ACTIVITIES OF THE PETROLEUM AND PETROCHEMICAL INDUSTRIES IN JAPAN

Petroleum Production in 1959*

by Hiroshi Shibamiya**

Introduction

The petroleum demand in Japan has rapidly increased for these past years and every year has broken the record of her petroleum consumption, while her domestic crude oil production has been only a few percent of her requirement, and the balance, most of her consumption, has depended on the imported crude oil from foreign countries. However, the petroleum industry has been active in its operation in the domain for these years. As the result of extensive exploration, new oil and gas fields have been discovered and exploited one after one. So it may not be in the far future that domestic productions of oil and gas will promptly increase even more in Japan.

Now most prospecting for oil in Japan is carried out by two companies: one is Teikoku Oil Company, Ltd. (Teiseki) and the other is Japan Petroleum Exploration Company, Ltd. (JAPEX). Although Teiseki almost monopolized Japan crude oil production, more than ninety percent up to 1955, the then exploration department separated from Teiseki, and established a new company, JAPEX, under the subsidiary investment from the Japanese Government. Ever since, JAPEX has been carrying out the five-year plan of extensive and intensive exploration. As the result, in 1959, the fourth year of the plan, a few new oil fields were discovered. Also Teiseki has placed the emphasis on the exploration of natural gas resources, and successfully discovered good gas fields and oil fields.

Natural gas in Japan is produced by very many companies and individuals besides the above mentioned two major companies, while the producers of crude oil are the two companies. Recently gas boom has come to Japan, for the gas demand increased as raw material for growing gas chemical industry and domestic fuel. Therefore, exploration of gas fields has been actuated all over the country and the Government grants subsidy to help the natural gas exploration.

The paper reports the exploration activity for oil and gas resources, newly developed oil fields, and further, recent production engineering matter in the existing oil fields of the two companies, Teiseki and JAPEX, in 1959.

Exploratory Investigation

Here explanation is made on the exploratory areas in Japan, grouping into three areas, Hokkaido, Tohoku, and Kanto. Hokkaido fell behind other areas in exploration because of unfavorable weather. However, in recent years, gradually prospecting is directed to Hokkaido area where the possibility of discovering new big oil fields begins to be expected, because the oil bearing formations range widely from Cretaceous to Neogene and the geological structures are comparatively large, while in the other areas in Honshu oil possibility is limited in Neogene. In Tohoku area, the northern part of Honshu, where most Japan domestic crude oil is produced, already exploration was considered to be made thoroughly, but recently new oil fields are successfully discovered one after one. In the existing oil fields, the zone deeper than the proved become an object of positive exploration. About Kanto area, which is the largest plain in Japan, possibility of oil and gas has been discussed for many years from old days, but little exploration activity has been observed. Only a good result is the development of gas field in Chiba Prefecture, where gas is produced in solution in water. But the larger development is expected in the near future, as exploration begins actively. The prospecting activities in the three areas in 1959 are shown by Table 1.

The marine prospecting on the Sea of Japan should be noted among those activities. The oil possibility has been believed in the continental shelf in the Sea of Japan from olden times, as the main producing oil fields are bordering on the Sea of Japan. In recent years the intensive prospecting was carried out on the shelf and some wild cats were

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Table 1 Prospecting activities in number of team operations in 1969

<table>
<thead>
<tr>
<th>Geological survey on the surface</th>
<th>Hokkaido</th>
<th>Tohoku</th>
<th>Kanto</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seismic survey</td>
<td>31</td>
<td>35</td>
<td>19</td>
<td>4</td>
</tr>
<tr>
<td>Gravimetric survey</td>
<td>8</td>
<td>6</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Drilled. During 1956, the seismic survey was initiated in the off-shore areas of Akita and Niigata Prefectures by crews of Geophysical Service International, U.S.A. and Gesellschaft für Praktische Lagerstätten-forschung, Germany under contract and by JAPEX own crews. "Sparker", adopted in 1959, brought even more data. "Sparker" of continuous seismic profiler by Marine Geophysical Service Company, Houston, Texas, U.S.A. was employed to investigate and confirm the structures of shallow zones in detail. The survey data revealed an anticline structure of considerable magnitude along the coast of Kubiki and its vicinity in Niigata Prefecture and several promising anticline structures along the coast of Akita, Akita Prefecture, and gave many information to decide the locations of exploratory wells with the help of series of seismic surveys.

Exploratory Wells

Numbers of main exploratory wells drilled in Japan in 1959 are shown by Table 2.

<table>
<thead>
<tr>
<th>Area</th>
<th>No. of wells</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hokkaido</td>
<td>10</td>
</tr>
<tr>
<td>Tohoku</td>
<td>25</td>
</tr>
<tr>
<td>Kanto</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>42</td>
</tr>
</tbody>
</table>

The exploratory wells in Hokkaido aim at oil mainly in Cretaceous deeper than 2,000 meters while the wells in the existing fields in Tohoku area, mainly in Akita and Niigata Prefectures, explore for new reservoir, deeper than the proved, but of same Pliocene. In Chiba Prefecture in Kanto area, exploratory wells were drilled for natural gas originated from petroleum. Now gas boom comes to Japan and recently many exploratory wells are drilled all over the country but a successful result is not seen except in Tohoku and Kanto areas which are favored with petroleum and natural gas from olden times. It should be noted that new exploratory wells are expected in earnest for natural gas originated from petroleum in Chiba Prefecture where natural gas has been produced only in solution in water.

In Niigata Prefecture, Niigata gas field, which is the most productive in Japan, is troubled by the serious problem of ground subsidence likely due to lot of water produced with gas. Fortunately the exploration succeeded in discovery of rich free gas reservoir, whose production is not associated with water and does not cause subsidence, at the depth of about 1,440 m in the well, SK 1 by JAPEX, and at 300 m in Kita-agha R 4, by Teiseki, in the northern part of Niigata along the Agano River.

As mentioned before, seismic survey was conducted on the continental shelf in the Sea of Japan since 1956, and in 1958 the exploratory off-shore drilling started with the mobile-type elevating drilling platform, which was made by Le Tourneau Incorporation, Longview, Texas, U.S.A., and shipped and constructed in Japan, and the draw works of Unit No. 15 manufactured by Unit Rig and Equipment Company and the slush pumps of EMSCO 7" to 16". Taking data of "Sparker" into consideration, the rig was moved to drill Tsuchizaki Off SK 1 at the off-shore of Tsuchizaki in 1959, where the oil bearing sands were found at the depth of around 540 m in Katsurane Zone and the daily production of 60 kl was obtained through the choke of 6 mm after the gunperforation on the cemented casing in November. This oil reservoir is correlated to the shallow zone of Yabase oil field where the deep zones are very prolific. Therefore the deeper zones at the off-shore are expected to be productive. It can be said that the large off-shore oil field has started to be developed here in Japan.

New Oil Fields

Newly discovered oil fields, where exploitation has commenced in 1959, are shown as follows,

Kubiki Oil Field: Four geological structures are proved in new Kubiki oil field: Asahi, Meiji, Kuroi, and Katamachi. Meiji structure has been developed to produce gas and supply industrial fuel of factories in the nearby city since 1953. Exploratory drilling for gas began in Kuroi and Katamachi structures in 1956, and found out abundant gas reservoirs ranged from 1,000 to 1,500 m deep, and the active development started. Now the produced gas is supplied to factories in the nearby city.
Activity of the Japan Petroleum Production Industry in 1959

through the pipe line of 40 km long. To farther district the gas pipe line is planned to extend. This gas field is believed to develop into the largest one that Japan has ever had. Furthermore, the good oil reservoir was found at the depth of about 1,000 m in August 1959. Katamachi R 8, or the discovery well of oil, initially produced 10 kl/day in Katamachi structure, and was followed by wells which produced the initial daily productions of a few tens kilo-liters. It is becoming clear that Kubiki field involves not only a prolific gas reservoir but also a promising oil reservoir in its structure. Katamachi structure extends along the sea shore and its proved area is within the range of directional wells from the beach. The artificial island will be considered for exploitation of the outer area.

**Mitsuke Oil Field** : Mitsuke oil field, in Mitsuke City, Niigata Prefecture, located about 10 km north north east of Nagaoka City, was discovered by a well SK 3, which produced 40,000 m³/day of gas from the gas zone extending from 1,080 to 1,215 m deep. Several wells were successively drilled to produce only gas until distillate oil was discovered by SK 8, which produced distillate oil of 15 kl and gas of 80,000 m³/day at the well head pressure more than 230 kg/cm², or 3,000 psi, from the green tuff, the oil bearing zone strategraphically deeper than the producing zone ever known in Niigata area. Furthermore, by re-drilling SK 7 a deeper, oil was found to produce 50 kl/day through the 1/8" choke. This fact promises that Mitsuke field will be very hopeful for its oil. Now development is proceeding.

**Sarukawa Oil Field** : Sarukawa is located in about 50 km north of Yabase oil field, which is the largest oil field in Japan, in Akita Prefecture. The drilling of exploratory well, SK 1, began in 1957, and the first oil was found by SK 2 in 1958, and successively drilled wells to SK 6 confirmed oil respectively in the same year. The wells which will be drilled in this year will show the magnitudes of structure and reservoirs in detail. This field is believed to become one of the most productive oil fields in Japan in the near future. It is remarkable that the nine proved oil wells are producing from different reservoirs, already more than five in number, at the various depths ranging from 650 to 1,300 m. However, the wells do not reach the most hopeful horizon, lower Nanakura tuff, corresponding to the deep zones of Yabase oil field, and the expected zones are still left for the future investigation. Sarukawa oil field is considered to extend horizontally and vertically with its exploitation.

**Barato Oil Field** : Barato oil field is only one field discovered in Hokkaido after World War II. Since the first well, Barato SK 1, discovered oil in 1956, the exploitation was carried out in 400 m deep reservoir and the oil production began regularly. It is remarkable that the oil producing field on the economical basis is discovered in Hokkaido after about 50 years absence.

**Production**

A few interesting items in oil and gas production engineering in Japan in 1959 are as follows.

**Hydraulic Fracturing** : Since 1956, hydraulic fracturing is applied to producing wells mainly in Yabase oil field and is contributing to Japan oil production by increasing the additional oil of 30,000 kl/year. Pumps and other equipments manufactured by Halliburton Oil Well Cementing Company, gel fluid made of Yabase lease oil, and sometimes, if needed, ball sealers, are used for fracturing. It should be noted that newly drilled wells increase its oil production.
to make pay with application of fracturing, even in the field where profitable exploitation was little considered because of poor production. Higashiyama oil field, which was developed from 1893 until the drilling stopped in 1934, was a depleted field, but it reveals that once valueless reservoirs can be changed to the pay with fracturing, successfully, by increasing field oil production by 30% through the newly drilled wells in this year.

Secondary Recovery: Since 1951, water flooding is applied to the shallow zones of Yabase oil field and other fields. Yabase project is successful economically, but others are not. There is not any new plan of water flooding in this year but same as in the last year.

In-situ combustion was tested on a small scale in I zone in Niitsu oil field in 1958 after many laboratory tests. The field test on a larger scale is under way in the same I zone, using existing oil wells whose depth is 250 m and pay thickness is 10 m, since the ignition in February of 1959.

On the miscible drive process through LPG injection, tests were conducted in laboratory and have brought various interesting results. However, its practical application to oil fields on a full scale will not be realized soon because of high price of LPG in Japan.

Underground Gas Storage: The underground gas storage is coming to be a matter of concern with the gas boom in Japan because of seasonal huge change in the gas market. A certain gas company is now exploring and investigating the structure for gas storage. Teiseki is injecting gas into the particular part of the shallow zone in Yabase oil field during the summer season to prepare for winter withdraw which is expected to bring various valuable data relating to gas storage.

Ground Subsidence: Niigata gas field, located in Niigata City, Niigata Prefecture, is an aqueous natural gas field where methane gas exists in solution in water in the reservoir and gas of one volume is produced with water of one volume. The ground subsidence is noticed in the area along the coast, where the harbor is the centre of it, since about 1955. At some place, the subsidence reaches to several tens centimeters, and is still continuing. Previously the district bordering on the Japan Sea was generally recognized its trend to sink gradually by the erosion for several tens years. Therefore, this fact could be a cause of the subsidence in Niigata area. The Government organized the investigation committee to investigate the cause. After one year's study, June in 1959, the committee has concluded that huge water production with gas is a suspicious main cause of subsidence and must be considered as important. Accordingly in September, gas production was stopped in the street area, that was 25 percent of total gas production of Niigata gas field. Still study is being continued on the subsidence by observing the intervals between isotope bullets perforating the casings into the formations and the marks of isotope on the casings, as the interval changes may reflect shrinkage of formation. And water injection project is planned to investigate its effect on the ground subsidence. Another earnest effort is directed to exploration for the free gas reservoir not involved in the subsidence around Niigata City.