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Alberta Oil Fields and the World Oil Supply

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INTRODUCTION.

When the Ontario Oil fields were first drilled in 1861 the demand was for kerosene, or coal oil as it was called. At that time gasoline was a by-product and was wasted. With the development of the internal combustion engine the demand for gasoline became the dominant factor in the oil industry. That now is being seriously challenged by the demand for fuel oil. In the United States, the greatest consumer of oil and oil products in the world, the daily consumption of fuel oil last year was 1,123,000 barrels, only slightly less than the daily gasoline consumption of 1,326,000 barrels. Perhaps the most striking use of fuel oil, other than the development of Diesel engines for trucks, has been the extent to which it has been applied to transportation by water. The *Normandie* for example uses oil in her boilers to generate power for four 40,000 h.p. electric motors. When using full power the oil consumed amounts to 60 tons an hour or a ton a minute. A ton is about 7 barrels. It is the same power as would be equivalent to 150 tons of coal per hour which would have to be carried to the stokehold and 10 to 12 tons of ashes and clinkers removed. The use of oil, therefore, has made such boats as the *Normandie* and *Queen Mary* possible. It is also interesting to note in this connection that the *Normandie* has 80 tons of lubricating oil in the oiling circuit which passes through the whole system once every ten minutes.

THE SITUATION IN THE UNITED STATES.

The United States has long been the greatest oil producing country of the world and supplies about 60% of the world's production. The production for 1936 was more than 3,300,000 barrels a day or twice the amount each day that Canada produces in a year, our annual production only amounting to 1,500,000 barrels. There is some fear in United States that this great production cannot be maintained and in spite of the fact that the oil industry is only beginning to catch up on over-production it is well known that oil reserves have been steadily decreasing in spite of very intensive work to discover new supplies. One of the major factors in the United States oil industry has been the East Texas field. This field was discovered in September, 1930, the discovery well flowing 300 barrels a day. A second well one mile west came in with 3,000 barrels a day, a third ten miles north with 10,000 barrels and a fourth twenty-five miles north with 12,000 barrels. This was the start of the development of the greatest field in the world which, when completely developed, will have an area of about 218 square miles or 140,000 acres. Ordinarily one well for 10 acres would have proven sufficient for extraction of the oil, but, owing to the fact that a thousand operating companies participated in this field, there will probably ultimately be 26,000 wells. At the end of 1935, 19,500 wells had been drilled but the output was very restricted. Before the restrictions became effective, however, the output reached 1,200,000 barrels a day in May, 1933, and at one time the price dropped to ten cents a barrel. The potential capacity of the field is regarded as 9,380,000,000 barrels—an enormous amount of oil in view of the fact that the total world production up to the end of 1934 was less than 26,000,000,000 barrels. The importance of East Texas is that it still contains between 25 and 30 per cent of the total reserves of United States. It is estimated 60 per cent of the oil in the field will be recovered, the high recovery being due to a water drive. Allowing for 20 per cent shrinkage after the oil is taken from the ground the net estimated recovery will be 4,500,000,000 barrels. Up to the end of 1935, 820,000,000 barrels were produced from this one field. At

present the allowable rate of production is 450,000 barrels a day and at this rate, 2,250,000 barrels of oil, the amount that can be obtained from flowing wells will have been produced by 1944. The remaining 2,250,000,000 barrels will be produced by mechanical means at an increasingly slower rate as the field is exhausted.

The value of petroleum exported from United States at present amounts to one-eighth the total value of all exports and is only exceeded by cotton. Since 1933 the exports of oil have been increasing but it is becoming apparent that this cannot continue. It is estimated that in 1934 the average cost of producing a barrel of crude oil in United States was 77.5 cents and the selling price was 98.4 cents.

SITUATION IN GREAT BRITAIN.

Less than 5 per cent of the British imports are of Empire origin. The main sources of Empire petroleum are in Trinidad, Burma, and India. British interests, however, have taken a very active part in developments of petroleum in many parts of the world but particularly in the Near and Middle East where in the last few years large scale developments have been undertaken.

SITUATION IN FRANCE.

France has only one small producing oil field at Pechelbronn. In 1935 this field gave slightly less than 540,000 barrels of which about 300,000 barrels came from drilling and the remainder from shafts and galleries. There is one small field in Algeria and exploratory work has been going forward in Morocco but no fields have been found. France has been interested in developments in the Near East and especially so because of her mandate of Syria. One of the pipe lines from Kirkuk empties on the Mediterranean at Tripoli in Syria.

Recently with money supplied by the state two plants for the hydrogenation of coal by different processes have been opened up. These plants are capable of producing 10,000 metric tons a year of liquid fuel. Another plant is now under consideration which would provide for the pro-

duction by synthetic methods of 300,000 tons a year or about one-tenth of the total present consumption. It has been the experience of every country that the costs under the most favourable conditions thus far developed are at least twice to five times as great as that of refining crude oil.

SITUATION IN GERMANY.

Most of the crude oil produced in Germany comes from Hanover, with a production of about 425,000 tons a year. Germany has tried four ways of producing liquid fuels: (1) Coking at high temperatures; (2) Hydrogenation by the Bergius process; (3) Semi-coking at low temperatures; (4) Fischer-Tropsch synthesis of gases. It has been estimated that by hydrogenation Germany would produce 600,000 tons of gasoline in 1936 and from coking 430,000 tons of benzol. The Fischer process uses coke water gas as its basis and this process has been put into operation on a large scale in the last few years, with the expectation that by the end of 1936, the production from this source will have been brought up to 450,000 metric tons. It was announced by the German Chancellor late in 1936, as the intention of the Government of Germany, to render the country completely independent of imported refined oil in three or four years. At present gasoline and gas oil are the largest import oil items.

NEAR EAST SITUATION.

There are three great producing areas in the Near and Middle East. These are Baku on the Caspian sea in U.S.S.R. Kirkuk east of the Tigris river in Iran and Bahrein, an island in the Gulf of Persia. Mosul in Iraq is one of the larger prospective fields, and several smaller producing fields have been to some extent already developed.

Baku comprises about six fields in the Apsheron peninsula which has an area of only nine square miles. This field was known to the early Persians from its mud volcanoes, oil and gas seeps and salt springs. Hand-dug wells were utilized for many centuries and finally, in 1873, drilling began and flowing wells resulted. The oil sands are very incoherent and sometimes a well will produce 25 to 30% of sand with the oil. This has caused a great deal of diffi-

culty in keeping up production. At the present time the Soviet Government is trying to increase production and bring the Baku fields up to 420,000 barrels a day, which would be slightly more than 150,000,000 barrels a year. In 1935 the production amounted to 136,000,000 barrels or about 77% of the total oil production of Russia. Two pipe lines connect Baku with the Black Sea and Russia exports a considerable amount of oil and oil products, but with industrial developments in the country this is decreasing. In 1935 the domestic consumption of oil and oil products increased 15.75% in Russia and the exports decreased 21.4%. One difficulty is that Baku is rather distant from the greater part of Russia particularly Asiatic Russia which eventually will need much larger oil supplies.

MOSUL.

A concession of 46,000 square miles was originally obtained from the Iraq Government for the development of oil by the British Oil Development Company. This Company was purchased by the Mosul Oil Fields Limited, which in 1935 came under Italian control with a smaller German interest. The rental for the concession has been on an increasing yearly scale and in 1937 will amount to £200,000. The Italian and German interests apparently found difficulty in meeting these payments and at the same time providing money for development and in 1936 the Mosul Oil Fields Limited was purchased by the Iraq Petroleum Company which is under British control with French, American and other smaller interests. It seems certain now that a development program will be put into effect. Certain drilling has been done and a large oil area proven although it is understood some of the oil at least is high in sulphur and rather low gravity (20 degrees A.P.I.).* A pipe line from Mosul to Alexandretta on the Mediterranean has been proposed but not yet built. The length will be about 400 miles.

KIRKUK.

A concession of 32,000 square miles of territory for oil prospecting was given to the Iraq Petroleum Company in

*American Petroleum Institute.

1925. Between 1927 and 1931 there were 30 wells drilled and a large supply of oil found. A pipe line opened in 1935 connects the Kirkuk field with two ports on the Mediterranean, one terminal is at Haifa in Palestine under British mandate; and the other at Tripoli in Syria under French mandate. The greater part of the pipe line is twelve inches and is 1,150 miles long with twelve pumping stations, nine of which are in the desert. Each pumping station has workshops, garages, tank facilities for oil and water, telegraph, telephone and aerodrome. The pipe line crosses the Tigris, Euphrates, and the Jordan Rivers and is capable of delivering 4.5 million tons of oil per year. Its cost was £10,000,000.

BAHREIN.

Bahrein is an island of 230 square miles in the Persian gulf. A concession was granted to the Standard Oil Company of California and drilling began in 1930. It soon became evident there was a large available production and No. 31 well which was finished in May, 1936, had a flow of 26,880 barrels a day at a depth of 2,273 feet. At the present time production amounts to 3,000,000 tons a year. A refinery is under construction and the field is likely to outrank Kirkuk. The Texas Company which has distributing facilities all over the world including the Orient, which is an important market for this oil, has now joined with the Standard of California in this enterprise. Another large concession has been granted on the west side of the Persian Gulf and already one field forty miles from Bahrein has been discovered. In this new field a well flowing 3,840 barrels a day was brought in last June (1936) of 53° Bé oil at a depth of 2,152 feet.

Thus the Near East fields assume a vast importance because they are strategic in relation to four-fifths of the world's population. From the pipe line ports of the eastern Mediterranean the distances are no more than half of those from North and South America.

SITUATION IN CANADA.

The oil fields in the southwestern peninsula of Ontario were among the first developed on the North American

continent and have thus a record of production extending back more than 75 years. In the early days in the Oil Springs field in Lambton county a few wells yielded 5,000 barrels a day and one well is estimated to have produced 7,500 barrels a day. The first developed fields of Oil Springs and Petrolia still are the largest producing fields of Ontario which now yield about 160,000 barrels a year. The probability of greatly increasing this supply is not good. A small gas and oil field near Moncton, New Brunswick, gives 10,000 to 11,000 barrels a year but the main objective of this field is the production of Natural Gas. A third producing area in Canada is that near Fort Norman in the Northwest Territories. No attempts have been made in recent years to extend the known producing area and at present a yield of 4,000 to 5,000 barrels during the summer months supplies the local requirements. The only other producing fields in Canada are in Alberta where the recent developments have centred around Turner Valley.

TURNER VALLEY FIELD.

Some drilling activity occurred in Turner Valley in 1913-14 but it was not until the discovery of naphtha in the Fall of 1924 by Royalite No. 4 well that the field entered on its present developments. Royalite No. 4 well during its lifetime produced 911,313 barrels of naphtha which as far as I know has not been exceeded by any other well. Up to June 1st, 1936, according to Spratt and Taylor,* the field produced 9,473,582 barrels of naphtha and 829,000,000 M. cu. ft. of gas, a large part of which was burnt as waste. In the early days of development the naphtha was recovered by the use of Smith separators but as the pressures in the field became less several extraction plants have been erected. Naphtha wells drilled on the top of the structure usually decline rather rapidly but the gravity of the oil remains fairly constant in spite of less efficient gas-oil ratio. Model No. 1 well, for example, originally produced naphtha with a gravity of 68° A.P.I. whereas it now produces crude oil with a gravity of 46° A.P.I. The rate of oil production in this well has declined only very

*Spratt, J. G., and Taylor, v.; Bull. Can. Inst. Min. and Met., Nov., 1936, p. 713.

moderately and in 1936 was actually increased by tubing methods although the amount of gas produced has fallen from 4,000 M. cu. ft. to 500 M. cu. ft. and the pressure from 1,900 lbs. to 1,025 lbs. in June, 1936. This well has been in production over six years and up to the end of July, 1936, has yielded 322,909 barrels of oil valued at \$916,000. Advance No. 5 well also started off as a naphtha well but gradually began to produce some crude oil. It was, therefore, evident that crude oil was migrating up the west flank of Turner Valley as the gas was drawn off the top.

This was the situation as far as concerned crude oil from the Palaeozoic limestone when the Turner Valley Royalties well was completed in June, 1936, with a flow of 850 barrels which has since been sustained at about 650 to 700 barrels. This well is in the southwest part of Turner Valley on the northwest side of Longview hill and is twelve miles from Model No. 1 well producing crude oil at the north end of the same structure. It is too early to say definitely that oil lies on the west flank of the whole of Turner Valley but certainly this is the inference suggested by these wells. Thus there is a mountain of limestone probably more than 3,000 feet high under Turner Valley within the producing area of this field. This, of course, makes Turner Valley a very exceptional field, as it is in other respects as well and, as already pointed out, the western limit of the field has not yet been reached. At this time it is not possible to make any predictions how wide the oil zone on the west flank will be. Certain wells in Turner Valley give small amounts of water and as pointed out by Spratt this water is similar in character to water which occurs in a well drilled on the northward extension of the Highwood uplift.

This uplift lies west of Turner Valley at the C. D. and P. well and the limestone was encountered in this well at a higher elevation than it occurs in Turner Valley but contained salt water instead of oil or gas. The significance, however, is that this higher uplifted area to the west probably is connected to Turner Valley in the Palaeozoic limestone through a syncline separating the two areas, an inference made because of the similarity in character of the salt water in the two areas. This inference is strengthened by the migration of the oil up the west flank as in

Advance No. 5 well because it is presumably moving up under the influence of a water drive from the west owing to the hydrostatic head provided by the Highwood uplift. Thus at some distance down the west flank of Turner Valley this water will be encountered and the oil-water boundary will form the west limit of the producing area of Turner Valley.

In a section drawn westward from Longview C. & E. well through Publex, Pacalta and British Dominion well it is inferred that, in a half mile west of the west boundary of Sec. 28 on which Turner Valley Royalties well is located, the limestone dips down 1,100 feet provided no faults intervene. There is a possibility of faults, however, overthrusting the limestone and thus bringing it closer to the surface, than such a projected dip, as known on the west flank would allow. Such a fault may cause a small repetition of Blairmore strata in Turner Valley Royalties well but it is not known if it cuts the Palaeozoic limestone. If it does cut the Palaeozoic limestone, the width of the oil zone might be greater than otherwise would be the case. At any rate a width of a quarter of a mile would be very conservative and a width of a half mile may be more probable. Spratt and Taylor, assumed a porosity in the oil zone of 10 to 20% and a thickness of 50 to 100 feet, and thus arrived at an average oil content of 100,000 barrels an acre. They allowed a shrinkage of 50% for the loss of gas, when the oil is brought to the surface of the ground and thus arrived at the figure of 50,000 barrels of oil an acre under atmospheric conditions. The pressure in the gas wells at the top of the structure was originally more than 2,000 lbs. to the square inch, whereas in June, 1936, the maximum was 1,420 lbs. and the minimum was 385 lbs. per square inch. Gas is the main propulsive force which causes oil to move and with the decrease of pressure the effect on the oil recovery cannot help but be very marked. To offset this in some degree there is a water drive on the west side of Turner Valley. The flow through the pores of the rock must be very slow and if oil is rapidly extracted the water drive will lag behind in its effect. Undoubtedly, however, a much larger volume of oil will be recovered, owing to the water drive, than would otherwise have been the case. Spratt and Taylor placed the recovery of oil at

25% but state this may be conservative. The effect of the propulsive force of gas is apparent in the B. & B. well recently completed and stated to have an initial flow of about 2,000 barrels of oil per day. Miracle No. 2 well, a naphtha well, reached the same horizon at an elevation of 1,870 feet below sea level. It is thus apparent that since B. & B. gives crude oil and Miracle No. 2 gives gas, the gas-crude oil dividing line is between 1,870 feet below sea level at Miracle No. 2 well and 1,940 feet at B. & B. well. Thus, at least is a partial explanation of the large flow of oil in B. & B. well, owing to its proximity to the oil-gas line with its consequent considerable volume of gas production with the oil. It is not to be assumed that this division between the oil and gas is sharply defined nor will it necessarily be at the same level throughout the whole structure. It would now be expected to be higher up the flank of the structure in those parts like the Home area where the gas pressure is relatively low. This fact again seems to be confirmed by the migration of oil up to Advance No. 5 well, which reached the top of the limestone at an elevation of 1,780 feet below sea level. Thus whatever the original character of the oil-gas line on the west flank of the structure, it is certain, now that a large amount of gas has been removed from the top of the structure, that the oil-gas level will vary widely in the height along the west edge of the structure.

THE PLAINS OF ALBERTA.

A comprehensive statement in regard to the prospects for oil on the Plains of Alberta cannot be given here. One well, however, needs attention. This is the Arca well being drilled southwest of High river by Imperial Oil Co., Calgary Gas Co., and Calgary and Edmonton Land Co. The well location is outside the foothills on a simple fold within the Alberta syncline. The well commenced drilling in Tertiary strata and reached the top of the Palaeozoic limestone at 8,750 feet. The limestone is now being drilled and the results of this well will have a far reaching effect on further exploration within the Alberta syncline but will have no bearing on developments within the foothills. In this con-

nection it should be remembered that many of the great oil fields of the world are on anticlines in basin structures.

The structure at the Arca well was delimited by means of a reflection seismograph. In such geophysical investigations, unless the rate of transmission of the vibrations sent out from the explosion point are accurately known, the actual depth to the top of the reflecting surface, in this case the top of the Palaeozoic limestone, cannot be precisely calculated. This is easily understood, when it is realized that the depth to the reflecting surface is great, and the time of transmission of the vibrations from the explosion point to the reflecting surface and back to the geophones is very small. A small error, therefore, in the rate of transmission of the vibrations may give a considerable error in calculated depth. In this type of work the depths at various shot points are only known relative to one another and the actual depth at any place can only be precisely calculated when the rate of transmission is accurately known. Thus, in seismograph work, it is the form of the structure based on relative depths that is obtained. It is known that the Arca well was somewhat deeper to the Palaeozoic limestone than originally anticipated but this is no condemnation of the method used to determine the structure on top of the limestone. The fact, however, that the anticline on which the well is being drilled is deeper within the Alberta syncline than at first believed, is not so favourable for production as would have been the case were the anticline somewhat higher on the flank of the basin structure. The well will be completed shortly, and should it prove productive, it is expected that other deep structures within the Alberta syncline will be tested.