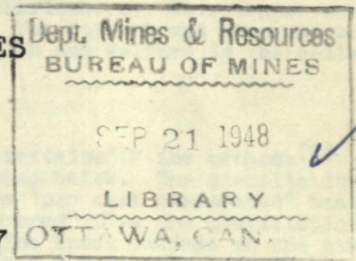


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OTTAWA, CANADA



GASOLINE SURVEY FOR SUMMER, 1947

by
H. McD. Chantler, P. B. Seely and F. E. Goodspeed

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A study of the gasoline sold in Canada during the summer has been made annually since 1923 at the Fuel Research Laboratories of the Division of Fuels, Bureau of Mines, and reports from the results obtained have been prepared and published up to and including 1946(1). Over the period from July 8 to August 5 in 1947, 61 samples of gasoline were obtained from the nine principal distributing cities in eight provinces, namely Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan, Alberta and British Columbia. These samples represent 21 brands of motor fuel sold by 15 wholesale dealers and distributors. This report contains the results in detail of the analyses of these 61 samples of gasoline. The support and generous cooperation of the Food and Drug Laboratories of the Department of National Health and Welfare in the collection of samples is gratefully acknowledged.

Method of Analysis

The characteristics of the gasoline were tested according to the latest revision of the methods(2) of testing of the American Society for Testing Materials (A.S.T.M.) except as noted below. The distillation range was determined according to A.S.T.M. method D 86 and was reported on the "per cent evaporated" basis. The "per cent evaporated" at any temperature is the sum of the "per cent recovered" plus the distillation loss. The temperatures at selected percentages were estimated from graphs. The knock ratings of the gasoline Reid vapour pressure was determined according to A.S.T.M. method D 323. The sulphur content was determined according to A.S.T.M. method D 90-34T, except that a modified apparatus(3) was used. The gum content was determined by A.S.T.M. method D 381. When the residual material obtained by the above gum test was "oily", the gum content was determined according to the procedure prescribed in Canadian Government Purchasing Standards Committee Specification. No. 3-GP-9(4) entitled: "Determination of gum content of gasoline in the presence of top cylinder lubricant". The difference between the amount of gum found by these two methods was reported as "oil". The corrosion test was made according to A.S.T.M. method D 130. The specific gravity was determined by means of the hydrometer at room temperature, according to A.S.T.M. method D 287 and the result calculated to 60°F., according to the National Standard Oil Tables(5). The equivalent degrees A.P.I. was obtained from the same tables. The apparent colour of the gasoline was observed. The tetraethyl lead content was determined according to A.S.T.M. method D 526 using the volumetric molybdate method.

Results of Laboratory Examination.

The results of the laboratory examination of the gasolines collected in the summer of 1947 are shown by cities in Table I, and are arranged under two groups of samples, viz.; Group 1 and Group 2 gasolines. The table gives the A.S.T.M. octane number, tetraethyl lead content, distillation characteristics, specific gravity, Reid vapour pressure, sulphur content, and gum content of all the samples. Averages for Group 1 and Group 2 gasolines are reported at the foot of each column in the table. Table 2 is a summary of the average analyses of the gasoline survey by cities for summer 1947 and shows the average of all samples in Group 1 and Group 2. It also gives the average of all samples tested in that summer. Table 3 gives the minimum and maximum and average figures for each characteristic of group 1 and group 2 gasolines tested in the summer of 1947. Table 4 shows the average results obtained by examination of samples of gasoline for the summers of 24 years, from 1923 to 1947, excepting 1940. Table 5 gives the summary of the data of the average of all samples of gasoline in Group 1 and Group 2 for ten summers, 1937 through 1947 (except 1940). Figure 1 shows graphically the data given in table 5 for Group 1 gasolines, except that the gum content is omitted. Figure 2 shows similar data for the Group 2 gasolines.

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 an engine will be found in the report on Gasoline Surveys for 1930 and 1931(6). Intervening changes in the significance of tests on motor fuels were discussed in the Gasoline Surveys for 1935 and 1936(7). For further information on motor fuels, a report(8) entitled "The Significance of Tests of Petroleum Products", which was prepared by A.S.T.M. Committee D-2 of American Society for Testing Materials; the "C.R.C. Handbook"(9), and other reports(10)(11)(12)(13)(14) should be consulted.

The purpose of this survey is not to ascertain whether the samples of motor fuel conform with a specification, Dominion Government(15), Provincial or otherwise. It is intended as a means whereby information regarding the characteristics of gasoline actually being sold will become available. No effort, therefore, has been made to fit the results into predetermined groups; rather, it is desired that the actual analyses would define as clearly as possible the limits of the different groups of gasoline on the market.

Knock Ratings

The knock ratings of the samples tested in summer 1947 were determined in a Coordinating Fuel Research Engine, known more briefly as the "C.F.R. Engine". The A.S.T.M. "motor" method, D 357-40 was used and the results are expressed in A.S.T.M. motor octane numbers. According to the knock rating only, the samples which were tested fell into two groups. The range in octane number of each group was as follows:

- Group 1. Gasolines with octane numbers of 78 and above.
- Group 2. Gasolines with octane numbers between 77 and 70.

These two groups correspond to the grades which are known in the oil trade as "Premium" and "Regular" gasoline. Generally speaking, the major oil companies now tend to sell only Group 1 and Group 2 gasolines at their service stations. Accordingly, samples of Group 3 or "Third Grade" gasoline, with knock ratings below 70 octane number, were not collected for this survey. The knock ratings of individual samples are given in Table 1 and the group in which each sample falls is shown. Of the 61 samples of gasoline collected in 1947, 24 samples were Group 1 gasoline and 37 samples were Group 2 gasoline.

Maximum and Minimum Knock Ratings

The minimum and maximum knock ratings of the samples tested in 1947 are shown in Table 3. The range in rating of the Group 1 gasolines was from a high of 82 to a low of 76 octane numbers. In 1946, the corresponding range of Group 1 gasolines was from 81 to 75 octane numbers. For the Group 2 gasoline samples, the range in knock rating was from a high of 77 to a low of 72 octane numbers in 1947. The corresponding range of Group 2 gasolines in 1946 was from 76 to 70 octane numbers.

Average Knock Rating

The average knock ratings of the gasoline sold in Canada in ten summers, 1937 through 1947, excepting 1940, are shown in Table 5 and graphically in Figure 1 for Group 1 gasoline and in Figure 2 for Group 2 gasoline. The average knock ratings of the samples in Group 1 for these ten summers were 77.6 octane number in 1937, 77.8 in 1938, 77.4 in 1939, 79.0 in 1941, 76.9 in 1942, 75.7 in 1943, 74.8 in 1944, 73.5 in 1945, 77.8 in 1946 and 79.2 in 1947. The average knock ratings of the samples in Group 2 for these same summers, excepting 1940 and 1943, were 70.1 octane number in 1937, 70.2 in 1938, 70.3 in 1939, 73.6 in 1941, 67.1 in 1942, 68.6 in 1944, 68.5 in 1945, 73.6 in 1946, and 75.0 in 1947.

Change in Knock Rating

The above results indicate that by the summer of 1941, the average knock rating of Group 1 gasoline had risen to 79.0 octane number and for Group 2 gasoline had also risen to 73.6 octane number. For the years 1942 to 1945, wartime restrictions applied in Canada according to the Orders of the Oil Controller (16)(11). Therefore during these four summers the average knock rating of Group 1 motor fuel decreased progressively to a low of 73.5 octane number in 1945. In the same period, the average knock rating of Group 2 motor fuel fell and remained fairly constant about 68 octane number. This decrease in knock rating of Group 1 and Group 2 gasolines was mainly due to the shortage of tetraethyl lead. When the wartime restrictions were lifted in August 1945 and more tetraethyl lead became available, the average knock rating of the gasolines rose in 1946 to 77.8 for Group 1 and to 73.6 octane number for Group 2. In 1947 the average knock rating of Group 1 motor fuel was 79.2, a rise of 1.4 octane numbers and in 1947 the average knock rating of Group 2 motor fuel was 75.0, a rise of 1.4 octane numbers as compared to 1946. This indicates a steady improvement in knock rating of Group 1 and Group 2 gasolines marketed since the end of the wartime restrictions. The difference between the knock rating of Group 1 and Group 2 motor fuels was 7.1 octane numbers in summer 1939, 5.4 in summer 1941 and 4.2 octane numbers in both the summers of 1946 and 1947. In the summer of 1947 the knock rating of Group 1 and Group 2 motor fuels sold in the provinces of Saskatchewan and Alberta was about 2 octane numbers lower than for similar grades of motor fuel sold in the other provinces.

Tetraethyl Lead Content

Tetraethyl lead is used to improve the knock rating of gasolines. The tetraethyl lead content of the individual samples, and the average tetraethyl lead content of Group 1 and of Group 2 samples in each city is given in table 1 and also, in table 2. As shown in table 3, the maximum tetraethyl lead content of Group 1 gasoline was 3.39 millilitres and the minimum was 1.75 millilitres per Imperial gallon. In Group 2, the maximum tetraethyl lead content was 2.89 millilitres, and the minimum was 0.51 millilitres per Imperial gallon for those samples that contained tetraethyl lead. It should be noted that in the summer of 1947 three samples of Group 2 motor fuel did not contain tetraethyl lead. These samples were from the cities of Montreal, Ottawa and Toronto. In summer of 1947, the average tetraethyl lead content of Group 1 gasoline was 2.01 millilitres and of Group 2 gasoline was 1.42 millilitres per Imperial gallon; whereas in the summer of 1946 the average tetraethyl lead content of Group 1 gasoline was 2.45 millilitres and of Group 2 gasoline was 1.4 millilitres.

Volatility

The volatility of the gasoline is indicated by the distillation range temperatures which are given in Tables 1 to 5 and are shown graphically in Figures 1 and 2. The distillation temperatures are reported on the "per cent evaporated" basis, as was done for the Gasoline Surveys for Seven Summers between 1939 and 1946(1), rather than on the "per cent recovered" basis, as in Gasoline Survey reports previous to 1939. It is now accepted practice in the petroleum industry to report the distillation range of motor fuels on the "per cent evaporated" basis, because these temperatures indicate more correctly the actual volatility of motor fuel as it occurs in engine operation.

There was a slight increase in the average volatility of the motor fuels in summer 1947 as compared with summer 1946, which was due to a drop of approximately 1°F. in the 20, 50, 70 and 90 per cent evaporated points in the distillation range, as shown in table 4. In 1947, Group 1 gasoline had a higher average volatility than Group 2 gasoline, as indicated by a drop of approximately 5°F. in the 20, 20, 50, 70 and 90 per cent evaporated points in the distillation range, as shown in table 3. As shown in table 2, the gasoline sold in the Maritime Provinces of Nova Scotia and New Brunswick during the summer of 1947 was lower in average volatility than that sold in the other provinces of Canada.

Vapour Pressure

The Reid vapour pressure for each of the samples tested in 1947 is shown in table 1. The average vapour pressure of all the gasolines in 1947 was 8.6 pounds per square inch and for 1946 was 8.4 pounds. The highest vapour pressure, namely 10.4 pounds, was obtained from a Group 1 gasoline from Ottawa. The lowest vapour pressure, namely 6.9 pounds, was obtained from a Group 2 gasoline, also from Ottawa. Four samples of 7 per cent of the samples had a vapour pressure over 10 pounds in 1947. The average vapour pressure of Group 1 motor fuels was 8.7 pounds and for Group 2 motor fuels was 8.5 pounds in 1947. In the summer, from 1937 to 1939 there was a definite trend towards higher, and more uniform vapour pressures for the gasolines being sold. This trend in the vapour pressure characteristics of motor fuels started again in 1946 and has continued during 1947.

Sulphur

The sulphur content for each of the samples tested in 1947 is shown in table 1. The average sulphur content of all the gasolines was 0.07 per cent by weight in 1947. In the summers of 1945 and 1946 the average sulphur content for the motor fuels was also 0.07 per cent. The sulphur content varied from a high of 0.20 per cent to a low of 0.01 per cent in 1947. Fifteen samples, or 25 per cent of the 61 samples tested in 1947, had a sulphur content exceeding 0.10 per cent. Only 4 samples, or 7 per cent of the samples tested had a sulphur content exceeding 0.15 per cent. Two of the above samples of motor fuel were received from Halifax with sulphur contents of 0.17 and 0.16 per cent; and two samples were from Vancouver with sulphur contents of 0.20 and 0.19 per cent. The average sulphur content was 0.07 per cent for both Group 1 and Group 2 motor fuels in 1947. As shown in table 2, in 1947 the Group 1 and Group 2 motor fuels sold in the Maritime Provinces of Nova Scotia and New Brunswick had a higher average sulphur content than the motor fuels sold in the other provinces of Canada, with the exception that Group 2 motor fuels sold in British Columbia had also a high average sulphur content.

Gum

The existent gum in the samples of gasoline was determined by the air-jet evaporation method, A.S.T.M. D 381-46. With this method the gum is deposited as a hard, varnish-like, or as a tacky residue. If the gasoline contains nonvolatile lubricating oil, such as solvent oil, the gum is deposited as an oily residue, because it is gum plus oil. In all cases where the gum was "oily", the gum was determined again according to the method prescribed in Canadian Government Purchasing Standards Committee Specification No. 3-GP-9(4), entitled "Determination of Gum Content of Gasoline in the presence of top-cylinder lubricant". By this method the oil is extracted from the gum with A.S.T.M. precipitation Naphtha⁽²⁾, and the oil-free residue is reported as gum. The difference between the amount of gum determined by A.S.T.M. method D 381-46 and amount of gum determined by method specification No. 3-GP-9 was reported as oil. Therefore, in this report when the gum content is stated, it refers only to "oil-free" gum. Oil, if present is shown in brackets in table 1. For example: "Gum, 5(2)" means that the gasoline contains 5 milligrams of gum plus 2 milligrams of oil per 100 millilitres of gasoline.

The gum content for each of the samples examined in 1947 is shown in table 1. The average gum content of all the samples was 4 milligrams per 100 millilitres of gasoline. In each of the three summers of 1944 to 1946 the average gum content for the motor fuels was also 4 milligrams. In 1947 the gum content varied from 17 milligrams to only a trace of gum. It is now generally accepted⁽¹⁵⁾ that not over 7 milligrams of gum should be present in 100 millilitres of motor fuel. Only four samples, or 7 per cent of the samples tested in 1947, had a gum content exceeding 7 milligrams. These four samples were Group 2 gasoline; one sample from Halifax had a gum content of 17 milligrams, two samples from Saint John had 17 and 13 milligrams, and one sample from Ottawa had 9 milligrams of gum. The average gum content for Group 1 gasolines was 3 milligrams and for Group 2 gasolines was 4 milligrams.

In 1947 several of the oil companies added solvent oil, as a top-cylinder lubricant to their motor fuels. The gum residue of these samples was therefore "oily". Twenty-eight samples, or 46 per cent of the motor fuels tested, contained oil. The average oil content of the above samples was 9 milligrams. The highest oil content was 32 milligrams and the lowest was 2 milligrams per 100 millilitres of gasoline.

Gravity

The specific gravity at 60°F., and gravity in degrees A.P.I. at 60°F. for each sample tested in summer 1947 is shown in table 1. The average specific gravity of all the gasolines collected was 0.736 or 60.8 degrees A.P.I. This is equivalent to a weight of 7.36 pounds per Imperial gallon. As indicated in table 3, the overall variation in specific gravity of the gasolines examined in 1947 was from 0.721 to 0.749, or from 64.8 to 57.4 degrees A.P.I. This is equivalent to a variation in weight of 7.21 pounds to 7.49 pounds per Imperial gallon for summer motor fuel. The average specific gravity of Group 1 motor fuels was 0.734 or 61.3 degrees A.P.I. and for Group 2 motor fuels was 0.737 or 60.5 degrees A.P.I.

Corrosion

The corrosion test for motor fuels is made by immersing a strip of polished copper for three hours in a sample of gasoline heated to 122°F. according to A.S.T.M. method D 130-30 and observing the tarnish, or corrosion, that takes place. The copper strip should not show more than "extremely slight discoloration". The corrosion test was made on all of the samples collected in 1947, but in order to conserve space was not reported in any of the tables 1 to 5. None of the 61 samples gave a positive test for corrosion according to the above procedure.

Colour

The apparent colour of the gasoline was observed in all samples but has not been reported in any of the tables 1 to 5. All of the samples of motor fuel in Group 1 and Group 2 were artificially coloured in 1947. All of the Group 1 motor fuels were dyed red. The majority of the Group 2 motor fuels were coloured yellow or orange.

Summary and Conclusions

This gasoline survey comprises the analyses of 61 samples of motor fuel collected for the Fuel Research Laboratories during the period from July 8th to August 5th in 1947, from nine cities in Canada. These samples represent 21 brands of motor fuel sold by 15 wholesale dealers and distributors. As the above samples were collected from eight provinces, namely Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan, Alberta and British Columbia, they may be accepted as representative of the motor fuels sold in Canada during the summer of 1947. For convenience and easy reference, summaries of the data obtained are tabulated and a comparison of gasoline characteristics is shown graphically.

Only Group 1 and Group 2 gasolines were tested in 1947. Samples of Group 3 gasolines were not collected. Since the war, it has become general practice not to sell Group 3 gasoline, except by special order, at the service stations of the major oil companies in Canada. Group 1 is usually known as "Premium", Group 2 as "Regular" and Group 3 as "Third Grade". These three groups differ principally in knock rating.

The average knock rating of Group 1 gasolines sold in summer 1947 was 79.2 A.S.T.M. motor octane number. In summer 1946 the average knock rating was 77.8 octane number. The average knock rating of Group 2 gasolines sold in summer 1947 was 75.0 A.S.T.M. motor octane number. In summer 1946, the average knock rating was 73.6 octane number. There has been a definite rise in knock rating for the Group 1 and Group 2 motor fuels sold in Canada since wartime restrictions were lifted in August 1945. The difference between the average knock rating of Group 1 and Group 2 motor fuels sold in Canada in both of the summers 1946 and 1947 was 4.2 octane numbers. In the summer of 1947, the knock rating of both the Group 1 and Group 2 motor fuels sold in the provinces of Saskatchewan and Alberta was about 2 octane numbers lower than for similar grades of motor fuel sold in the other provinces.

The average tetraethyl lead content of the gasolines sold in Canada in summer 1947 was 2.61 millilitres per Imperial gallon for Group 1 motor fuels and 1.42 milliliters per Imperial gallon for Group 2 motor fuels.

The average volatility of motor fuels sold in Canada in 1947 was slightly higher than the average volatility of motor fuels sold in 1946. Group 1 gasolines had a higher average volatility than Group 2 gasolines in summer 1947.

The average Reid vapour pressure of the motor fuels tested in summer 1947 was 8.6 pounds as compared with 8.4 pounds in summer 1946. Four samples had a Reid vapour pressure over 10 pounds in summer 1947.

The average sulphur content of the gasolines sold in Canada was 0.07 per cent in summer 1947 and was also 0.07 per cent in the previous two summers 1945 and 1946. Four samples, two from Nova Scotia and two from British Columbia had a sulphur content exceeding 0.15 per cent in summer 1947. The Group 1 and Group 2 motor fuels sold in the Eastern Maritime Provinces in summer 1947 had a higher average sulphur content than the motor fuels sold in the other provinces of Canada, with the exception that Group 2 gasolines sold in British Columbia also had a high average sulphur content.

The average gum content of all the gasoline tested in summer 1947 was 4 milligrams per 100 millilitres of motor fuel and it was also 4 milligrams in the summers 1944 through 1946. The average gum content for Group 1 gasolines was 3 milligrams and for Group 2 gasolines was 4 milligrams. Only 4 samples of Group 2 motor fuel exceeded the usually accepted limit of 7 milligrams of gum per 100 milliliters of motor fuel. Twenty-eight samples, or 46 per cent of the motor fuels tested in summer 1947, contained oil. These samples gave a gum residue which was "oily". The average oil content was 9 milligrams per 100 millilitres of motor fuel.

The average specific gravity of the gasolines tested in summer 1947 was 0.736, or 60.8 degrees A.P.I.

None of the motor fuel samples tested in summer 1947 gave a positive test for corrosion with a copper strip.

All of Group 1 and Group 2 motor fuels tested in summer 1947 were artificially coloured; all of Group 1 gasolines were dyed red and the majority of Group 2 gasolines were dyed yellow or orange.

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TABLE I

GASOLINE SURVEY ANALYSES BY CITIES FOR SUMMER 1947.

Sample No.	Group	A.S.T.M. Octane No.	Tetra Ethyl Lead**	I.B.P.	Distillation Range, °F.										Reco-End Pt.	Resi- due %	Loss %	Sp. Gr. 60°F.	Deg- rees A.P.I.	Reid V.P. lb.	Sul- phur %	Gum**
					Per Cent Evaporated																	
					5	10	20	30	50	70	90	95										
HALIFAX, N.S.																						
1	I	79.4	2.65	91	115	137	172	206	265	307	365	387	429	97.0	1.3	1.7	0.748	57.7	9.5	0.17	5(2)*	
2	I	79.8	2.53	94	115	132	165	200	253	302	359	384	428	97.0	1.2	1.8	0.744	58.7	9.4	0.13	7	
Average		79.6	2.59	92	115	135	169	203	259	304	362	385	428	97.0	1.2	1.8	0.746	58.2	9.4	0.15	6	
3	II	76.0	1.46	96	120	140	167	197	250	298	355	379	413	97.3	1.2	1.5	0.742	59.2	9.1	0.11	17(8)*	
4	II	74.6	0.83	94	115	137	173	207	267	315	362	390	425	97.0	1.4	1.6	0.749	57.4	9.4	0.16	2	
5	II	74.8	0.78	95	113	135	170	204	260	310	366	387	420	96.0	1.2	2.8	0.747	57.9	9.6	0.15	7(10)*	
Average		75.1	1.02	95	116	137	170	203	259	308	361	385	419	96.7	1.3	2.0	0.746	58.2	9.4	0.14	9	
SAINT JOHN, N.B.																						
6	I	80.1	2.92	104	121	137	159	180	220	262	330	361	399	97.0	1.0	2.0	0.729	62.6	8.7	0.08	5	
7	I	79.5	2.35	98	115	131	162	196	254	307	367	392	427	96.5	1.0	2.5	0.742	59.2	10.0	0.14	6	
Average		79.8	2.63	101	118	134	160	188	237	284	349	376	413	96.8	1.0	2.2	0.735	61.0	9.3	0.11	6	
8	II	74.8	1.02	103	116	134	165	196	251	303	360	384	426	96.5	1.1	2.4	0.742	59.2	9.5	0.13	17(8)*	
9	II	75.5	0.66	100	114	131	160	191	248	299	359	384	423	96.5	1.1	2.4	0.740	59.7	9.2	0.12	2(7)*	
10	II	75.1	0.91	102	121	140	168	196	249	299	359	381	421	97.5	1.0	1.5	0.744	58.7	8.2	0.12	13(29)*	
Average		75.1	0.86	102	117	135	164	194	249	301	360	383	423	96.8	1.1	2.1	0.742	59.2	9.0	0.12	11	
MONTREAL, QUE.																						
11	I	80.0	2.99	102	115	131	160	189	234	275	324	345	373	96.5	1.1	2.4	0.732	61.8	9.0	0.06	7	
12	I	79.4	2.94	98	112	131	159	184	234	281	344	370	397	96.5	1.1	2.4	0.730	62.3	9.2	0.09	6(5)*	
13	I	79.8	2.24	102	120	135	159	185	240	289	335	355	388	97.0	1.0	2.0	0.731	62.1	8.5	0.02	2	
Average		79.7	2.72	101	116	132	160	186	236	282	334	357	386	96.6	1.1	2.3	0.731	62.1	8.9	0.06	5	
14	II	77.3	nil ^{1/2}	100	118	134	161	186	236	289	364	392	417	97.0	1.1	1.9	0.747	57.9	8.0	0.02	4(3)*	
15	II	75.5	1.58	102	120	143	176	203	246	284	329	345	372	97.0	1.0	2.0	0.739	60.0	8.4	0.08	5(4)*	
16	II	75.9	1.05	105	123	141	166	187	232	274	333	356	394	97.0	1.2	1.8	0.736	60.8	8.0	0.06	1(8)*	
17	II	76.0	1.79	104	125	143	169	194	238	279	327	347	384	97.0	1.0	2.0	0.733	61.5	7.8	0.03	1	
18	II	74.5	1.82	106	127	145	177	206	252	292	343	367	409	97.0	1.4	1.6	0.738	60.2	8.3	0.11	4(4)*	
Average		75.8	1.56	103	123	141	170	195	241	284	339	361	395	97.0	1.1	1.9	0.739	60.0	8.1	0.06	3	
OTTAWA, ONT.																						
19	I	79.3	2.82	93	107	127	157	184	232	269	316	337	367	95.5	0.9	3.6	0.729	62.6	10.4	0.06	2	
20	I	79.6	3.25	99	120	140	168	192	233	268	313	340	382	96.5	1.1	2.4	0.738	60.2	8.5	0.11	2	
21	I	79.2	2.29	103	128	144	168	189	230	273	334	367	398	97.0	1.4	1.6	0.741	59.5	7.4	0.05	3(20)*	
22	I	79.8	2.76	99	125	139	163	184	219	251	299	325	375	97.5	1.1	1.4	0.728	62.9	8.2	0.07	0.5	
23	I	79.3	1.99	97	111	127	150	174	228	276	333	355	390	96.5	1.0	2.5	0.726	63.4	10.1	0.02	1	
24	I	79.2	2.29	104	130	143	168	189	231	274	338	368	396	98.0	1.3	0.7	0.739	59.9	8.0	0.05	2(7)*	
Average		79.4	2.57	99	120	137	162	185	229	268	322	348	385	96.9	1.1	2.0	0.733	61.5	8.8	0.06	2	
25	II	74.8	1.79	100	118	139	171	203	248	283	327	345	370	96.5	1.0	2.5	0.737	60.5	8.9	0.08	3	
26	II	75.8	2.89	102	127	141	168	193	233	271	322	345	384	96.5	1.0	2.5	0.738	60.2	7.2	0.13	7	
27	II	75.0	1.12	103	120	137	161	185	228	272	335	361	399	96.0	1.2	2.8	0.738	60.3	8.7	0.04	9(32)*	
28	II	75.3	1.23	99	123	138	162	184	225	267	323	347	390	98.0	0.9	1.1	0.733	61.5	7.8	0.08	0.5	
29	II	76.0	2.40	108	135	154	180	206	249	283	328	350	384	98.5	1.0	0.5	0.739	60.0	6.9	0.03	2	
30	II	76.7	nil ^{1/2}	99	121	137	162	187	237	290	367	391	417	97.5	1.0	1.5	0.748	57.7	8.0	0.01	2	
31	II	75.0	0.80	102	124	140	163	187	228	270	333	357	394	97.0	1.2	1.8	0.737	60.5	8.5	0.04	2(3)*	
Average		75.5	1.71	102	124	141	167	192	235	277	333	357	391	97.2	1.0	1.8	0.739	60.0	8.0	0.06	4	
TORONTO, ONT.																						
32	I	78.8	2.26	100	119	140	163	185	227	272	337	368	399	96.5	1.5	2.0	0.737	60.5	8.5	0.04	2(7)*	
33	I	79.6	3.20	106	126	142	165	188	227	267	322	349	385	97.0	1.2	1.8	0.734	61.3	8.2	0.07	2	
Average		79.2	2.73	103	122	141	164	186	227	269	330	358	392	96.8	1.3	1.9	0.735	61.0	8.3	0.06	2	
34	II	74.5	2.38	105	127	145	170	195	235	273	325	347	380	96.8	1.2	2.0	0.729	62.6	8.0	0.03	2	
35	II	74.5	1.29	96	116	130	154	176	216	255	311	340	379	97.5	1.2	1.3	0.721	64.8	9.8	0.05	5	
36	II	73.6	0.69	99	121	138	165	188	232	277	347	376	426	97.5	1.2	1.3	0.739	60.0	8.2	0.04	1(6)*	
37	II	74.0	1.03	102	124	142	167	190	229	266	323	345	388	98.0	1.1	0.9	0.733	61.5	8.2	0.06	1	
38	II	75.9	2.03	104	130	148	175	199	243	286	338	367	389	97.5	1.1	1.4	0.736	60.8	7.3	0.03	3	
39	II	77.2	nil ^{1/2}	105	120	136	162	188	239	298	374	400	424	97.5	1.1	1.4	0.748	57.7	8.5	0.02	5(7)*	
Average		75.0	1.48	102	123	140	166	189	232	276	336	363	398	97.5	1.1	1.4	0.734	61.3	8.3	0.04	3	

Milligrams per 100 millilitres and in addition * contains milligrams oil - in brackets. ** Millilitres per Imperial gallon. ^{1/2} Not included in average.

TABLE I (Continued)

GASOLINE SURVEY ANALYSES BY CITIES FOR SUMMER 1947.

Sam- ple No.	Group	A.S.T.M. Octane No.	Tetra Ethyl Lead**	I.B.P.	Distillation Range, °F.									End Pt.	Reco- very %	Resi- due %	Loss %	Sp. Gr. 60°F.	Deg- rees A.P.I.	Reid V.P. lb.	Sul- phur %	Gum**																					
					Per Cent Evaporated																																						
																						WINNIPEG, MAN.																					
40	I	79.7	3.13	96	115	132	159	183	227	268	325	349	384	97.0	1.2	1.8	0.728	62.9	10.1	0.05	3																						
41	I	79.6	2.33	106	118	137	162	185	228	273	337	361	392	96.5	1.2	2.3	0.738	60.2	8.1	0.05	2(16)*																						
Average		79.7	2.73	101	116	135	160	184	228	270	331	355	388	96.8	1.2	2.0	0.733	61.5	9.1	0.05	2																						
42	II	74.8	1.48	100	118	135	162	186	230	270	321	343	382	97.0	1.1	1.9	0.727	63.1	8.8	0.05	2																						
43	II	74.6	0.51	102	121	136	161	184	226	269	333	359	390	97.0	1.2	1.8	0.736	60.8	8.6	0.05	2(8)*																						
44	II	74.5	1.09	105	121	138	164	186	229	271	335	365	396	97.0	1.0	2.0	0.737	60.5	8.2	0.04	2(6)*																						
45	II	72.8	2.26	101	123	143	172	200	248	292	340	360	380	97.5	1.1	1.4	0.729	62.6	7.8	0.06	2																						
Average		74.2	1.34	102	121	138	165	189	233	276	332	357	387	97.1	1.1	1.8	0.732	61.8	8.4	0.05	2																						
																						REGINA, SASK.																					
46	I	76.0	2.46	99	117	133	161	187	238	283	337	360	402	97.0	1.3	1.7	0.730	62.3	8.8	0.09	3(17)*																						
47	I	76.0	2.48	103	124	137	160	190	240	285	341	368	411	97.3	1.1	1.6	0.730	62.3	8.6	0.09	2(7)*																						
Average		76.0	2.47	101	120	135	160	188	239	284	339	364	407	97.2	1.2	1.6	0.730	62.3	8.7	0.09	2																						
48	II	72.4	1.62	101	120	141	172	198	240	281	332	351	376	97.0	1.0	2.0	0.730	62.3	8.9	0.05	1																						
49	II	72.4	0.55	93	111	127	155	184	234	282	339	359	377	97.0	1.0	2.0	0.729	62.6	10.2	0.05	1																						
50	II	73.6	1.75	103	122	139	165	190	236	281	338	362	408	97.5	1.0	1.5	0.728	62.9	8.7	0.07	1(4)*																						
Average		72.8	1.31	99	118	136	164	191	237	281	336	357	387	97.2	1.0	1.8	0.729	62.6	9.3	0.06	1																						
																						EDMONTON, ALTA.																					
51	I	77.6	3.39	104	125	143	167	191	239	286	344	367	392	97.0	1.3	1.7	0.732	61.8	7.8	0.06	3																						
52	I	77.2	2.28	103	119	135	159	184	232	282	341	362	392	97.0	1.3	1.7	0.731	62.1	8.7	0.04	Tr.(7)																						
53	I	77.9	2.69	106	130	147	173	196	243	286	340	362	388	97.8	1.2	1.0	0.738	60.2	7.1	0.10	6																						
Average		77.6	2.79	104	125	141	166	190	238	285	342	364	391	97.3	1.3	1.4	0.734	61.3	7.9	0.07	3																						
54	II	73.6	1.40	110	130	147	169	192	237	284	340	363	392	97.5	1.2	1.3	0.731	62.1	7.3	0.05	6																						
55	II	74.4	1.86	104	120	136	160	186	234	280	338	359	388	97.0	1.4	1.6	0.729	62.6	8.5	0.03	Tr.(15)																						
Average		74.0	1.63	107	125	141	165	189	236	282	339	361	390	97.3	1.2	1.5	0.730	62.3	7.9	0.04	3																						
																						VANCOUVER, B.C.																					
56	I	81.9	2.75	100	118	136	163	184	221	255	308	333	387	96.5	1.2	2.3	0.733	61.5	8.2	0.06	Tr.(8)																						
57	I	82.2	1.75	95	109	126	151	176	219	264	323	346	378	97.0	1.0	2.0	0.735	61.0	8.5	0.03	1																						
Average		82.0	2.25	97	113	131	157	180	220	260	315	339	382	96.8	1.1	2.1	0.734	61.3	8.3	0.05	1																						
58	II	75.4	1.59	103	120	139	170	198	239	275	313	332	364	96.3	1.0	2.7	0.736	60.8	8.6	0.12	1																						
59	II	77.0	1.66	103	121	138	164	189	230	270	328	359	398	97.0	1.1	1.9	0.735	61.0	8.7	0.06	Tr.(4)																						
60	II	76.0	1.28	102	120	136	165	192	239	280	338	358	385	97.0	1.1	1.9	0.738	60.2	8.3	0.19	7																						
61	II	76.5	1.65	102	112	136	170	202	247	285	332	355	389	96.0	1.1	2.9	0.744	58.7	8.6	0.20	3																						
Average		76.2	1.55	103	118	137	167	195	239	278	328	351	384	96.6	1.1	2.3	0.738	60.2	8.6	0.14	3																						

Milligrams per 100 millilitres and in addition * contains milligrams oil - in brackets. *Millilitres per Imperial gallon. Tr. means Trace.

TABLE II

AVERAGE OF GASOLINE SURVEY ANALYSES BY CITIES FOR SUMMER 1947.

CITY	No. of Samples	Group	A.S.T.M. Octane No.	Tetra Ethyl Lead**	Distillation Range, °F.										Recovery %	Residue %	Loss %	Sp. Gr. 60°F.	Degrees A.P.I.	Reid V.P. lb.	Sulphur %	Gum**
					I.B.P.	Per Cent Evaporated	10	20	50	70	90	Pt. very	End									
Halifax, N.S.	2	I	79.6	2.59	92	135	169	259	304	362	428	97.0	1.2	1.8	0.746	58.2	9.4	0.15	6			
Saint Joh, N.B.	2	I	79.8	2.63	101	134	160	237	284	349	413	96.8	1.0	2.2	0.735	61.0	9.3	0.11	6			
Montreal, Que.	3	I	79.7	2.72	101	132	160	236	282	334	386	96.6	1.1	2.3	0.731	62.1	8.9	0.06	5			
Ottawa, Ont.	6	I	79.4	2.57	99	137	162	229	268	322	385	96.9	1.1	2.0	0.733	61.5	8.8	0.06	2			
Toronto, Ont.	2	I	79.2	2.73	103	141	164	227	269	330	392	96.8	1.3	1.9	0.735	61.0	8.3	0.06	2			
Winnipeg, Man.	2	I	79.7	2.73	101	135	160	228	270	331	388	96.8	1.2	2.0	0.733	61.5	9.1	0.05	2			
Regina, Sask.	2	I	76.0	2.47	101	135	160	239	284	339	407	97.2	1.2	1.6	0.730	62.3	8.7	0.09	2			
Edmonton, Alta.	3	I	77.6	2.79	104	141	166	238	285	342	391	97.3	1.3	1.4	0.734	61.3	7.9	0.07	3			
Vancouver, B.C.	2	I	82.0	2.25	97	131	157	220	260	315	382	96.8	1.1	2.1	0.734	61.3	8.3	0.05	1			
Average	(24)	I	79.2	2.61	100	136	162	234	277	334	394	96.9	1.2	1.9	0.734	61.3	8.7	0.07	3			
Halifax, N.S.	3	II	75.1	1.02	95	137	170	259	308	361	419	96.7	1.3	2.0	0.746	58.2	9.4	0.14	9			
Saint John, N.B.	3	II	75.1	0.86	102	135	164	249	301	360	423	96.8	1.1	2.1	0.742	59.2	9.0	0.12	11			
Montreal, Que.	5	II	75.8	1.56	103	141	170	241	284	339	395	97.0	1.1	1.9	0.739	60.0	8.1	0.06	3			
Ottawa, Ont.	7	II	75.5	1.71	102	141	167	235	277	333	391	97.2	1.0	1.8	0.739	60.0	8.0	0.06	4			
Toronto, Ont.	6	II	75.0	1.48	102	140	166	232	276	336	398	97.5	1.1	1.4	0.734	61.3	8.3	0.04	3			
Winnipeg, Man.	4	II	74.2	1.34	102	138	165	233	276	332	387	97.1	1.1	1.8	0.732	61.8	8.4	0.05	2			
Regina, Sask.	3	II	72.8	1.31	99	136	164	237	281	336	387	97.2	1.0	1.8	0.729	62.6	9.3	0.06	1			
Edmonton, Alta.	2	II	74.0	1.63	107	141	165	236	282	339	390	97.3	1.2	1.5	0.730	62.3	7.9	0.04	3			
Vancouver, B.C.	4	II	76.2	1.55	103	137	167	239	278	328	384	96.6	1.1	2.3	0.738	60.2	8.6	0.14	3			
Average	(37)	II	75.0	1.42	102	139	166	239	283	339	396	97.1	1.1	1.8	0.737	60.5	8.5	0.07	4			
Average of all Samples	(61)	I&II	-	-	101	138	165	237	280	337	395	97.0	1.1	1.9	0.736	60.8	8.6	0.07	4			

**Milligrams per 100 millilitres **Millilitres per Imperial gallon.

TABLE III

SUMMARY OF DATA OF GASOLINE SURVEY ANALYSES FOR CANADA FOR SUMMER 1947

Test	GROUP I (Octane No. 78 and above)			GROUP II (Octane No. 77 to 70)		
	Minimum	Average	Maximum	Minimum	Average	Maximum
Specific Gravity at 60°F....	0.726	0.734	0.748	0.721	0.737	0.749
Gravity, Degrees A.P.I.....	63.4	61.3	57.7	64.8	60.5	57.4
Reid Vapour Pressure, lb....	7.1	8.7	10.4	6.9	8.5	10.2
Sulphur, Per Cent.....	0.02	0.07	0.17	0.01	0.07	0.20
Gum, milligrams per 100 millilitres.....	Trace	3	7	Trace	4	17
Tetraethyl Lead, millilitres per imp. gal.....	1.75	2.61	3.39	nil	1.42	2.89
A.S.T.M. Octane Number.....	76.0	79.2	82.2	72.4	75.0	77.3
Distillation Range--						
Initial Boiling Point, °F.	91	100	106	93	102	110
5% Evaporated, °F.....	107	119	130	111	121	135
10% Evaporated, °F.....	126	136	147	127	139	154
20% Evaporated, °F.....	150	162	173	154	166	180
30% Evaporated, °F.....	174	188	206	176	193	207
50% Evaporated, °F.....	219	234	265	216	239	267
70% Evaporated, °F.....	251	277	307	255	283	315
90% Evaporated, °F.....	299	334	367	311	339	374
95% Evaporated, °F.....	325	359	392	332	362	400
End Point, °F.....	367	394	429	364	396	426
Recovery, Per Cent.....	95.5	96.9	98.0	96.0	97.1	98.5
Residue, Per Cent.....	0.9	1.2	1.5	0.9	1.1	1.4
Distillation loss, Per Cent.....	0.7	1.9	3.6	0.5	1.8	2.9
Number of Samples.....	---	24	---	---	37	---

TABLE IV

AVERAGE OF GASOLINE SURVEY ANALYSES FOR CANADA FOR SUMMERS, 1923 THROUGH 1947. (EXCEPT 1940)

Year	I.B.P.	Distillation Range, °F.					End pt.	Recovery %	Residue %	Loss %	Sp. Gr. 60°F.	Deg-rees A.P.I.	Reid V.P. lb.	Sul-phur %
		Per Cent Evaporated												
		10	20	50	70	90								
1923	120	163	189	251	294	351	423	97.1	1.1*	1.8	0.737	60.5	-	-
1924	113	169	192	246	285	341	410	97.4	1.1*	1.5	0.736	60.8	-	-
1925	116	168	195	254	295	352	412	97.0	1.1*	1.9	0.739	60.0	-	-
1926	110	158	187	253	296	354	410	97.4	1.1*	1.5	0.739	60.0	-	-
1927	107	156	184	255	299	359	416	97.0	1.1*	1.9	0.741	59.5	-	-
1928	107	155	182	251	294	353	409	97.3	1.1*	1.6	0.737	60.5	-	-
1929	102	147	176	250	296	355	411	97.0	1.1*	1.9	0.736	60.8	-	-
1930	101	149	178	250	297	356	406	97.2	1.1	1.7	0.741	59.5	-	0.07
1931	104	151	181	254	299	359	406	96.9	1.3	1.8	0.741	59.5	-	0.05
1932	102	151	181	251	297	357	408	97.9	1.2	0.9	0.742	59.2	7.4	-
1933	101	147	176	249	292	345	396	97.5	1.2	1.3	0.739	60.0	6.9	-
1934	101	144	172	244	287	346	395	97.5	1.2	1.3	0.738	60.2	7.5	-
1935	101	143	171	240	281	337	393	97.4	1.1	1.5	0.735	61.0	7.7	0.06
1936	101	145	173	242	283	335	388	97.6	1.0	1.4	0.736	60.8	7.7	-
1937	98	143	173	248	293	343	391	97.1	1.0	1.9	0.739	60.0	8.0	-
1938	99	145	174	248	291	342	393	97.5	0.9	1.6	0.740	59.7	8.2	-
1939	99	142	173	249	292	343	393	97.0	0.9	2.1	0.740	59.7	8.3	-
1940	NO SURVEY													
1941	101	143	172	243	285	338	392	97.2	0.9	1.9	0.741	59.5	8.2	0.06
1942	97	135	161	234	277	333	390	97.0	1.0	2.0	0.733	61.5	9.2	0.05
1943	100	140	170	246	287	339	391	97.3	1.0	1.7	0.741	59.5	8.1	0.08
1944	100	142	177	257	298	352	401	97.1	1.2	1.7	0.743	58.9	7.9	0.06
1945	103	144	175	247	289	345	401	97.1	1.2	1.7	0.740	59.7	7.9	0.07
1946	99	137	166	238	282	338	394	97.0	1.2	1.8	0.737	60.5	8.4	0.07
1947	101	138	165	237	280	337	395	97.0	1.1	1.9	0.736	60.8	8.6	0.07

*estimated

TABLE V

SUMMARY OF DATA OF GASOLINE SURVEY ANALYSES BY GROUPS FOR CANADA FOR SUMMERS, 1937 THROUGH 1947. (EXCEPT 1940)

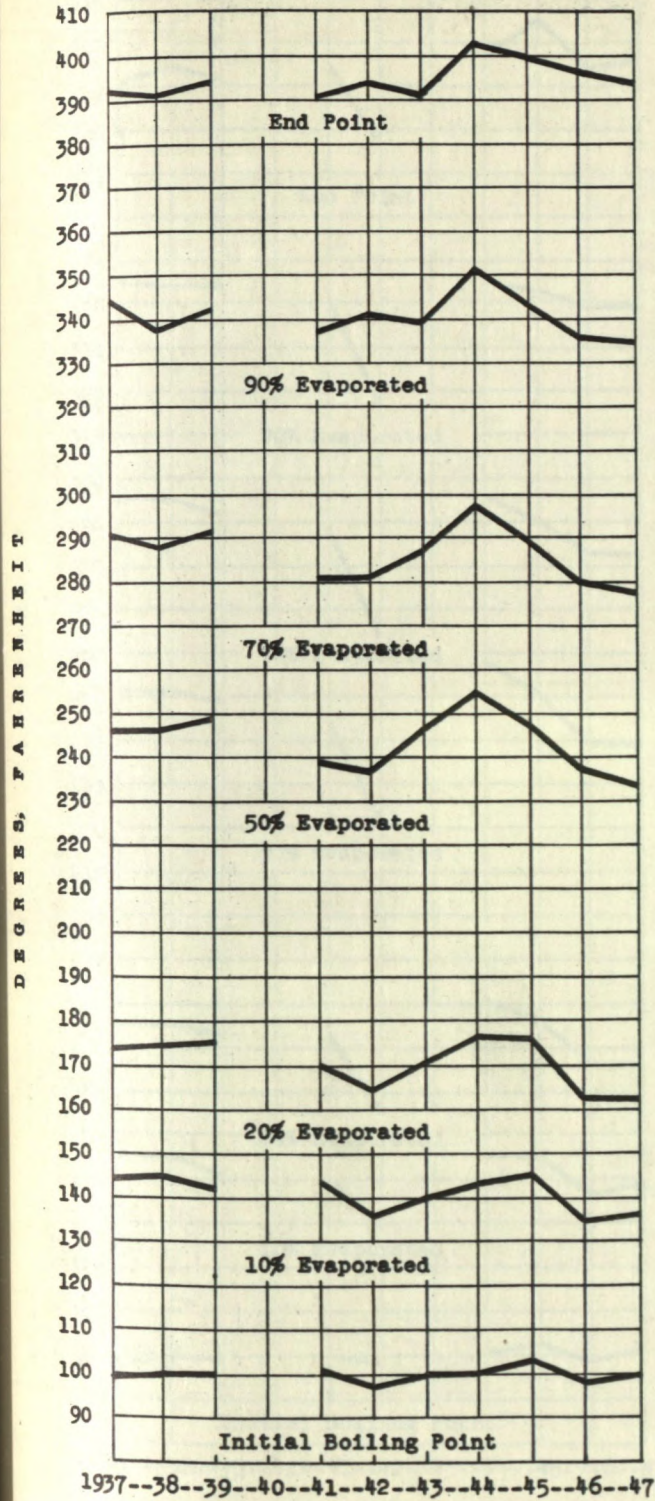
Year	Group	No. of Samples	A.S.T.M. Octane No.	I.B.P.	Distillation Range, °F.					End pt.	Recovery %	Residue %	Loss %	Sp. Gr. 60°F.	Deg-rees A.P.I.	Reid V.P. lb.	Sul-phur %	Curt
					Per Cent Evaporated													
					10	20	50	70	90									
1937 I	(Octane No. 75 & above)	14	77.6	99	144	173	246	291	344	392	97.0	1.1	1.9	0.740	59.7	8.2	-	-
1938 I	(Octane No. 75 & above)	14	77.8	100	145	174	246	287	337	391	97.6	0.9	1.5	0.739	60.0	8.2	-	-
1939 I	(Octane No. 75 & above)	13	77.4	100	142	175	248	291	342	394	97.0	1.0	2.0	0.741	59.5	8.3	-	-
1941 I	(Octane No. 77 & above)	23	79.0	101	143	170	239	281	337	391	97.3	0.9	1.8	0.743	58.9	8.1	0.07	-
1942 I	(Octane No. 78 to 75)	32	76.9	97	135	163	237	281	341	394	97.0	1.0	2.0	0.736	60.8	9.0	0.05	6
1943 I	(Octane No. 78 to 75)	32	75.7	100	140	170	246	287	339	391	97.3	1.0	1.7	0.741	59.5	8.1	0.08	4
1944 I	(Octane No. 76 to 74)	45	74.8	100	143	177	255	298	352	403	97.0	1.2	1.8	0.745	58.4	8.0	0.07	4
1945 I	(Octane No. 74 to 73)	64	73.5	103	145	176	247	289	343	399	97.1	1.2	1.7	0.741	59.5	7.9	0.07	3
1946 I	(Octane No. 77 & above)	17	77.8	98	134	162	236	279	335	396	96.8	1.3	1.9	0.737	60.5	8.8	0.08	4
1947 I	(Octane No. 78 & above)	24	79.2	100	136	162	234	277	334	394	96.9	1.2	1.9	0.734	61.3	8.7	0.07	3
1937 II	(Octane No. 74 to 65)	39	70.1	98	145	175	251	296	345	391	97.1	1.0	1.9	0.741	59.5	7.9	-	-
1938 II	(Octane No. 74 to 65)	41	70.2	100	145	175	251	295	344	395	97.4	1.0	1.6	0.741	59.5	8.2	-	-
1939 II	(Octane No. 74 to 65)	43	70.3	99	141	173	249	292	344	392	97.0	0.9	2.1	0.739	60.0	8.4	-	-
1941 II	(Octane No. 76 to 70)	53	73.6	100	141	173	244	288	341	395	97.1	1.0	1.9	0.741	59.5	8.4	-	-
1942 II	(Octane No. 70 to 65)	9	67.1	98	129	155	220	263	317	377	96.7	0.9	2.4	0.721	64.8	10.1	0.05	-
1943	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1944 II	(Octane No. 70 to 66)	16	68.6	101	146	181	258	296	345	397	97.2	1.2	1.6	0.738	60.2	7.4	0.05	4
1945 II	(Octane No. 70 to 66)	21	68.5	103	145	177	251	290	343	405	96.9	1.4	1.7	0.739	60.0	7.9	0.06	5
1946 II	(Octane No. 76 to 70)	41	73.6	99	137	166	239	283	339	394	97.0	1.2	1.8	0.738	60.2	8.2	0.07	4
1947 II	(Octane No. 77 to 70)	37	75.0	102	139	166	239	283	339	396	97.1	1.1	1.8	0.737	60.5	8.5	0.07	4

*Milligrams per 100 millilitres.

YEAR-SUMMER

1937--38--39--40--41--42--43--44--45--46--47

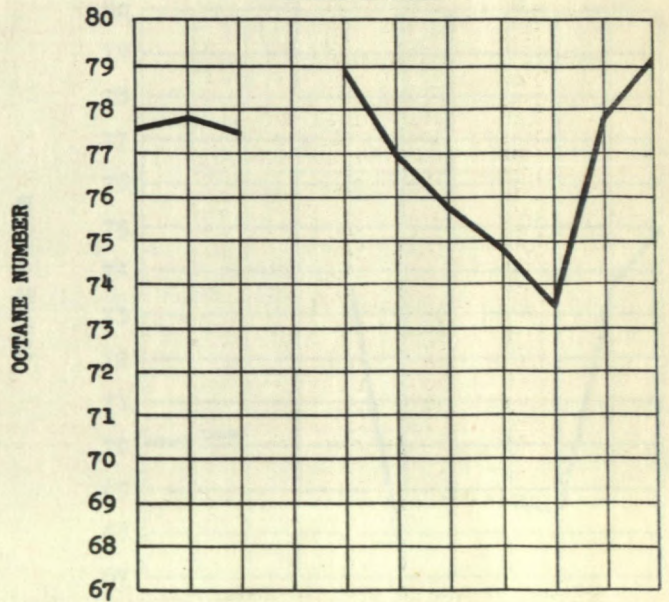
DISTILLATION RANGE



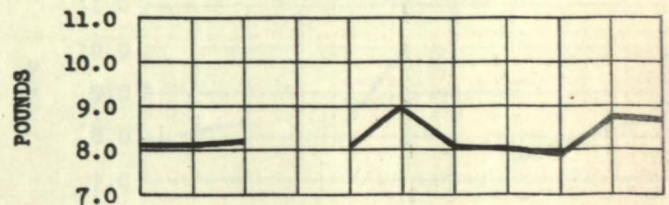
YEAR-SUMMER

1937--38--39--40--41--42--43--44--45--46--47

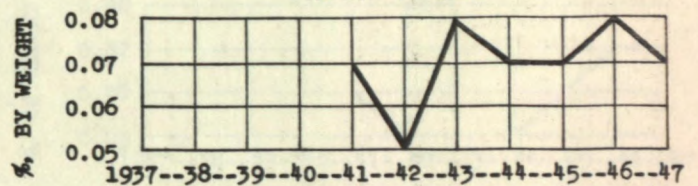
KNOCK RATING



REID VAPOUR PRESSURE



SULPHUR CONTENT



GROUP I GASOLINE

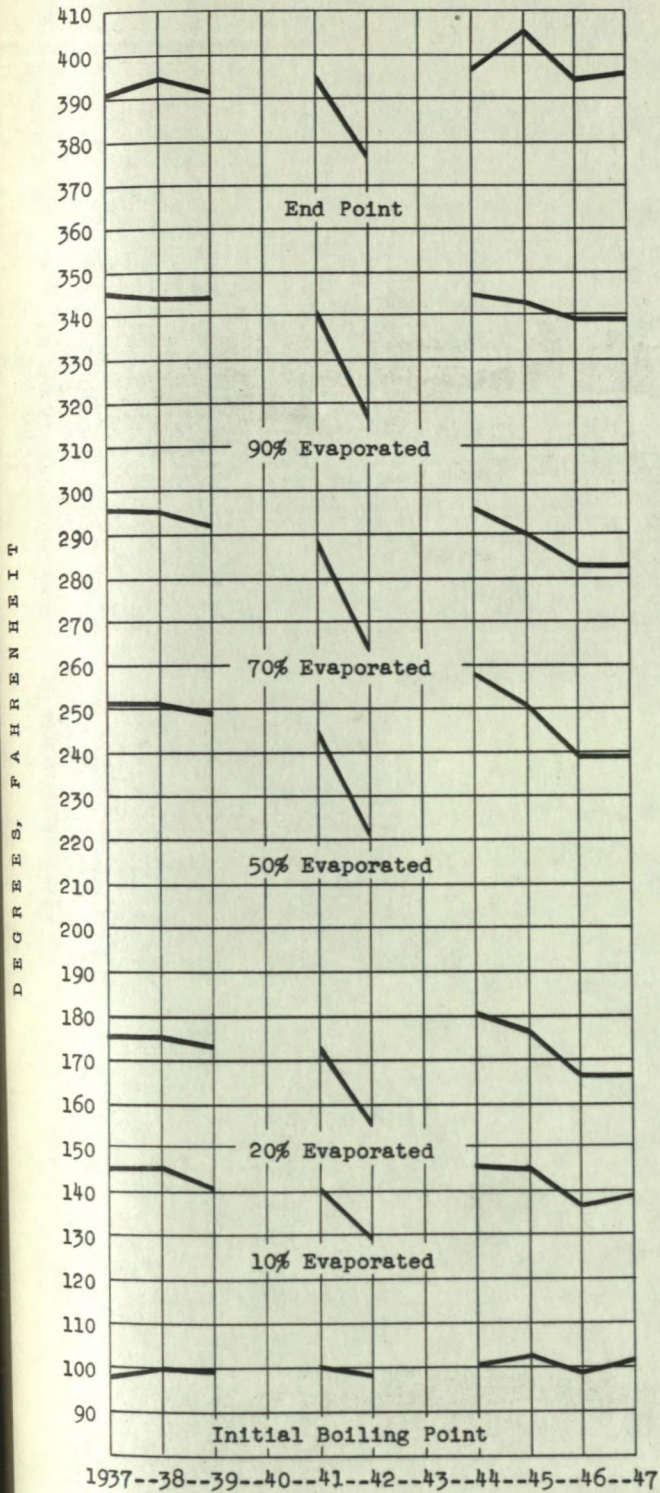
FIGURE I - COMPARISON OF GASOLINE CHARACTERISTICS FROM SUMMER SURVEYS OF 1937 THROUGH 1947

NOTE: No Survey was made in 1940 for Group I.

YEAR-SUMMER

1937--38--39--40--41--42--43--44--45--46--47

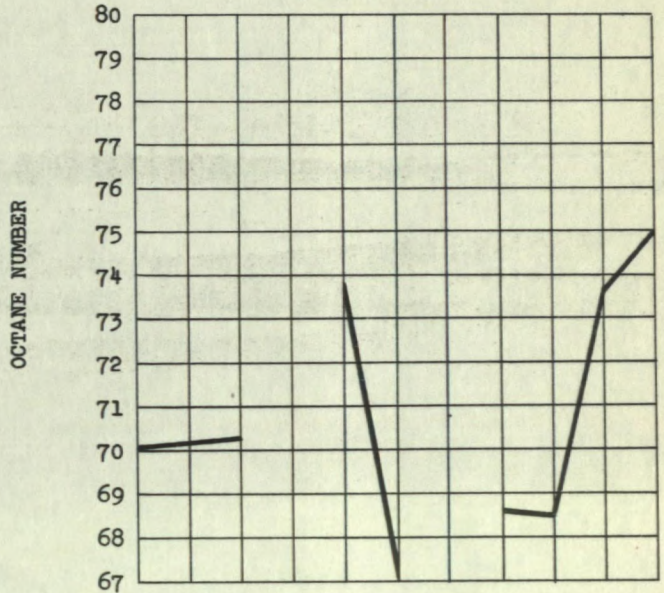
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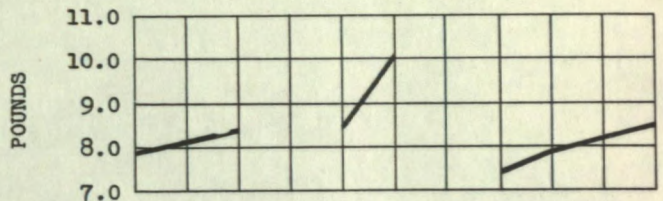
YEAR-SUMMER

1937--38--39--40--41--42--43--44--45--46--47

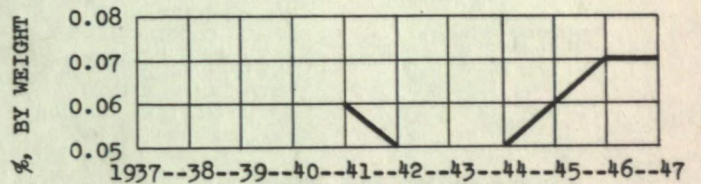
KNOCK RATING



REID VAPOUR PRESSURE



SULPHUR CONTENT



GROUP II GASOLINE

FIGURE II - COMPARISON OF GASOLINE CHARACTERISTICS FROM SUMMER SURVEYS OF 1937 THROUGH 1947

NOTE: No Survey was made in 1940 and 1943 for Group II.