

## **CO<sub>2</sub> Sources and Future EOR Prospects In Sumatra Island-Indonesia**

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### **ABSTRACT**

This study is present CO<sub>2</sub> injection opportunity in South Sumatra Basin. South Sumatra and Jambi Province are part of that basin. The oil company has been producing more than 50 years ago. Currently, some of oil fields in that basin is mature categories. But, recovery factor is low due to primary production stage in this time. Generally, Oil production has been declining in Indonesia since 1995. Some of effort was conducted to improve an oil production such as water injection. Advance methods are developing such as surfactant or polymer, seismic vibration, and microbial as field's trial in particularly oil fields. Currently, primary and secondary recovery are major phase production stage in that basin. According those stage, a lot of oil is remaining in the reservoir. The existing method to improve oil recovery is steam flood in Duri Field (Central Sumatra Basin). It method is favorable for heavy oil and shallow reservoir only. Majority of oil are light to moderate oil gravity. Therefore, applying another methods are important in order to improve oil recovery. In the worldwide, CO<sub>2</sub> injection is mature technology to improve oil recovery. Close of CO<sub>2</sub> sources to oil fields and purity are success keys for CO<sub>2</sub> injection in US. South Sumatra Basin is one of third basin in Sumatra Island. It basin has abundant gas reservoir with high CO<sub>2</sub> concentration, especially in Talang Akar and Batu Raja Formation. Besides that, gas source and oil fields are closed each other in that basin. According gas sources, the distance between them, and previously study, CO<sub>2</sub> injection is offering the new opportunity to increase oil recovery in South Sumatra Basin. These results shown, natural gas processing are potential as CO<sub>2</sub> sources in those area. CO<sub>2</sub> concentrations are variously between 32-90% in some formation. Regarding this study, CO<sub>2</sub> injection be expected can develop in the near future and leading as EOR method in Indonesia.

**Key Words:** CO<sub>2</sub>, Oil recovery, South Sumatra Basin.

### **1. Introduction**

The oil production has been declining since 1995. Currently, the average oil production is approximately 800,000 bbls/day (SKKMigas 2011). On the other side, oil consumption is increase every year. Indonesian government was conducted some effort to improve oil production. Presidential decree was published in 2012. That

decreed is encourage oil production to pursue 1.2 million barrels per day. One of contain in the decree is EOR as effort to implementation an oil recovery methods in an oil industry. The existing EOR is Steam Flooding in Duri field. Some an oil company has been trial to implementation EOR methods such as thermal injection, gas injection, chemical injection, and seismic vibration since 1967 in several oil fields. From those methods, only steam flooding is getting success to increase oil recovery from Duri field. Recently, total oil production from steam flooding is approximately 165,057 bbls/day. Its oil production is approximately 20% of national production (SKKMigas 2011).

Gas injection is favorable method in order to improve oil recovery. The oil properties for that method is favorable between moderate to light oil even heavy oil. Oil fields in Indonesia has been mature and an oil gravity between moderate to light oil except in Duri fields (heavy oil). Mostly, oil fields and gas fields in similar basin. Even, the oil fields and gas fields are closed for each other. Several gas fields is contain high CO<sub>2</sub> during the production phase in South Sumatra and Jambi Province. The percentage of the CO<sub>2</sub> between 30-80%. According several factors such as oil gravity, deep of reservoir, temperatures, and CO<sub>2</sub> sources. Gas injection using CO<sub>2</sub> gas is favorable in the near future especially in Sumatra.

This study is present CO<sub>2</sub>-EOR prospect in oil fields based on CO<sub>2</sub> sources and its location focus in Sumatra Island. The major reason is Sumatra Island has oil reserve approximately 4.6 billion barrels oil (61.8% of total Indonesia reserve). According this study CO<sub>2</sub>-EOR can applying in the near future to improve oil recovery. CO<sub>2</sub>-EOR as one of target method due to abundant of CO<sub>2</sub> sources nearby the oil fields. If this opportunities is exploited CO<sub>2</sub>-EOR become leading EOR method in the near future.

## **2. CO<sub>2</sub> Sources**

Commonly, CO<sub>2</sub> sources are organized into three categories such as natural source (CO<sub>2</sub> concentration more than 90%), natural gas processing, and industrial processing. Indonesia has limited CO<sub>2</sub> data as natural sources. Furthermore, gas processing and industrial processing are abundant in several area such as in South Sumatra. Natuna "D" Alpha Field (Fig. 1) is a biggest gas field in Asia Pacific. It field has CO<sub>2</sub> contain at 70%. Total CO<sub>2</sub> resource is about 157 TCF (Hanif et al, 2002). In another cases, some of gas fields is high CO<sub>2</sub> concentration in such as Jambi Province (Fig. 2). But, the problem is very limited data from these fields. Table 1 is shown the CO<sub>2</sub> from gas fields in Sumatra. Another CO<sub>2</sub> sources from natural gas processing Indonesia are located in South Sumatra Basin (in Table 2 and Fig. 3). CO<sub>2</sub> from an industrial processing sources are plentiful in industrial area. But, it sources still require future study due to high cost for capturing CO<sub>2</sub>. It is potential sources for the future. Therefore, in this study we are focused in natural gas processing as CO<sub>2</sub> sources. Table 2 is shown natural gas processing plant as produced CO<sub>2</sub>.

**Table 1.** CO<sub>2</sub> sources from gas reservoir in Sumatra.

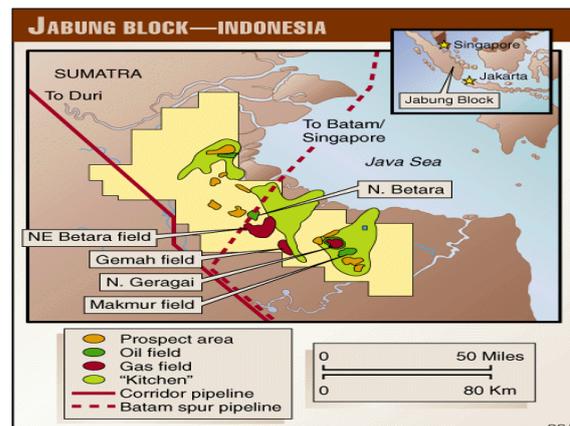
No	CO <sub>2</sub> Sources	Locations	Operators	CO <sub>2</sub> , mole %
1	Natuna D Alpha Field	Natuna Sea	Pertamina	70
2	North East Betara Field	Jambi Province	Petrochina	60
3	Gemah Field	Jambi Province	Petrochina	60
4	West Tanjung Jabung	Jambi Province	Petrochina	87

Muslim from variously Sources

The distance from Jambi Province to South Sumatra Province is about 200 km. According Lemigas study, the distance from natural gas processing as CO<sub>2</sub> sources to oil fields are approximately 33 km – 460 km. The gas fields and oil fields are closed (Fig. 4). It condition as opportunities to implementation CO<sub>2</sub>-EOR. However, how to delivery CO<sub>2</sub> to oil fields is should be considering such as transportation by truck or pipeline. Transportation depending on the project scope, if trial or pilot project is efficient by truck. But, for large or full project is more economic to construct the pipe line.



**Fig. 1** Natuna D Alpha Gas Field (migas.esdm.go.id)



**Fig. 2** Jabung Block as CO<sub>2</sub> sources (migas.esdm.go.id)

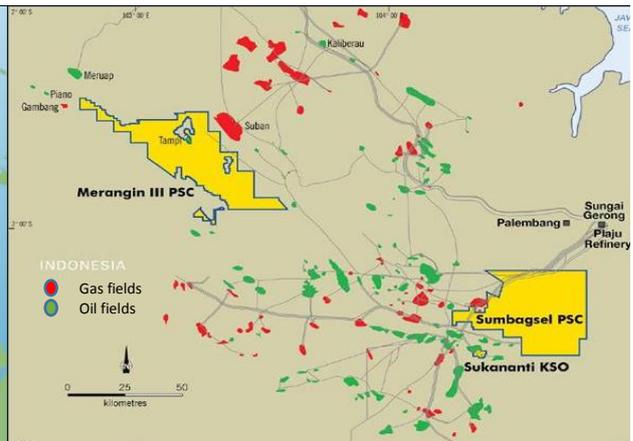
**Table 2.** Natural Gas Processing in Sumatra.

No	Locations	Owners	Gas Production, MMscfd	CO <sub>2</sub> Concentration, Mole %
1	Muara Enim-Palembang	PT. Medco Energy	38	32
2	Prabumulih-Palembang	PT. Pertamina	415	40-90
3	Grissik-Palembang	Conoco Philips	986	40-90
4	Jambi	Conoco Philips	301	40-90
5	Jambi	Petrochina	146	40-90

Muslim from variously sources

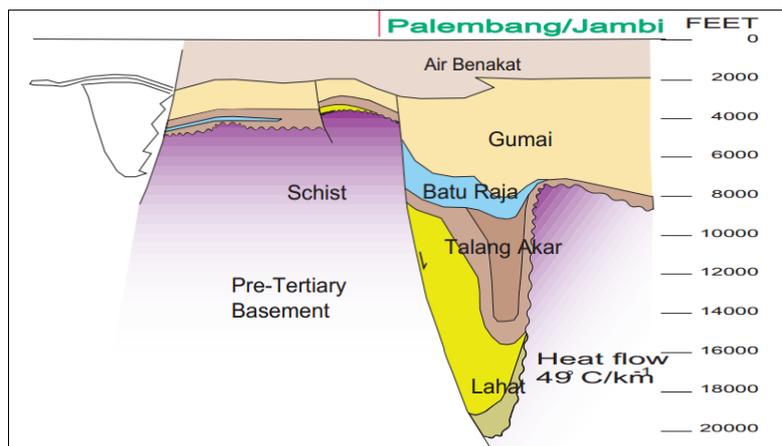


**Fig. 3** Natural Gas Plan in Jambi and South Sumatra Province (migas.esdm.go.id)



**Fig. 4** Distribution gas fields and oil fields in South Sumatra (migas.esdm.go.id)

According Michelle G Bishop (2001), CO<sub>2</sub> sources in South Sumatra and Jambi were accumulated in two formation such as Batu Raja and Talang Akar formation. In some case CO<sub>2</sub> concentration in those formation is around 70-80%. Some of wells were drilled in these formation, due to high CO<sub>2</sub> concentration those wells were abandoned. For example, such as well Sogo-1, Tiung-1, Tiung-2 has CO<sub>2</sub> contains 87%, 70%, 70% respectively. Due high CO<sub>2</sub> concentration, those wells are abandon up to know. Furthermore, those wells are potential asset as CO<sub>2</sub> sources in the near future in order to apply CO<sub>2</sub>-EOR. Close distance between of CO<sub>2</sub> sources and oil field are chance for that method. Fig. 5 is shown the variously formation in south Sumatra basin. Batu Raja formation is limestone and Talang Akar is sandstone. Those formations are rich CO<sub>2</sub> concentration in gas reservoir or as gas solution in oil reservoir. Batu Raja and Talang Akar Formation Depth are approximately 5,000 – 14,000 ft.



**Fig. 5** CO<sub>2</sub> sources from Batu Raja and Talang Akar formation (Bishop, 2001).

### 3. CO<sub>2</sub>-EOR Study in Sumatra

Gas injection program has been planning in Meruap field (PT. Pertamina-BWP Meruap) and Gemah field (Petrochina) are located in Jambi Province (SKKMigas 2011). Simultaneous CO<sub>2</sub> injection and surfactant were conducted under laboratory work by Lemigas and Institute Technology Bandung (BrioleTTY, et al, 2005). Improving oil recovery using CO<sub>2</sub> injection under laboratory work and the oil sample is taken from an oil field in Natuna Sea (Abdassah, et al, 2000). Some of opportunities and challenges CO<sub>2</sub> flooding in Indonesia has been introduced since several year ago (Muslim, et al, 2013). Minimum Miscibility Pressure (MMP) in Air Benakat Formation was conducted by Muslim et al (2014).

Based on previous results study, almost researchers are suggested gas injection is potential to increase oil recovery. South Sumatra Basin and Central Sumatra Basin are the biggest EOR target in Indonesia. According Lemigas study is approximately 58% EOR target in those area. In South Sumatra Basin, 64 reservoir from 136 reservoir is candidate for CO<sub>2</sub> injection (Edward, et al, 2004). Lemigas has been conducted screening criteria CO<sub>2</sub>-EOR in South Sumatra basin since 2011. Almost of oil fields operated under Pertamina (national oil company). Table 3 is shown screening CO<sub>2</sub>-EOR study in South Sumatra.

**Table 3.** CO<sub>2</sub>-EOR Screening Study

Company	Oil Fields	Reservoirs	Miscible	Immiscible
Pertamina EP Area Prabumulih & Pendopo	13	213	147	62
Pertamina UBEP Adera	3	181	181	0
Pertamina UBEP Ramba	12	8	6	2
Pertamina UBEP Limau	3	10	10	0
Pertamina EP (another JOB/TAC/KSO)	10	56	3	18
<b>Total</b>	<b>41</b>	<b>486</b>	<b>347</b>	<b>82</b>

Edit by Muslim (Source from Lemigas 2004)

### 4. Conclusions

Almost oil fields in South Sumatra and Jambi Province under primary stage. Abundant of oil is remaining in the reservoir after that stage. According sources, CO<sub>2</sub> concentration, distance, and previous study. CO<sub>2</sub> injection is favorable in order to improve oil recovery in South Sumatra and Jambi Province. However, lack of data as obstacle to develop this method. Further research is requiring to ensure CO<sub>2</sub> availability from each natural gas processing. Thus, supporting from gas company is crucial to ensure the availability supply of CO<sub>2</sub> as injection gas into the oil fields.

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