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Onshore Treatment of SBM Cuttings as Zero Discharge Preparation: Cost Efficiency of a Compliance Method in Offshore Mahakam

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Abstract. Offshore Mahakam is a mature field developed by Pertamina Hulu Mahakam. In Maintaining production going, more wells must be drilled. Consequently, a large amount of cuttings is generated, particularly SBM cuttings, which is considered hazardous waste. Hazardous waste management is regulated in Peraturan Pemerintah (PP) Republik Indonesia No. 22 tahun 2021 and Peraturan Menteri LHK no 6 tahun 20211, which stated that SBM cuttings can be discharged to the sea in designated areas with a dumping permit. Ex-situ dumping methods had been applied initially for handling SBM Cuttings in Offshore Mahakam, but the costs involved are quite large. Therefore, the Onshore Treatment method is developed to achieve cost efficiency in drilling operation, which is still in compliance with the regulation. This study examined the technical and financial viability of implementing the onshore treatment for SBM cutting in Offshore Mahakam.

Keyword(s): Cost efficiency; Drilling waste management; Ex-situ dumping; Onshore treatment; SBM Cuttings; Zero Discharge.

1 Introduction

Pertamina Hulu Mahakam is one of the main contributors for natural gas production in Indonesia. Oil and gas exploration and production activity is carried out in Mahakam areas, both in offshore and swamp/delta areas. The Offshore Mahakam is located in East Kalimantan Province, Indonesia. Located in Makasar Street, this block consists of three gas fields Peciko, Sisi-Nubi and South Mahakam, also one oil field Bekapai.

Generally, Oil and gas extraction from offshore fields is more expensive than onshore fields. One of the cost factors that lead to high drilling costs in offshore operations is logistics (Molavi, 2011). Considering the locations and drilling mud type, drilling waste management in Offshore Mahakam Fields is significantly affected by the logistic concerns. Any type of drilling waste management method in offshore fields is quite costly, since storage facilities and additional vessels are involved. The logistical costs of waste management can only be ignored if the drilling waste generated is dumped directly on site, commonly referred to in-situ dumping method. However, as a rule, in-situ dumping cannot be implemented in all offshore fields. Only fields with water depth greater than 50 meters can discharge on site.

In offshore Mahakam fields with water depth less than 50 meters like Bekapai, Peciko and Jempang-Metulang, the drilling waste management method implemented initially is ex-situ dumping, where the waste is collected on rig, then shipped and discharged into a designated and permitted dumping area. This method has complied with regulation. However, the cost involved is quite large.

During 2019 – 2021, the Re-entry Wells Architecture as optimization initiatives is being introduced to offshore fields like Bekapai and Peciko to unlock marginal reserves. This architecture utilizes the old non-productive well bore that will be abandoned and utilizes the old well to reach the new reservoir target by sidetracking. With this architecture mostly only the reservoir section being drilled, and no surface section drilling as it utilized old wellbore (see appendix A)

2 Drilling Waste Management Methods and Regulation

In Offshore Mahakam context, there are three types of waste produced during drilling operations such as WBM (water based mud) drill cutting, WBM used mud and SBM (synthetic based mud) drill cuttings. The waste types & volume generated will depend on drilling fluid utilized and well architecture. WBM is practically used for surface sections, while SBM is mainly utilized for intermediate and reservoir sections. Mahakam drilling waste characteristics are shown in Table 1 below.

Table 1. Mahakam Drilling Waste Characteristic.

Drilling Waste Type	Oil Content (%)
WBM Cuttings	0.01
Used WBM	0.04
SBM Cuttings	4.18

Waste produced during drilling using both WBM (water based mud) drill cutting, WBM used mud and SBM (synthetic based mud) drill cuttings can be discharged to sea in accordance with the environment regulation. Dumping of drilling waste is regulated in Peraturan Pemerintah (PP) Republik Indonesia No. 22 tahun 2021 and Peraturan Menteri LHK No. 6 tahun 2021. Dumping is allowed for locations with water depth greater than 50 meter. The characteristic of waste must meet the dumping standard with OOC (oil content) below 5%. Dumping permit from the authority must be obtained prior to dumping process. Furthermore, the dumping location must also comply with the Pertek/Perling issued by the Ministry of Environment and Forestry of Indonesia

3 Ex-situ Dumping Method in Offshore Mahakam

There are two types of dumping methods that can be implemented in Offshore Mahakam, in-situ dumping for fields with water depth more than 50 meters and Ex-situ dumping with water depth less than 50 meters. From mid-2019 until 2021, there are massive drilling campaigns in Peciko and Bekapai fields utilizing Re-entry Wells Architecture, where its water depth is less than 50 meters and only the reservoir section with SBM is drilled. Thus, initially the ex-situ dumping method is utilized. Ex-situ dumping method is performed by collecting SBM cuttings that meet requirement in a cutting skips on rig. The filled cutting skips are then being moved to a boat to be transported to the designated dumping area. Upon the arrival at the dumping location, an overboard line is installed on the boat to flow the waste into the sea with a discharge point 10

meters below mean sea level. SBM cuttings are then pumped out of cutting skips by a vacuum pump unit. SBM cuttings generally contained high OOC. In order to meet oil content <5% OOC as regulated, a Vertical Cutting Dryer unit is installed on the Rig. The Vertical Cutting Dryer unit will reduce the Oil content within the SBM cuttings. The general flow of Ex-situ dumping method can be shown below figure.

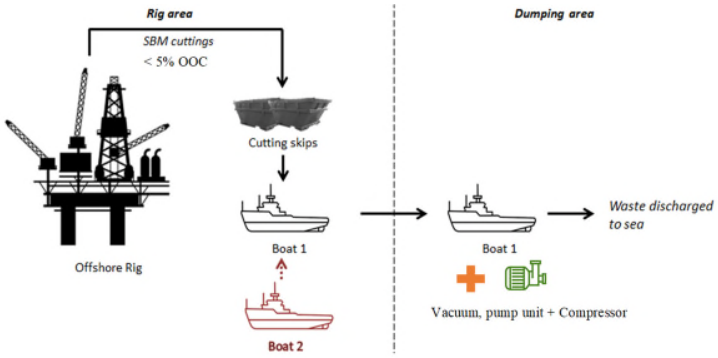

Figure 1. Ex-situ dumping mechanism in Offshore Mahakam.

Generally, one offshore well produced around 450 MTon of SBM cuttings. Thus with a cutting skips full capacity of 10 MTon, an estimated 57 cutting skips are required. But in most cases, higher SBM cuttings are produced depending on hole size and length (As per 2021 data, the maximum SBM cuttings generated in Mahakam offshore well is 890 MTon equivalent to 118 cutting skips). One boat for Ex-situ dumping transportation can only accommodate 40 cutting skips, which is less than the number average of cutting skips required from one well. Ex-situ dumping process itself, both back-and-forth transportation from rig to dumping area and waste discharge process, needs at least 3-4 days. While the boat goes to dumping area, the drilling waste on Rig is continuously generated. Therefore, one additional boat is required as a substitute boat for collecting the cutting skips from the rig and ensuring continuity of drilling operation.

In summary, 2 boats are utilized for this method, complete with two vacuum pump unit each; one for pumping SBM cuttings out of skips and one for back-up. Number of personnel required is 15 personnel; 4 waste supervisors (2 shift with 2 personnel each), 8 waste technicians on boats (2 shifts with 4 personnel each), and 3 Technicians to support cutting skips handling on Rig. With this Ex-situ dumping method, the average cost per well for drilling waste management (including 2 vessels cost) is nearly USD 860,000 or equivalent USD 1,095 per tonnage of cutting. The use of two boats and four vacuum pumps are the main cost contributors with 44.7% for boats and 27.3% for vacuum pumps. The Ex-situ dumping cost structure is shown in Figure 2 below.

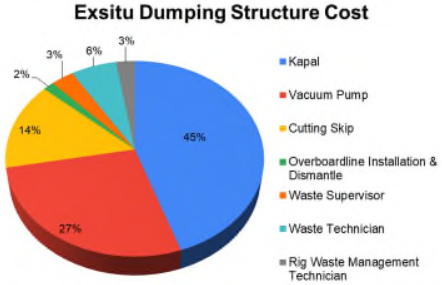

Figure 2. Ex-situ dumping cost structure in Offshore Mahakam.

Based on this cost structure, a study is conducted to optimize the drilling waste management cost. Considering the massive re-entry wells, where SBM cuttings from reservoir section is the only waste produced during drilling operation, and the availability of Final Treatment facility in Cement Kiln, onshore treatment method is then introduced in Offshore Mahakam.

4 Offshore Mahakam Onshore Treatment Method

In onshore treatment method for Offshore Mahakam, SBM cuttings produced from drilling operation on rig will be collected in a cutting skip and loaded to a boat. The boat, which is filled with full cutting skips, departed to a shore base. In the shore base, the full cutting skip is exchanged with empty cutting skips then the boat being sent back to Rig to continue support drilling operation. In the shore base, SBM cuttings in the cutting skips are re-bagged into a jumbo bag and then transported to a transfer point using a Working Barge. Jumbo bags full of SBM cuttings will be transported to a cement plant from the transfer point by using a Mother Barge. The Cement Kiln facility utilized must have Permit from authority for waste treatment. Onshore treatment mechanism in Offshore Mahakam is shown in Figure 3 below.

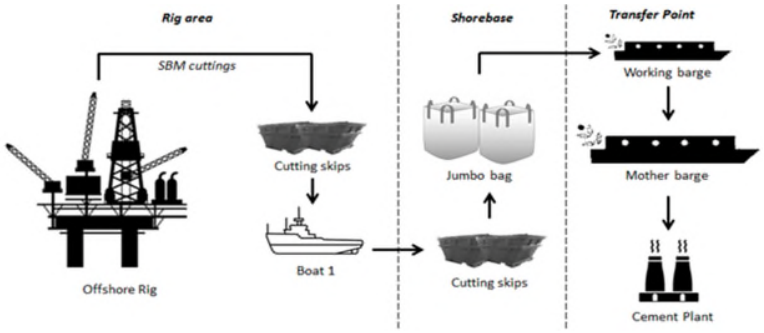

Figure 3. Onshore treatment mechanism in Offshore Mahakam

SBM Cuttings generally contained high amounts of limestone, clay, coal, and oil. Limestone and clay within the cuttings can be utilized as raw material for cement production, where high limestone and clay source is needed. (Rykusova et al., 2020).

The Onshore Treatment method, which complies with the environmental regulation, can reduce drilling waste management cost significantly. The main concern in Ex-situ dumping is the long duration of waste discharge to the sea due to dry characteristics of SBM cutting. This caused an increased requirement for boats to be two in order to accommodate cutting skips generated from Rig during ongoing drilling activity. While, in the onshore treatment method, there is no waste discharge activity, but only a transfer of cutting skips to the shore base which is much shorter in duration (at least 1-2 days). Thus the boat requirement can be reduced to one because the same boat can be used directly after from shore base to accommodate the cutting skips on rig. In addition, the need for a vacuum pump is eliminated. additionally, the space to accommodate additional cutting skips is wider due to absence of pumps. Thus, the boat can accommodate 50 cutting skips which is higher compare to Ex-situ dumping method which only accommodates 40 cutting skips. The comparison for Ex-situ dumping and onshore treatment method is shown in Table 2 below.

Table 2. Comparison of ex-situ dumping and onshore treatment requirement per rig.

Requirement	Ex-situ Dumping	Onshore treatment
Boat	2	1
Vacuum Pump	4	-
Overboard line	1	-
Cutting Skips	120	120
Mother Barge	-	1
Working Barge	-	1
Max. Cutting Skips on Boat deck	40	50
Duration of Boat cycle to re-empty skips	4 days	1.5 days
Environmental Regulation Compliance	Dumping permit obtained	Permitted hazardous waste treatment facility

As stated, 57 skips are required for one well. In onshore treatment, 50 cutting skips can be accommodated on the boat, while the remaining 7 skips can be placed on rig or supply boat decks which can accommodate up to 15 skips. This cutting skips management is the key for ensuring drilling operations continuity in onshore treatment methods where only one boat is required. A cost simulation for the onshore treatment method is performed for PK-1 and PK-2 well and the result is compared to actual Ex-situ dumping cost. It is shown that the cost reduction is up to 230,000 USD or reduction of USD 290 per tonnage per well by using onshore treatment method as result of boat reduction and vacuum pump elimination.

Overall, this approach can be said covers the three pillars of sustainable; planet, people and profit. A less polluted **"planet"** by switching the dumping become utilizing waste as raw material of cement, no waste is released to environment. Furthermore, by reducing the boat needs and eliminating all vacuum pump uses, the carbon footprint of the operation itself is lessen The reduction in equipment, manpower and mainly waste management cost per wells can be considered as company's "**profit**". Instead of just discharging the waste, this method inquired company to utilized the waste. This utilizing concept can be a shifting paradigm of how **people** of the company, see waste from something trivial can be recycled into useful everyday items like cement

5 Onshore Treatment Method Implementation in Offshore Mahakam

The novel onshore treatment method has been successfully implemented in 19 Mahakam Offshore Re-entry Wells with no HSE & operational issue and also in accordance with regulation during 2020-2021. In these 19 wells, an average reduction of USD 380 per tonnage per well in drilling waste management cost has been achieved by switching to Onshore treatment method. This equals 35% optimization compared to the ex-situ dumping method. The cost comparison for both methods in each well is shown in Figure 4 below.

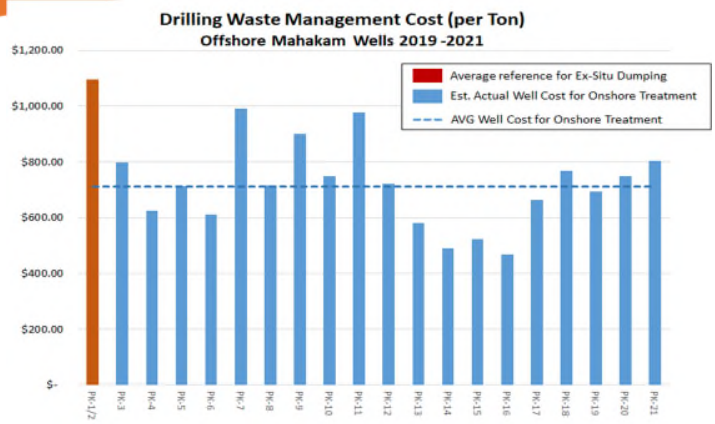

Figure 4. Ex-situ dumping and Onshore treatment cost per tonnage comparison in Offshore Mahakam.

Since this onshore treatment method showed a compromising result, it has potential to be implemented in other drilling waste types such as WBM cuttings in order to reduce drilling waste management cost. Furthermore, this method can also be developed to face zero discharge regulation, which will take place in 2025, where dumping is no longer permitted by the environmental regulation

6 Conclusion

The onshore treatment is successfully implemented in 19 Offshore Mahakam wells with no major issue in safety, operational, environmental and compliance. Initially, ex-situ dumping generates a significant waste management cost due to vessels and pumps requirement. Majority of the cost, nearly 45%, is made up from the lease fee of two boats and 27% for pump systems. The Onshore treatment, on the other hand, reduced the boats utilization to become one only and replaced the pump means by Final Treatment cost. The total waste management can be optimized by this method is up to 35% per well compared to ex-situ dumping. Therefore, the onshore treatment method is proven to be more cost-efficient and more sustainable waste management with the same level of compliance to regulation.

Appendices

Appendix A – Offshore Mahakam Typical Architecture & Re-entry Well architecture

References

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Appendix A – Offshore Mahakam Typical Architecture & Re-entry Well architecture

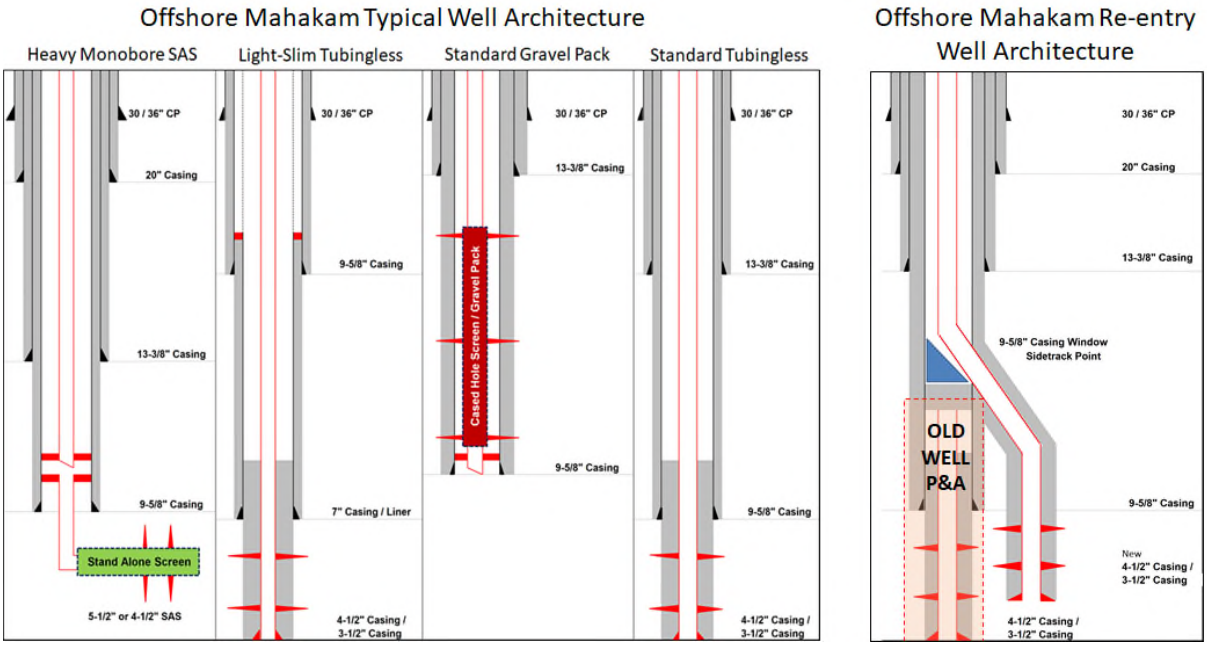

Figure A-1. Comparison Offshore Mahakam Typical Architecture & Re-entry Well architecture