



## OIL INDUSTRY II. IRAN'S OIL AND GAS RESOURCES

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The Iranian oil industry is the oldest in the Middle East. Although the occurrence of numerous seeps in many parts of Iran had been known since the ancient times, the systematic exploration and drilling for oil began in the first years of the 20th century.

In 1901 [William Knox D'Arcy](#), who had made a fortune in the Australian gold rush during the 1880s, obtained an oil concession from the Iranian government (Yergin, pp. 134-49). The first unsuccessful well was drilled at a locality called Čāh-e sorḡ, near Qaṣr- e-Širin. After years of efforts and expenditures, oil in commercial quantities was struck at Masjed-e Soleymān, situated in southwestern foothill of the Zagros Mountains (the Dezful basin), in May 1908. After this discovery, the [Anglo-Persian Oil Company](#) (APOC) was formed in 1909 (the name was changed to Anglo-Iranian Oil Company [AIOC] in 1935). The company purchased a piece of land on the island of Ābādān and started the construction of a refinery with an initial capacity of 2,400 barrels per day (120,000 ton per year). This refinery was completed in 1912, and in 1914, the British government acquired a controlling interest in the APOC. Given the British navy's requirement for fuel, the refinery's capacity was steadily increased to around 20,000 barrels per day (one million tons per year) by 1918. At this time, production of crude oil had also reached 23,600 barrels per day.



Masjed-e Soleymān remained the main source of petroleum production in Iran, though exploration continued in many other areas by APOC such as Qešm island, Dehlorān, Šāhābād-e ġarb, Kuh-e mand, Dālpari, Zelāy, Pirgāh, Gačkalaj, Sarnaftak, Ahwāz, Māmātayn, Čalangar and Šolhābād without much success. Then the Naft-e Šāh oilfield was discovered in the western region in 1927, and soon after, two other fields: Haftkel and Gačsārān were discovered in 1928 (Fāteḥ, p. 281), and both proved to be larger than Masjed-e Soleymān. By 1930, in addition to Masjed-e Soleymān, Haftkel was also producing about 20,000 barrels per day and the total production from the two fields had soared to 125,000 barrels per day (Fāteḥ, pp. 272-82). At this time the capacity of the Ābādān refinery had also increased to 100,000 barrels per day (5 million tons per year), with upward of 20,000 people working for the APOC in Iran.

After the APOC agreement was revised in 1933—the company's name was later changed to Anglo-Iranian Oil Company (AIOC) in 1935—further discoveries were made: Naft-e Sefid in 1934, Aġājāri and Pāznun in 1936, and Lāli in 1938. All these fields (except Naft-e Šāh that was connected to a small refinery at Kermānšāh and Pāznun which was a gas-field) were connected through a network of pipelines either to Ābādān or to Māhšahr on the coast of the Persian Gulf where a terminal had been built for the export of crude oil.

In the years immediately after the Second World War, the global consumption of petroleum products increased at a rapid pace and Iran received many proposals for exploration in areas outside AIOC concession. Amongst them was one from the Soviet Union, covering the northern provinces of Iran. Because of the prevailing political situation of the time the parliament (*majlis*) rejected that proposal.

The Iranian government then set up an agency for the exploration and development of the petroleum prospects of the country outside the area under AIOC agreement. This government agency, named Iran Oil Company (IOC), began its activities in 1948 in an area of over one million square kilometers. During the course of ten years the IOC, by systematic applications of scientific techniques for exploration of petroleum, developed a full understanding of the following sedimentary basins of Iran: the Moġān basin near Baku oil producing district, with good oil producing prospect; the Rašt embayment, with possible prospect for oil production; the Māzandarān embayment, where early drilling could not reach the objective zone and was inconclusive; the Gorgan plain, which has favorable conditions for oil production; the Saraḡ basin, where in 1968, a giant gas field was discovered at Kangirān and fully



developed for internal consumption, and later another gas field called Gonbadli was discovered in 1982; the K̄oi-Māku, Tabriz-Šahpur, and Miāneh basins with negligible prospect for petroleum; Main Central basin, which was opened as a new petroleum province with the discovery of Alborz in 1956 and Sarājeḥ field in 1958; the Isfahan-sa'īd-ābād basin, 600 km long, positioned intermediate between the Zagros sector and the Main Central basin, with no strong indication of the presence of petroleum reservoirs; the Ṭabas-Kermān basin where there are no meaningful assessment of petroleum potential (Mostofi and Ala, pp. 97-115 ). Three years after the formation IOC, the National Iranian Oil Co. (NIOC) was founded and IOC was merged into NIOC in the early 1960s.

After the nationalization of the oil industry in Iran in 1951 and the subsequent signing of the Consortium Agreement in 1954, exploration activities started anew in the Southern Province of K̄uzestān. Moreover, the new Petroleum Act of 1957 made it possible to sign many agreements with the international oil companies for both onshore and offshore exploration. As a result, nearly 90 new oil and gas fields were discovered during the pre-revolutionary era before 1979. Since then, some 30 additional oil and gas fields (many already explored in earlier years, even during the 1920s) discoveries have been announced (Table 4)

Since early 1980s, the following fields have been added to both onshore and offshore discoveries: Huleylān\*, Kabir Kuh\*, Dālpārī, Šakeḥ, Bangestān 1\*, Darquain, Siba 1, Āzādegān, Māmātayn, Moḳtār, Khaviz, Maṣṣurābād, Kešt, Ḳayrābād 1\*, Čahār Bišeh, Rudak, Šur, Bušehr, Zāqeh, Gardan\*, Homā, Assaluyeh\*, Tabnak\*, Sa'ādat-ābād, Balāl, Gašu, Qezel-tappe, and South Pārs\*.

*Production of crude oil.* The discoveries made in K̄uzestān during the 1920s and 1930s and the follow up development activities made Iran the principal oil producer and refiner in the Middle East till the end of Second World War. The most productive reservoirs in the Zagros fields are in a rock formation called Asmari Limestone. The most prolific reservoirs discovered in the early periods of Iranian petroleum industry in Asmari Limestone, had been Haftkel (1928), Gačsārān (1928) and Aḡājāri (1936). By the eve of the Second World War, the Iranian crude oil output had reached to 215,000 barrels per day, and while production declined somewhat during the war, it again started growing to reach 279,000 and 357,000 barrels per day in 1944 and 1945, respectively. Output then increased very rapidly to around 664,000 barrels per day during 1950 before the oil industry was nationalized in March 1951. By this time the



Iranian oilfields had produced some 2.385 billion barrels of oil.

Because of the nationalization of the oil industry and the subsequent embargo placed on the export of Iranian oil by the British government, as well as the reluctance of the major international oil companies to lift oil from Iran, production fell to around 27,000 barrels per day in both 1952 and 1953, only to start increasing once the 1954 agreement was reached with the Consortium of the international oil companies. This coincided with the post-war economic recovery in the West that demanded considerable supplies of energy, notably oil. Consequently and despite sizeable crude oil production in other countries of the Persian Gulf region, Iranian output during 1957 had surpassed the 1950 level and reached 720,000 barrels per day (during the same year the daily production of crude oil in Iraq, Kuwait and Saudi Arabia was 450,000, 1,171,000, and 1,031,000 barrels, respectively).

While production from the Consortium agreement area continued to rise during the 1960s, in response both to the pressures brought to bear by the Iranian government (that needed the income to finance its ambitious and successful economic development program) and the strong global demand, new sources of crude oil supply became available from the Joint Venture agreements that had been entered with the international and independent oil companies for exploration and development of other prospective area onshore and offshore Persian Gulf, pursuant to the ratification of the Petroleum Act of 1957. This increase continued until 1974, during which average daily production hit a high of 6,021,000 barrels (Table 5). The daily production receded and remained below 6 million barrels until 1979 when the Iranian Revolution created serious disruptions. In fact a combination of factors such as the national energy policy, sanctions during the Hostage Crisis and the Iran-Iraq war helped reduce the Iranian crude oil production and kept it in the 1.5-2.4 million barrels per day range until the cease-fire between Iran and Iraq in 1988. The cessation of hostilities allowed Iran to once again revise its oil policy and seek international assistance, both financially and technically, through the signing of the Buy-Back style agreements in order to rehabilitate the badly neglected existing fields and/or to develop other oil and gas prospects.

A list of some 40 onshore and offshore fields currently producing in Iran is given in Table 6.

Published reports indicate that the cumulative crude oil production of Iran



was nearly 54 billion barrels up until the end of 2002 (OPEC, *Annual Statistical Bulletin*, 2002). Iran's contribution to the total world crude oil production is shown in [Table 7](#). The peak of Iran's share was achieved in 1974, when Iran produced some 10.7% of the world output. This share has now dropped to around 5%.

*Production of natural gas.* In the early years of the petroleum industry in Iran and up until the 1960s, Iran produced a considerable quantity of associated gas along with the production of crude oil. However, only a small part of this gas was utilized in the oil industry and the bulk of it was flared. This flaring of associated gas was estimated at around the equivalent of 7 million tons of oil in 1964, when the country produced nearly 85 million tons of crude oil. The economic utilization of these associated gases was handicapped by limited size of the domestic market and the large distances between Iran and the consuming centers of the world in the USA, Japan and the Western Europe.

A major breakthrough came in 1966, when an agreement was signed between the governments of Iran and the Former USSR for the construction of a large gas pipeline from the southern Iranian oilfields to the Soviet border at Āstārā for the transport of some 10 billion cubic meters of gas per year. A part of the pipeline was designed with a capacity of 17 billion cubic meters of gas and the extra gas was earmarked for domestic market, mainly in the Tehran Region and the north- western provinces of the country. From the time this pipeline was completed in 1970 and Iranian natural gas began to flow to the Former USSR, natural gas became another source of energy for the internal consumption in Iran steadily increasing its market share.

In the early 1970s and especially when the Consortium Agreement of 1954 was replaced with the Sale and Purchase Agreement of 1973, an elaborate program of re-pressurization and gas injection of the southern oilfields was started by the National Iranian Oil Company. This program called for the re-injection annually of nearly 90 billion cubic meter of gas into several oilfields for enhanced oil recovery. Before the Iranian Revolution of 1979, many projects were being implemented whereby gases gathered from oilfields as well as those produced from gas-fields, both on-shore and off-shore, would be utilized for the expanded domestic consumption, increased exports to the Former USSR through a second pipeline and for re-injection into specified fields. Since the Revolution, exports to the Former USSR have been halted and the re-injection projects were considerably delayed. After the cease-fire in the Iran-Iraq war, many of the re-injection projects were gradually restarted, and in



recent years the South Pars offshore field is being developed on a priority basis in order to meet the increasing demand for natural gas for various end uses.

Since the 1960s, exploration in the southern and southwestern regions of the country as well as the coastal and offshore areas of the Persian Gulf has resulted in the discovery of sizeable gas and gas condensate deposits that have made Iran the repository of the second largest gas reserves in the world. In the year 2002, Iran produced a gross quantity of 117.6 billion cubic meters of gas from which nearly 30% or 34.3 billion cubic meters were re-injected into oilfields and 60% or 70.5 billion cubic meters were marketed. The remaining 10% was lost in shrinkage or flared. Iran's share of the world's marketed production of natural gas has been steadily rising from around 0.20% to 2.7% in the last 40 years (Table 8).

#### *Resources and reserves.*

In the petroleum industry, it is customary to speak of the proved recoverable reserves as petroleum reserves that exist in discovered fields that can be produced with known technology and under the current economic conditions. The U.S. Geological Survey has the following definitions (World Petroleum Assessment, 2000): 1) Cumulative Petroleum Production is the reported cumulative volume of petroleum that has been produced; 2) Remaining Petroleum Reserves are volumes of petroleum in discovered fields that have not yet been produced; and 3) Known Petroleum Volume is the sum of cumulative production and remaining reserves also called Estimated Total Recoverable Volume (sometimes called "Ultimate Recoverable Reserves" or "Estimated Ultimate Recovery").

The Organization of Petroleum Exporting Countries defines Proven Reserves as: "an estimated quantity of all hydrocarbons statistically defined as crude oil or natural gas which geological and engineering data demonstrate with reasonable certainty to be recoverable in future years from known reservoirs under existing economic and operating conditions. Reservoirs are considered proven if the economic potential productivity is supported by either actual production or conclusive formation testing. The area of an oil reservoir considered proven are those portions delineated by drilling and defined by gas-oil or oil-water contacts, if any, and the immediately adjoining portions not yet drilled, but which can be reasonably judged as economically productive on the basis of available geological and engineering data. In the



absence of information on fluid contacts, the lowest known structural occurrence of hydrocarbons controls the lower proven limit of the reservoir. Crude Oil estimates include oil that can be produced economically through application of improved recovery techniques following successful completion of testing. Estimates do not include: oil that may become available from known reservoirs but is reported separately as ‘indicated additional reserves’; oil, the recovery of which is subject to reasonable doubt because of uncertainty as to geology, reservoir characteristics or economic factors; oil that may occur in untested prospects; and, oil that may be recovered from oil shale, coal, gilsonite and other such sources. Natural gas estimates are prepared for total recoverable natural gas, non-associated gas and associated dissolved gas. Estimates do not include gaseous equivalent of natural gas liquids expected to be recovered from reservoir natural gas as it is produced, natural gas being held in underground or non-hydrocarbon gases.”

In most petroleum industry journals, definitions similar to those proposed by OPEC are used for estimating the proven recoverable reserves of various countries in the world. It is also quite customary that reserves claimed by the official bodies of the petroleum producing countries are accepted by and reflected in the industry publications.

As discussed earlier, upward of 120 oil, oil and gas, gas, and gas/condensate fields have been discovered on-shore and off-shore since the first discovery at Masjed-e Soleymān in 1908 (Map 1) Many Iranian oil and gas fields such as Āgājāri, Gačsārān, Ahwāz, Marun, Āzādegān, and South Pārs are ranked as super-giants. The remaining proven recoverable reserves of oil and gas in the Iranian reservoirs as of the end of 2002 are shown in [Table 9](#) and [Table 10](#).

It should be noted that the reserves of oil and gas indicated in the above tables are estimates that are based not only on the methodology adopted by the estimators, but also on their familiarity with and knowledge of the subsurface geology, reservoir characteristics and many other factors that enter any such estimations including the response of the reservoirs to enhanced recovery techniques. Moreover history tells us that at times the international petroleum industry or the governments of the oil producing countries have inflated or deflated their estimates in line with what they perceive to be their financial or other interests. With such caveats in mind, it can be stated that according to the internationally reported estimates, as of the end of 2002, Iran’s proven recoverable oil and gas reserves constituted around 8-9 percent and 15 percent of the worldwide oil and gas reserves, respectively.



In late 2003, Iran's Ministry of Petroleum submitted a new estimate of Iran's oil and condensate reserves to OPEC that upgraded the country's total proven recoverable liquid reserves to 130.81 billion barrels as of the end of 2002 (Middle East Economic Survey, vol. XLVI, 17 November 2003) as shown in [Table 11](#).

*Caspian Sea*. In discussion of the petroleum resources of Iran, it is important to keep in mind that the country has an extensive shoreline on the Caspian Sea and future discoveries in this region could add to such resources. The Caspian Sea region, including Sea and the States surrounding it, is important to world energy market because of its potential to become a major oil and natural gas exporter over the next decade. However, this potential has been complicated by several factors, including a lack of adequate export infrastructure and border dispute between the littoral states.

The discovery of large offshore oil and gas deposits in the area has added urgency to the need to resolve the issues of the legal status of the sea and the corresponding mining rights. Map 2 (*International Petroleum Encyclopedia*), below, shows the map of Caspian Sea and its Petroleum fields.

Proven reserves in the Caspian basin are estimated at 15.31 billion barrels of oil. The basin is also estimated to contain about 10 billion cubic meters of natural gas. Estimates of possible petroleum reserves vary from 20 billions to 200 billion barrels (OECD, *Observe*, June 22, 1999).

The share of coastlines of each country around the Caspian Sea is calculated to be; Russia 18.5 %; Kazakhstan, 30.8 %; Turkmenistan, 16.8; Iran, 18.7%; and Azarbaijan, 15.2%; (Clagget, p. 3,10), but the respective shares of mineral rights of these states are not clear as of May, 2004.

[Figure 1](#). Map of oil resources of the Persian Gulf region.

[Figure 2](#). Map of oil resources of the Caspian region.



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