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**EVALUATION OF MODERN METHODS OF LONG-TERM DEVELOPMENT AND
TRANSMISSION OF UTILIZING AND OPTIMIZING OIL AND GAS RESOURCES**

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ABSTRACT

Importance of research and technology in development and production of countries has been increasing constantly since half 20th century. In this regard, developed and industrial countries and after that developing countries, over the 50 years, have been significantly focused on empowerment of different research indicators through being aware of role of research in creating technology and accelerating development. In this case, presenting modern technologies in Oil Industry has special importance because of its high profitability and considerable role in economy of countries. At the present study, an overview would be presented on some applied methods in regard with development and production and also long-term transmission of utilizing and optimizing oil and gas resources.

Keywords: Modern development technologies, production, long-term transmission, oil and gas resources

INTRODUCTION

Today, all countries allocate considerable budget to promote studies and development. However, the more important issue than credit allocation for research and development is using modern technologies. If technology is considered as an important competition in oil industry, it should be noted that while oil companies consider data collection, exploration and utilization

of oil and gas resources and have competition, they believe that modern technology is the only instrument for reduction of time and cost of completion of projects. Development of technology in oil industry has been varied in different ages and times. Since early 1980s decade, large companies decided to reduce amount of research and development and purchase

technology instead of producing it. Accepting modern technologies can be an economic risk in one aspect. It may not have better and more expensive results than existing technologies. In oil and gas industry, generally this issue has been accepted that technology can decrease exploration risk and reduce time of excavation. The mentioned advantages can make companies to accept modern technologies carefully and slowly (Rao & Rodriguez, 2005). On the other hand, capitals of an investment can be returned just when the ideas have been changed into salable commercial products. The longer the time of changing the idea to sale is, the higher financial commitment would be for maintaining them for companies and projects.

Due to importance of oil incomes in oil countries and due to instability of oil incomes and resulted outcomes, how to make decision by the governments on how to extract oil and change it to different alternative properties is the main concern of these courtiers. The issue of scarcity of exhaustible energy resource like oil and increase in its price over the time and also attempt to replace required energy resource has resulted in development of production technologies of oil competitor.

Explorative activities include mainly geology and geochemical studies,

explorative excavation and seismography operations, processing and analyzing obtained data. This phase that is the most risky part of upstream cycle has possessed about 5-15% of production costs for a hydrocarbon field. If the first phase is successful and signs of presence of an oil or gas reservoir are available, conducted legal and economic-technical studies and also results of risk analysis can determine decision making in regard with investment on development of field.

Development and improvement of the field would be began with providing comprehensive project of development of field or hydrocarbon reservoir, which is itself depended on fulfilling reservoir information such as identifying properties of stones and fluids completely using gained data from explorative operations; construction of static model; preparation of production scenarios; designation of underground facilities and economic evaluation. Next steps include developed excavation; in-well measurements and completion of wells; providing required infrastructures for the region and field; installing facilities and primary processing units and also transition lines, which are main activities of the development phase.

After completion of the development phase, the phase of primary recycle of the reservoir would be started. Lifetime of a

reservoir can be divided to three periods of production growth, peak and decline of production. Maintenance and enhancement of production and meeting problems of wells are the main challenges with the management phase of reservoir. Increase in production from reservoirs is usually in three forms of excavating new wells, optimizing production and injecting during phases of secondary and tertiary recycle. In this regard, modern methods have been applied and some of these methods would be referred as follows.

Development of oil fields

Projects related to oil industry are completely different from other projects in other industries because of their unique features. Features and characteristics that can make oil industry different from other projects include high investment rate and long time of completing the projects, so that an oil project lasts 10-15 years averagely and it is clear that longer designing time can increase relevant uncertainties and risks. Another unique feature in regard with implementing oil field development projects is uncertainty in oil volume, which is being produced, since oil reservoir is hundred meters under the ground and its expansion and volume can never be determined certainly.

Usually a few years later development and production of the field, natural pressure of

reservoir would be decreased and gradually production from the wells would be reduced. In order to prevent the problem, some operation should be conducted under the title of maintenance of pressure in the field. The operation would be mainly divided to two activities as follows:

1. injection of water in the well, which is under the oil reservoir, if it is existed
2. Injection of gas in gas cap on top of the reservoir

Decision making on selecting one of the mentioned strategies for purpose of maintaining pressure of the reservoir and time of this operation is one of the most important decisions in the development phase of the field.

Another important issue in regard with development of the field for purpose of decreasing uncertainties and risks of this phase in updating reservoir model and development project of the field. Usually a few years after production from field, it could be observed that conducted predictions are inconsistent with actual performance of the field. If these inconsistencies are considerable, it could be found that reservoir model has some problems. Hence, the model of reservoir simulation should be updated in this phase through collecting new obtained data from the reservoir and designing reservoir experiments.

Accordingly, project of field development could be modified if necessary. For example, if it has been predicted in the primary development plan that since the third year injection of gas in the field for maintaining reservoir pressure should be done with rate of 50million square feet and it is observed in the development phase that the pressure is rapider than the predicted value and is decreasing, the reservoir model should be updated and the development plan has to be also modified. Probably results of the new study indicate that since the second year, gas injection should be conducted with rate of 100million Sq feet per day in the field (Suslick, Schiozer, & Rodriguez, 2008).

Modern methods of production

Most oilfields of Persian Golf are in phase of natural production, which using artificial lift method with help of gas, along with Submersible Bore Hole Pumps Installation method, for purpose of optimal use of reservoir pressure in the phase of natural production has been applied in many oil production wells in zone of Persian Golf (Samizo, 2005). For example, in Khajafi sq of Arabia, due to increased discharge level of the filed and drainage of reservoirs, using artificial lift method with gas has been considered as a part of implementing methods of preserving production rate in long-term in the mentioned field (Al-

Khaldi, Ghoniem, & Jama, 2009). Optimizing production and meting problems with sensitive points of production system has been selected as the best solution for purpose of preserving production rate, along with avoiding required great investments for exploration operations and excavation of new wells. Optimization process presented for this field has been designed based on a solution of field production plan. The plan has been applied through combining multiphase network model with a nonlinear GA technique for optimization, named Genetic Algorithm in form of an optimization system, which has been developed and presented to the market recently by Shalambarjeh Company under the title of gas lift system optimization.

In Khajafi Field, there are about 100 well loops, which have been completed using artificial lift system with gas. Although most of the completed wells with artificial lift method with gas are still being naturally produced without using lift system, some of them are not able to produce under the natural pressure any more and have been closed as a result. Hence, the best wells were selected for purpose of conducting artificial lift operation with gas through performing screening processes through applying gas distribution models in

artificial lift method with gas (Ghoniem, Al-Khaldi, Samizo, & Al-Thuwainy, 2006). Performance of production optimizing models in Khajfi Sq has been significantly positive. Increase in net production of 12.5% has been realized using artificial lift system optimization with gas in Khajafi Field. For the first time in Khajfi Field, genetic algorithm (GA) was applied and its abilities were proved under condition of imposing complicated field limitations in regard with optimizing production. Applied optimization system in this study has the ability to produce diagrams of performance of wells automatically and hence, time has been saved to high extent. As the next step, it has been suggested to monitor operative conditions in form of a closed cycle or controlling systems and to gain information of the real time. Production optimization models have been significantly effective in regard with preserving production rate in Khajfi Field and increasing production time with maximum potential of the field. According to existing conditions in similar fields in limit of coastal activity of Iran National Oil Company, it seems that designing and implementing similar projects can have successful results.

On the other hand, increasing need for hydrocarbon fuels and also decrease in energy of many hydrocarbon reservoirs, using modern technologies for purpose of

increasing utilization of reservoirs and reduction of production costs has been regarded as an undeniable issue (Rahimi & Tahami, 2010). One of the developed technologies in oil and gas industry (petroleum industry) is using multilateral wells (Lawati, 2010). Increasing development of multilateral and intelligent well technology in petroleum industry has made people to use the technology for purpose of increasing output of utilizing hydrocarbon reservoirs as a common method in different states around the world. Those reservoirs, in which technology of multilateral wells is used, optimization of multilateral structure and determination of production strategy are highly significant (Al-Ramis & Al-Yami, 2012).

Optimization of design and features of well is significantly effective in production rate from the reservoir. Designing well through based on capabilities of the reservoir is an important issue for purpose of achieving optimized production. Factors that are applicable in optimization of design include type and geometry of the well, thickness of core pipe, wellhead pressure and so on. Through improving and developing excavation method of multilateral wells, production can be promoted significantly in coastal fields (Hembling, Berberian, Al-Mumen, Simonian, & Salerno, 2010). With presence of potential and proved

advantages of intelligent and multilateral wells, still the dominant perception is that the technology is overcomplicated and has high risk. However, the mentioned technology has high potential for reducing costs of upstream plans for development of state's petroleum. Through referring backgrounds of pioneer companies in application of the mentioned technology, moving toward intelligent and multilateral wells and using the technology can cause reduction of excavation costs, optimization of production and enhancement of output and utilization. Moreover, cost reduction can be easily measured for purpose of explaining successful application of the technology. Those reservoirs, in which technology of multilateral wells is used, optimizing structure of multilateral well and also determining production strategy is so important (Johannessen & Vestvik, 2005).

In another example, changes in producing anomalistic shale gas formations in the U.S enhanced production in this country considerably. Divergence of natural gas prices and crude oil has caused utilization of technical methods for exploration of shale gas, which were considered uneconomic and hard to use previously. Hydraulic fracture applied successfully in development of anomalistic gas fields indicates that these methods are also

applicable similarly for anomalistic liquids trapped in shale formations. Hydraulic fracture is depended on injecting mixture of chemicals and water with high pressure in wells, so that shale containing liquids can be fractured and liquid chambers can be achieved through horizontal excavation and as a result, higher rate of liquids can be extracted and transferred to the surface.

Features of enhanced oil recovery (EOR) of oil reservoirs and its importance

Usually every oilfield passes three different phase of production in its lifetime as follows:

1. Primary recovery
2. Secondary recovery
3. Tertiary recovery

All methods, in which reservoirs are not able to produce oil economically and energy would be inculcated on them from external space, are known as Enhanced Oil Recovery (EOR) methods. In primary recovery, natural energy of the reservoir would be applied for purpose of oil production. However, if the oil is not extracted automatically and using natural energy of the reservoir and artificial lifting methods are applied for this purpose such as in-well pumps, again oil is being explored, since no external and extra energy is imposed on the reservoir in this phase. In addition, when natural energy and pressure of the reservoir is maintained

through injection of water in the discharge space of reservoir or through injection of gas in space of gas cap of the reservoir, again primary recovery is being conducted.

When the reservoir is discharged and it is impossible to produce oil even through pumping the oil from the well to the surface, secondary recovery methods would be applied, which are currently known as water injection methods. In this method, water would be injected to the reservoirs from the injection well, which can influence system of reservoir and cause displacement of oil and movement of it towards the production well. In many cases, water injection has not required efficiency for displacement of oil and other methods should be considered for purpose of economic oil production. Processes of tertiary phase of oil production include gas injection (carbon dioxide, nitrogen, associated gas and air); chemical injection (polymer, materials for decreasing surface tension and soda); thermal methods (steam impulsion, steam propulsion, hot water propulsion and in-reservoir ignition); microbial or a combination of the mentioned methods.

Improved Oil Recovery (IOR) methods cover wide range, which includes the above mentioned EOR methods, using modern excavation technologies, and processes of oil production from wells. In other words,

IOR is a process that can be applied through using existing technologies for purpose of oil recovery. The process can be conducted at the primary recovery phase or secondary or tertiary phases. Some technologies such as horizontal drilling, multilateral wells, and optional lattice work. Hydraulic fraction or in-place gel injection are types of IOR. Therefore in IOR, production process would not be changed, but technology would be adjusted in a manner, so that more amount of oil would be produced using same process. However, EOR refers to a process, in which the attempt is reduce saturation percent of the residual oil as much as possible and minimize remained oil in the reservoir (Kokal & Al-Kaabi, 2010).

Today based on features of every reservoir, different methods are being applied in order to enhance oil recovery from reservoirs around the world. Hence, finding an optimized method for oil recovery from reservoirs, technical and economic studies should be conducted. Increase in oil recovery and decrease in residual oil in reservoirs, which their natural production time has been expired can be considerable help in order to enhance profitability and economic goals. On the other hand, applying EOR methods in lower possible time can help also safeguarding production of reservoirs.

Oil recovery

Because of reduction of production resulted from reservoir pressure decline, how to extract the oil has key role in safeguarded production of reservoirs. Importance of oil safeguarded production can result in using tools for increasing recovery coefficient of the production and increasingly development of the tools. Today based on features of every reservoir, different methods are being applied in order to enhance oil recovery from reservoirs around the world. Hence, finding an optimized method for oil recovery from reservoirs, technical and economic studies should be conducted. Increase in oil recovery and decrease in residual oil in reservoirs, which their natural production time has been expired can be considerable help in order to enhance profitability and economic goals. On the other hand, applying EOR methods in lower possible time can help also safeguarding production of reservoirs. Increase in price and value of crude oil has made it necessary to study common and modern methods, so that they can help enhancement of production and profitability of the reservoir. In addition, effectiveness of research projects is depended on actual need assessment and proper definition of technology. This issue in form of unit management of oil reservoirs is a strategy that guarantees its

efficiency in order to achieve safe production and facility of operations with help of senior director and desirable resources. Due to supplement of suitable mechanisms in regard with knowledge-based development and determining research strategy for purpose of gaining technology in all executive plans, through considering orientation of production optimization and EOR, it is necessary to define, determine and implement research requirements in unit form, due to position of every field of technology of exploration, production, knowledge management and so on. Then, obtained results from the studies should be created in form of value added and improvement of processes can be measured.

Natural oil recovery

Primary recovery is natural recovery of oil under natural pressure of the reservoir. Natural displacement of oil from pores of the reservoir rock to production well occurs usually because of different mechanisms in the reservoir. Reservoir pressure is resulted from pressure of fluid in the pores or pore pressure. Pressure difference between inside the reservoir and surface of production well can conduct oil toward the production well and can also transfer it toward surface of the ground as a result of natural pressure through flowing well or using pump through pumping well. Position

of the reservoir in terms of pressure and fluid saturation can determine this issue that in every time how much fluid would be moved from reservoir rock or matrix blocks. Along with continuity of field production, pressure of the reservoir would be reduced and recovery from field would be also reduced. The negative relation between extraction and cumulative production is one of the basic elements of oil engineering and is known as Darcy's Law. Many technical factors interfere in natural oil recovery and gravity drainage of oil.

Secondary oil recovery

In method of secondary recovery, reservoir pressure would be increased using a suitable fluid for purpose of displacement of oil from pores of the reservoir rock. Secondary recovery includes increase in number of drilled wells, horizontal and oblique drilling, on-ground equipment improvement, water injection, gas injection, water and gas injection, thermal process, chemicals or fume injection methods, microbe removal methods and so on.

Methods of development and utilization of fields can be effective in enhancement of recovery of similar fields in the Middle East, if they are along with systematic process of collecting data, conducting studies and applying effective technologies.

Here, case studies would be introduced in regard with recovery methods such as fusion injection of nitrogen (N₂) and fusion injection of CO₂ alternatively (WAG) in carbonated reservoirs. In addition, figure 2 would present a process, in which an oilfield is explored, developed and finally is abandoned.

Fusion injection of N₂ in Jay Field

Jay Field is located in southwest of the U.S and in boundary zone between Florida State and Alabama State and has been explored by Jun 1970. This field is a relatively deep field with high temperature and pressure rates. Exploitation of this field is from upper Jurassic formation that is carbonated and is located in depth of 15000 to 16000 feet. By 1974, flooding operation by water was implemented in this field in order to prevent high pressure drop and as a result, fusion injection of N₂ was started alternatively using water in 1981. Wide expanded laboratory studies on rock and fluid samples of this field indicated that N₂ injection method has been effective in this point. It could be predicted that using this method, recovery percent of crude oil in this field would achieve about 60%. If N₂ injection is not conducted, then final recovery percent should achieve about 50%. Hence, N₂ injection has enhanced recovery percent of crude oil about 10%.

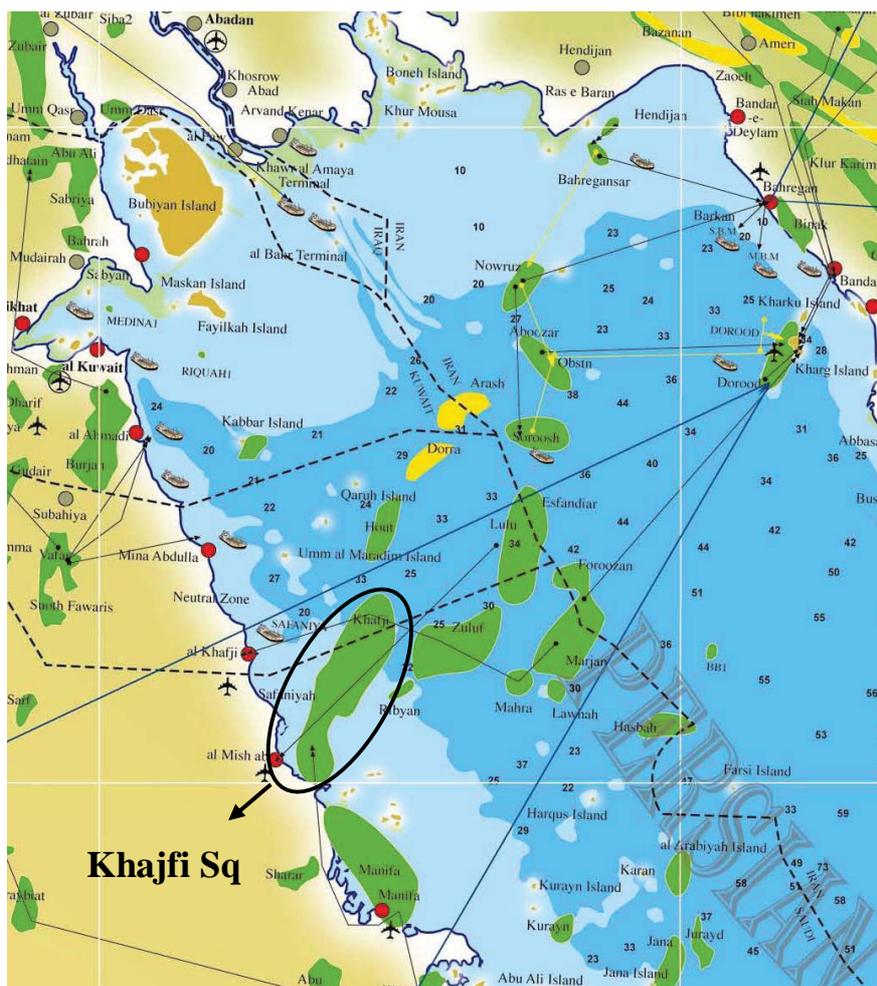


Figure 1: location of Khajafi Field

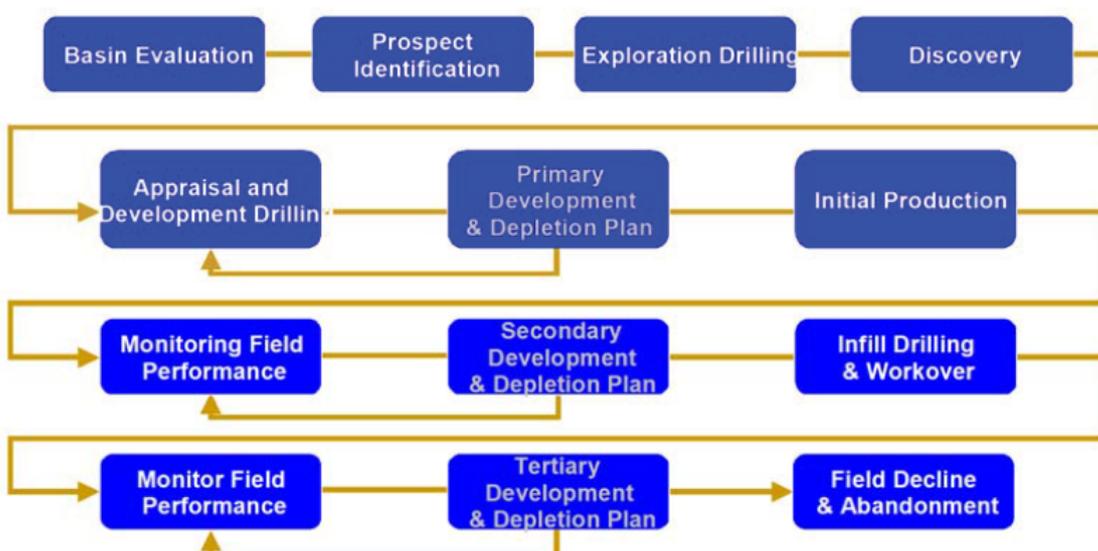


Figure 2: exploration and development stages of oilfield

Water flooding and CO₂ injection in form of WAG in Salt Creek Filed

Salt Creek Field has been located in Kent region in Texas State and has been explored by 1950. Gas injection operation was started in this filed by 1952 in order to stabilize pressure. Afterwards, water injection operation was implemented in May 1953. Exploitation in this filed can be conducted from heterogeneous reservoir of Canyon Line in depth of 6300 feet. According to obtained results from reservoir studies in this field, expansion of the field has been enforced in different phases. Gas injection operation was started in 1952 and water injection in 1953. In 1970s and 1980s decades, several infill wells were drilled and several production wells were changed into injective wells for purpose of stabilizing pressure and improving swept process. During 1980s decade, various studies have been conducted in regard with economic-technical evaluation of implementing CO₂ injection operation. CO₂ injection in this field has been successful both economically and technically and has enhanced crude oil recovery percent to 12%.

Water flooding and CO₂ injection in form of WAG in Means Field

Means Field is located in Andrews Region of Texas State and about 50-mile distance of Midland City's Northwest and has been

explored in 1934. Primary development of this field was conducted in 1950s decade and following that, secondary recovery operation was started in 1963. Tertiary recovery operation and expanded drilling of infill wells was started in 1980. Performance of this field indicates that implementing different phases of filed expansion and primary, secondary and tertiary recovery of crude oil have been successful. Final recovery of crude oil induced by water flooding in this field has been predicted less than 20% of in-place crude oil. However, in some parts of the field, in which CO₂ injection is implemented, recovery percent of crude oil has been increased to 45%. Currently, more than 30% of in-place crude oil has been produced in this field (Wilkinson, Genetti, Henning, Broomhall, & Lawrence, 2004).

Transmission

There is no doubt that natural gas is an important resource for energy supply in the current century. Today, many technologies have been developed for purpose of extraction, transmission and utilization of gas resources. Rapid development of gas industry has been also affected by important technologies, which have been presented since mid 20th century. Natural gas transmission has some difficulties because of its gas nature and it can also face problems even in regard with using

simplest transmission methods; meaning pipelines in long distances. According to existing capabilities of the technology for transferring gas to far distances, LNG method or Liquefied Natural Gas, as an economic method, has been able to meet difficulties of gas transmission to high extent. However, recent advances in regard with using other technologies have also caused using some methods such as CNG and hydrate as solutions for gas transmission to long distances. Some experts have considered changing gas to liquid products as a good solution for transmitting gas to distant markets, since they believe that although the technology has not been still applied in wide range by gas holder countries, transporting liquid products to consumptive markets is simpler and has lower cost than LNG conversion method. In this method, natural gas would be firstly converted to synthesis gases of carbon monoxide and hydrogen and then in a series of chemical reactions under effect of catalyst context, liquid hydrocarbon products would be produced, which currently have good market. The technology is still at the begging of development way in commercial scale, although it has a background more than 70 years. Although technology of converting gas to liquid products is known for many suppliers of the technology like Shell,

Sasol, Exxon Mobile and Sinter Liam, number of large commercial units in the world in this field is so limited and currently, a small amount of financial resources of large institutes have been devoted on this issue. In this regard, CNG technology for purpose of natural gas transmission in long distances can be considered as an important capability. CNG can be deposited in special boats and then transported to desired destinations. CNG technology can be applied for purpose of transferring gas of deep water reservoirs, which transferring their gas using pipelines to coast is difficult and expensive. Simplicity of production process of CNG and simpler technology of constructing transportation boats, comparing to LNG, has made CNG to be considered as a potential option for gas transmission. Based on existing conditions of CNG technology, using it seems reliable just for gas transmission to distances of 2500miles. Studies in field of using CNG technology is still being continued for natural gas transmission in U.S and Australia countries.

Iran, as the second holder of natural gas reservoirs in the world, follows various plans for purpose of using gas, specifically for exports through pipelines. With the presence of huge gas reservoirs, potential ability of natural gas export if still existed

for Iran. Natural gas export is one of the most important and strategic issues for the state. In general, gas export would be possible for the country in three ways as follows:

1. Natural gas transmission through pipeline
2. Gas transmission through changing gas to LNG and transporting it by boat to consumer markets
3. Changing gas into GTL and transferring it to target markets. One of the most important and easiest methods for gas export, especially for adjacent regions, is transferring gas through pipelines.

CONCLUSION

As using advanced technologies for exploitation of oil and gas reservoirs can increase production costs, the technologies are so important in achieving goals of landscape document of petroleum industry. Increase in price and value of crude oil has made it necessary to study common and modern methods, so that they can help enhancement of production and profitability of the reservoir. In addition, effectiveness of research projects is depended on actual need assessment and proper definition of technology. This issue in form of unit management of oil reservoirs is a strategy that guarantees its efficiency in order to achieve safe production and facility of operations with help of senior director and desirable

resources. On the other hand, reduction of natural gas prices and enhancement of crude oil price has caused utilization of technical methods for exploration of shale gas, which were considered uneconomic and hard to use previously. Iran has huge gas reservoirs and is in second world position. As oil export is the main exchange earning resource for Iran, development of gas consumption in the country is essential for purpose of reducing oil consumption and as a result, oil exports. It should be also mentioned that ratio of energy consumption in industry sector, comparing to other consumptions, is an indicator for economic growth of the country. In addition, according to opinions of experts, gas injection is the best method for enhancement of oil well recovery. Hence, this issue should be considered among preferences of industrial authorities.

REFERENCES

- [1] Al-Khaldi, M. A., Ghoniem, E. S., & Jama, A. A. (2009, Jan). production enhancement for Khafji Field using advanced optimization techniques.
- [2] Al-Ramis, H. S., & Al-Yami, A. S. (2012, Jan). well structure optimization in complex wells for high permeability reservoirs. *SPE International Production and*

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- Operations Conference and Exhibition.*
- [3] Ghoniem, E. S., Al-Khaldi, M. A., Samizo, N., & Al-Thuwainy, A. K. (2006, Jan). dynamic production optimization in Khajfi Offshore Field. *Abu Dhabi International Petroleum Exhibition and Conference.*
- [4] Hembling, D. E., Berberian, G. m., Al-Mumen, A. A., Simonian, S., & Salerno, G. (2010). production optimization of multilateral wells using passive inflow control devices. *Saudi Aramco Journal of Technology*, 3.
- [5] Johannessen, B., & Vestvik, J. (2005, Jan). smart operations: cheap? high tech? or simply the best fit? optimized drilling solutions on the South Pars Field Offshore Iran. *SPE Europec/EAGE Annual Conference.*
- [6] Kokal, S., & Al-Kaabi, A. B. (2010). enhanced oil recovery: challenges and opportunities.
- [7] Lawati, Rahimi, R., & Tahami, A. (2010, Jan). implementing smart solution for controlling water cut in South Pars Gas Field from environmental point of view. *SPE deep Gas Conference and Exhibition.*
- [8] Rao, V., & Rodriguez, R. (2005). accelerating technology acceptance: hypotheses and remedies for risk-adverse behavior in technology acceptance. *Paper SPE.*
- [9] Samizo, N. (2005, Jan). successful application of production optimization models to sustain field target and to defer capital investment in offshore Khafji Field. *SPE Middle East Oil and Gas Show and Conference.*
- [10] Suslick, S., Schiozer, D., & Rodriguez. (2008). uncertainty and risk analysis in petroleum exploration and production. *Terrae*, 3, 36-47.
- [11] Wilkinson, J. R., Genetti, D. B., Henning, G. T., Broomhall, R. W., & Lawrence, J. J. (2004, Jan). lessons learned from mature carbonates for application to Middle East Fields. *Abu Dhabi International Conference and Exhibition.*
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