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The First Five Years Operation of Patuha Geothermal Power Plant

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ABSTRACT

Patuha Geothermal Power Plant started commercial operation on September 22th 2014. Geo Dipa Energi (Persero) is a company that operates in this area, using the steam field and power plant operation activities. After five years operation, the Patuha GPP has 59,88 MW install capacity, still operate in good condition, mainly for all power plant facilities. In the first-year operation the turbine generator produced electricity for 8760 hours of operation (1 year operation). Now after the first maintenance period, turbine generator Patuha Unit 1, has improve duration operation hours to more than 17500 hours (more than 2 years operation period). Some of the operational problems have appeared during the five years of production. In the steam field area, natural declining well flows are happening at the production wells. From 8 production wells at the first time Patuha area operated in 2017, GDE should add 2 production wells to generate 59,8 MW install capacity in best performance. Some of operation strategies have been improved in the power plant, such as maintaining cooling water in cooling tower to get the best quality of water, and operating the gas removal system only 60% if the gross generation from the turbine is less than 55 MW. Total electricity production from 2014-2018 is 2000 GWh.

1. INTRODUCTION

PT. Geo Dipa Energi (GDE) is a state owned company that runs Patuha Geothermal Power Plant. Patuha geothermal field is located in West Java, Indonesia, about 50 kilometers southwest of Bandung. Patuha geothermal field is a vapour-dominated reservoir.

Patuha Geothermal Power Plant was commercially operated in 2014. Through the years, Patuha Geothermal Power Plant sustains its production and performance. For almost 5 years of commercial operation, Patuha Geothermal Power Plant delivers 55 MWe to the Java-Bali grid. During those years of operation some problems have appeared.

In this paper, we will share the information that is connected with the operation strategy and the improvements made to get the best result in upstream and downstream operations during the first five years of operations at the Patuha Geothermal Power Plant.

2. OPERATION

Figure 1 below shows the Patuha Geothermal Power Plant diagram. We are monitoring the operation data at all times, upstream to downstream.

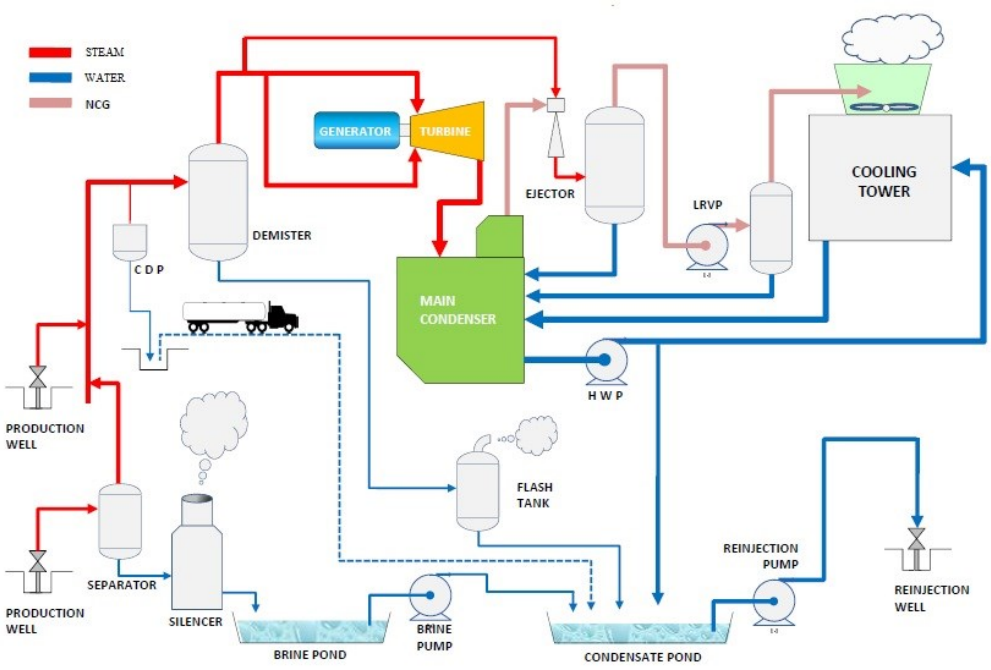


Figure 1: Patuha geothermal power plant diagram

2.1 Upstream

Patuha Geothermal Field has had 8 production wells, 3 injection wells, and 2 idle wells since 2014. Some problems have appeared in the steam field area during the operations. These are some problems and improvements in steam field area:

2.1.1 The Separator

One of the production wells at Patuha geothermal field is PPL-2. The fluid produces by PPL-2 consisting of two phase with 80% vapor fraction. From the beginning of the operation, the trimming valve PPL-2 has never opened more than 35% because it carries over the water to the power plant. That condition has also been assisted by a condensate drain pot bypass valve crack, open along the steam above ground system (SAGS) westline towards to the power plant to reduce the water. In total, there are 5 condensate drain pots, one packaged with a steam trap system. With this condition of operation, PPL-2 produces approximately 4 MW.

In March 2016 the separator at PPL-2 was already installed and ready to operate. PPL-2 can be operated optimally. The trimming valve was opened more than 50% and PPL-2 produces approximately 5.5 MW. With separator installed, it also improved the value of the chemical content.

2.1.2 Added Wells to SAGS

In July 2017 GDE added 2 production wells. PPL-4, the previously idle well, and PPL-6, the reinjection well, were tied in to the SAGS. PPL-4 and PPL-6 produce approximately 3 MW sustaining the total load generated at 55 MWe.

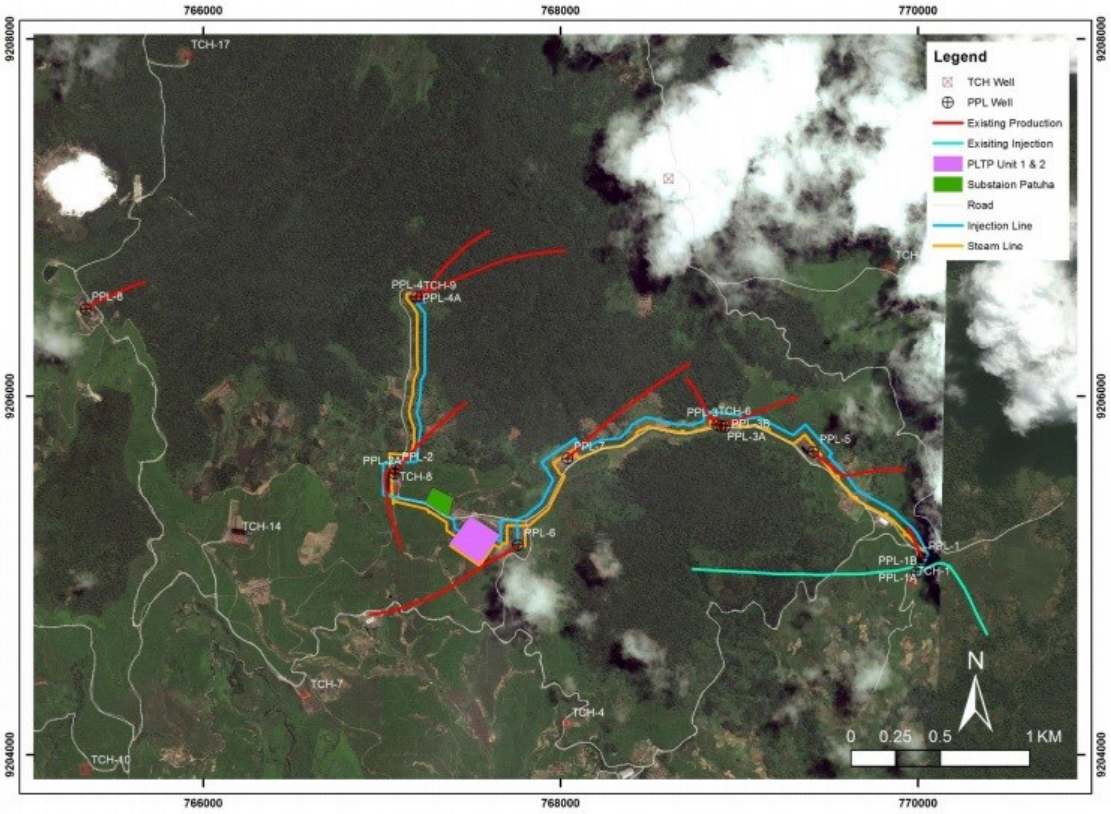


Figure 2: Patuha geothermal field

2.1.3 Wells Decline

During the commercial exploitation stage, natural declines have happened to production wells as shown in figure 3. All of production wells are incorporated to the systems, being difficult to shut them off because it will affect the power plant load generation.

Well	PPL-1	PPL-2A	PPL-3	PPL-3A	PPL-3B	PPL-4	PPL-6	TOTAL PROD. (tph)	TOTAL PROD. (Exc. PPL-3A & PPL-4) (tph)
Decline Rate (%/year)	4.4%	6.4%	6.8%	32.9%	4.6%	44.0%	0.0%		
Production (tph)	68.5	43.5	54.3	15.3	78.8	7.2	6.8	274.5	251.9
Decline Prod. (tph)	3.0	2.8	3.7	5.0	3.6	3.2	0.0	21.3	13.1
Remarks				Scaling 2-1/4" tag @380m (2018)		Scaling 3-1/2" tag @782m (1998)			
Average Decline								7.8%	
Average Decline (exclude scaling well)									5.2%
Note:	Data started October 2016 to exclude the first 2 year transient period								

Figure 3: Decline curve analysis data of Patuha production wells

2.1.4 Well Injection Switching

Tracer interference test shows that reinjection at PPL-1B only proven at PPL-1 with sample recovery 2.11%. The tracer sample also is not found at other production wells. At that time the decline of steam from PPL-1 reached 27.57%. In addition, a pressure drop of 2.7 bars also occurred, with a decreased temperature around 15°C. Based on the results of calculation and modeling of the reservoir by the engineering team, more reinjection at PPL-1B will lead to a greater production decline in PPL-1. In November 2017 GDE switched reinjection wells, from PPl-1B to PPL-1A.

2.1.5 Well Washing PPL-7

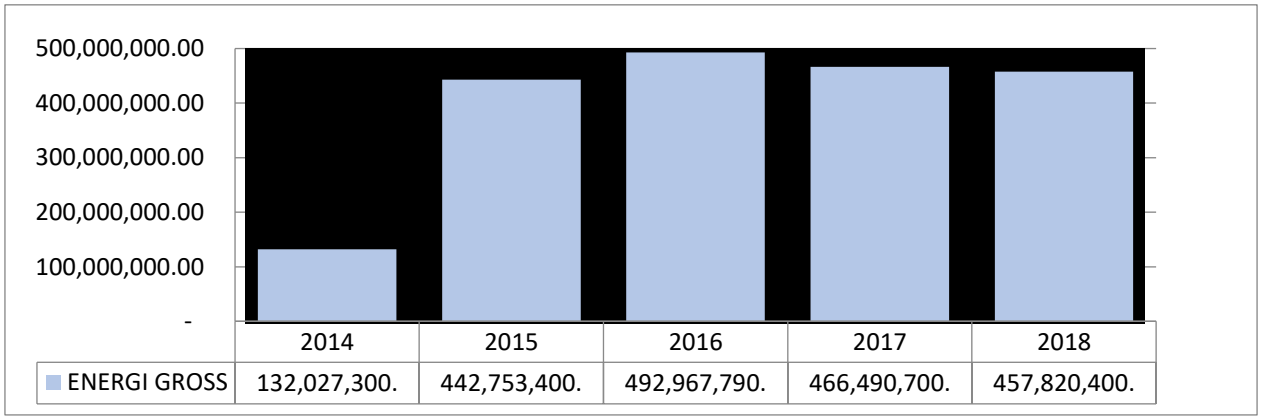
PPL-7 is one of production wells and the most unique well in Patuha field. The well originally produced 12.7 MW at 155 psig WHP in 1998. But at the beginning years of power plant operation, PPL-7 did not produce the steam. The indication was blocked by $CaCO_3$ (calcite). In December 2015 there was an overhaul of PPL-7, and again in May 2018 PPL-7, using acidizing to maximize well productivity. After the overhaul, the productivity of PPL-7 still didn't last long. The well decline was very fast. The indication was still same - the wellbore was blocked by $CaCO_3$. Since the power plant needed more steam to sustain production and the price for additional overhaul is expensive, GDE came up with a strategy to inject the condensate water from PPL-7. This activity proposed to clean the wellbore condition of PPL-7 so this well could produce steam again. This activity is called well washing. In total, as of May 2019, PPL-7 has had 19 periods of well washing, that were included with two overhauls. With this conditioning the well produces 3-5 MW, sustained for approximately 1 month.

2.2 Downstream

The Patuha Geothermal Power Plant is the first make Single Flow Turbine at the Power Plant in Indonesia. We can see at the below in the figure 4.

Figure 4: Single flow turbine

One Unit 1 x 59.8 MW Toshiba Turbine with Condensing system have been used. The unit has been producing reliable electricity since September 2014. The generated electricity is connected to a 150 kV transmission line to the Bandung grid system. The Turbine single flow shows high efficiency because we can operate with minimum inlet pressure until 6.5 bars from the initial press design 7.15 bars. To optimally generating electricity from 2017, we do overhaul the turbine and we can extend overhaul time from 1 year to 2 years because it is possible to depend on parameter operations in the normal range. For generating electricity after 2016, we are going down because there is a problem from the well we can see the below figure 5.



	2014	2015	2016	2017	2018
ENERGI GROSS	132,027,300.	442,753,400.	492,967,790.	466,490,700.	457,820,400.

Figure 5: Generating electricity

Some of strategies of operation: We do treatment with chemicals contained in the cooling tower which have many sulfur deposits at the filler pack and it can reduce the efficiency of the cooling water system. We can see below, in figure 6, from this treatment we can increase the temperature of cooling water system and can effectively increase load.

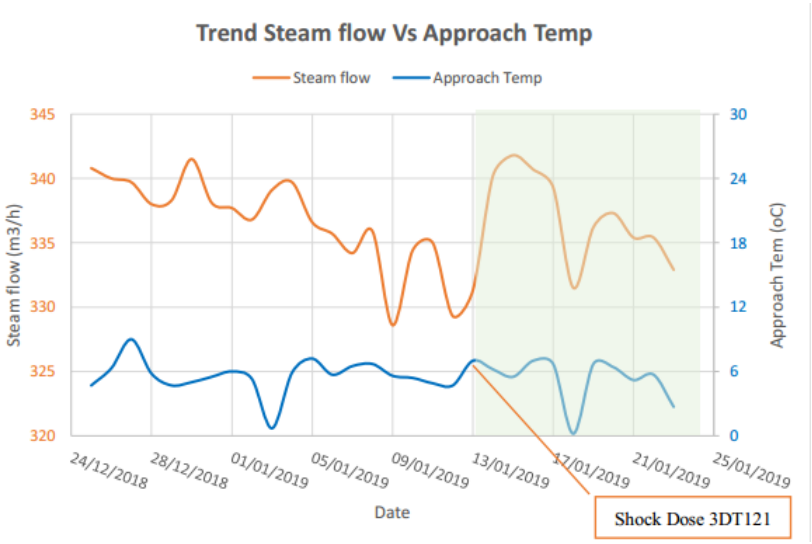


Figure 6: Trending data after treatment chemical cooling tower

In another strategy for the normal operation we used 2 liquid ring vacuum pumps (capacity power is @ 550 kW) for vacuum in the condenser. After 2018 we use 1 pump, it can reduce our own power consumption by 0.5 MW, as we can see the below figure 7.

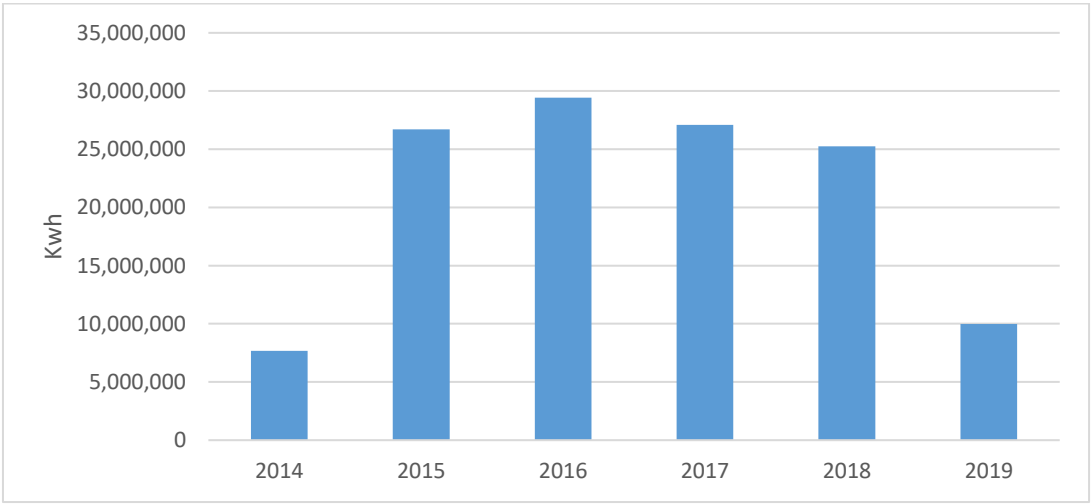


Figure 7: Own use energy consumption

3. CONCLUSION

The results of this paper are from the Patuha geothermal field which is vapour-dominated steam. The first geothermal powerplant to use a single flow turbine in Indonesia. Many problems have appeared during the first 5 years of operation but it is still able to sustain delivery of 55 MWe to the Java-Bali grid. We can improve the reliability and performance from upstream to downstream.

REFERENCES

Aqui, Arvin R. Optimization of Palinpinon-1 Production Field Based on Exergy Analysis –The Southern Negros Geothermal Field, Philippines. Proceedings World Geothermal Congress 2005. Antalya, Turkey. 2005.

Ameri, Mohammad, et.al. Energy and Exergy Analysis and Optimization of A Double Flash Power Plant for Meshkin Shahr Region. World Renewable EnergyCongress 2011. Linkoping, Sweden. 2011.

Cengel, Yunus A. Thermodynamics : An Engineering Approach. 2006.

Daeil Aqua Co. Cooling Tower Thermal Design Manual. Cooling Tower Technical Site of Daeil Aqua Co., Ltd. For Cooling Tower Engineers, Operators and Purchasers. 2003.

Dagdas, Ahmet. Performance Analysis and Optimization of Double-Flash Geothermal Power Plants. Journal of Energy Resources Technology. Besiktas, Istanbul, Turkey. 2006.

DiPippo, Ronald. Geothermal Power Plants. BH. Massachusetts, USA. 2007.

JBIC., 2006, *Feasibility Study for Patuha Geothermal Power Development.* Final Feasibility Report. Not published.

Internal Operation Monitoring Data PT.Geo Dipa Energi (PERSERO).