The Analysis of Pressure Drop on RL 014 for Condensate Disposal on Geothermal Pipe Line

(Analisis Penurunan Tekanan pada RL 014 untuk Kegiatan Pembuangan Kondensat pada Saluran Pipa Panas Bumi)

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Abstract

Geothermal energy from the Earth’s magma is manufactured in the form of hot steam. On the process of transmission of steam in the Pipe Line, there are various problems such as condensation in the steam. Condensation can cause problems such as pressure drop. The formation of condensate gives a negative impact on production activities both in the pipeline or power plant, thus condensate formed in pipelines should be disposed of via the blow down or steam trap. Due to a large number of steam pipelines in the DW area then to do an analysis of pipelines in order to prioritize the disposal of condensate in the pipe more prone formed condensate. DW Area special analysis was not done against condensation and the number of condensates that are formed so as to indicate the occurrence of condensation done with regular analysis pressure drop in the pipeline. The results of the analysis of the pipeline must first and more frequently carried out disposal of condensate on the RL 014 based on pressure drop highest is line DW 14 a and DW 67, next line DW 18 and 17, and the last is the line 11 and 14 b DW. The condition of the steam trap is also noteworthy if the steam trap leak then it can lower the temperature in the pipe. The drop in temperature in the pipeline will accelerate the condensation, the results of the analysis there is a steam trap leaked is 401.00.17.ST19 and 401.00.05.ST14 . Steam trap leaked that needs to be done to combat the most. The production of steam RL 014 per day was able to donate a 52.52% or about 73.5 MW of the total needs of PLTP (geothermal power plant) 140 MW per day.

Keywords: Condensate, Steam Pipe, Pressure Drop, Geothermal

I. INTRODUCTION

Geothermal energy is the heat energy that is moved from the inside of the Earth. That energy can be taken in the form of steam or hot water. The geothermal resource is defined as a reservoir there is geothermal energy to economically extracted and utilized for power generation or for industrial use, agriculture, or domestic purposes accordingly [1].

Based on the fluid contained inside the reservoir, geothermal systems are grouped into a single-phase systems and two-phase systems (systems of domination of steam (vapor dominated system) system and the dominance of water (water dominated system) [2].

The formation of condensate is a problem that often occurs in transmission line pipe steam,
usually due to a result of a steam saturation point when there is experiencing a decrease in temperature. In addition, there are some things that can form a condensate at a pipe as inappropriate pipe insulation or other things. There are two ways that can be done to cleaning the condensate on piping systems in Steam Field, disposal via steam trap and disposal using the blowdown valve. On the steam field, there is many line pipeline with different condition, the difference condition that can support fast or slow formed condensate in the pipeline. Therefore we must do an analysis of the transmission of steam pipeline in order to prioritize the pipeline must first dispose of the condensate. Disposal of condensate is one of the mandatory maintenance activities performed on a routine basis so as not to cause any further problems in the operation process of the production of geothermal energy in the steam field, not just on the field, the formation of steam condensate overload also gives problems at the power plant. This activity is also one form of optimization of quality steam to keep awake well up to the power plant.

As for the specific purpose of implementation of this study, namely to calculate the pressure drop value on RL 014, analyzes the value pressure drop on RL 014, analyzing the condition of the steam trap on RL 014 which may cause a decrease in temperature, analyzed total production RL 014 to generate electricity, and determine the percentage of total production of steam RL 014 toward PLTP.

II. METHOD

The procedure of the research is depicted in Figure 1. The data required for the research covered diameter of pipe, steam velocity, steam mass, total production, and steam trap production.

Before determining the conclusion then the steps that need to be done consists of input data planning engineering and data simulation. Determine the score of pressure drop, things to do in determine the score of friction factor, calculate Reynold Number, calculate the relative roughness and moody diagram plotting determine the friction factor. After it calculates the pressure drop, analyzes the score of pressure drop, input data ROT, analyze the condition of the steam trap, input data of the production of monthly reports, analyze the total production to generate electricity, determines the percentage of total production toward PLTP (geothermal power plant).

After calculating the parameters well completion test will get the estimated production results obtained in RL wells, these results will be the benchmark for the production test phase. If the results match the profit and loss factors of the company, it will proceed to the production test. If it is not appropriate further assessment will be done to maintain production from the well. If it still does not match, then it will be converted into an injection well [3, 4].

In the flowchart (Figure 1) shown then first of all start by collecting data planning engineering and simulation data. Next to the data used to determine the pressure drop, from results obtained then the analysis was undertaken by way of sorts from the highest score in the RL 014, after analysis and entering data ROT to analyze the condition of the steam trap. The last entered data report monthly production operation to know the electricity generated from RL 014 and determine what percentage of the total production of steam RL 014 capable donated to PLTP.

III. RESULTS AND DISCUSSION

The results of pressure drop and total production of steam are discussed as follows.

3.1 The Calculation of the Pressure Drop

Table 1 contains the data required to calculate the pressure drop in the steam pipe transmission. Prior to the calculation of pressure drop then do convert for steam and steam velocity data mass, the results of the conversion are presented in Table 2.

In Table 2 contains the results of the conversion from steam velocity and mass in each line on a pipeline 014, with units of the early steam velocity m/s changed to ft/s and early steam unit mass tonne/h converted to lb/hour. The conversion is done to adjust the units of the formula used in the calculation of the pressure drop.

To find out the score of f (friction factor) on the calculation of pressure drop diagram needed moody, before f in the diagram values plotting moody then have to find the score of Re (Reynold number) and Relative roughness. Table 3 contains the data
required to calculate the Relative Roughness and Re. Table 4 contains the values of Re and relative roughness that is used to find the value of f to plotting moody diagram.

### Table 1. Results of the Reading of the Data of the Planning Engineering and Simulation

| Line  | Steam Velocity (m/s) | Steam Mass (ton/hr) | Diameter (inch) |
|-------|----------------------|---------------------|-----------------|
| DW 11 | 18.3                 | 37.93               | 20              |
| DW 14 a | 20.3                | 35.61               | 16              |
| DW 14 b | 13.0                 | 35.61               | 20              |
| DW 18 | 34.8                 | 85.18               | 20              |
| DW 17 | 23.2                 | 47.31               | 16              |
| DW 67 | 35.2                 | 55.54               | 12              |

### Table 2. Unit Conversion Results for Steam and Steam Velocity Mass

| Line  | Steam Velocity (ft/s) | Steam Mass (lb/jam) |
|-------|-----------------------|---------------------|
| DW 11 | 60.04                 | 83,621.34           |
| DW 14 a | 66.60                | 85,561.40           |
| DW 14 b | 42.65                | 78,506.61           |
| DW 18 | 114.17                | 187,789.77          |
| DW 17 | 76.12                 | 104,300.70          |
| DW 67 | 115.49                | 112,444.74          |

### Table 3. Data to Determine Re and Relative Roughness

| Data | Value | Relative Roughness |
|------|-------|--------------------|
| \( \rho \) | 0.6   | Data               |
| \( \mu \) | \( 1.3 \times 10^{-4} \) | Steel, 0.025 |

### Table 4. Unit Conversion Results for Steam and Steam Velocity Mass

| Line  | Re | Relative roughness |
|-------|----|--------------------|
| DW 11 | 5,542,061.54 | 0.00125          |
| DW 14 a | 1,844,335.38 | 0.00417          |
| DW 14 b | 3,936,923.08 | 0.00125          |
| DW 18 | 10,539,046.15 | 0.00125          |
| DW 17 | 5,620,800.00  | 0.00156          |
| DW 67 | 6,396,092.31  | 0.00208          |

Moody diagram (Figure 2) is used to find the score of f (friction factor) on the pipe where the score of f would be in relation to the same as the pressure drop. [4]. When the fluid friction that occurs in the pipe gets bigger then the pressure drop scores will also be relatively large. How to find the score of f with the diagram above specify a multiple of the number that corresponds to the score of Re that has been obtained from the calculation on the horizontal axis (bottom) and determine the point score of the relative roughness corresponds to the calculation on axes vertical right image, then the plot line of score Re vertically upwards and Relative roughness scores of line plot horizontally to the left, the second plot line until there is a meeting point, having obtained a meeting point and then drag the dotted straight lines, break up towards the vertical axis to the left towards the friction factor, then the score of the friction factor is obtained. Example diagram of plotting moody on DW 11 contained in Figure 4 as well as to other line uses the same way, and the results of moody diagram plotting to the score of f is contained in Table 5. Table 5 contains the scores of f on the moody diagram which is used to calculate the pressure drop.

### Table 5. Results of Friction Factor Obtained from Moody Diagram

| Line  | f   |
|-------|-----|
| DW 11 | 0.0225 |
| DW 14 a | 0.0230 |
| DW 14 b | 0.0215 |
| DW 18 | 0.0215 |
| DW 17 | 0.0230 |
| DW 67 | 0.0240 |

To find the score of pressure drop on DW 11 to DW 67 using the same calculation on the fundamental theory but each value of the friction factor, steam velocity, steam mass, and the diameter of the pipe is differents according to the score that has been known. The results of the calculation of the pressure drop is contained in table 6. In the DW field units used for pressure drop is the bar, the score of the converted unit pressure drop into the bar. Table 6 is the result of the calculation of pressure drop of RL 014 and the unit has been...
converted into a bar in accordance with the units used on the field DW.

Table 6. The Score of Pressure Drop Which Was Searched

| Line   | ΔP (psi) | ΔP (bar) |
|--------|----------|----------|
| DW 11  | 3.96     | 0.27     |
| DW 14a | 2352.57  | 162.20   |
| DW 14b | 2.20     | 0.15     |
| DW 18  | 33.72    | 2.32     |
| DW 17  | 21.16    | 1.46     |
| DW 67  | 180.85   | 12.47    |

3.2 Analysis of the Score of the Pressure Drop on RL 014

At DW filed does not do a calculation or the installation of a special tool to find out if condensation occurs and the amount of condensate that forms along the steam pipe lines. Condensate in pipes buried in the steam causes the number of pressure drop rise, therefore one way to indicate there is condensate in the pipe line by analyzing the score of pressure drop. The higher the score of the pressure drop will be more condensate which is pooled in the pipe. For a sequence of scores of pressure drop from the highest will be listed in table 7.

Table 7. Highest Pressure Drop Score Sequence on RL 014 DW Field

| No. | Line   | The Score of Pressure Drop (bar) | Classification Of Pressure Drop |
|-----|--------|----------------------------------|---------------------------------|
| 1   | DW 14a | 162.20419                         | High                            |
| 2   | DW 67  | 12.46950                          | High                            |
| 3   | DW 18  | 2.32493                           | Intermediate                    |
| 4   | DW 17  | 1.45914                           | Intermediate                    |
| 5   | DW 11  | 0.27272                           | Low                             |
| 6   | DW 14b | 0.15178                           | Low                             |

Table 7 contains a sequence of pressure drop from each line in the highest order of RL 014 to the lowest. Based on the scores in the table above, the pipeline should get attention more often to address the problem of condensate at the start of the DW 14 a to DW 14 b corresponding to the sequence in the table above.

3.3 Analysis of Steam Trap Condition on RL 014 Which May Cause a Decrease in Temperature

On the steam trap that can leak due to a less insulating as well as the consumption age too long so corrosion at the steam trap and drain pot. It cannot be left as it can lower the temperature of steam in the pipe because the presence of a steady stream of heat coming out of the pipeline to the outside air through the leaky gaps, with a significant drop in temperature will then cause the incidence of more condensate and influential with pressure drop. Another impact of leakage of the steam trap is wasted a number of steam which can cause losses. Steam trap for the data that must be analyzed contained in Table 8.

Table 8. Condition of Steam Trap on RL 014

| No. | Steam Trap Name | Condition |
|-----|-----------------|----------|
| 1   | 401.00.00.ST01  | Good     |
| 2   | 401.00.00.ST02  | Good     |
| 3   | 401.01.01.ST02  | Good     |
| 4   | 401.01.01.ST01.S| Good     |
| 5   | 401.00.00.ST04  | Good     |
| 6   | 401.00.00.ST03  | Good     |
| 7   | 401.00.00.ST05  | Good     |
| 8   | 401.00.00.ST06  | Good     |
| 9   | 401.02.01.ST03  | Good     |
| 10  | 401.02.01.ST02  | Good     |
| 11  | 401.02.01.ST01  | Good     |
| 12  | 401.00.00.ST07  | Good     |
| 13  | 401.00.00.ST08  | Good     |
| 14  | 401.00.00.ST09  | Good     |
| 15  | 401.03.01.ST02  | Good     |
| 16  | 401.00.00.ST10  | Good     |
| 17  | 401.03.01.ST01.S| Good     |
| 18  | 401.00.00.ST11  | Good     |
| 19  | 401.04.01.ST01  | Good     |
| 20  | 401.04.01.ST02  | Good     |
| 21  | 401.00.00.ST12  | Good     |
| 22  | 401.00.17.ST19  | Leakage  |
| 23  | 401.00.05.ST14  | Leakage  |
| 24  | 401.00.00.ST15  | Good     |
| 25  | 401.05.01.ST02  | Good     |

Table 8 shows 25 condition of steam trap found on RL 014, 2 of which are experiencing a leak is 401.00.17.ST19 and 401.00.05.ST14. Things need to be done to resolve the issue that is the turn of the steam trap at regular intervals, and the control of routine against the condition of the steam trap in order to repair the insulation routinely do. Picture of a leak in the Steam Trap 401.00.17. ST19 can be seen in Figure 3.

3.4 Analysis of Total Production RL 014 to Generate Electricity

RL 014 consists of 5 wells production DW 11, DW 14, DW 17, 18, and DW 67 with a total production of 5022.66 tonnes/day received geothermal power plant after experiencing a reduction of part of steam in the pipe transmission from the well production. The entire production of steam RL 014 streamed to the geothermal power plant. Steam reused for 1 MW is 68.297 tonne/day.
Total production of Steam RL 014 is 5022.66 tonnes/day. Capability production RL 014 to generate electricity can be calculated and the result from 5022.66 tonnes/day production of steam RL 014 can raise approximately 73.50 MW of electricity.

3.5 Percentage of Total Production RL 014 against PLTP

The percentage of production capabilities RL 014 to drive the turbine at geothermal power plant (PLTP) 140 MW can be calculated. Based on the total production of steam RL 014 5022.66 tonnes/day can contribute 52.50% of the total steam requirement for geothermal power plant 140 MW.

Figure 3. Figure 3. Steam Trap 401.00.17.ST19
(Source: PT. Pertamina Geothermal Energy, 2018)

IV. CONCLUSIONS

The first pressure drop calculation based on the lowest score below 1 bar is line DW 14 b and DW 11, including an intermediate-range 2 – 6 bar is line DW 17 and 18, and above 10 bar highest in line 67 DW and 14 a. The second is based on the results of the analysis of the pressure drop score then the disposal of condensate needs to be done on RL 014 line DW 14 a and DW 67 as much as 3 times in one week, line 17 and 18 DW twice in one week, as well as line DW 11 and DW 14b one time enough for one week. The third is a conclusion from the results of data analysis, there is two steam trap a leak is 401.00.17.ST19 and 401.00.05.ST14, second steam trap handling needs to be done. Conclusion based on the results of the next calculation of total production of steam RL 014 is 5022.66 tonnes/day can awaken 73.50 MW of electricity, and at the conclusion of the result of the calculation with the total production of steam RL 014 can donate 52.50% of the total needs of PLTP 140 MW each day.

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