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Brine Injection Pump Operation and Maintenance Actions (A Lesson Learned from Dieng Geothermal Field)

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ABSTRACT

A geothermal industry is a high-cost and high-risk industry that common problems arise from the fluid characteristic. In order to achieve an effective and efficient operation, a series of activities such as maintenance should be well-managed. Dieng geothermal field is owned and operated by PT Geo Dipa Energi which had a great lesson learned about a brine injection. This paper was carried out to identify the problems and the maintenance actions related to the brine injection pump. The two main types of brine injection pump that being used are the vertical and horizontal pump. The identifying process was started by collecting historical data on problems and maintenance. The comparison result between two types of the pump is being used to determine which one of the pumps that has the highest maintenance effectivity and reliability according to the Dieng's characteristic. Furthermore, this paper can become a reference for another geothermal field in order to determine the type of pumping unit and prepare the maintenance actions.

1. INTRODUCTION

The Dieng Geothermal Field is located in the Dieng Plateau, 120 kilometres south of Semarang, the capital city of Central Java Province. The area is 63 km2 spreading in four districts; Wonosobo district, Banjarnegara district, Batang district, and Kendal district. The development area is divided into two part; Northwestern part and southeastern part. The area is operated by PT Geo Dipa Energi which currently has 60 MW installed capacity.

Dieng geothermal system is high temperature liquid-dominated with temperature about 330˚C (Sirait et al., 2015). The brine that produces contains with dissolved SiO2 which potentially deposited. The dissolved SiO2 potentially deposited in the wellhead (wing valve, surface facilities (two-phase pipeline, separator, and AFT), cooling pond, and brine reinjection system (Utami et al., 2014). The chemical is injected into the two-phase pipeline to prevent silica deposition in the surface facilities while cooling pond is prepared to cool down the brine temperature which is expected to decrease the solubility of silica and silica will be deposited in the cooling pond.

This paper discusses the effect of high-temperature brine (about 50˚C) and carried silica which is causing some operation problems in brine reinjection system (pump). Operation maintenance is also mentioned to solve every obstacle occurs.

2. DIENG REINJECTION PUMP

The Dieng geothermal field uses two types of pumps; a centrifugal vertical pump and centrifugal horizontal pump, which is used to pump the brine into the injection well. The capacity of each type of pump is dependent on where the pump installed is. The installation schema of each type of pump is described in the following pictures:

Centrifugal Vertical Pump

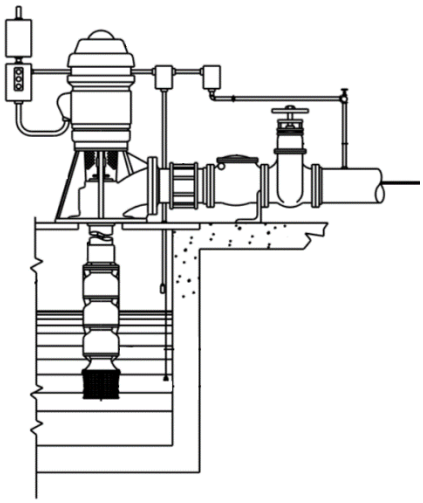

Figure 1: The Schematic Installation of Wet Pit Centrifugal Vertical Pump

In the wet pit centrifugal pump, the output brine from the atmospheric flash tank (AFT) will flow through the cooling pond and entering the collection basins. Collection basins are used to store the brine to obtain a minimum level requirement. In the operational, there are not priming equipment needed, the lowest impeller is always submerged and will automatically start pumping when the motor starts rotating.

Centrifugal Horizontal Pump

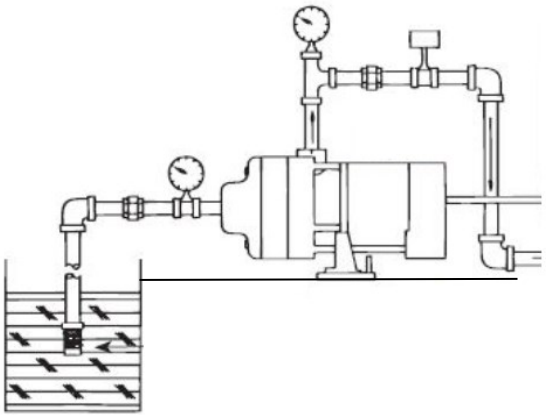

Figure 2: The Schematic Installation of Centrifugal Horizontal Pump

Horizontal pump installed with foot valve and y-strainer to prevent solid/material pumped. The priming equipment is needed to support the priming process of the horizontal pump.

3. Problems Identification

The dissolved SiO2 which not deposited in the cooling pond will be carried to the brine injection system; in some cases, it will be deposited in the place where the pressure/temperature drop is present. The problems identification is divided into two part; operational part and maintenance part. The detail part for every type of pump is described in the following workflow:

Centrifugal Vertical Pump

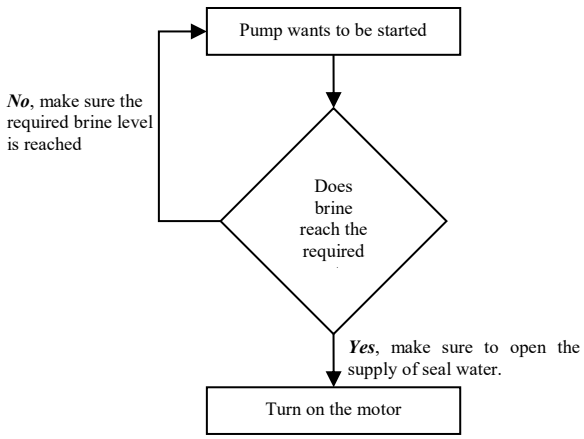

Figure 3: The Workflow of Centrifugal Vertical Pump

In the workflow (Figure 3) shown that the two factors which are required to operate the pump are minimum brine level and supply of seal water. The minimum brine level is needed to prevent the pump run out of brine which can cause any damage in the pump components, while the supply of seal water is used to cool down the mechanical seal. Centrifugal vertical pump needed another pumping unit to support the seal water supply, the supply of seal water cannot come from the working fluid (brine) because of TDS that contained in the brine.

Based on the historical data, the pump components which usually need to be changed/maintain are bushing, mechanical seal and bearing. The bushing materials are formed from carbon, where the unbalance or vibration is present in the shaft, the shaft will be directly hit the bushing and causing crack/damage in the bushing. The mechanical seal was damaged because of brine breakthrough to the spring of mechanical seal. The brine will be mixed with seal water while the mixing process causes temperature drop, which is causing silica deposition in the mechanical seal spring. This obstacle occurs when the seal water pressure is not bigger than pump

discharge pressure, or the discharge pressure is unconditionally changed because of blocking in the discharge pipeline. Like with the bushing, the bearing can be damaged by the unbalancing condition which comes from the pump or high operational pressure.

Figure 4: The Illated Centrifugal Vertical Pump

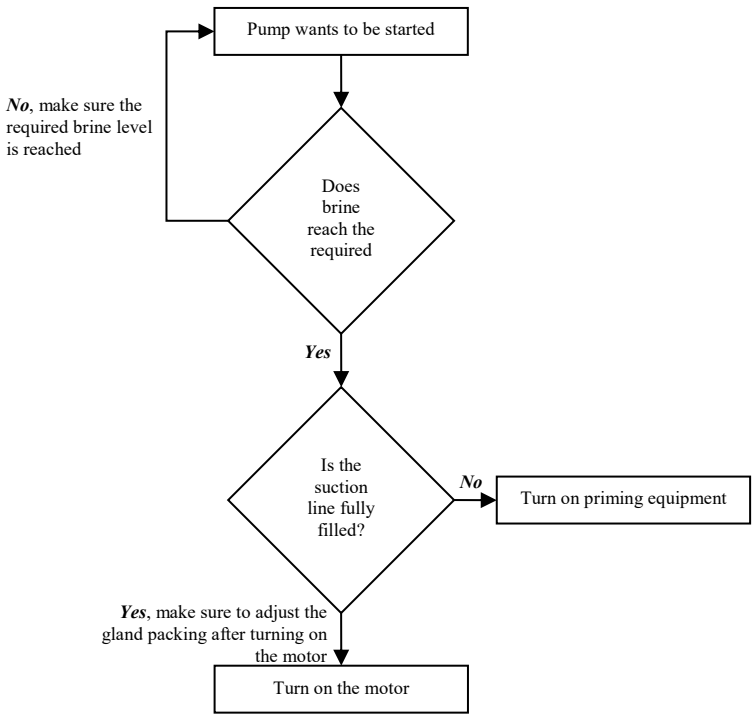

Figure 5: The Workflow of Centrifugal Horizontal Pump

Figure 6: The Installed Centrifugal Horizontal Pump

Centrifugal Horizontal Pump

Figure 4 describes the workflow of the centrifugal horizontal pump; the first step is the same with the centrifugal vertical pump which is started by checking the minimum water level to prevent the pump run out of the brine. Then if the minimum brine level is reached, the step continues to make sure the suction line is filled. The condition of the suction line is not completely filled can be caused by leakage in the foot valve. Usually, the leakage in the foot valve is caused by silica deposition in the disc of foot valve which causes foot valve is stuck in open condition.

The historical data shown the pump equipment, which usually changes/maintain are gland packing, y-strainer, suction line, and foot valve. The gland packing that has a function like mechanical seal usually changed because of the condition of gland packing is not capable of holding the pump pressure. The leakage in the gland packing can cause the oil in the gearbox to become milky, and the pump must be shut down to change the oil.

The y-strainer is installed with screen to prevent solid/material flowed with the brine. The y-strainer must clear continuously to prevent blockage because of silica deposition in the screen. While the pressure drops and heat loss in the suction line cause the inlet diameter of the suction line becomes smaller than the initial diameter after a certain time. The smaller diameter will be causing the flow which flows to the pump is decreasing and increasing the cavitation possibility.

4. Maintenance Action of The Problems

Based on the identification of the problems, the maintenance action for every problem of each type of pump is described in the following table. The problems which occur was obtained from the history of maintenance data.

Centrifugal Vertical Pump

Table 1: The Maintenance Action of Centrifugal Vertical Pump Commons Problems

Problems	Intensity (in a year)	Actions	Approximate Time/Maintenance			Approximate Cost/Maintenance
			Uninstall Pumping Unit (hour)	Repair/Change Spare Part (hour)	Install Pumping Unit (hour)	IDR
Bushing broke/crack	Four times a year (3 months lifetimes)	Change the pump with stand-by pumping unit/spare pump	1 hour	2 hours	1 hour	Rp 5.500.000
The mechanical seal broke/leaked out	Three times a year (4 months lifetimes)	Change the mechanical seal and inspect the pump	1 hour	1 hour	1 hour	Rp 44.000.000
Bearing broke/crack	Three times a year (4 months lifetimes)	Change the bearing and inspect the pump	1 hour	2 hours	1 hour	Rp 8.700.000

Centrifugal Horizontal Pump

Table 2: The Maintenance Action of Centrifugal Horizontal Pump Commons Problems

Problems	Intensity (in a year)	Actions	Approximate Time/Maintenance			Approximate Cost/Maintenance
			Uninstall Pumping Unit (hour)	Repair/Change Spare Part (hour)	Install Pumping Unit (hour)	IDR
Gland packing broke	12 times a year (1-month lifetimes)	Change the gland packing	1 hour	1 hour	1 hour	Rp 3.000.000
Milky oil	12 times a year (1-month lifetimes)	Change the oil	1 hour	2 hours	1 hour	Rp 200.000
Y-strainer	24 times a year (2 weeks lifetimes)	Open and clean the y-strainer	2 hours	2 hours	2 hours	-
Suction line	Four times a year (3 months lifetimes)	Uninstall all component of the suction line include foot valve	4 hours	24 hours	4 hours	-
Foot valve	12 times a year (1-month lifetimes)	Uninstall foot valve including all suction line component	4 hours	8 hours	4 hours	-

5. CONCLUSION

The Dieng's geothermal brine characteristic cause several differences in the operation and maintenance of each type of pump. History maintenance data shows that the maintenance intensity of horizontal pumps is more often than vertical pumps. While the cost of maintenance required shows an inverse number where the vertical pump requires a high maintenance cost compared to the horizontal pump. Based on the identification of the problems, horizontal pumps show a higher probability of failure compared to vertical pumps. The foot valve that often gets stuck causes the priming process inflexible while the vertical pump will be easier to activate/deactivate as needed.

Vertical pumps show a shorter time requirement in the maintenance process compared to a horizontal pump. The high maintenance cost of the vertical pump will be proportional to the impact arising from the high intensity of the problem on the horizontal pump.

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