743	58.9	7.4	5	No	Yellow
10	22	8	2	67	105	147	171	249	296	351	392	98.0	1.2	0.8	1606	0.738	60.2	6.9	Nil	No	Blue
Average..					104	150	176	253	295	351	401	97.6	1.2	1.2	1626	0.738	60.2	7.1			
QUEBEC, QUE.																					
11	23	6	2	66	107	160	186	258	296	346	387	98.0	1.2	0.8	1633	0.744	58.7	5.8	5	No	Green
12	23	6	3	60	106	164	196	264	303	358	407	98.0	1.3	0.7	1692	0.747	57.9	5.3	Nil	No	+28
13	21	6	2	71	106	153	178	248	290	352	405	98.0	1.4	0.6	1626	0.745	58.4	7.2	Nil	No	Purple
14	25	6	1	76	104	147	173	247	291	356	414	97.0	1.3	1.7	1628	0.735	61.0	7.1	5	No	Red
15	23	6	2	70	102	148	178	251	291	350	403	98.0	1.2	0.8	1621	0.738	60.2	7.3	Nil	No	Green
16	22	6	2	66	100	138	158	222	267	334	383	97.0	1.0	2.0	1502	0.728	62.9	7.9	Nil	No	+30
Average..					104	152	178	248	290	349	400	97.7	1.2	1.1	1617	0.740	59.7	6.8			

*Group used as above and at other places in this report means an arbitrary octane number group, selected by the Fuel Research Laboratories, and may be defined as follows: Group I (1) octane number 75 and above; Group II (2), octane number 74 to 65; and Group III (3), octane number 64 and below.

TABLE I—Continued
Gasoline Survey Analyses for 1934 by Cities—Continued

Sample No.	Price, cents per gallon		Group ^a	Octane number at 345 °F. and 900 r.p.m.	Distillation Range						Recovery	Residue	Dis-tillation loss	Index No. °F.	Specific gravity	De-grees A.P.I.	Vapour pressure	Gum milli-grams per 100 milli-litres	Corrosion test	Colour Saybolt	
	Gasoline	Tax			1st drop °F.	10% °F.	20% °F.	50% °F.	70% °F.	90% °F.											End point °F.
MONTREAL, QUE.																					
17	20	6	1	75	98	144	172	242	287	344	374	97-0	1-2	1-8	1562	0-730	62-3	9-3	Nil	No	Red
18	18	6	2	65	94	143	176	250	294	349	374	96-0	1-2	2-8	1591	0-732	61-8	9-4	5	No	Green
19	20	6	1	77	122	169	184	216	256	335	400	98-0	1-2	0-8	1560	0-791	47-4	4-9	5	No	Pink
20	18	6	2	70	100	152	187	259	297	353	405	97-0	1-2	1-8	1653	0-741	59-5	7-2	Nil	No	Purple
21	23	6	1	76	101	150	179	255	300	360	412	97-0	1-3	1-7	1656	0-740	59-7	6-3	10	No	Red
22	21	6	2	68	100	148	178	254	296	355	406	97-0	1-2	1-8	1637	0-738	60-2	7-3	5	No	Green
23	21	6	2	70	104	153	180	262	303	352	395	98-0	1-0	1-0	1645	0-748	57-7	6-7	Nil	No	Blue
24	21	6	2	69	98	147	175	252	293	347	383	97-0	1-2	1-8	1597	0-738	60-2	8-4	5	No	Blue
25	23	6	1	77	97	146	177	251	292	349	411	97-5	1-3	1-2	1626	0-738	60-2	7-6	10	No	Red
26	21	6	2	69	100	148	180	257	298	354	408	97-0	1-2	1-8	1645	0-739	60-0	7-6	5	No	Green
Average..	21	6	2	69	101	150	179	250	291	350	397	97-2	1-2	1-6	1617	0-744	58-7	7-5			
OTTAWA, ONT.																					
27	14½	6	3	63	108	155	182	255	295	345	388	97-0	1-2	1-8	1620	0-738	60-2	7-4	Nil	No	+20
28	14	6	3	63	101	152	182	254	293	345	387	97-5	1-1	1-4	1613	0-738	60-2	6-5	Nil	No	Blue
29	19	6	2	72	119	162	173	191	226	327	384	98-0	1-1	0-0	1463	0-789	47-8	5-7	Nil	No	Pink
30	17	6	3	61	100	149	172	229	282	341	375	97-0	1-0	2-0	1548	0-744	58-7	8-1	Nil	No	Green
31	15	6	3	56	97	149	180	253	299	373	419	96-0	1-1	2-9	1673	0-736	60-8	8-8	Nil	No	+30
32	17	6	1	75	98	144	171	242	286	344	374	97-0	1-1	1-9	1561	0-732	61-8	9-0	Nil	No	Red
33	15	6	2	65	96	145	164	250	296	348	377	97-0	1-0	2-0	1580	0-735	61-0	8-5	Nil	No	Green
34	13	6	3	57	99	150	177	245	290	346	374	96-5	1-0	2-5	1582	0-736	60-8	8-6	Nil	No	+30
35	17	6	1	76	98	141	167	251	303	364	412	97-0	1-3	1-7	1638	0-738	60-2	7-6	10	No	Red
36	15	6	2	69	98	152	178	253	295	352	401	97-5	1-2	1-3	1631	0-738	60-2	7-2	Nil	No	Green
37	15	6	3	58	98	150	177	244	289	345	375	97-0	1-1	1-9	1580	0-732	61-8	8-1	Nil	No	+30
38	17	6	1	77	95	137	164	249	293	353	411	97-0	1-4	1-6	1607	0-736	60-8	9-4	5	No	Red
39	15	6	2	69	99	147	177	254	296	355	403	96-5	1-2	2-3	1632	0-737	60-5	7-6	5	No	Green
40	13	6	3	64	98	148	181	256	291	355	405	97-5	1-0	1-5	1636	0-742	59-2	6-7	Nil	No	+27
41	17	6	1	77	100	148	178	252	291	349	411	98-0	1-4	0-6	1629	0-739	60-0	7-3	10	No	Red
42	15	6	2	69	100	150	179	252	295	350	402	98-0	1-2	0-8	1628	0-740	59-7	7-0	Nil	No	Green
43	13	6	3	63	100	154	182	256	293	353	405	98-0	1-1	0-9	1643	0-744	58-7	6-2	5	No	+26
44	13	6	2	67	102	152	185	267	305	355	395	98-0	1-0	1-0	1659	0-751	56-9	7-2	5	No	+25
45	17	6	1	78	100	147	178	263	304	354	389	97-5	1-1	1-4	1635	0-749	57-4	7-7	Nil	No	Red
46	15	6	2	66	97	144	173	250	296	350	377	96-5	1-1	2-4	1590	0-734	61-3	8-7	Nil	No	Blue

TABLE I—Continued
Gasoline Survey Analyses for 1934 by Cities—Continued

Sample No.	Price, cents per gallon		Group*	Octane number at 345 °F. and 900 r.p.m.	Distillation Range							Recovery	Residue	Distillation loss	Index No. °F.	Specific gravity	De-grees A.P.I.	Vapour pressure	Gum milligrams per 100 millilitres	Corrosion test	Colour Saybolt
	Gasoline	Tax			Ist drop °F.	10% °F.	20% °F.	50% °F.	70% °F.	90% °F.	End point °F.										
OTTAWA, ONT.—Concluded																					
47	13	6	3	58	100	147	174	245	289	347	376	97.0	1.0	2.0	1578	0.733	61.5	7.9	5	No	+30
48	19	6	1	77	103	150	172	240	282	340	397	98.0	1.2	0.8	1581	0.742	59.2	7.1	15	No	Red
49	16	6	2	66	97	134	154	220	265	327	379	98.0	1.1	0.9	1479	0.728	62.9	7.8	Nil	No	+30
50	14	6	2	67	101	150	178	253	296	349	388	97.5	1.2	1.3	1614	0.741	59.5	7.6	5	No	Blue
51	19	6	1	76	102	146	176	248	288	349	394	96.5	1.4	2.1	1601	0.739	60.0	7.7	10	No	Red
52	15	6	2	69	98	147	174	254	294	351	406	97.5	1.2	1.3	1626	0.738	60.2	8.0	Nil	No	Green
53	13	6	3	62	104	164	194	259	298	357	412	97.5	1.2	1.3	1684	0.736	60.8	6.1	Nil	No	+30
Average..					100	149	176	247	290	349	393	97.3	1.1	1.6	1604	0.740	59.7	7.6			
TORONTO, ONT.																					
54	19	6	2	65	104	148	174	246	290	344	376	97.0	1.1	1.9	1578	0.732	61.8	7.8	Nil	No	Green
55	18½	6	2	66	99	147	173	245	290	344	375	98.0	0.9	1.1	1574	0.732	61.8	8.1	5	No	Green
56	19	6	2	69	104	156	186	254	292	342	386	97.5	1.1	1.4	1616	0.738	60.2	6.6	Nil	No	Green
57	16	6	3	42	96	127	152	266	335	407	449	97.0	1.5	1.5	1736	0.723	64.2	10.0	10	No	+20
58	18½	6	2	69	99	146	174	251	288	343	385	97.0	1.1	1.9	1587	0.734	61.3	7.9	5	No	Green
59	18½	6	2	69	105	154	188	263	305	362	404	98.0	1.3	0.7	1676	0.748	57.7	6.2	5	No	Blue
60	18½	6	2	66	98	134	155	226	275	340	386	97.5	1.1	1.4	1516	0.730	62.3	8.7	5	No	+30
61	18½	6	2	67	100	146	177	252	293	347	388	98.0	1.2	0.8	1603	0.740	59.7	8.1	5	No	Blue
62	18½	6	2	70	102	149	178	252	290	339	383	97.0	1.2	1.8	1591	0.734	61.3	8.2	Nil	No	Green
63	13	6	3	42	94	132	158	270	340	419	450	96.0	2.4	1.6	1799	0.728	62.9	9.3	5	No	+27
Average..					100	144	172	252	300	359	398	97.3	1.3	1.4	1625	0.734	61.3	8.1			
HAMILTON, ONT.																					
64	18½	6	2	66	98	143	170	246	291	344	375	97.5	1.0	1.5	1569	0.735	61.0	8.4	Nil	No	Green
65	17½	6	3	62	112	153	168	200	254	339	376	98.0	1.0	1.0	1490	0.768	52.7	7.0	5	No	Green
66	18½	6	2	69	95	149	178	250	288	337	369	97.0	1.2	1.8	1571	0.733	61.5	8.3	5	No	Green
67	20½	6	1	77	96	138	164	239	276	332	381	97.0	2.0	1.0	1530	0.725	63.7	8.5	110	No	Red
68	18½	6	2	70	98	144	175	250	289	338	368	97.0	1.0	2.0	1564	0.731	62.1	8.0	Nil	No	Green
69	18½	6	2	65	98	148	176	251	289	349	378	97.0	1.1	1.9	1598	0.735	61.0	8.5	Nil	No	Blue
70	18½	6	3	57	99	150	176	247	289	344	373	97.0	1.1	1.9	1579	0.732	61.8	8.2	Nil	No	+30
71	18½	6	2	66	100	140	162	226	274	336	378	97.0	1.0	2.0	1516	0.731	62.1	7.4	Nil	No	+30
72	18½	6	2	68	106	148	174	254	296	352	393	98.0	1.2	0.8	1617	0.742	59.2	7.7	5	No	Blue
73	18½	6	2	68	106	148	174	254	296	352	393	98.0	1.2	0.8	1617	0.742	59.2	7.7	5	No	Blue
Average..					101	146	172	241	284	341	376	97.3	1.1	1.5	1560	0.736	60.8	8.0			

TABLE I—Continued
Gasoline Survey Analyses for 1934 by Cities—Continued

Sample No.	Price, cents per gallon		Group*	Octane number at 345 °F. and 900 r.p.m.	Distillation Range							Recovery	Residue	Dis-tillation loss	Index No. °F.	Specific gravity	De-grees A.P.I.	Vapour pressure	Gum milli-grams per 100 milli-litres	Corrosion test	Colour Saybolt
	Gasoline	Tax			1st drop °F.	10% °F.	20% °F.	50% °F.	70% °F.	90% °F.	End point °F.										
LONDON, ONT.																					
74	20½	6	2	65	106	149	174	250	295	347	375	97.5	1.2	1.3	1590	0.735	61.0	8.9	Nil	No	Green
75	20½	6	3	52	106	162	183	248	288	343	398	98.0	1.2	0.8	1627	0.733	61.5	5.7	Nil	No	+27
76	20½	6	2	69	96	148	179	255	293	355	419	97.0	1.8	1.2	1649	0.735	61.0	8.6	Nil	No	Green
77	20½	6	2	69	100	149	182	252	289	338	370	97.5	1.3	1.2	1580	0.734	61.3	7.6	40	No	Green
78	18	6	3	55	112	161	187	256	300	358	397	98.0	1.4	0.6	1659	0.740	59.7	6.4	Nil	No	Green
79	20½	6	3	63	101	151	173	239	280	337	380	97.0	1.2	1.8	1560	0.740	59.7	7.5	Nil	No	+30
80	20½	6	2	68	105	145	175	250	296	351	390	97.0	1.4	1.6	1607	0.742	59.2	7.7	5	No	Blue
81	20½	6	2	69	98	148	178	250	286	334	367	98.0	1.1	0.9	1563	0.733	61.5	7.7	5	No	Green
Average					103	152	179	250	291	345	387	97.5	1.3		1604	0.737	60.5	7.5			
FORT WILLIAM, ONT.																					
82	24	6	3	57	105	150	177	244	288	344	377	97.0	1.0	2.0	1580	0.734	61.3	7.9	Nil	No	+30
83	24	6	3	57	95	146	175	242	284	343	379	97.5	1.0	1.5	1569	0.731	62.1	8.5	Nil	No	+29
84	24	6	2	65	94	137	171	246	286	338	368	97.0	1.1	1.9	1546	0.729	62.6	9.6	Nil	No	Green
85	24	6	2	66	104	158	187	262	306	353	392	98.0	1.1	0.9	1658	0.747	57.9	6.2	5	No	Blue
86	24	6	3	63	100	150	178	253	299	350	381	97.0	1.1	1.9	1611	0.736	60.8	8.1	10	No	Green
Average					100	148	178	249	293	346	379	97.3	1.1	1.6	1593	0.735	61.0	8.1			
WINNIPEG, MAN.																					
87	21	7	3	58	96	154	180	244	287	343	378	98.0	1.0	1.0	1586	0.732	61.8	8.1	Nil	No	+30
88	25	7	3	58	96	144	174	243	287	344	378	97.0	1.2	1.8	1570	0.731	62.1	8.4	Nil	No	+30
89	21	7	3	59	102	146	171	240	284	340	399	98.0	1.1	0.9	1580	0.731	62.1	7.4	10	No	+22
90	21	7	3	55	110	163	188	250	290	341	386	98.0	1.2	0.8	1618	0.739	60.0	5.9	5	No	+28
91	21	7	3	48	102	140	163	252	309	384	422	97.5	1.2	1.3	1670	0.729	62.6	7.3	5	No	+30
92	26	7	3	52	104	148	169	236	280	338	384	98.0	1.0	1.0	1555	0.725	63.7	6.8	5	No	+26
Average					102	149	174	244	290	348	391	97.8	1.1	1.1	1596	0.731	62.1	7.3			
REGINA, SASK.																					
93	26	6	2	70	103	148	173	246	289	338	388	98.0	1.1	0.9	1582	0.731	62.1	6.3	5	No	Green
94	23	6	3	51	104	154	178	243	284	338	386	98.0	1.0	1.0	1583	0.733	61.5	6.8	5	No	+30
95	25	6	3	41	102	156	179	246	296	368	429	97.0	2.0	1.0	1674	0.729	62.6	6.9	5	Yes	Green
96	26	6	2	67	93	134	156	228	273	330	377	97.5	1.2	1.3	1498	0.719	65.3	8.6	Nil	No	Green
97	23	6	3	54	101	156	184	247	289	342	384	98.0	1.0	1.0	1602	0.737	60.5	6.2	Nil	No	+28
Average					101	150	174	242	286	343	393	97.7	1.3	1.0	1588	0.730	62.3	7.0			

TABLE I—Concluded
Gasoline Survey Analyses for 1934 by Cities—Concluded

Sample No.	Price, cents per gallon		Group*	Octane number at 345 °F. and 900 r.p.m.	Distillation Range						Recovery	Residue	Distillation loss	Index No. °F.	Specific gravity	Degrees A.P.I.	Vapour pressure	Gum milli-grams per 100 milli-litres	Corrosion test	Colour Saybolt	
	Gasoline	Tax			1st drop °F.	10% °F.	20% °F.	50% °F.	70% °F.	90% °F.											End point °F.
CALGARY, ALTA.																					
98	25½	6	2	66	98	149	177	258	305	363	404	97.0	1.0	2.0	1656	0.745	58.4	7.3	Nil	No	Green
99	25½	6	2	66	98	146	170	241	290	354	409	98.0	1.3	0.7	1610	0.731	62.1	6.2	Nil	No	Green
100	28	6	3	54	104	146	162	207	245	317	389	97.5	1.1	1.4	1466	0.719	65.3	6.5	Nil	No	+29
101	25½	6	3	64	104	150	169	241	287	350	409	98.0	1.2	0.8	1606	0.731	62.1	6.9	Nil	No	Green
102	25½	6	2	71	110	160	188	266	312	359	396	98.0	1.2	0.8	1681	0.748	57.7	5.8	Nil	No	Yellow
Average..					103	150	173	243	288	349	401	97.7	1.2	1.1	1604	0.735	61.0	6.5			
EDMONTON, ALTA.																					
103	21	6	3	46	89	126	148	214	292	464	540	97.0	1.3	1.7	1784	0.729	62.6	10.5	Nil	No	+28
104	25	6	3	57	106	148	163	205	237	301	382	98.0	1.2	0.8	1436	0.719	65.3	6.4	5	No	+28
105	25	6	2	65	100	143	163	232	288	356	412	98.0	1.2	0.8	1594	0.729	62.6	7.2	20	No	Blue
106	24	6	3	46	106	149	170	232	298	399	458	98.0	1.4	0.6	1706	0.734	61.3	6.4	5	No	Green
107	25	6	2	65	99	151	182	264	304	366	402	97.5	1.2	1.3	1669	0.748	57.7	7.3	Nil	No	Orange
Average..					100	143	165	230	284	377	439	97.7	1.3	1.0	1638	0.732	61.8	7.6			
VANCOUVER, B.C.																					
108	22	7	2	68	99	155	182	261	305	358	399	98.0	1.2	0.8	1660	0.748	57.7	6.0	Nil	No	+28
109	24	7	2	66	98	152	184	262	306	364	404	98.0	1.3	0.7	1672	0.749	57.4	7.0	5	No	Violet
110	25	7	2	70	96	142	174	257	303	366	409	97.5	1.4	1.1	1651	0.747	57.9	7.5	Nil	No	Green
111	24	7	2	70	98	144	173	253	295	358	402	98.0	1.3	0.7	1625	0.745	58.4	7.7	Nil	No	Green
112	22	7	2	72	105	164	188	254	299	364	400	97.5	1.2	1.3	1669	0.746	58.2	6.2	Nil	No	Yellow
113	24	7	2	70	104	146	175	254	293	360	404	97.5	1.4	1.1	1632	0.746	58.2	7.5	Nil	No	Orange
Average..					100	150	179	257	300	362	403	97.7	1.3	1.0	1651	0.747	57.9	7.0			
VICTORIA, B.C.																					
114	24	7	2	70	97	150	179	255	300	367	413	97.5	1.2	1.3	1664	0.746	58.2	8.1	Nil	No	Green
115	24	7	2	69	99	151	179	252	290	345	398	97.5	1.3	1.2	1618	0.745	58.4	6.8	Nil	No	Green
116	24	7	2	68	100	151	182	263	307	364	401	97.5	1.1	1.4	1668	0.749	57.4	6.1	Nil	No	+27
117	24	7	2	70	102	146	176	247	297	354	400	97.5	1.2	1.3	1612	0.742	59.2	7.9	Nil	No	Orange
Average..					100	149	179	254	297	358	403	97.5	1.2	1.3	1640	0.746	58.2	7.2			

TABLE II

Average of Gasoline Survey Analyses for Cities for 1934

City	Distillation Range							Recov- ery	Resi- due	Distil- lation loss	Index No. °F.	Specific gravity	Degrees A.P.I.	Vapour pres- sure	Octane number at 345°F. and 900 r.p.m.
	1st drop °F.	10% °F.	20% °F.	50% °F.	70% °F.	90% °F.	End point °F.								
Halifax, N.S.....	105	149	177	247	285	346	397	97.8	1.2	1.0	1601	0.737	60.5	7.3	.....
Saint John, N.B.....	104	150	176	253	295	351	401	97.6	1.2	1.2	1626	0.738	60.2	7.1	.....
Quebec, Que.....	104	152	178	248	290	349	400	97.7	1.2	1.1	1617	0.740	59.7	6.8	.....
Montreal, Que.....	101	150	179	250	291	350	397	97.2	1.2	1.6	1617	0.744	58.7	7.5	.....
Ottawa, Ont.....	100	149	176	247	290	349	393	97.3	1.1	1.6	1604	0.740	59.7	7.6	.....
Toronto, Ont.....	100	144	172	252	300	359	398	97.3	1.3	1.4	1625	0.734	61.3	8.1	.....
Hamilton, Ont.....	101	146	172	241	284	341	376	97.3	1.2	1.5	1560	0.736	60.8	8.0	.....
London, Ont.....	103	152	179	250	291	345	387	97.5	1.3	1.2	1604	0.737	60.5	7.5	.....
Fort William, Ont.....	100	148	178	249	293	346	379	97.3	1.1	1.6	1593	0.735	61.0	8.1	.....
Winnipeg, Man.....	102	149	174	244	280	348	391	97.8	1.1	1.1	1596	0.731	62.1	7.3	.....
Regina, Sask.....	101	150	174	242	286	343	393	97.7	1.3	1.0	1588	0.730	62.3	7.0	.....
Calgary, Alta.....	103	150	173	243	288	349	401	97.7	1.2	1.1	1604	0.735	61.0	6.5	.....
Edmonton, Alta.....	100	143	165	230	284	377	439	97.7	1.3	1.0	1638	0.732	61.8	7.6	.....
Vancouver, B.C.....	100	150	179	257	300	362	403	97.7	1.3	1.0	1651	0.747	57.9	7.0	.....
Victoria, B.C.....	100	149	179	254	297	358	403	97.5	1.2	1.3	1640	0.746	58.2	7.2	.....
Average (117 samples)*.....	101	149	175	247	291	351	395	97.5	1.2	1.3	1608	0.738	60.2	7.5	66

*This is the average value for all the samples tested.

TABLE III
Annual Averages of Gasoline Survey Analyses for Canada

Year	Distillation Range							Recovery	Residue and Distillation loss	Index No. °F.	Specific gravity	Degrees A.P.I.	Sulphur	Vapour pressure	Octane number at 345°F. and 900 r.p.m.
	1st drop °F.	10% °F.	20% °F.	50% °F.	70% °F.	90% °F.	End point °F.								
1923.....	120	170	193	255	296	358	423	97.1	2.9	1695	0.737	60.5			
1924.....	113	173	195	249	288	347	410	97.4	2.6	1662	0.736	60.8			
1925.....	116	174	199	258	299	359	412	97.0	3.0	1701	0.739	60.0			
1926.....	110	164	191	256	300	360	410	97.4	2.6	1681	0.739	60.0			
1927.....	107	161	189	259	304	366	416	97.0	3.0	1693	0.741	59.5			
1928.....	107	160	186	255	298	359	409	97.3	2.7	1667	0.737	60.5			
1929.....	102	153	181	255	300	363	411	97.0	3.0	1663	0.736	60.8			
1930.....	101	155	182	254	301	362	406	97.2	2.8	1660	0.741	59.5	0.07		
1931.....	104	157	186	258	304	366	406	96.9	3.1	1677	0.741	59.5	0.05		
1932.....	102	154	183	254	299	361	408	97.9	2.1	1659	0.742	59.2		7.4	62*
1933.....	101	152	180	252	295	351	396	97.5	2.5	1626	0.739	60.0		6.9	65
1934.....	101	149	175	247	291	351	395	97.5	2.5	1608	0.738	60.2		7.5	66

*Estimated from octane number at 212°F. and 600 r.p.m.

TABLE IV
Average Analysis of the Three Groups of Gasoline Sold in Canada in July 1934

Group	Number of samples	Octane number at 345°F. and 900 r.p.m.	Distillation Range							Recovery	Residue	Distillation loss	Index No. °F.	Specific gravity	Degrees A.P.I.	Vapour pressure	Artificially coloured, per cent of samples
			1st drop °F.	10% °F.	20% °F.	50% °F.	70% °F.	90% °F.	End point °F.								
I (Octane No. 75 and above).....	15	77	102	147	174	246	288	348	399	97.3	1.3	1.4	1602	0.741	59.5	7.6	100
II (Octane No. 74 to 65).....	66	68	101	148	176	250	292	349	392	97.5	1.2	1.3	1607	0.739	60.0	7.5	89
III (Octane No. 64 and below).....	36	56	102	150	175	244	290	355	400	97.4	1.2	1.4	1614	0.735	61.0	7.4	22
Average for all samples..	117	66	101	149	175	247	291	351	395	97.5	1.2	1.3	1608	0.738	60.2	7.5	70

TABLE V

Ten Per Cent of Samples Having Maximum Index Number* in 1934

Sample No.	Index No. °F.	Distillation Range						End point °F.	Recovery %	Residue %	Distillation loss %	Vapour pressure
		1st drop °F.	10% °F.	20% °F.	50% °F.	70% °F.	90% °F.					
103	1784	89	126	148	214	292.	464	540	97.0	1.3	1.7	10.5
63	1769	94	132	158	270	340	419	450	96.0	2.4	1.6	9.3
57	1736	96	127	152	266	335	407	449	97.0	1.5	1.5	10.0
106	1706	106	149	170	232	298	399	458	98.0	1.4	0.6	6.4
12	1692	106	164	196	264	303	358	407	98.0	1.3	0.7	5.3
53	1684	104	164	194	259	298	357	412	97.5	1.2	1.3	6.1
102	1681	110	160	188	266	312	359	396	98.0	1.2	0.8	5.8
59	1676	105	154	188	263	305	362	404	98.0	1.3	0.7	6.2
95	1674	102	156	179	246	296	368	429	97.0	2.0	1.0	6.9
31	1673	97	149	180	253	299	373	419	96.0	1.1	2.9	8.8
109	1672	98	152	184	262	306	364	404	98.0	1.3	0.7	7.0
91	1670	102	140	163	252	309	384	422	97.5	1.2	1.3	7.3
Aver.....	1701	101	148	175	254	308	384	432	97.4	1.4	1.2	7.5

TABLE VI

Ten Per Cent of Samples Having Minimum Index Numbers* in 1934

Sample No.	Index No. °F.	Distillation Range						End point °F.	Recovery %	Residue %	Distillation loss %	Vapour pressure
		1st drop °F.	10% °F.	20% °F.	50% °F.	70% °F.	90% °F.					
104	1436	106	148	163	205	237	301	382	98.0	1.2	0.8	6.4
29	1463	119	162	173	191	226	327	384	98.0	1.1	0.9	5.7
100	1466	104	146	162	207	245	317	389	97.5	1.1	1.4	6.5
49	1479	97	134	154	220	265	327	379	98.0	1.1	0.9	7.8
65	1490	112	153	168	200	254	339	376	98.0	1.0	1.0	7.0
96	1498	93	134	156	228	273	330	377	97.5	1.2	1.3	8.6
16	1502	100	138	158	222	267	334	383	97.0	1.0	2.0	7.9
71	1516	100	140	162	226	274	336	378	97.0	1.0	2.0	7.4
60	1516	98	134	155	226	275	340	386	97.5	1.1	1.4	8.7
67	1530	96	138	164	239	276	332	381	97.0	2.0	1.0	8.5
84	1546	94	137	171	240	286	338	368	97.0	1.0	1.9	9.6
30	1548	100	149	172	229	282	341	375	97.0	1.0	2.0	8.1
Aver.....	1499	102	143	163	220	263	330	380	97.5	1.1	1.4	7.7

TABLE VII

Difference Between Maximum and Minimum Index Numbers*

Year	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934
Maximum, 10%..	1791	1806	1821	1815	1823	1791	1773	1787	1774	1760	1738	1701
Minimum, 10%..	1500	1428	1497	1524	1518	1488	1503	1471	1547	1531	1522	1499
Difference.....	291	378	324	291	305	303	270	316	227	229	216	202

*The index number is the sum of the following points in the distillation range, 10%, 20%, 50%, 70%, 90% and the end point.

TABLE VIII

Classification of the 1934 Samples According to Three Arbitrary Octane Number Groups

City	Group I Octane No. 75 and above		Group II Octane No. 74 to 65		Group III Octane No. 64 and below		Total number of samples
	Number of samples	Average octane number	Number of samples	Average octane number	Number of samples	Average octane number	
Halifax.....	2	77	3	70	..	..	5
Saint John.....	..	..	4	69	1	60	5
Quebec.....	1	76	4	68	1	60	6
Montreal.....	4	76	6	69	..	..	10
Ottawa.....	7	77	10	68	10	61	27
Toronto.....	..	..	8	68	2	42	10
Hamilton.....	1	77	7	67	2	60	10
London.....	..	..	5	68	3	57	8
Fort William.....	..	..	2	66	3	59	5
Winnipeg.....	..	..	..	..	6	55	6
Regina.....	..	..	2	69	3	49	5
Calgary.....	..	..	3	68	2	59	5
Edmonton.....	..	..	2	65	3	50	5
Vancouver.....	..	..	6	69	..	..	6
Victoria.....	..	..	4	69	..	..	4
Number of samples in grade.....	15	..	66	..	36	..	117
Per cent of total sam- ples.....	12.8	...	56.4	..	30.8	..	100
Average octane No. for grade.....	..	77	..	68	..	56	..

TABLE IX

Average *Knock Rating of 50 Brands of Gasoline

Group I Octane No. 75 and above	Group II Octane No. 74 to 65	Group III Octane No. 64 and below	Company or Distributor and Head Office Address (or city from which samples originated)
		Beach S.Q. and BML Blue...	Beach Motors, Ltd. (Ottawa).
		Bell.....	Bell Refining Co., Ltd., Calgary.
		Benzogas and Commercial.....	Benzolene Corporation, Ltd. (Ottawa).
Peerless Ethyl.....	Benzolene.....	British Motor.....	British American Oil Co., Ltd., Toronto.
	Nevr-Nox.....	Bengal.....	Burlington Refineries, Ltd., (Hamilton).
Canadian Ethyl.....	White Rose No Knock.....	White Rose.....	Canadian Oil Companies, Ltd., (Toronto).
Sylvester Benzol.....	Champlain Purple.....		Champlain Oil Co., Ltd., (Montreal).
Cities Service Ethyl.....	Koolmotor.....	Cities Service.....	Cities Service Oil Co., Ltd., Toronto.
	Green Flash.....		Crown Dominion Oil Co., Ltd., (Hamilton).
	Hi-Octane.....		Dominion Oil Co., Ltd., (Vancouver).
	Violet Ray.....		General Oil Co., Ltd., (Vancouver).
		Goodrich**.....	Good Rich Oil Co., Ltd., (Toronto).
		Hi-way Green Star**.....	Hi-way Refineries, Ltd., Regina.
	Home.....		Home Oil Distributors, Ltd., Vancouver.
Imperial Ethyl.....	Three Star.....	Premier.....	Imperial Oil, Ltd., Toronto.
Irving Ethyl.....	Primrose Blue.....		Irving Oil Co., Ltd., (Halifax).
	Diamond Hi-Octane.....		Island Pacific Oil Co., Ltd., (Victoria).
	Richtest.....		Mahoney and Rich, (Ottawa).
		Marquis**.....	Marquis Oil Co., Ltd., (Edmonton).
Cyclo Ethyl.....	Marathon Blue.....	Standard White.....	McColl-Frontenac Oil Co., Ltd., Montreal.
		Economy.....	North Star Oil, Ltd., Winnipeg.
		Electro.....	Prairie City Oil Co., Ltd., (Winnipeg).
	Good Gulf.....		Putman Bros., Ltd., (Saint John).
Super-Shell Ethyl.....	Shell.....	Regal.....	Regal Oil and Refining Co., Ltd., Calgary.
	Super-Shell.....		Shell Oil Co. of Canada, Ltd., Toronto.
	Blue Sunoco.....		Shell Oil Co. of B.C., Ltd., (Vancouver).
Supertest Ethyl.....	Wonder.....	Supertest.....	Sun Oil Co., Ltd., Toronto.
		White**.....	Supertest Petroleum Corp., Ltd., London.
	Texaco Fire Chief.....		Supreme Oil Co., Ltd., (Toronto).
	Union 76.....		Texas Co. of Canada, Ltd., Calgary.
	Mobilgas.....		Union Oil Co. of Canada, Ltd., (Vancouver).
			White Star Refining Co., Ltd., (Hamilton).
Average.....77	Average.....68	Average.....56	

*The averages are based on tests of a total of 117 samples collected in Canada in July 1934. It should be emphasized that the volatility of the individual samples in the three groups, with a few notable exceptions as shown in Table I, does not vary greatly, and, therefore, the gasolines in each group will be found satisfactory for use in gasoline engines if the compression ratio of the engine in which it is to be used is not too high. High compression engines will require either Group II or Group I gasolines. Low compression engines can use Group III gasolines. Further discussion of compression ratio of engines and octane numbers of gasolines is to be found on page 2.

**The average octane number is below 50.

TABLE X

Average Knock Rating (Octane Number) of 21 Different Brands of Gasoline Sold by 8 Companies in 1934, Arranged According to Groups

Company	Group I Octane No. 75 and above		Group II Octane No. 74 to 65		Group III Octane No. 64 and below	
	Number of samples	Average octane No.	Number of samples	Average octane No.	Number of samples	Average octane No.
A.....	5	77	13	69	2	61
B.....	1	78	7	67	5	56
C.....	2	75	9	66	3	57
D.....	1	76	2	68	7	57
E.....	2	77	4	69	1	62
F.....	1	77	5	65	..	..
G.....	1	77	3	69	1	64
H.....	..	..	6	68	..	..
Total number of samples tested..	13		49		19	
Average octane No. of grade.....		77		67		58

TABLE XI

Classification of Samples According to Results of Reid Vapour Pressure Determination in 1934

City	Reid vapour pressure, pounds per square inch							Total
	11.0 to 10.1	10.0 to 9.1	9.0 to 8.1	8.0 to 7.1	7.0 to 6.1	6.0 to 5.1	5.0 to 4.1	
Halifax.....	3	2	..	..	5
Saint John.....	3	1	..	..	5
Quebec.....	4	..	2	..	6
Montreal.....	..	2	1	4	2	..	1	10
Ottawa.....	..	1	7	13	5	1	..	27
Toronto.....	..	2	4	2	2	..	..	10
Hamilton.....	5	4	1	..	..	10
London.....	2	4	1	1	..	8
Fort William.....	..	1	2	1	1	..	..	5
Winnipeg.....	2	2	1	1	..	6
Regina.....	1	..	4	..	..	5
Calgary.....	1	3	1	..	5
Edmonton.....	1	..	..	2	2	..	..	5
Vancouver.....	3	2	1	..	6
Victoria.....	1	1	2	..	..	4
Total.....	1	6	25	47	29	8	1	117
Per cent of total.....	0.9	5.1	21.3	40.2	24.8	6.8	0.9	100

Reid vapour pressure, average all samples, 7.5.
 Reid vapour pressure, highest sample, 10.5.
 Reid vapour pressure, lowest sample, 4.9.

TABLE XII
Classification of Samples According to Gum Content in 1934

City	Gum content in milligrams per 100 millilitres (glass dish with air jet at 320°F. or at 374°F.)								Total
	110 (oily)	60 (oily)	40 (oily)	20 (oily)	15	10	5	Nil	
Halifax.....	5	..	5
Saint John.....	..	1	..	..	..	..	1	3	5
Quebec.....	2	4	6
Montreal.....	2	5	3	10
Ottawa.....	1	3	6	17	27
Toronto.....	1	6	3	10
Hamilton.....	1	..	..	..	..	..	3	6	10
London.....	1	..	..	..	2	5	8
Fort William.....	1	1	3	5
Winnipeg.....	1	3	2	6
Regina.....	3	2	5
Calgary.....	5	5
Edmonton.....	1	..	..	2	2	5
Vancouver.....	1	5	6
Victoria.....	4	4
Total.....	1	1	1	1	1	8	40	64	117
Per cent of total.....	0.9	0.9	0.9	0.9	0.9	6.8	34.0	54.7	100

TABLE XIII
Gum Content of Gasoline Samples* in 1934 Determined by Two Methods

Sample No.	Gum content in milligrams per 100 millilitres	
	at 320°F. (A.S.T.M. Method D381-34T)	at 374°F. (A.S.T.M. Proposed Method B)
1.....	10 (oily)	5
14.....	10 (oily)	5
57.....	10 (oily)	10 (oily)
89.....	15 (oily)	10 (oily)
103.....	20 (oily)	Nil
21.....	30 (oily)	10
25.....	30 (oily)	10
35.....	30 (oily)	10
48.....	30 (oily)	15
105.....	30 (oily)	20 (oily)
41.....	40 (oily)	10
51.....	40 (oily)	10
38.....	50 (oily)	5
77.....	60 (oily)	40 (oily)
7.....	90 (oily)	60 (oily)
67.....	300 (oily)	110 (oily)

*Only those samples that were "oily" and had 10 milligrams or more of gum at 320°F. were tested at 374°F.

TABLE XIV
Percentage of Artificially Coloured Gasolines in Different Years

Year	Artificially coloured gasolines %	Year	Artificially coloured gasolines %
1927.....	10	1931.....	34
1928.....	13	1932.....	52
1929.....	18	1933.....	66
1930.....	26	1934.....	70

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Survey for 1934. Mines Br.
Report 764. 1935~~

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