Strategies to Improve Reinjection Facility Management in Maibarara Geothermal Power Facility, Batangas, Philippines

Joseph Nikko M. Mazaredo, Miller A. Sanggalang, Arnold B. Sinogba, Ian L. Mendivil

Maibarara Geothermal Inc., 7th Floor, JMT Building, ADB Avenue, Ortigas Center, Pasig City, 1600, Metro Manila, Philippines

jmmazaredo@maibarara.com.ph

ABSTRACT

Maibarara Geothermal Inc. (MGI) operates the 32 MW Maibarara Geothermal Power Facility (MGPF) in Batangas, Philippines. Reinjection is a critical component of geothermal operations, ensuring the sustainability of the reservoir by returning spent geothermal fluids back into the reservoir and in meeting environmental regulations on zero RI surface discharge.

MGPF employs a cold reinjection scheme that integrates thermal ponds and Alvenius lines connected to the reinjection well. To enhance the efficiency and reliability of this system, the frequent need for pipe cleaning due to scaling and clogging in the enclosed Alvenius pipelines had to be addressed. To mitigate this issue, we replaced the Alvenius pipes with open concrete canals along the reinjection line. This strategic modification allowed for easier monitoring, quicker maintenance access, and a reduced likelihood of flow restrictions. Moreover, the open concrete canal design facilitated greater exposure of the brine to ambient temperature conditions, which further helped in cooling the brine before being reinjected into reinjection wells. As a result, this improvement not only streamlined operational workflows but also optimized reinjection performance and enhanced the overall efficiency and sustainability of the system.

Keywords: Maibarara, reinjection, injection temperatures, open concrete canal

1. INTRODUCTION

The Maibarara Geothermal Field is situated approximately 70 kilometers southeast of Manila, the capital of the Philippines. It is one of two active geothermal reservoirs associated with Mt. Makiling and is positioned on the mountain's northwest flank (**Figure 1**).

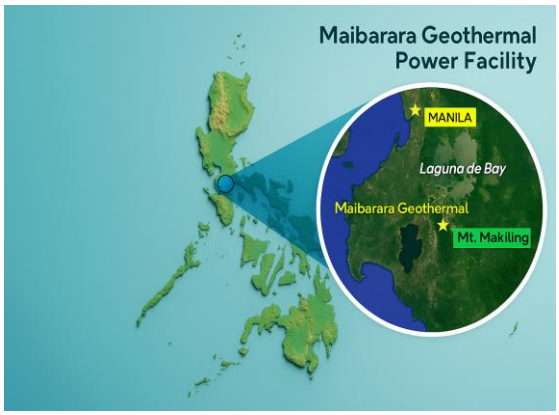


Figure 1: Maibarara Geothermal Field is about 70 kms southeast of Manila

The Maibarara geothermal power project was developed on a compact 9.85-hectare site, which houses both the steam field and the two power plant units, the 20 MW Maibarara-1 Geothermal Power Plant and the 12 MW Maibarara-2 Geothermal Power Plant. The production wells and separators for M1GPP and M2GPP are located on the same pad, leading to a relatively short two-phase pipeline. The two power plants are positioned approximately 100 meters to the west of the production well pad for M1GPP and 200 meters for M2GPP, allowing for the construction of shorter steam lines (**Figure 2**).

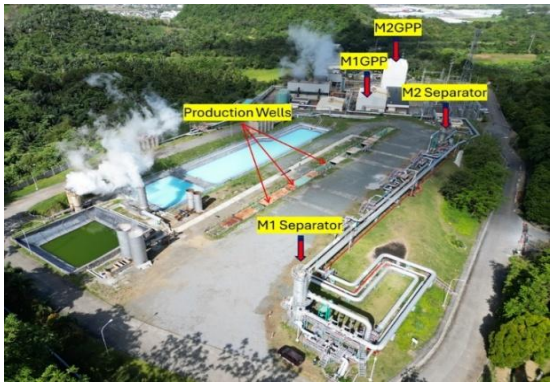


Figure 2: Compact 9.85-hectare site of the 32 MW Maibarara Power Facility

Maibarara's reinjection system was initially designed as a hot reinjection, in which separated brine at approximately 162°C was directly injected into the reinjection wells within a closed-loop system. However, during the testing and commissioning of M1GPP in 2013, a decline in injection capacities and constant flooding of the separator vessel were observed. Tests were done using the cold reinjection to prove that a colder brine temperature has better injection flow acceptance. These tests led to the conclusion that switching from hot to cold reinjection was necessary. To do this, the brine from the separator is directed to the silencer and then to the thermal ponds (**Figure 3**) through a series of alvenius pipes to cool down before being injected into the reinjection wells using the engine-driven pumps. At that time, these engine-driven pumps were the readily available option to convey brine fluids into the reinjection wells.

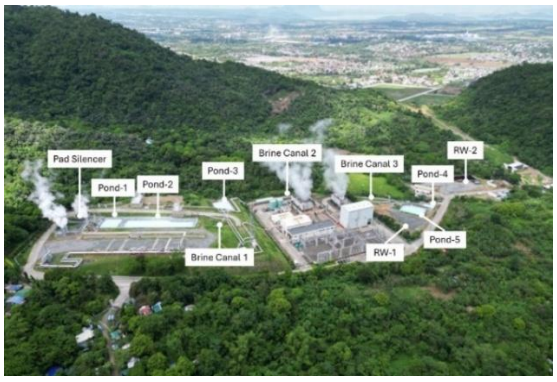


Figure 3: Brine travels from Pad Silencers going to RI wells (RW-1 and RW-2)

Over time, clogging issues began to arise in the alvenius pipes, leading to reduced flow rates and a noticeable decline in cooling efficiency before being injected into the reinjection wells. These blockages, likely caused by the buildup of silica scale and other minerals within the pipes, hindered the smooth flow of brine (**Figure 4**). As a result, the cooling process became less effective, with the brine not reaching the desired lower temperatures before reinjection. Additionally, the high temperature of the brine caused damage to the pumps and reduced their operational lifespan and efficiency. This performance issue led to the need for regular maintenance to prevent such issues from compromising the overall efficiency and reliability of the reinjection process.

This paper focuses on the improvement of the MGPF reinjection facilities by transitioning from Alvenius pipes to open concrete canals.

2. METHODOLOGY/APPROACH

2.1 Replacement of alvenius pipes to open concrete canals

To address the clogging issues associated with the alvenius pipeline, a solution was implemented by switching to open concrete canals, which enhanced fluid flow and minimized the risk of blockages as shown in **Figure 4** below.



Figure 4: Silica scales build up in alvenius pipes. Transition from alvenius pipes to open brine canal

This change not only improved flow but also allowed for additional cooling of brine before its reinjection into the RI wells. Furthermore, a series of facility upgrades were carried out to further optimize brine cooling and reinjection efficiency. These

improvements included the construction of perimeter canals around the thermal ponds, the addition of two new brine ponds, and the creation of an extended open concrete canal which also allowed the use of power plant condensates as a dilution fluid and help lower the temperature of the hot brine prior to reinjection **(Figure 5)**. These upgrades significantly improved the performance and durability of the reinjection process, ensuring smoother operations and reducing the likelihood of disruptions.

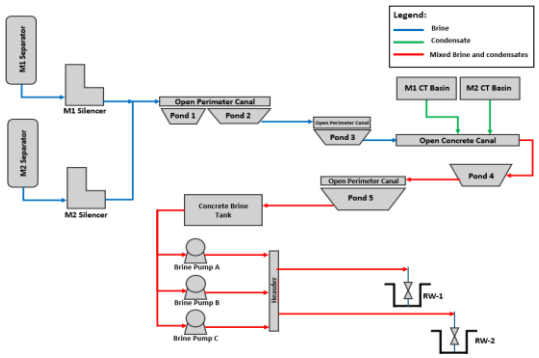


Figure 5: 32 MW cold brine reinjection scheme.

3. RESULTS AND DISCUSSIONS

3.1 Brine temperature reduction

To validate the system's efficiency, brine temperature profiling was conducted to assess the concrete canal's effectiveness in lowering brine temperatures prior to reinjection. Temperature readings taken at various points along the concrete canal provided critical data on the cooling process's efficiency, as summarized in **figure 6**.

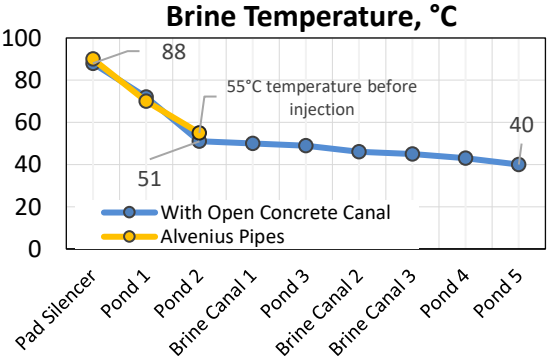


Figure 6: Brine temperature reduction before reinjection into the RI wells

These measurements highlight the progression of temperature reduction throughout the system, demonstrating the effectiveness of each cooling stage in achieving the lower temperature before reinjection.

Figure 7 shows that cold reinjection significantly improves the flow rate and acceptance of brine, as evidenced by the marked increase in flow rates when colder fluids are being reinjected into the RI wells.

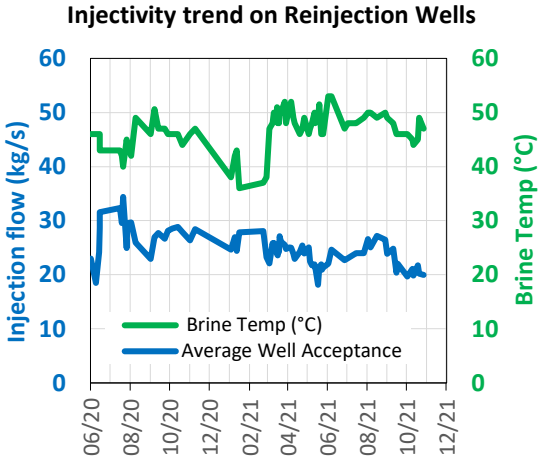


Figure 7: Injectivity trend against changing brine temperatures.

The operational parameters indicate that colder reinjection temperatures increase the flow rate, allowing for better acceptance by the reinjection wells and improved overall system efficiency.

4. SUMMARY AND CONCLUSIONS

The analysis shows that the colder the brine temperature, the greater the injection flow rate that the reinjection wells can accommodate. This clearly demonstrates the significant increase in flow rates against changing brine temperatures. The implementation of open concrete canals has been instrumental in lowering brine temperatures prior to reinjection, thereby enhancing the efficiency and performance of the system. These canals not only promote better cooling through exposure to ambient conditions but also simplifies monitoring and maintenance due to their accessible design. Overall, these improvements have optimized the

system's cooling capacity, strengthened operational efficiency, and supported a more sustainable and cost-effective approach to long-term brine management of the Maibarara Geothermal Power Facility.

ACKNOWLEDGEMENTS

The authors would like to thank Maibarara Geothermal Inc. management for its continuous support in the study and implementation of enhancement to the reinjection system. Special thanks to the operations team for their contributions and assistance during the testing and transition process.

REFERENCES

Esberto, M. B., Sinogba, A. B., Llenarizas, L. J., Fernandez, L. C. D., Mendivil, I. L., Maturgo, K. M., & Callos, P. G., Jr. (2021). *Evolution of the reinjection system in a compact operating geothermal field: The Maibarara experience*. Proceedings of the World Geothermal Congress 2020+1.

Maibarara Geothermal Inc. (2021). *Steam field operations (2018 to 2021): Reinjection capacity and reinjection loading monitoring* [Internal report].

Sinogba, A. B. (2021). *Cost benefit analysis_EBP_Global Pump.xlsx* [Internal file]. Maibarara Geothermal Inc.