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Exploitation Strategies to Minimize Decline Rate at Lumut Balai Area, PT. Pertamina Geothermal Energy, Indonesia

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ABSTRACT

Lumut Balai is one of the prospective geothermal fields in Sumatra which is located in South Sumatra Province, Indonesia. It has been operated 1 unit of geothermal power plant with installed capacity 55 MWe in 2020, will be following to another 55 MWe in 2023. Based on the reservoir characterization, Lumut Balai is classified as a medium to high enthalpy reservoir, with wellhead flowing pressure around 6-9 barg, with pressure line 4-5 barg. There are 3 well pads as the production wells such as Cluster 1, 6, and 9. Due to anticipate Transient Pressure Effect of reservoir exploitation and the small difference between WHP operation, Pipeline, Separator and Turbine Inet pressure about 2-3 barg, it needs production management and strategies to minimize the significance of the decline rate. There are several strategies to manage the exploitation of Lumut Balai reservoir, the first strategy is to operate the throttle valve into the optimum open valve around 40 to 50% with WHP 6-7 barg and operate the production rate of each well without disturbing the stability of steam supply at 2400 ton/hr to the plant through changing the valve open and exercise the valve, secondly reducing the effect of reservoir cooling due to injection through reinjection well which is located far from production area, thirdly monitoring scale development in well and surface facilities regularly, finally maintenance reliability of existing turbine power plant with SSC 6.8 t/hr/MW, Inlet pressure 4.3 barg and monitoring steam quality frequently. Eventually, Lumut Balai geothermal field has no significance production decline with rating percentage less than 1% for TPE period in 9 months.

1. INTRODUCTION

Lumut Balai Geothermal Field is located in Penindaian Village, Semende Darat Laut, Muara Enim Region around (108 km from Baturaja City) , South Sumatera. This field has around 223 ha. The drilling exploration has begun since 2005, and EPPC Unit 1 (55 MW) in 2015. This field is projected to have 2x55 MW and currently held on going project to build Unit 2 with 55 MW. Net capability of Unit 1 (URC) is 55.417 MW, with availability of steam in wellhead is about 68.75 MW, and reinjection capacity is 4400 ton/hour for 2 unit. During the lifetime production of this field, there is not significant production decline from exploitation activities.

Figure 1. Location of Lumut Balai Geothermal Field

2. WELL OVERVIEW

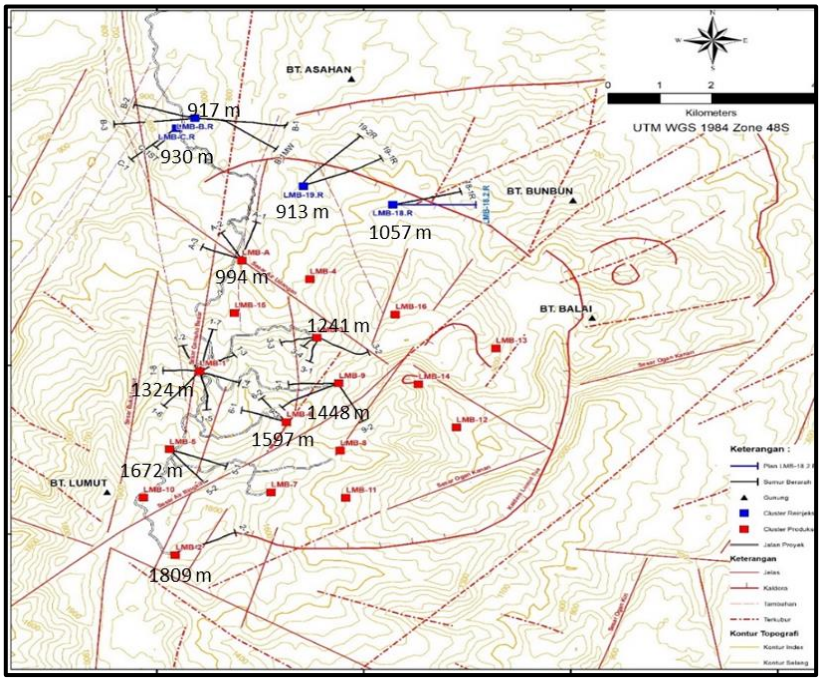
In accordance with the actual operating conditions of the wells in the Lumut Balai (LMB) Field recently, there are 9 wells in flowing condition, 3 wells in bleeding conditions, 3 reinjection wells, 16 wells in shut-in condition. Thus the total wells available at PT. PGE Lumut Balai Area for 2x55 MW Generation of 31 wells. Lumut Balai Geothermal Field is currently operating 3 wellpad/cluster as production wells and 1 wellpad/cluster as reinjection wells for generating 55 MW.

Steam consumption/operation is 116.6 kg/s ≈ 420 t/hr with the total availability 152.5 kg/s ≈ 549 t/hr. Production wellpad to supply steam for power plant Unit 1 is :

- Cluster 1 : 78.1 kg/s ≈ 281 t/hr
- Cluster 6 : 34.1 kg/s ≈ 123 t/hr
- Cluster 9 : 40.3 kg/s ≈ 145 t/hr

Well reinjection Capacity (temporary): 765.6 kg/s ≈ 2756 t/hr. Reinjection wellpad is :

- LMB A1: 170 kg/s ≈ 612 t/hr
- LMB A2: 297.8 kg/s ≈ 1072 t/hr
- LMB A3: 297.8 kg/s ≈ 1072 t/hr



Wells	Elevation	Power (MW) Unit-1 SSC 7 t/hr/MW
LMB -1/3	1324	10.5
LMB -1/4	1324	6.9
LMB -1/5	1324	10.2
LMB -1/6	1324	9.4
LMB -6/1	1597	9.4
LMB -6/2	1597	7.8
LMB -9/1	1448	8.4
LMB -9/2	1448	4.9
LMB -9/3	1448	8.6

Figure 2. Well Distribution Map of Lumut Balai Geothermal Field

3. RESERVOIR OVERVIEW

Lumut Balai (LMB) Geothermal reservoir is water dominated reservoir with dryness 12%-23%, enthalpy 900-1200 kJ/kg, permeability characteristics is medium – high, reservoir temperature is 230ºC – 260 ºC and pressure 50-60 barg. The reservoir pressure in each LMB well is still on a hydrostatic line which indicates that the LMB reservoir is in 1 system. The Feed Zone is at depth range of 300 s/d -1000 mASL.

Table 1. Daily Monitoring Operational Data

Parameter	Value
Generation	59 MW (Gross), 56 MW (Nett)
Daily Steam Consumption	400 t/hr + 20 t/hr (Dibuang ke rockmuffler)
SSC Turbine	6.8 t/hr/MW (Gross)
Inlet Pressure Turbine	4.3 barg
Jumlah Condensate	180 t/hr

Total Mass Production	2400 t/hr
Total Mass Injection	1900 t/hr
Total Mass Loss	500 t/hr (20% of Total Production Mass)
Temp Fluid Reinjection	150°C
WHP Reinjection Wells	1-3 barg (P Line 20 Barg)
WHP Production Wells	6.7- 9.4 barg
Separator Pressure	4.7 barg

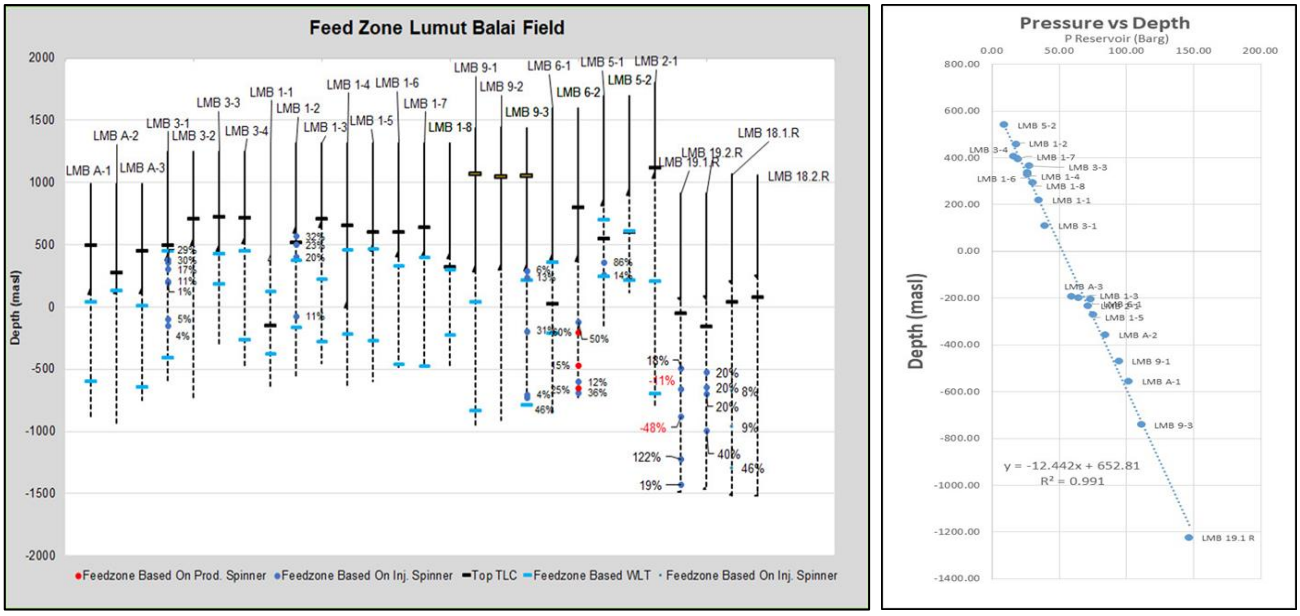


Figure (3). Feed Zone Distribution and (4) Reservoir Pressure Lumut Balai Field

4. PRODUCTION MONITORING

Table 2. Production Monitoring Strategies for Lumut Balai Geothermal Field

No	Main Issue	Information Requirement	Technical plan
1	Production Monitoring	Mass Flowrate, WHP, Enthalpy etc	Tracer Flow Test (4 times/year)
2	Production Decline	Daily Production Data	Monitoring Daily Production data and wellbore modeling
3	Reinjection strategy & Injection breakthrough	Inter-well connectivity	Reservoir tracer test (1 time/year)
4	Well Testing	Pressure & Temperature	Survey of Pressure & Temperature (routine), situational depend on SDTA schedule
5	Transient Pressure Effect (First Year Put On Production)	Reservoir Pressure Change During First Stage of Production	Survey of Pressure Tool every 2 weeks at LMB 1-7 but changed to LMB 1-2 & LMB 3-1 (LMB 1-7 has geometry obstruction)

4.1 PRODUCTION MONITORING WELLPAD 1

Based on the monitoring of production from wellpad 1, it shows that there is no visible change or decrease in WHP at the same HCV openings but the response of WHP fluctuation is not significantly affected by changes in HCV (35-60%) possibly because the maneuvering of HCV openings is not too large and the effect of mass balancing from the well the surroundings.

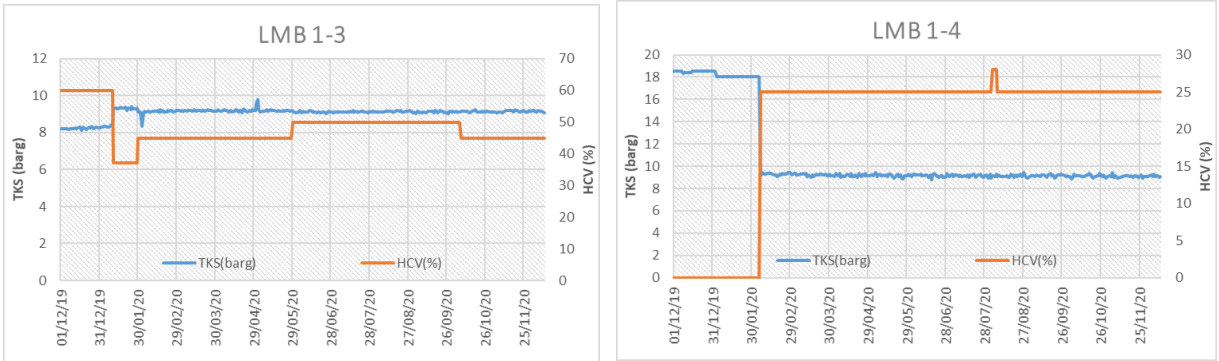


Figure (5) Production Data 2019-2020 LMB 1-3 & (6) LMB 1-4

Based on data monitoring at wellpad 1, LMB 1-5 & LMB 1-6 show fluctuative pressure because from the monitoring results from January to December 2020, there was a decrease in TKS by 0.1-0.2 barg from January to October 2020, but again experienced an increase in TKS of around 0.2 barg from November - December 2020.

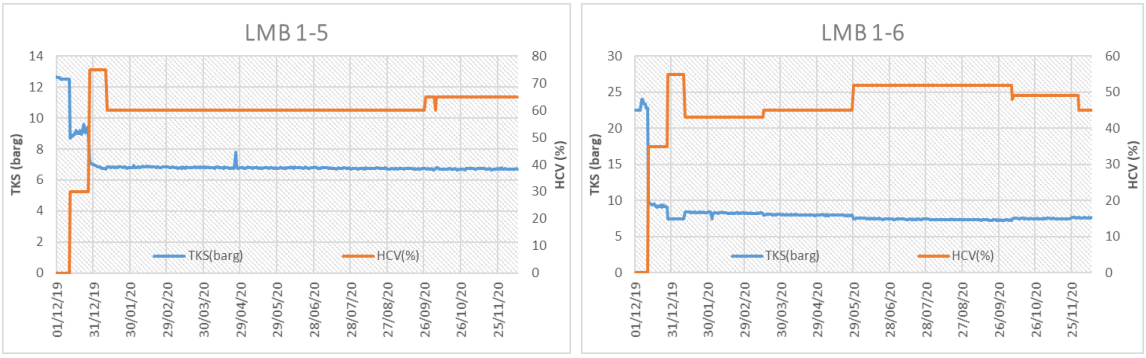


Figure (7) Production Data 2019-2020 LMB 1-5 & (8) LMB 1-6

4.2 PRODUCTION MONITORING WELLPAD 6

These 2 wells also have similar characteristics to LMB 6-1 & LMB 6-2 with TKS fluctuation of up to 2-3 barg and very high fibration at production facilities which is dangerous for the strength of the facilities on the surface. Furthermore, maneuvering the well openings to be larger, namely 40% to reduce the effect of fibration and unstable TKS dynamics.

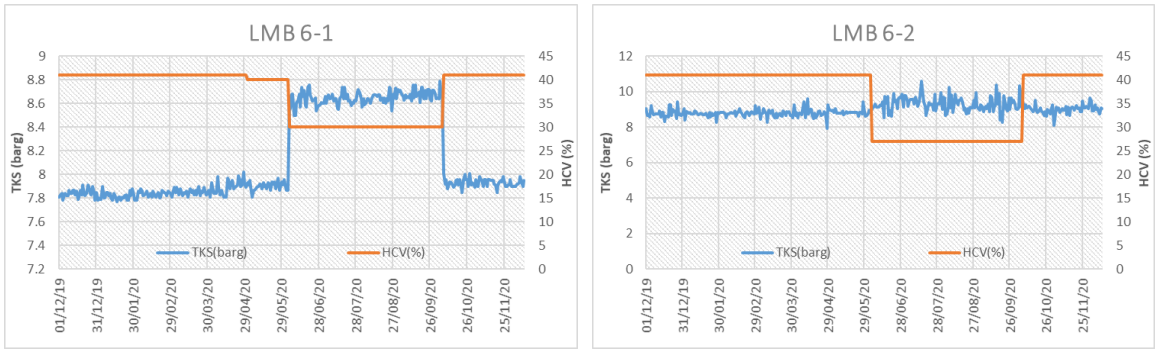


Figure (8) Production Data 2019-2020 LMB 6-1 & (9) LMB 6-2

4.3 PRODUCTION MONITORING WELLPAD 9

During the monitoring of well production there ware also no significant change or anomaly in the supply of steam to Unit 1 from this wellpad. Changes in HCV openings were made in an effort to maintain the availability of steam in Unit 1 if at any time the dispatcher asked for more or less steam in the generator.

Wellpad 9 is designated to support power plant for any request in increasing or decreasing generation from dispatcher or buyer.

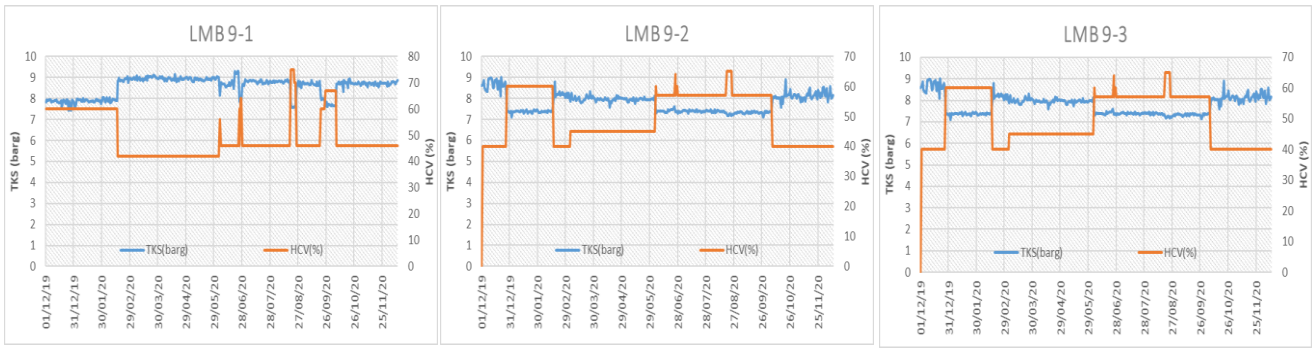


Figure (10) Production Data 2019-2020 LMB 9-1, (11) LMB 9-2, (12) LMB 9-3

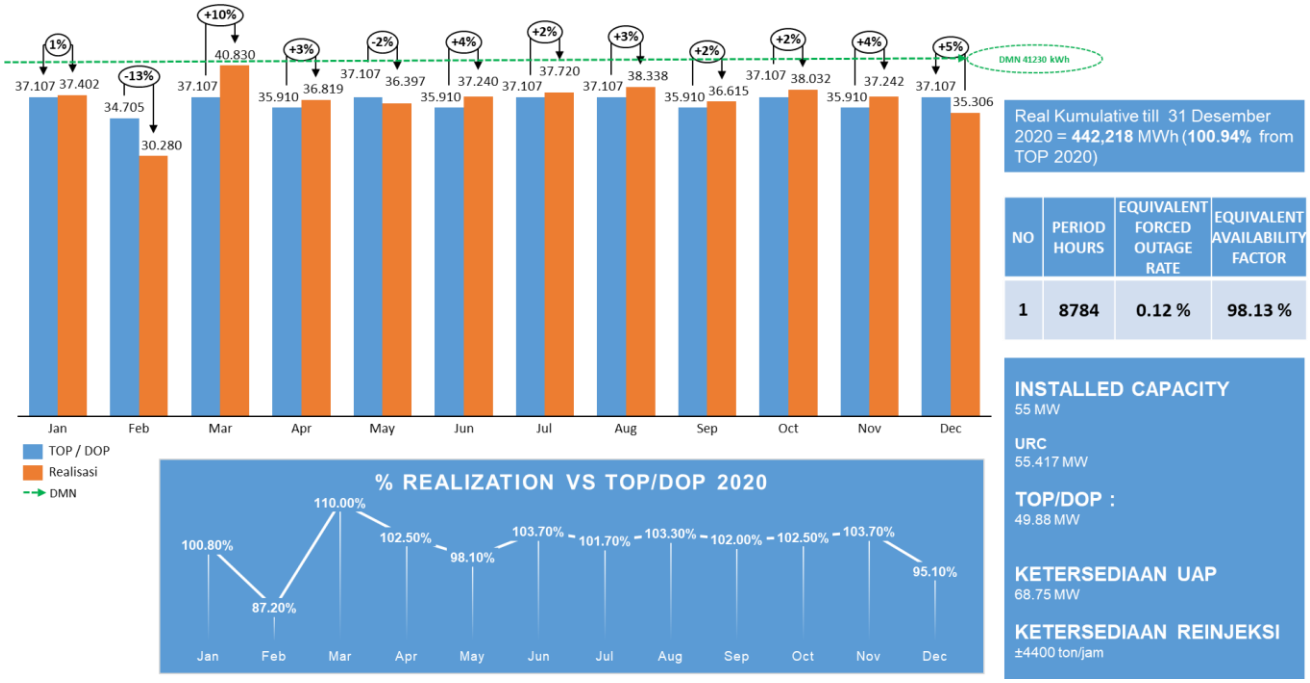


Figure 13. Electrical Generation Lumut Balai Power Plant 2020

5. REINJECTION MONITORING

Reinjection monitoring is needed to determine the performance of the generation and to maintain mass recovery in Lumut Balai reservoir in the supply of geothermal steam. The total amount of brine fluid injected from January to December 2020 was 700,748 tonnes / hour.

In terms of well capability, there was no backpressured being found, which is the main issue, namely the reliability of the reinjection facilities which often experience leaks due to the high fluid TDS so that routine monitoring is required regarding the reinjection facilities in Cluster A.

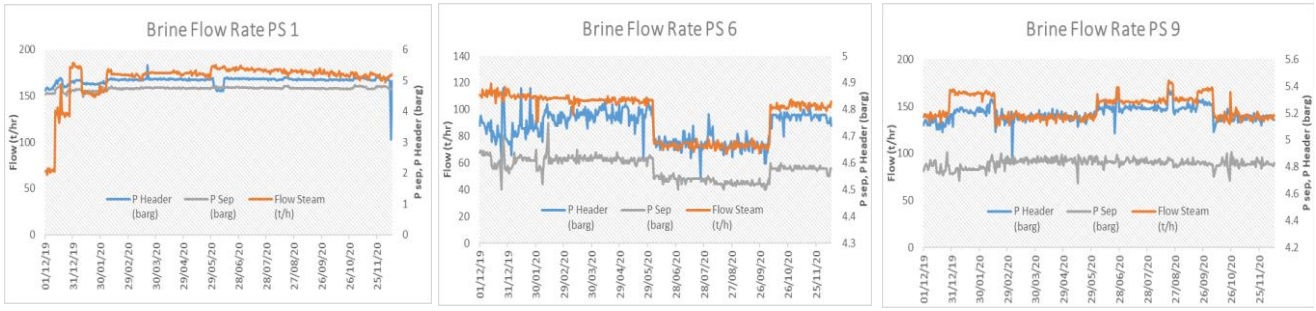


Figure (14) Brine Flow Rate Data 2019-2020 After Separator Wellpad 1, (15) Wellpad 6, (16) Wellpad 9

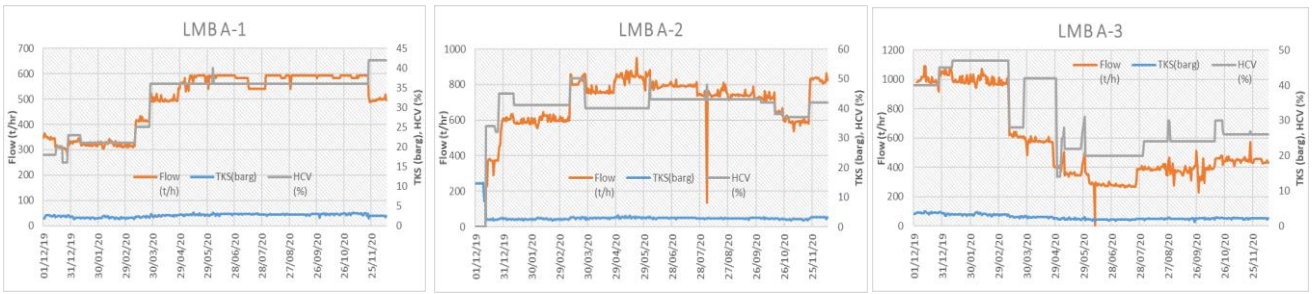


Figure (17) Reinjection Data 2019-2020 LMB A-1, (18) LMB A-2, (19) LMB A-3

6. EXPLOITATION STRATEGIES

Based on production monitoring 2019-2020, Geothermal Lumut Balai has no significant decline in reservoir pressure, WHP, or either flowrate. There are several strategies to manage the exploitation of Lumut Balai reservoir, there are several strategies has been conducted in Lumut Balai Field as follows :

- Operate the throttle valve into the optimum open valve around 40 to 50% with WHP 6-7 barg, which slightly above line pressure, but still below Maximum Discharge Pressure (MDP) of the wells.
- Then, operate the stable production rate at 2400 ton/hr to the plant through changing the valve open and exercise the valve, secondly reducing the effect of reservoir cooling due to injection through reinjection well which is located far from production area,
- Monitoring scale development in well and surface facilities regularly, maintain reliability of existing turbine power plant with SSC 6.8 t/hr/MW, Inlet pressure 4.3 barg and monitoring steam quality frequently. Eventually, Lumut Balai geothermal field has no significance production decline with rating percentage less than 1% for TPE period in 12 months.

Besides, Lumut Balai has a large reservoir porspective area around 46 km^2 with,the reservoir thickness is about 1400 m, and reserves 250 MW, steam availability of Lumut Balai Field has a few excess or buffer so that no need to produce or exploit the wells at maximum capacity. Therefore, transient pressure effect (TPE) in Lumut Balai still can't calculate due to unsignificant value or the decline percentage. But, there is still consideration and tight monitoring for LMB 1-5 and LMB 1-6 because these 2 wells have a little decreasing in their wellhead pressure.

7. CONCLUSION

There are a few summary which can conclude from geothermal production characteristics in Lumut Balai Field, as follows :

- Lumut Balai Geothermal Field has excess in steam availability in wellhead so that there is no need a huge exploitation strategies
- Production methods through throttling valve frequently and Operate the throttle valve into the optimum open valve around 40 to 50% with WHP 6-7 barg.
- Monitoring scale development in well and surface facilities regularly can maintain the reliability of production and facilities.
- Maintain reliability of turbine with SSC 6.8 t/hr/MW, Inlet pressure 4.3 barg.

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