

Saudi-American Forum



SAF Item of Interest

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By Dr. Sadad Al-Husseini

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Saudi Arabia's Oil Reserves

By Dr. Sadad Al-Husseini

Recent media reports have suggested Saudi Arabia may not be able to supply its share of the world oil demand for the near future. "Experts" have argued in major U.S. papers and at energy forums that not only are the Kingdom's petroleum reserves overstated but also that the Kingdom has rejected necessary foreign investments in its energy sector and that poor production practices have damaged its oilfields.

Are these allegations true? Are there problems in the Kingdom's oilfields? Can the Kingdom meet the growth in demand for additional production? These questions require explicit answers. Unfortunately, the policy of years of withholding technical information has allowed such misconceptions to flourish even though they have little substance in point of fact.

As of 2004, Saudi Aramco has established its oil reserves at 260 billion barrels, which is approximately 25% of the world's proven oil reserves. Some reports have speculated that these figures may be drastically inflated. In February 2004, for instance, the Association for the Study of Peak Oil and Gas suggested that the Kingdom's oil reserves might be only 180 billion barrels. Others have speculated that the Kingdom's increase in reserves by almost 100 billion barrels in the early 1980s was unsupported by technical assessments. The fact that oil prices had doubled

between the late 1970s and early 1980s and are still three to four times the oil prices of the early 1970s in year 2000 dollars was not factored in by many of these analysts (IEA World Energy Outlook 2002).

In fact, the Kingdom's oil reserves estimates are based on SPE, AAPG and WPC definitions, conventional petroleum engineering practices, state of art reservoir simulation, and conservative economics. While these definitions differ from the more stringent SEC requirements typical of smaller, shorter life accumulations, they are the same definitions utilized throughout the world by countries holding giant oil and gas resources.

During my own tenure at Saudi Aramco as the senior executive in charge of exploration and production, we undertook numerous initiatives to improve the accuracy and reliability of these estimates. We drilled, cored and logged numerous key wells in every active field and reservoir and surveyed the most significant oilfields with complete 3-D seismic coverage. Massive simulation models were constructed to consolidate this and huge archives of geological and production data were accumulated to support our understanding of the reservoirs. These simulations spanned decades of performance history on a zone-by-zone and well-by-well basis. Over the years, these models have been updated annually and have confirmed our predictions of reservoir performance and our calculations of reserves and oil recoveries.

As to the possibility of future reserves additions, there are extensive reservoir and source rocks in Saudi Arabia spanning the Paleozoic through Cenozoic time scales. These must surely offer additional opportunities for oil and gas discoveries. The size of such fields, however, will be substantially smaller than current proven accumulations. This is due to the seismic reconnaissance and grid coverage that has already spanned the most promising regions of the Kingdom in search of giant oil and gas structures. While there may yet be many undiscovered oil and gas accumulations with millions of barrels of reserves, they are likely to be of limited acreage and vertical closure by Saudi standards.

Whether the exploration for such accumulations will add billions of barrels of future reserves will depend on the prevailing economics and government policies within the Kingdom. The more liberal the policies, the more commercially viable exploration and development will become in future decades.

In terms of immediate additions, the enhancements to conservative oil recoveries in undeveloped reservoirs will be more important than new field discoveries. Furthermore, if the past is any indication of the future, advances in technology are bound to reduce the cost of recovering marginal discovered resources, thus adding to the reserves figures. Given the fact that the discovered but undeveloped Saudi reservoirs make up about 130 billion barrels of the Kingdom's total reserves, the addition of new proven reserves through future reservoir developments is a foregone conclusion.

A 10% increase in recovery estimates for these reservoirs alone would generate 13 billion barrels of additional reserves. This is significant but clearly not sufficient to replace the high rates of Saudi production, currently averaging 3 billion barrels per year. On the other hand, at the current production rates and with an existing reserves base of 260 billion barrels, the issue of

future reserves replacements will not be a concern until well beyond 2020.

The supposed inability of Saudi Arabia to meet its production targets in the next few years also requires discussion. At the current depletion rate of 3 billion barrels per year, which represents 2.3 % of the remaining 130 billion barrels of proven developed reserves, this concern is debunked by simple mathematics. Utilizing existing technology and sound engineering analysis, my staff and I were confident that Aramco could sustain even higher rates of production, if necessary.

From an economic point of view, however, the cost of production must rise to meet increasing production complexities that evolve with reservoir maturity. Although the Kingdom's oil reserves are immense, they are not infinite, and they do include a broad spectrum of reservoir qualities. As production increases to include lower quality or mature reservoirs, the cost of production will increase accordingly.

Such steady cost escalations have been anticipated for a long time. For example, the majority of the Saudi carbonate reservoirs under production are supported by water injection. As their depletion advances, high resolution reservoir simulations have shown that the flood fronts will disperse within the numerous oil zones. The produced oil will inevitably commingle with increasing volumes of injected water. Workovers, recompletions and new horizontal laterals will delay the water ingress into the producing wells for an extensive period of time. Eventually, however, this becomes unavoidable. At high water cuts, wide-spread artificial lift is virtually inevitable. This in turn will require the processing and disposal of very high volumes of produced water. These maturity-related transitions may not occur for years to come, but they are ultimately unavoidable and have obvious economic implications.

The offshore clastic reservoirs do not have water injection, but they do have complex geological configurations and matching variability in aquifer support. The main sands benefit from very dynamic aquifer support while stringer sands have less access and therefore less support from the aquifers. As the main sands are depleted, and in spite of careful reservoir management, major workovers will become necessary. These workovers will attempt to selectively tap into the remaining oil reserves. Since these are concentrated in the stringer sands, offshore artificial lifts will also become inevitable in years to come. Whether gas lift or submersible pumps are utilized, given the size and scale of these operations, the investments will be substantial and will be accompanied by increasing operating costs.

Historically, such cost escalation has been deferred by developing new increments of oil reserves in parallel with maturing old fields and reservoirs. The past economic limits that have driven production declines in the older reservoirs in Saudi Arabia have often occurred at 20% to 25% depletion of the original reserves in sand and shale reservoirs and 35% to 40% in the carbonates. Technology and the addition of reserves may extend these production plateaus to higher levels of depletion, but this is unlikely to exceed a further gain of 10% to 15% under optimum economic considerations. On the other hand, once declines begin, highly commercial production will still extend for decades, as has been demonstrated by virtually every mature reservoir in Saudi Arabia.

Inevitably, the higher the production rates, the more the reservoir maturity is accelerated and the shorter the overall duration of the optimum economic production plateau. Front-end investments may be accelerated to achieve higher production plateaus, but these do not always give optimum oil and gas recoveries or full reservoir life cycle economics. In Saudi Arabia, optimum economics depend on many variables, including the integrated economics of the full suit of reservoir developments, based on the maturity and status of all the available fields and reservoirs.

Based on these considerations, the Kingdom can certainly increase its production to 15 million barrels per day based on its existing reserves base. Sustaining such an elevated rate of production for decades, however, will be contingent on the future quantity and quality of reserves additions. This in turn will be contingent on future technology developments and the then prevailing prices for fossil fuels and energy substitutes. In addition, it will be vital that such a rate increase is managed by a very large and highly qualified body of professional Saudi-Arab specialists. This is essential in order to avoid any misjudgments in reservoir or production engineering practices and to avoid undermining the available reserves base through inadequate reservoir management.

From a policy point of view, the decision to actually expand long-term production capacity is further complicated by the quality of long-term energy forecasts. For 2020, these estimates have varied in recent years from 90 to over 120 million barrels per day of total oil consumption. With such disparities in projected demand, the risks of idle capacity or price collapse are very severe for major oil producers. In an industry with project lead times that are measured in years and capital investments measured in billions of dollars, such inconsistencies are not conducive to firm long-term facilities planning or capacity investments. In my own experience, the quality of the long-term forecasts has been the most severe impediment in the face of orderly capacity expansions and long-term project economics.

Accounts in the Western press have also criticized Saudi oil production practices, claiming that they have damaged the reservoirs in some of the major oilfields. Yet, extensive studies have been undertaken over the years, some with direct assistance from ExxonMobil and Chevron, in order to anticipate and prevent any such damages. Quarterly production testing of virtually every active oil well in Saudi Aramco is conducted to forestall such problems. Breakthrough logging tools have been developed with Schlumberger, among others, in order to monitor all oil and gas reservoir zones. These have included developments to monitor zones shielded behind casing in order to capture the full spectrum of information required by the reservoir management teams. This process was institutionalized by the Kingdom's Ministry of Petroleum and Mineral Resources as far back as the early 1980s when it demanded from the outset "first class oilfield practices" from Saudi Aramco.

If this commitment to prudence is adhered to in the future, the risks of reservoir damages will be minimized. On the other hand, if cost cutting strategies and high risk production practices are allowed to prevail, the consequences can be both devastating and sudden. Examples of such ill considered strategies might be an early shift to in-field water injection patterns, a shift to dry crestal production strategies away from wet flank areas, and the heavy dependence on artificial lift without an adequate number of wells to tap into the various complex reservoir zonations.

Finally, the Saudi government has been accused of being unwilling to accept foreign investments that would facilitate the development of its oil resources. Without such investments, it is argued, the Kingdom's capability to satisfy the world's energy needs will be further eroded. There are two problems with this argument. First, it ignores the fact that the government does actively pursue foreign investment in its economy as exemplified by the downstream energy sector and the recent gas projects. Such investments have allowed the Kingdom to focus on its upstream oil sector, which has not suffered for lack of financing.

Secondly, it ignores the reality that investments in the oil sector generate their own incremental revenues. These in turn finance additional investments. The only scenario where this process would not operate is the scenario where oil prices collapse, and the returns on investments are inadequate. In such circumstances, investments to increase production capacity would not be realistic, and the financing issue would be a moot point in any case.

In the long-term, the real issues in the oil industry are not the technical questions of Saudi Arabia's reserves or oil production capacity. Both of these issues have been managed well in the past and will continue to be addressed effectively in the future through advances in technology and engineering practices.

The real issue is whether there is a real willingness and commitment by both producers and consumers to achieve political and economic cooperation in addressing the unyielding economic imperatives imposed by the global energy markets. Without such cooperation, energy-related volatility can only be exacerbated in the face of increasing demand for fossil fuels and the concentration of reserves in a few centers of operation.

Regardless of such future developments, however, it is a foregone conclusion that Saudi Arabia will remain the cornerstone of global energy supplies, and its role will be the key role in stabilizing the world's energy markets.

20 Years of Market Driven Volatility ⁽¹⁾

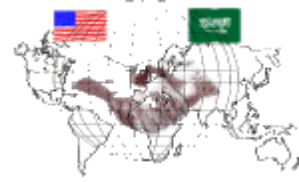
	Saudi Arabia's Oil Production (000 b/d)	Landed Price Saudi Crude in USA (\$/barrel)
1973 Average	7,596	5.37
1974 Average	8,480	11.63
1975 Average	7,075	12.50
1976 Average	8,577	13.06
1977 Average	9,245	13.69
1978 Average	8,301	13.94
1979 Average	9,532	18.95
1980 Average	9,900	29.80
1981 Average	9,815	34.20

1982 Average	6,483	34.99
1983 Average	5,086	29.27
1984 Average	4,663	29.20
1985 Average	3,388	24.72
1986 Average	4,870	12.84
1987 Average	4,265	16.81
1988 Average	5,086	13.37
1989 Average	5,064	17.34
1990 Average	6,410	21.82
1991 Average	8,115	17.22
1992 Average	8,332	17.48
1993 Average	8,198	15.40
1994 Average	8,120	15.11
1995 Average	8,231	16.84
1996 Average	8,218	20.49
1997 Average	8,362	17.52
1998 Average	8,389	11.16
1999 Average	7,833	17.48
2000 Average	8,404	26.58
2001 Average	8,031	20.98
2002 Average	7,634	24.77
2003 Average	8,848	27.44

(1) - DOE - EIA Published Public Records (oil prices in then current dollars)

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