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THE GASOLINE SITUATION ¹

By H. H. Hill.²

The United States has often been referred to as a nation on wheels. It might properly be called a nation on rubber tires, or even better, a nation that rides behind gasoline engines. There are now approximately 20,000,000 automobiles and trucks in this country, which is somewhat more than 80% of those in use in the entire world and is equivalent to 1 car for each 6 people. When we consider that the total registration includes motor busses and trucks, we find that by a little crowding it would be possible to load the entire population of the United States into the motor vehicles now available.

The remarkable growth of the automotive industry has been attributed to a number of factors, such as the roving spirit of the American people and their desire to attain high standards of living, the inventive genius of our engineers and metallurgists resulting in the development and application of alloy steels, improvements in automotive equipment such as the self-starter, more general use of the closed car, partial payment plan for purchasing automobiles, etc., but probably no single factor has been so important as a plentiful supply of a relatively cheap fuel and its availability even in the most remote sections of the country. It not only has more than 80% of the automobiles of the world, but produces more than 70% of the world’s annual output of crude oil (70.5% in 1924), and consumes practically the same percentage of the total.

History of crude oil production

Although the United States has been producing crude oil since 1859, and up to January 1 of this year has produced approximately 8,662,000,000 barrels, it is interesting to note that during the past ten years the production has amounted to 58% of the total, and during the past five years we have produced 37% of all the oil that has been taken from the ground since the first well was drilled. Also the average monthly production for the year 1925 was practically the same as the entire production for the year 1900. These figures clearly illustrate the remarkable growth of the petroleum industry during the past few years. Production figures for the 10-year period

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1916 to 1925 are shown in Column 1 of Table 1. It will be noted that during this brief period the production has increased from 300,767,000 barrels in 1916 to an estimated figure of 755,852,000 barrels in 1925, a gain of 152%. The production for 1925 averages somewhat more than 2,000,000 barrels a day, reaching a peak of 2,346,900 barrels daily during the last week of May and declining to 1,972,550 barrels daily at the end of the year.

History of Gasoline Production

The production of gasoline has increased even more rapidly than the production of crude oil. Formerly considered as a waste product from the refineries, gasoline did not become an important product from crude oil until the development of the automobile provided a market for a highly volatile fuel. In 1904 when the automobile industry was just getting well under way the production of gasoline was 290,640,000 gallons, while in 1925, with 20,000,000 cars to supply, the production of gasoline amounted to approximately 10,886,127,000 gallons or 37 times the production of 1904. The production of gasoline, like the production of crude oil, has increased very rapidly during the past few years. Column 3 of Table 1 shows that for the 10-year period 1916 to 1925 the gasoline production of the United States increased from approximately 2,059,000,000 gallons to 10,886,127,000 gallons, and increase of 429%.

History of Automobile Registration

While the increase in the production of crude oil and of gasoline has been remarkable, the growth of the automobile industry has been even more spectacular. Starting in the late nineties with a total production of only 3,723 cars in the year 1899, the production has increased by leaps and bounds, exceeding 4,000,000 cars and trucks in the year 1925. The registration of cars and trucks has shown a correspondingly rapid increase, particularly during the past few years. Column 5 of Table 1 shows that the registration of cars and trucks in this country has increased from 3,512,996 in 1916 to an estimated total of 20,100,000 in 1925, an increase of 472%.

Comparison of increases of crude oil production, gasoline production, and registration of cars and trucks.

It has been shown that during the 10-year period 1916 to 1925, which represents the most rapid growth in the number of cars and trucks in use, the production of crude oil increased 152%, the production of gasoline increased 429% and the number of cars and trucks registered increased 472%. In other words there was 2.3 times as much crude oil produced in 1925 as in 1916, 5.3 times as much gasoline produced and 5.7 times as many cars and trucks registered. Although the increase in cars registered has been slightly higher than the increase in the production of gasoline, the amount of gasoline has been adequate. Despite the fact that the number of barrels of crude oil per car registered decreased from approximately 100 barrels per car in 1916 to about 40 barrels in 1925, the production of gasoline has been sufficient to take care of the domestic demand and allow a reasonable amount for export. Column 7 of Table 1 shows the number of gallons of gasoline per car, based on the mean number of cars registered at the beginning and end of the year. It will be noted that the figure decreased from 562 gallons per car in 1916 to
<table>
<thead>
<tr>
<th>Year</th>
<th>Production of Crude Oil (bbl.)</th>
<th>Crude oil refined (bbl.)</th>
<th>Production of Gasoline (gal.)</th>
<th>Yield of Gasoline, Per Cent.</th>
<th>Indicated Domestic Demand for Gasoline (gall.)</th>
<th>Registration of Cars and Trucks</th>
<th>Gallons of Gasoline per Car and Truck Base on Mean of Registered Cars and Trucks</th>
<th>Average, Retail-Tank-Warehouse, Price per Gallon of Gasoline</th>
</tr>
</thead>
<tbody>
<tr>
<td>1916</td>
<td>300,767,000</td>
<td>286,992,015</td>
<td>2,058,880,596</td>
<td>19.8</td>
<td>-</td>
<td>3,512,996</td>
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<td>1917</td>
<td>335,116,000</td>
<td>315,131,681</td>
<td>2,850,546,423</td>
<td>21.6</td>
<td>2,363,236,401</td>
<td>4,983,340</td>
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<td>1918</td>
<td>355,928,000</td>
<td>326,024,630</td>
<td>3,570,312,963</td>
<td>26.1</td>
<td>3,129,266,347</td>
<td>6,146,617</td>
<td>562</td>
<td>24.2</td>
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<tr>
<td>1920</td>
<td>442,925,000</td>
<td>433,915,029</td>
<td>4,882,546,699</td>
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<td>4,250,596,163</td>
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<td>1921</td>
<td>472,183,000</td>
<td>433,362,857</td>
<td>5,153,594,318</td>
<td>27.7</td>
<td>4,516,027,256</td>
<td>10,463,295</td>
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<td>26.1</td>
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<tr>
<td>1922</td>
<td>557,531,000</td>
<td>500,705,616</td>
<td>6,202,234,613</td>
<td>29.5</td>
<td>5,372,085,042</td>
<td>12,238,175</td>
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<td>25.1</td>
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<tr>
<td>1923</td>
<td>728,407,000</td>
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<td>7,555,985,143</td>
<td>30.9</td>
<td>6,885,035,280</td>
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<tr>
<td>1924</td>
<td>713,940,000</td>
<td>643,719,349</td>
<td>8,959,820,220</td>
<td>33.1</td>
<td>7,763,408,308</td>
<td>17,591,981</td>
<td>476</td>
<td>18.0</td>
</tr>
<tr>
<td>1925</td>
<td>755,858,000*</td>
<td>740,004,000*</td>
<td>10,886,127,000*</td>
<td>35.0*</td>
<td>9,362,094,000*</td>
<td>20,100,000*</td>
<td>497*</td>
<td>19.1</td>
</tr>
</tbody>
</table>

* Preliminary figures subject to revision.

(a) Data from U. S. Geological Survey and U. S. Bureau of Mines.
(b) Data from U. S. Bureau of Public Roads.
(c) Data from U. S. Department of Labor.
(d) Data from reports on Refinery Operations - U. S. Bureau of Mines.
in 1921, and has since increased to an estimated figure of 497 for 1925. The increase in the average gasoline consumption per car is doubtless due to the increasing percentage of trucks and motor buses. No figures are available on the percentage of gasoline that is used for automobiles as compared to the amount used for other purposes but it is believed that the percentage has been fairly uniform from year to year and for that reason the figures on gasoline demand per car probably reflect the changes in actual consumption.

Meeting the demand for gasoline

Although the extremely rapid growth of the automobile industry has placed a real responsibility on the oil industry to provide sufficient fuel to keep the cars in operation, the industry has been equal to the task and has made it possible for the motorist to obtain a satisfactory fuel at all times. In order to meet this demand the oil industry has had to extend itself as thousands of wells have been drilled, a large number of which have not been profitable, and constant improvements have been made in refinery practice in order to get more gasoline out of the crude. A number of factors have contributed to increased production of crude oil, among which the following may be mentioned:

(a) Improved methods for locating favorable structures.

(b) Improvements in drilling methods.

(c) Improvements in drilling equipment.

(d) Improved production methods.

During the past few years scientific instruments such as the seismograph and torsion balance have been used with considerable success in locating structures that are favorable for the accumulation of oil, particularly in the Gulf Coast district where oil is usually found associated with salt domes. The diamond drill has also been used successfully in Oklahoma for locating structures that are not evident on surface indications. The discovery of at least two fields in Oklahoma is attributed to information that was obtained by core drilling with the diamond drill.

Although a number of important developments have been made in drilling methods, particularly in those employed in rotary drilling, probably the most important has been the development and use of the rotary core barrel. By using the core barrel it has been possible not only to locate oil sands that would be passed in the ordinary method of rotary drilling, but to determine proper points for landing casing in order to prevent the entrance of water into the well. A more general use of mud and cement has doubtless resulted in the recovery of thousands of barrels of oil, which otherwise would have been lost by entrance of water into the wells and the migration of oil and gas into barren sands above.

Improvements in drilling equipment have made it possible to obtain oil from sands that only a few years ago were considered beyond the reach of the drill. Several of the most prolific fields in California are producing oil from depths in excess of 4,000 feet and there are a number of deep wells in
Oklahoma, Colorado and Texas. A number of wells in California are producing from depths of 5,000 to 6,000 feet and the deepest producing oil well in the world which reached a total depth of 7,591 feet and is producing from a sand at 7,300 feet, is in the Athens field in California.

In addition to improvements in locating structures and in drilling the wells, there has been a constant effort on the part of the oil producer to obtain more oil from the sands and to save the oil after it has reached the surface. Improvements have been made in pumping equipment so that it is now possible to lift oil from the deep wells. Additional amounts of oil are now being recovered from oil-water emulsions and in some sections of the country operating methods are being changed in order to make better use of the gas that is produced with the oil. Evaporation losses on the lease are being appreciably reduced by the installation of gas-tight tanks, and a large percentage of the gas that is produced with the oil is being run through absorption or compression plants in order to recover the gasoline that it contains.

**Improvements in refinery practice**

As previously stated, the part played by the oil producer in supplying fuel for the motor cars in use has been very important, and he has increased his production to 2½ times that of 1916, while the refiner has increased the production of gasoline to more than 5 times that of 1916. The manufacturer of natural-gas gasoline also has had an important part in increasing gasoline production, for he has contributed a product that has materially helped the refiner in increasing the yield of gasoline from the crude. As shown in Column 4 of Table 1, the refinery yield of gasoline has increased from 19.8% in 1916 to 35.0% in 1925. This has been due to a number of factors, chief of which are the following: (a) Improvements in fractionating equipment, (b) More general use of cracking processes, and (c) Use of natural-gas gasoline.

Other factors that doubtless have contributed to an increased yield of gasoline are: Reduction of evaporation losses on the lease and at the refinery for the material lost is largely gasoline; a slight lowering of the volatility of gasoline marketed; recovery of gasoline from still vapors; and a more general use of improved refinery equipment such as continuous treaters. Although these improvements are important they would account for only a small percentage increase in the gasoline yield.

**Importance of improvements in fractionating equipment**

No figures are available to show the importance of improved fractionating equipment in increasing the yield of gasoline, but it is believed that such equipment has a decided effect. Bubble towers now in use in some of the refineries have resulted in increased yields of gasoline amounting to as much as 6 to 8% by straight distillation of crude oil. Equipment of this kind has not as yet been generally adopted by the refiners, and for that reason it will be of more importance in the future than at present.
Importance of cracking

According to the best information available, about 26% of the gasoline output of the refineries for 1925 was produced from heavier oils by cracking. This represents a production of approximately 2,824,000,000 gallons of gasoline by the use of cracking processes as compared to 400,000,000 gallons in 1918 and 1,000,000,000 gallons for the 5-year period preceding 1918. In other words almost 7 times as much gasoline was made by cracking in 1925 as in 1918, and almost 3 times as much as for the 5-year period preceding 1918.

This large production of cracked gasoline has been an extremely important factor in the providing of an adequate supply of motor fuel, as it has greatly increased the amount of gasoline available, without a corresponding increase in the production of crude oil. On the basis of the estimated yield of gasoline by straight distillation (23.4%) in 1925, it would have required approximately 287,000,000 barrels of crude oil to furnish the gasoline made by cracking processes.

Importance of natural gas gasoline

Approximately 7% of the gasoline output of the refineries for 1925 was from natural-gas gasoline that was brought to the refineries and either run through the stills or blended with gasoline to produce a finished motor fuel. This amounted to about 760,000,000 gallons and represents approximately 60% of the total production of natural-gas gasoline for that year. The amount of natural-gas gasoline that was used at the refineries in 1925 is equivalent to the gasoline yield by straight distillation (23.4%) from approximately 77,000,000 barrels of crude oil, and the total production of natural-gas gasoline for that year is equivalent to the amount of gasoline that would be obtained from 129,000,000 barrels of crude oil by straight distillation. The amount of natural-gas gasoline produced is even more important than is indicated by the above figures, for on account of its extremely high volatility, it has rendered available as motor fuel large quantities of distillates that would be unsatisfactory as motor fuel if used alone, due to their lack of low-boiling constituents.

If the gasoline production for 1925 had been obtained entirely by straight distillation of crude oil, the gasoline yield would have been 23.4% (67% of 35.0%) and instead of running 740,000,000 barrels of crude oil to the stills it would have been necessary to use 740,000,000 ÷ 287,000,000 = 129,000,000 or 1,156,000,000 barrels, which amount exceeds the world's production for 1924. If the production of gasoline had been limited to the domestic demand, and the entire amount had been made by straight distillation, it would have required approximately 950,000,000 barrels of crude oil which is almost 200,000,000 barrels (about 520,000 barrels daily) in excess of the production of the United States for the year 1925.

Use of substitute fuels

Blended fuels consisting of benzol and gasoline or benzol and naphtha are used in certain sections of the country and have helped to some extent in meeting the demand for motor fuel. The amount of such fuels is very small when
compared to the amount of gasoline used, for the production of benzol amounts to about 6,500,000 gallons monthly as compared to a production of gasoline of approximately 30,000,000 gallons daily. Blended fuels containing alcohol were sold in a number of Eastern cities shortly after the war but have apparently been withdrawn from the market.

Possibilities for the future

The question is often asked, can the oil industry continue to furnish the vast quantities of gasoline that will be needed for the cars and trucks that are now in use and the increased number that will doubtless be in use from year to year? No attempt will be made to answer that question. Attention is called, however, to the following factors that will doubtless be important in contributing to a supply of fuel for our motor vehicles.

(a) Additional improvements in methods of locating oil deposits.
(b) Improvements in drilling methods that will result in even deeper drilling.
(c) Improvements in pumping equipment that will make it possible to lift oil from greater depths than at present.
(d) More efficient use of gas for recovering oil from the sands.
(e) More extended application of artificial methods of recovery.
(f) Increased use of cracking processes.
(g) Increased efficiency in distillation equipment.
(h) Importation of foreign oils.
(i) Development of substitute fuels.
(j) Increased efficiency in utilization.

Particular attention is called to items a, e, f and j. Although the other factors mentioned will doubtless be very important, these four appear to be outstanding at the present time. It will be necessary to discover new fields, therefore any improvements in methods for locating favorable structures will be extremely important, as some structures that contain oil have doubtless been overlooked due to limitations in the methods that have been followed in the past. Since a large percentage of the production of this country has been coming from new fields, a decided drop in the amount of flush production would result in temporary shortages at least.

Artificial methods of recovery such as the use of compressed air or gas, water flooding or some method not yet in use will doubtless have a very important bearing on the future production of crude oil and likewise on the supply of motor fuel. Estimates differ as to the percentage of oil that is left in the sand after making use of our present methods of flowing and pumping, but the figures often used are from 60% to 80% of the total amount of oil.
originally contained in the sand. Since the production to date has been in excess of 8,000,000,000 barrels the amount remaining in the sands would therefore be between 12,000,000,000 and 13,000,000,000 barrels. The recovery of at least a part of this oil is probably the most important problem that confronts the oil industry. The introduction of compressed air and gas has been successful in limited areas, and at present there is an immense amount of activity in the district around Bartlesville and Nowata, Oklahoma. Water flooding as a means of recovering additional quantities of oil from the sand has been successfully employed in the Bradford field in Pennsylvania for several years. Since there are now more than 300,000 producing oil wells in this country in addition to several thousand that formerly produced oil but have been abandoned it can be realized that an appreciable increase in the production per well would add large quantities of oil to our daily output.

There is probably no one factor that is more important with regard to a future supply of motor fuel than a more extended use of the cracking process in the refineries of the country. As previously stated approximately 25% of the refinery output of gasoline in 1925 was made by cracking heavier oils. This figure could be materially increased as processes are now in use that will convert almost all grades of heavy oil into gasoline. The production of gas oil and fuel oil for the year 1925 was approximately 15,300,000,000 gallons, or about 49% of the crude oil charged to the stills. Although part of this material is used for gas making purposes, and a certain percentage is burned as fuel for purposes that coal could not be satisfactorily used, a large percentage is used in direct competition with coal and if necessary could be replaced by that more plentiful fuel. This gas oil and fuel oil could be used for the production of gasoline by cracking, and if used for that purpose it would be possible to double the production of gasoline by the cracking process without using all the material that would be available. It would doubtless be more expensive to manufacture gasoline from this material than from the distillate oils that are now generally used, but if needed for motor fuel the material could be made available for that purpose.

**Efficiency in utilization**

Automotive engineers have frequently stated that it is possible to double the efficiency of the present type of automobile engine which would result in doubling the miles per gallon of gasoline. If this can be accomplished its importance on the future consumption of gasoline can be readily appreciated as 40,000,000 cars and trucks could be operated on the amount of gasoline that is now being consumed, or we could operate the present number of cars and trucks on one-half the gasoline that is now consumed as motor fuel. Doubtless a new fuel that will stand high compressions will be required in order to obtain satisfactory results, but it is understood that a number of refiners are now making an extended effort to develop such a product and it is very possible that a suitable fuel will be available by the time a new type of engine is in general use.
Conclusion

To summarize, the oil industry has been able to meet the gasoline demand of the past by developing new fields, by improvements in drilling and production practices, by recovering increasing amounts of gasoline from natural gas, and by a more general use of the cracking process for manufacturing gasoline from heavier oils.

If the producer of crude oil will appreciably increase the percentage recovery of oil from the sands, if the refiner will double the production of gasoline made by the cracking process, and if the automobile manufacturer will market cars that will travel twice the distance of the present cars on the same amount of motor fuel, we will not need to discover new fields as often as in the past or to maintain the same rate of increase in the production of crude oil in order to meet the gasoline demand of the future. - Information Circular, Bureau of Mines, Department of Commerce.