PROCEEDINGS, 48th Workshop on Geothermal Reservoir Engineering
Stanford University, Stanford, California, February 6-8, 2023
SGP-TR-224

Potential Closed-loop Geothermal Power Generation Application for Non-commercial Well in Indonesia: A Preliminary Study

Rizki Ratna[1], Daniel W. Adityatama[1], M. Rizqi Al Asyari[1], Respati Katmoyo[4], Dorman Purba[4], Nadya Erichatama[1]

[1] Geoenergi Solusi Indonesia (GEOENERGIS), Jakarta, Indonesia
[2] Institut Teknologi Bandung, Bandung, Indonesia
[4] ENERKA Bhumi Pratama, Cibis Nine 11th floor, Jakarta Selatan, Indonesia

daniel.adityatama@geoenergis.com

Keywords: geothermal, drilling, waste management, regulation, Indonesia..

ABSTRACT

The 2030 national target of Indonesia geothermal energy development will boost many drilling activities in various geothermal prospects, especially in the eastern part of Indonesia. In some cases, geothermal developers in Indonesia, when planning drilling operations, are too focused on rig equipment and well construction and tend to simplify matters related to drilling waste. This in fact often lead to negative impacts on the overall drilling project where poor waste management creates environmental pollution that harms the local community and ultimately destroys the trust that has been built among the stakeholders.

This paper aims to summarize various aspects related to drilling waste management such as various types of drilling waste, waste management regulations, available options and estimated costs for each option. In addition, this paper will also discuss some relevant case studies in Indonesia to provide context to the reader. The goal is to bring and increase awareness to the geothermal community in Indonesia on how important implementing a proper waste management in order to achieve the overall drilling project objectives.

1. INTRODUCTION

1.1. Indonesia Geothermal Development

Indonesia hosts 40% of world's geothermal resource with approximately 25 GW of potential power to be extracted. Despite the massive potential from the reserves, Indonesia had only brought 8% of the power to service with the amount of 2,130 Mwe (EBTKE, 2020). According to Hochstein and Sudarman (2008), the first geothermal well in Indonesia was drilled in 1926, and the first geothermal power plant in Indonesia was commissioned in 1983. From the beginning of its development, Indonesia had only increased its capacity by a staggering 57 MWe annually, this is insufficient to effectuate the 2030 target by the Government of Indonesia to produce 7000 MWe from geothermal energy.

The current development of geothermal power in Indonesia is centered in the exploration phase, many geothermal fields are already exploited which steps up the challenge due to less geothermal manifestation is found on surface in newer prospects, the uncertainties of geothermal sources that are predicted by 3G surveys (Geology, Geophysics, and Geochemistry), and also some upflow zones are located in protected national parks that results in much tighter regulation regarding land acquisition, not to mention the presence of local communities that lives around geothermal prospects could trigger a disapproval/rejection of the project. The exploration phase is also jeopardized with high capital cost and risk in the exploration drilling stage (IFC, 2013), this challenging situation requires a careful decision to avoid failures that could cost the project itself.

1.2. Exploration Drilling Challenges

Exploration drilling is aimed to conduct the feasibility study on a new geothermal field, it is done after the completion of the 3G survey (Geology, Geophysics, and Geochemistry). The aim of the drilling is to prove the reserve and to gather data for further study, not to produce or reinject brine/steam from the wells.

1.2.1. Challenging Terrain and Poor Access Road to Pad Location

Many times, supporting infrastructure for mobilization are not available, as many geothermal prospects in Indonesia are found in remote areas in elevated terrains due to the volcanic and tectonic activities associated with geothermal resources. (Purba et al., 2020) where the road conditions are rather challenging. Another contributing factor is that Indonesia is an archipelago, which requires shipping the equipment & drilling rigs, and supporting equipment to the proposed drilling area. This has caused the rise of the logistics cost. In general, the higher the drilling rig capacity, the higher cost has also needed to build the proper infrastructure to support rig mobilization.

1.2.2. Lack of Awareness in Geothermal Projects

Many communities that resides around geothermal drilling projects in Indonesia are not highly educated thus is not well informed about the risks and benefits they may encounter during a geothermal drilling campaign. This can lead to rejections by the communities if community engagement is not properly done and may result in the unfortunate relationship between the developer company and local communities.

2. DRILLING WASTE MANAGEMENT

2.1. Types of Waste Generated

Geothermal drilling generates waste that are classified into 3 different categories by the Indonesian government through Government Regulations No 101 of 2014 regarding the Management of Hazardous and Toxic waste, which are: domestic waste (solid & liquid), non-B3 waste, and B3 (Toxic and hazardous) waste.

By regulations, geothermal drilling mud & cutting waste are classified as non-B3 waste as per 2014. This is justified by the Government Regulations No.101 of 2014 regarding the Management of Hazardous and Toxic Waste. This regulation is implemented since the content of the drilling mud for geothermal drilling is also regulated in the Minister of Energy and Mineral Resources Regulation No. 21/2017 on the Drilling Cutting and Mud Utilization.

2.2. Regulation Drilling Waste Management

Here is a list of regulations regarding geothermal drilling waste management:

1. Law of The Republic of Indonesia 32 Year 2009 regarding Environmental Protection and Management
2. Government Regulations No.101 of 2014 regarding the Management of Hazardous and Toxic Waste
3. Minister of Energy and Mineral Resources Regulation No. 21/2017 on the Drilling Cutting and Mud Utilization.
4. "Peraturan Menteri Lingkungan Hidup No 02 tahun 2008 tentang Pemanfaatan Limbah Bahan Berbahaya Dan Beracun"
5. "Peraturan Menteri Lingkungan Hidup No 30 tahun 2009 tentang Tata Laksana Perizinan Dan Pengawasan Pengelolaan Limbah Bahan Berbahaya Dan Beracun Serta Pengawasan Pemulihan Akibat Pencemaran Limbah Bahan Berbahaya Dan Beracun Oleh Pemerintah Daerah"
6. "Peraturan Menteri Lingkungan Hidup No 33 Tahun 2009 Tentang Tata Cara Pemulihan Lahan Terkontaminasi Limbah Bahan Berbahaya Dan Beracun"
7. Decree of the Head of Environmental Impact Management Agency (BAPEDAL) No.: KEP-01/BAPEDAL/091995, on Procedures and requirements for the Storage and Collection of Hazardous and Toxic Waste
8. Decree of the Head of Environmental Impact Management Agency (BAPEDAL) No.: KEP-02/BAPEDAL/091995, on Procedures and requirements for a Hazardous and Toxic Waste Manifest
9. Decree of the Head of Environmental Impact Management Agency (BAPEDAL) No.: KEP-03/BAPEDAL/091995, on Technical Requirements for Hazardous and Toxic Waste Treatment
10. Decree of the Head of Environmental Impact Management Agency (BAPEDAL) No.: KEP-04/BAPEDAL/091995, on Procedures and requirements for Disposal of Treated Hazardous and Toxic Waste Treatment and Landfill Sites
11. Permen LH No. 14 Tahun 2013 tentang Simbol dan Label Limbah Bahan Berbahaya dan Beracun
12. Perda Kabupaten Bandung No 06 tahun 2010 tentang Pengendalian Pengelolaan Lilmbah Bahan Berbahaya dan Beracun
13. Circular Letter from the Ministry of Environment Number SE.10 / PSLB3 / UPLB3 / PLB3 / 6/2016

According to the Government Regulations No.101 of 2014 regarding the Management of Hazardous and Toxic waste, geothermal drilling mud and cuttings waste are no longer classified as B3.

The updated regulation has enabled geothermal developer companies to repurpose the drilling waste instead of treating it and send it into landfills for disposal. The previous Government Regulation No. 85 of 1999 concerning the Management of Hazardous & Toxic Waste stated that drilling waste should be tested by the TLCP test or the Toxicity Characteristic Leaching Procedure for humans, also the LD_{50} test for animals. These test are predominantly used to detect heavy metals in drilling waste where it is compulsory to test the presence & concentration (in mg/L) of Arsenic, Barium, Boron, Cadmium, Chromium, Copper, Lead, Mercury, Selenium, Silver, and Zinc (Hidajat, 2019).

The Minister of Energy and Mineral Resources Regulation No. 21/2017 on the Drilling Cutting and Mud Utilization also stated that the developer company must deliver the drilling waste management report to the Minister through the EBTKE directorate of ESDM (Ministry of Energy and Mineral Resources) in 3 (three) months prior to the drilling activity by minimum. The plan should consist of a budget plan, and systematic for a period of one year of drilling campaign. The company will recieve penalty from the ministry if not complying to the existing regulations, further actions could be seen at the regulation document.

2.3. Equipment for Waste Handling and Management

Processing drilling waste requires some equipment which in general are categorized into 3 distinct processes, which are (1) Solid control, (2) Containment & handling, (3) Treatment & disposal.

Solid control equipment is used to separate the cuttings, gasses, and other forms of impurities within the mud from the drilling mud (or foam in aerated drilling). Often it is also a part of the mud circulation system within the drilling rig. Solid control process involves some equipment such as pyramid screens, shale shaker, desander, desilter, centrifuge, degasser to name a few.

The next process is containment & handling. This process is aimed to collect & transfer cuttings, then contain it in a container for the next process. It requires some equipment such as screw conveyor to move the previously processed cuttings, then secured in a cutting container by rig-vacuum device. Later it will be transported to the available treatment & disposal facilities.

The last processes are to treat and dispose the waste, which will be done in a separate facility. This process requires some equipment such as cutting dryer to absorb and remove the remaining moisture & trapped fluid from the cuttings (figure 1), then it will undergo the solidification process on a dedicated device. The end product of the treated waste will be utilized & repurposed (Katmoyo, 2020). This will be explained in the following section.

2.4. Utilization Options of Drilling Waste

All drilling cuttings and mud utilization processes must comply to the government regulation which is stated in the Minister of Energy and Mineral Resources Regulation No. 21/2017 on the Drilling Cutting and Mud Utilization. The regulation suggested to divide the produced drilling waste into 2 categories, Ex-situ and in-situ utilization. Ex-situ utilization is done by a 3rd party legal entity that is registered at the government office, while in-situ is processed by the geothermal developer company.

There are some available options to utilize the drilling waste, 2 proven methods are to repurpose them as construction materials (concrete mixture and bricks). Both products are advantageous as it utilizes 100% of the drill cuttings as a mixture of concrete roads and bricks, it also makes social impact for the surrounding communities as it requires labor of 2-3 workers to make the bricks (Hidajat, 2019).

Developer company may also want to engage more with the local residents with the good intend of giving new job opportunities for the locals with low education & low skillsets, although they would require a basic training on how to manufacture bricks from drilling mud & cuttings that had been previously processed. This is also to show the local communities that the company can give meaningful impact towards their community, thus gaining trust and lowers the rejections (if there is any). As far as we're concern, many geothermal drilling projects in Indonesia faced rejections from past experiences. Local residents has many concerns regarding the environmental impact (such as land subsidence, deforestation, surface water contamination, etc), and also the eerie of the notorious Lapindo mud flow incident that was caused by drilling activities (Putro P.B.S, 2012), their arguments are also supported by some NGOs with the recent case in Mount Slamet, Central Java, Indonesia (Meijaard, et al, 2019).

3. CONCLUSION

In order to reach the national geothermal energy development target, Indonesia is required to push exploration activities massively, where in the exploration phase, drilling is one of the most complex part since it involves lots of personnel from different companies and also it has to face the fact that uncertainty and risk is present.

One of the challenges in drilling activities is the waste management planning. Failure to manage various drilling waste may jeopardize the project as a whole and can damage the surrounding environment where local residents live and earn a living. This paper had help to summarize the vast amount of aspects of drilling waste management which includes the types of drilling waste, regulations regarding waste management, and available options to manage the drilling waste. And of course, we understand that each project will face different challenges in each operation areas.

4. REFERENCES

Meijaard, et al.: Rapid environmental and social assessment of geothermal power development in conservation forest areas of Indonesia. *PROFOR,* Washington, DC, United States. (2019).

International Finance Corporation: Success of geothermal wells: a global study. (2013).

Katmoyo, R.A.: Geothermal Waste Management Training Material: "6 Days Training Managing Geothermal Drilling Projects in Indonesia". Universitas Indonesia / KS Orka Renewables Pte. Ltd. Depok, Indonesia. (2020).

Putro, P.B.S.,:Social and Economic Impacts Of The Sidoardjo Mudflow: Community Resettlement After Disaster, *Master Thesis. Graduate School of Agricultural Science. Tohoku University*. Japan. (2012).

Purwanto, E. H., Suwarno, E., Lukman, R. F., Herdiyanto, B.: Geothermal drilling in Indonesia: a review of drilling operation, evaluation of well cost and well capacity. Proc. 6th Indonesia International Geothermal Convention & Exhibition, Jakarta, Indonesia. (2018).