TECHNOLOGY CHALLENGES IN INDONESIA OIL AND GAS DEVELOPMENT

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ABSTRACT

This paper presents the challenges in oil and gas development in Indonesia, especially in technical aspects. In upstream, this country faces the fact that the production as well as the proven reserves of oil is continuing to decline. The challenges are therefore on how to find new resources, how to develop frontier area and how to produce more oil from the remaining oil in place in the existing fields. The oil deposit and traps are small, but also complexes. Very limited primary data makes it difficult to have a discovery. More accurate, intensive and comprehensive exploration data are therefore needed which, in turn, will need the use of the most sophisticated exploration technology. On the other hand it is recommended that Government of Indonesia should generate primary exploration data prior to oil and gas prospecting. Regarding production, there is still hope to maintain the production level by exploiting further the remaining oil in place, the effort of which will need the use of advanced technology. The future of EOR application in Indonesia is bright and steps have been taken towards the objective. However, some important technical matters should still be overcome. In petroleum refining Indonesia faces increasing demand, the need of lighter products, more stringent fuels specifications, demand increase of petrochemical products, old and low complexity existing refineries and not sufficient margin for developing new refinery. The development of new refineries seems a must from the view of energy security. However, low margin should be overcome by appropriate strategy such as integration with petrochemical and employing more efficient technology. Some challenges that need to be considered in gas development in Indonesia include increasing gas demand, more gas reserve offshore, scattered gas consumers, limited infrastructure, not optimal domestic utilization and weak willingness to pay. Several technological approaches should be done to overcome those challenges.

Keywords*: oil and gas, technology, exploration, production, refining*

I. INTRODUCTION

At present Indonesia faces a rapid increase in final energy demand of 6.7% per year. In year 2025, in business as usual scenario, the need of primary energy would be about 4700 million barrel oil equivalent per year, including about 3 million barrel oil per day. On the other hand this country faces the fact that the production as well as the proven reserves of oil is continuing to decline. The challenges are therefore on how to find new resources, how to develop frontier area and how to produce more oil from the remaining oil in place in the existing fields.

In petroleum refining Indonesia faces increasing demand, the need of lighter products, more stringent fuels specifications, demand increase of petrochemical products, old and low complexity existing refineries and not sufficient margin for developing new refinery. The development of new refineries seems a must from the view of energy security. However, low margin should be overcome by appropriate strategy in order to make profitable refinery.

Some challenges that need to be considered in gas development in Indonesia include increasing gas demand, more gas reserve offshore, scattered gas consumers, limited infrastructure, not optimal domestic utilization and weak willingness to pay. Several technological approaches should be done to overcome those challenges.

II. EXPLORATION

Regarding exploration, Indonesia is faced by the fact that the proven reserves of oil in this country is continuing to decline, which means that a barrel produced is only replaced by less than a new barrel. The challenges faced by Indonesia in oil and gas exploration is therefore is how to find new resources, how to develop frontier area. The expectation is aimed to deep water exploration, especially in eastern Indonesia. Referring to the result of exploration of previous years, it seems that to find giant traps is not a big possibility.

Comparing Indonesia geology with those in other places shows that the oil deposit in Indonesia is generally small and poor in oil, whereas in case of gas, we can find the giant deposit. Many of the oil and gas resources are also found in offshore. The deposit and traps characteristic, beside being small, they are also complex. It is always more difficult to have a discovery and it needs therefore to use the most sophisticated technology.

As we know, exploration at the time being encounters a lot problem such as:

- Area to be explored lack of comprehensive and detail supporting data
- Available geologic data are less attractive
- Remaining oil traps are located in complex geological area
- The remaining prospects are small in size

Very often, available grid line spacing is much wider than the size of the prospect area. This means that our remaining prospects escape from the grid size, we cannot detect their existence accurately.

This is just an example of the previous reservoir structure commonly found in the past. An ideal oil trap such as anticline and direct hydrocarbon indicator in the form of bright spot of flat spot sometimes can be observed (Figure 1).

On the contrary, in open area where exploration is supposed to be carried out intensively, for example in Eastern Indonesia, we have a quite complicated structure. Although seismic processing effort has been applied to this data the result is not clear and the locations of the oil traps are still in big question (Figure 2).

So, what should we do in order to boost the exploration activities or investment in exploration? Those need more accurate, intensive and comprehensive exploration data.

To do that we have to carry out the following tasks:

- Executing additional seismic survey
- Reprocessing old seismic data
- Do more exploration drilling and well logging
- Collect detail cuttings and cores data
- Use the most appropriate and the most sophisticated tool/technology
- Correlate fluid and core characteristics with elastic wave behavior

In order to increase investment in oil exploration we have to change our exploration paradigm, that is: Government of Indonesia should generate primary exploration data prior to oil and gas prospecting.

III. PRODUCTION

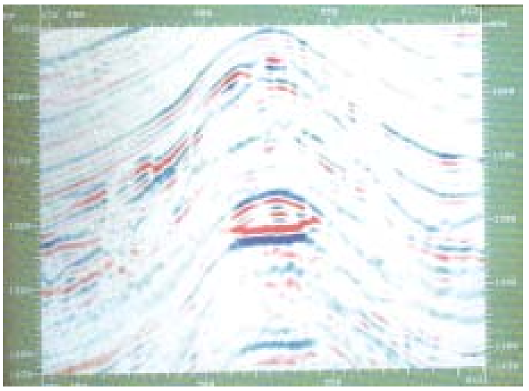
Oil production is continuing to decline with the rate of 12 % per year in the already matured oil fields. However there is still hope to maintain the production level by exploiting further the remaining oil in place, the effort of which will need to employ more advanced technology.

Figure 3 shows that in addition to the already recovered oil there is remaining commercial reserves (P1 – P3) that needs to be recovered through primary recovery mechanism under existing commitment/contract while non-commercial reserves (P4 – P6) is also in need for commercialization leading to production in future. Any secondary recovery scheme (i.e. water flood, WF) is estimated to add for another 15% to the primary recovery while EOR (enhanced oil recovery) is expected to add further (roughly) 20% using the most suitable EOR process. When a field is at present producing under primary recovery scheme only then the opportunity may reach as high as 35% encompassing primary production of non-commercial reserves (P4-P6) and incremental production through water flood. For some suitable reservoirs, newer technology such as Vibro-seismic may theoretically enhance recovery further by 15% leaving a totally irreducible hypothetical residual oil of roughly 10%.

Primary recovery is basically obtained through producing reservoirs using natural mechanism. Production increase of producing field under natural mechanism is normally obtained through some techniques such as infill drilling (addition of production wells between existing production wells), production optimization (e.g. optimum choke size, optimum lifting method), and well stimulation (aiding production in production well through locally induced techniques, e.g. acidizing, surfactant stimulation, steam huff n puff). On the other hand EOR is field-scale production enhancement techniques that add additional recovery mechanisms to the natural one(s). Suitable and successful EOR application may far surpass production enhancement gained by any production optimization and stimulation. Combination between the two is termed improved oil recovery (IOR).

Figure 4 shows worldwide situation of EOR application. EOR appears to be mostly applied on heavy oil, indicated by the high number of thermal EOR (not clear however whether this figure also includes in situ combustion technique). Heavy oil projects in the US and Latin America are the examples. In the second comes CO_2 flooding, most of which is applied in the United States. In US CO_2 resources are in abundance (often obtained from factories and power plants) allowing widespread of CO_2 flooding nationwide. Hydrocarbon gas is usually used when there is no market available economically for the gas while the gas is in relative abundance. Fields in the North Sea operations serve as examples. Chemical flooding methods (polymer, surfactant, and alkaline surfactant) are traditionally considered as expensive. However, with high oil price at present the trend is upward. Planning on some chemical EOR projects worldwide are reported in progress.

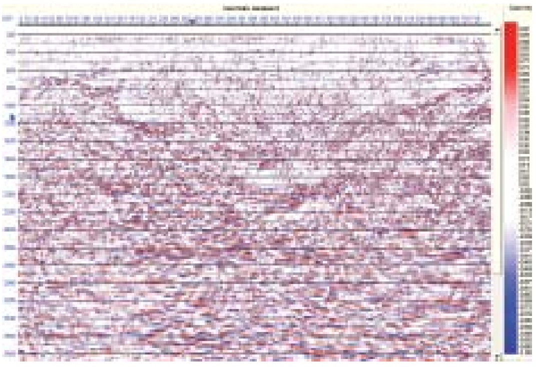
The EOR situation in the US is not as different in composition when compared to the world. This is due partly to the fact that EOR applications in the US indeed dominate the worldwide figure. Total oil pro-



Clear and Rich Data : Fluid can be identified from the existences of bright spot

Figure 1
Example of Previous Reservoir Structure

Where is the Trap?



Complicated structure

Figure 2
Example from Eastearn Indonesia

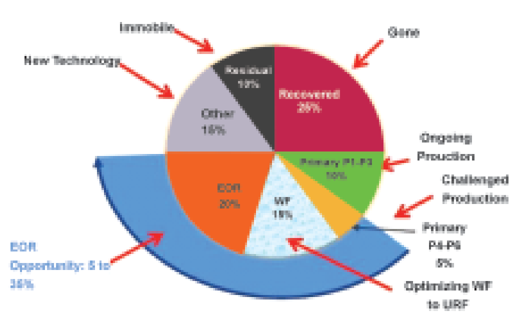


Figure 3
Production Increase Opportunity from Producing Fields

duction contributed by EOR is around 700 MBOPD or around 13% out of 5 MMBOPD US national daily oil productions. This is somewhat surpassed by Indonesia, having around 20% of its daily oil production coming from EOR application. However, this may cause biased conclusion since this comes from a single project only (Duri Steam flood, DSF, with its 180 MBOPD) out of current daily production of about 910 MBOPD.

Despite the prospect, EOR may prove challenging. It is always associated with multi-billion dollar projects, and it also involves high dose of advanced technology with sufficient experience and efficiency in operating it. Although it has been proven that Indonesian personnel are capable in handling project like Duri Steam flood, some important decisions over technical matters are still overtaken by Chevron head office on pure technical ground. Environmental concerns are also embedded with EOR process. Careless handling of produced CO_2 in CO_2 flooding, hot air surrounding steam flooding application, and improper waste water handling in chemical flooding may provide hazard to environment and breach the newly issued regulation concerning quality of environment (UU No. 32/KLH th 2009 Tentang Baku Mutu Lingkungan). Other potential constraint is difficulties in procuring EOR-related equipment and chemicals, as reportedly faced by a national company that is currently in the planning of launching its first chemical pilot project in Sumatra.

The future EOR application in Indonesia is bright and steps have been taken towards the objective. Next year or two years from now will see the launch of Minas surfactant pilot project while later this year a similar pilot project is launched in Kaji-Semoga fields in Sumatra. In addition, CPI and Pertamina have also screened and proposed some fields to be approved by BPMIGAS for further study leading to design of pilot projects. With hundreds of fields that are either idle or producing under primary mechanisms, it is natural to conclude that Indonesia has an excellent opportunity for EOR applications. Rigorous efforts are needed, nevertheless, for overcoming the constraints and challenges to be faced.

IV. REFINING

The challenges faced by this country in petroleum refining are increasing demand, the need of lighter products, the shift of petroleum specifications

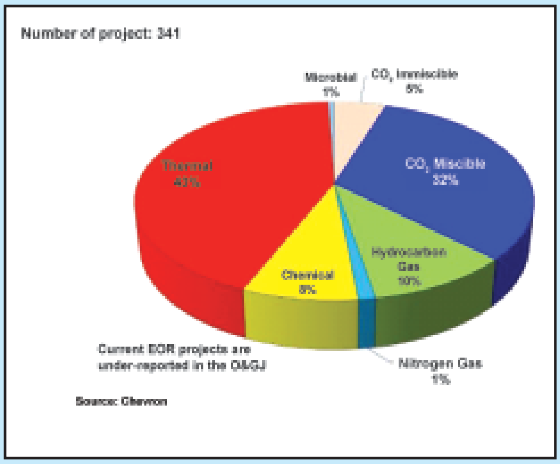


Figure 4
EOR in the World 2010

toward more and more stringent, the demand increase of petrochemical products, not sufficient margin for developing new refinery and the need of new technology to improve the efficiency of the refinery operation.

At present the total refining capacity in Indonesia is about one million barrel crude oil per day. Because of low complexity, those existing refineries are only able to produce about 750 thousand barrel finished petroleum fuels per day, whereas the need is much more above it. Indonesia must therefore import about 400 thousand barrels petroleum fuels per day. This import will continue to increase as the annual growth of petroleum fuels demand is almost 5 % per year. It is estimated that in the year 2030 the import will reach about 2 million barrel per day if the refining capacity still the same as that of present time, the situation of which is not favorable for the energy security of this country.

The composition of petroleum fuel consumption will also be shifting toward lighter products. In year 2030, 51% of the petroleum fuel consumed will consist of gasoline, 34% diesel, 9% of avtur and avgas, indicating that more than 95% of petroleum fuel is used for transportation (Figure 5).

Regarding product specifications, the trend is to more and more stringent standard. As we can see from figure 6, Indonesia enters to Euro 2 standard in 2010 for gasoline and in 2012 for diesel, whereas the other countries are already in Euro 3, Euro 4 and

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Euro 5. This situation would be a strong driving factor for an improvement or development of Indonesian refineries.

Most of Indonesian refineries are relatively low complexity. Balongan refinery has the highest complexity of 10.9, Dumai of 7.4 whereas the others are from 1 to 4.4. This is one of the main reasons that make Indonesian refineries incapable to convert all of its feedstock to the required finished products and to produce better quality.

A study has been conducted by the Ministry of Energy and Mineral Resources to assess the requirement and the strategy of refinery development in Indonesia. Ideally, by the year of 2020, four high complexity new refineries of 300 thousand barrels each should be constructed. The location of those refineries could be at Banten and Tuban, and near the existing refineries such as Balongan and Cilacap.

After year 2020, 3 new refineries should also be constructed, two of them of 300 thousand barrels per day each would be located near Dumai and Musi refineries, and the other one of 125 thousand barrels per day would be in Sulawesi, in order to fulfill the demand in eastern Indonesia (Figure 7).

It is well known that the objective of refining is to separate the fraction or component valuable to be a finished product or to convert chemically the low quality product into high value components. The technology of refining has been developing according to the development of demand of quality and quantity of fuels, which are driven mainly by the development of engine technology and environmental concern. We can see in Figure 8 the main processes in a refinery.

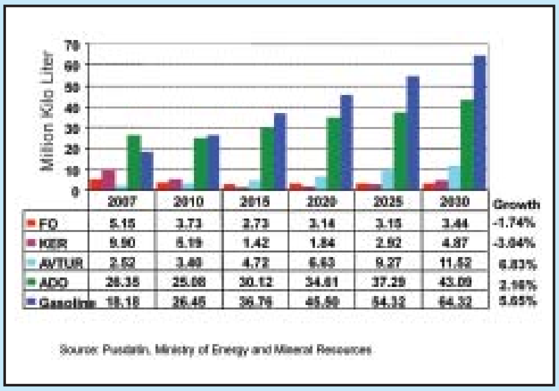

FIgure 5
Demand Will Go Towards Lighter Products

Euro I
Euro II
Euro III
IV/(V*)

ADO (Sulphur)	1996	2000	2004	2006	2008	2010	2012	2014	2016
Japan	500	500	50		10				
Hong Kong	500	500	50			10			
Australia	500			50		10			
Singapore	5000	500		50		10			
South Korea	5000	500		50		10			
Thailand	2500	500	350				50		
China	5000	2000	2000	500		350		50	
Malaysia	5000		3000		500			50	
India	2500			500		350			50
Indonesia	5000			3500			500		

Gasoline (S/Bz)	1996	2000	2004	2006	2008	2010	2012	2014	2016
Japan	500/5	500/2	150/1	50/1	10/1				
Hong Kong	500/5	500/2	150/1	50/1		10/1			
South Korea	500/5	500/2	150/1	50/1		10/<1			
Australia	500/5			150/1	50/1	10/1			
Thailand	1000/5	500/2				50/1			10/1
Singapore	1000/5		500/3.5		500/3.5		50/3.5	50/1	
Malaysia	1000/5				500/5	150/1	50/1		
China	800/5		500/2.5			150/1		50/1	
India	1000/5			500/2.5		150/1			50/1
Indonesia	5000/5	2000/5				500/5			

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Source: Pertamina

Figure 6
Indonesia is Lagging Behind in Euro Standards Development

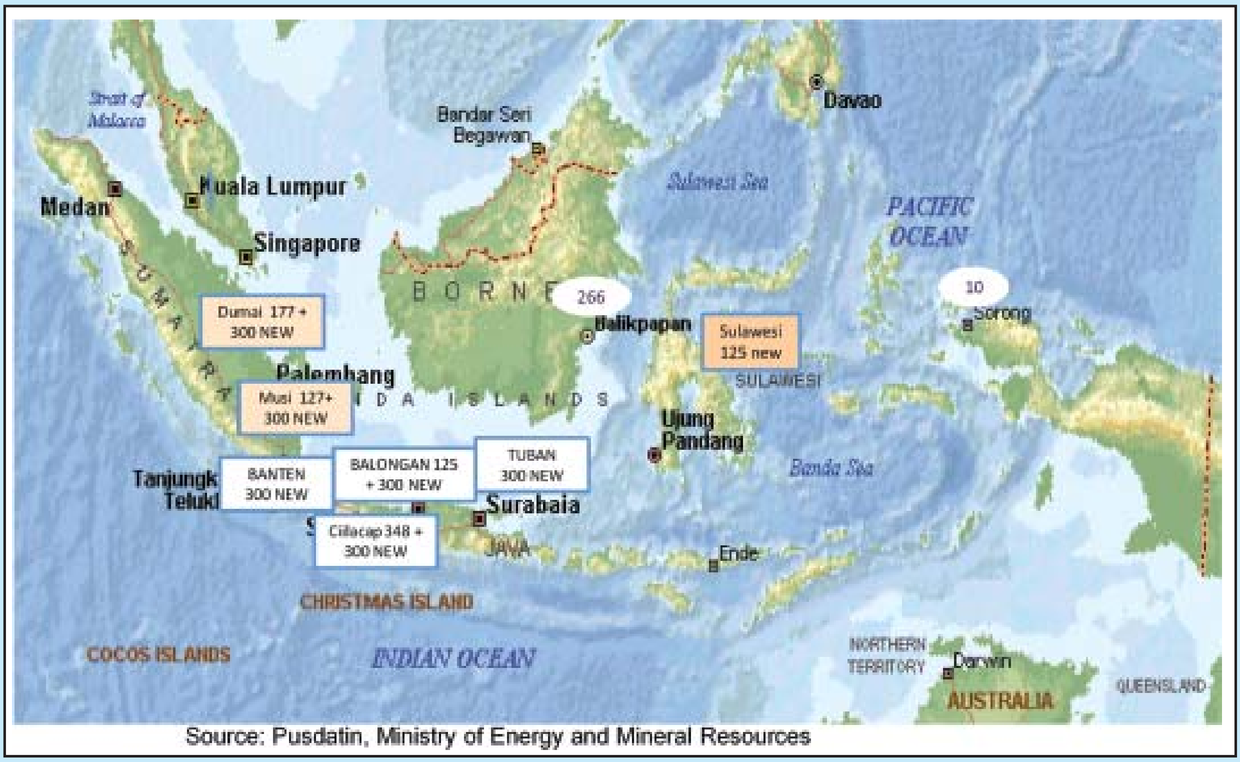

Figure 7
4 High Complexity Refineries by 2020 and 3 Others After 2020 Should be Developed

The research and development in this field is still continuing to find ways to have better and cheaper catalyst, separation method, new conversion route, et cetera.

Since 2004 the margin of a refinery now is between $2-7 per barrel crude intake, which is considered low return for high investment refinery. Integrating of a refinery with petrochemical production as well as power production could be an alternative for increasing the added value of the products and to obtain higher margin of the refinery (Figure 8).

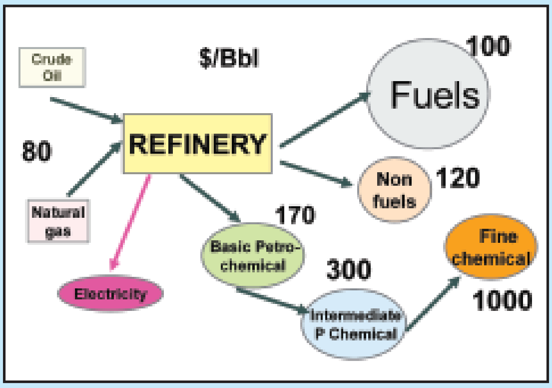

Figure 8
Refining, Petrochemical and Power Integration to Increase Added Value/Margin

V. GAS

Regarding gas development in Indonesia, some challenges that need to be considered include:

- Increasing Gas Demand, in line with the growth of industry and any other gas consumption. Indonesia Energy Statistic shows the growth of gas demand around 27 percent during the last decade, between year 2000 and year 2010.
- More Gas Reserve Offshore and High Acid Gas Composition. The evidence show, huge gas reserves like Natuna or Masela gas fields are located offshore. These conditions, of course, will require high technology approach with massive investment. Moreover, high acid component contains in gas reserves such as around 72 % CO_2 of Natuna Gas leading to a unique challenge to be overcome, not only for economic reasons but also from environmental pressure stand point.

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- Scattered Gas Consumers. The unique characteristic of gas consumers in Indonesia is scattered, small consumption but widely distributed, brings about the difficulties in developing a feasible gas pipeline to reach end consumers. The difficulties lead to a limited gas infrastructure in Indonesia.
- Not Optimal Domestic Utilization. Indonesia Energy Statistic shows around 40 % of produced (non associated) gas was domestically utilized for industry and power plant. While the rest of produced gas were exported to generate state revenue.
- Weak Willingness to Pay. One of the reasons why most of the gas was exported is the weakness in willingness to pay of most Indonesia gas consumers. This weakness is reflected in government's subsidy provision in almost every energy price in Indonesia.

Technology approaches will be required to overcome challenges in gas development in Indonesia. Floating/Offshore LNG technology is a viable choice to exploit offshore gas reserves. Due to huge CO_2 content in the reserves, a multi stage CO_2 separation technology need to be considered to be applied in order to gradually transport and store the removed CO_2 in to geological storage or aquifer surrounding the reserves to prevent CO_2 venting in to air. Meanwhile, small scale gas storage in the form of gas adsorbent, gas transmission coupled with city gas technology approaches can be economically fitted to overcome the limited gas infrastructure and the weakness in willingness to pay of gas consumers in Indonesia.

VI. CONCLUDING REMARK

New oil and gas discovery is expected in Eastern Indonesia. However, facing more complexes geological characteristics of that area, it must be emphasized to collect comprehensive data and using the most sophisticated technology.

Enhanced Oil Recovery is the best way to recover additional oil from the existing mature field. The technology, using various suitable methods, should be implemented in order to produce the remaining oil.

To satisfy the increasing demand and the more stringent fuel specification, new refineries of high complexity should be developed. More efficient technology and integration of refining and petrochemical will be a way to improve the margin of the new refinery.

Gas development in Indonesia faces various technical problems to overcome. Suitable technology such as floating LNG plant, separation and storage of CO_2, transportation and distribution method of the gas to the household should be explored.

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