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Adjustment of Logic Operational Chemical Injection Pump in pH Control of Water Steam Cycle to Improve Steam Turbine 5.8 Reliability of Power Plant PT. PJB UP Muara Tawar

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Abstract: *Water quality in power plant is the main factor of equipment reliability. Standard water quality can assure performance of equipment and minimize equipment defact especially from corrosion. In Block 5 UP Muara Tawar, water is used to producing steam from HRSG. Actually pH for HP drum is 30% above the upper limit. To overcome this problem, it is needed to do some adjustment with the method as follows: data collection from process information system, brainstorming with operation, engineering and instrumentation to improve quality of water for short and long term period of operation, perform temporary corrective maintenance by Operate CBD in higher opening Operate phospate chemical injection manually based on pH set point or regulate based on time, literature review about logic system of phospate chemical injection in drum and make a research plan to find source of problem. From adjustment of operational logic injection pump the pH and conductivity value is under control in both higher and lower limit. It is shown that pH value are laid in 9.0-9.4. Moreover, the actual conductivity value are about 7.23 µs /cm and 21.34 µs /cm, respectively. It is match with ABB conductivity limit i.e. maximum 40 µs /cm. Morover, water consumption decrease from 6413 m3/days to 45.1 m3/days*

Keywords: *chemical, CBD, pH, reliabiity, water*

I. Introduction

Water quality in power plant is the main factor of equipment reliability. Standard water quality can assure performance of equipment and minimize equipment defact especially from corrosion [1]. Block 5 UP Muara Tawar is combine cycle power plant that built in 2011.

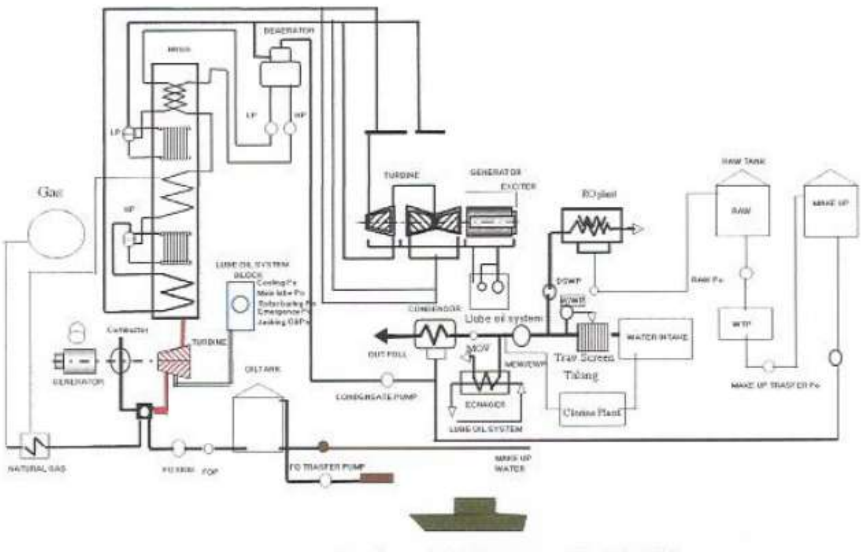

Figure 1. Combined Cycle Power Plant

In Fig. 1, steam turbine require superheated steam to produce electricity. The steam is produced in HRSG [2] and it is condensed by condenser as water steam cycle [3]. In order to minimize equipment failure, the water quality should be monitored using online monitoring displayed in HMI and offline monitoring by laboratory work. Water quality control is performed by chemical injection control.

Chemical injection control is connected to integrated logic to allow proper operating condition. Steam turbine 5.8 is a new unit that operate from 2011 in UP Muara Tawar. Sometimes erected plant required some modification in operational stage to match with process requirement. pH control function is maintaining acidity of water 9.0 – 9.4. There are two possibilities, lower pH value tend to corrosion problem, in higher value the scaling will present. In actual most of pH value is reach above upper limit. It condition trigger some risk as follow:

- Scaling/deposit, that cause reduce overall heat transfer coefficient in heat transfer equipment (HRSG) and cause mass unbalance in turbine blade that lead to plant trip due to high vibration [4].
- Deposit or fouling cause metal corrosion in equipment and piping that reduce plant life time [5].
- Caustic embritliement in HRSG will affect to deposit fouling that reduce plant reliability and availability.
- Increase water consumption due to rapid valve opening in continous blowdown system (CBD) to maintain pH in normal condition.

II. Theory

Steam turbine require water steam cycle as energy agent. A steam cycle power plant is operated using the Rankine cycle. Water enters a boiler where it is heated to create steam. The steam is then sent through a steam turbine that rotates the shaft of a generator to create electricity. The steam exits the turbine into a condenser, which converts the steam back into saturated water. The saturated water is then pumped back into the boiler to repeat the process. Water quality is very important due to affect to turbine lifetime, reduce overall heat transfer coefficient and turbine efficiency. The water quality influence to:
1. Corrosion rate [6]
2. Scaling in piping system
3. Scaling in blade turbine

Chemical parameter that should be controlled in water steam cycle as follows:
1. pH, this parameter indicate the acidity of the fluid that affect corrosion and embrittlement to the system.

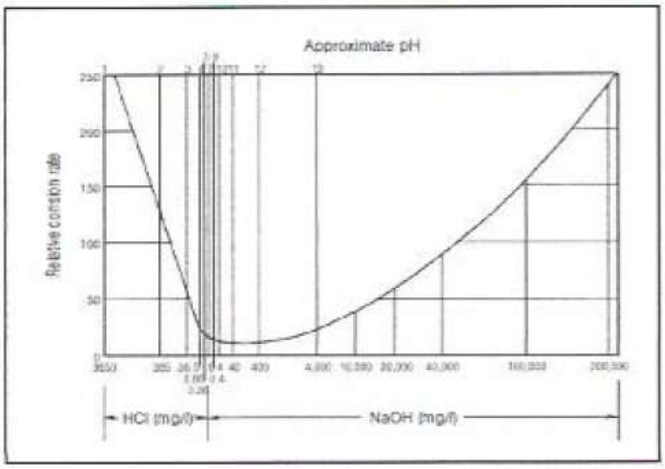

figure 2. pH Diagram and Corosion Rate

Fig. 2 shows the low corrosion regime at pH 9-12. Hence, the pH control set point should be in this range by manipulate the flow rate of NH_4OH and Na_3PO_4 that flow into the water steam cycle.

2. Conductivity, this parameter indicated ammount of mineral dissolved in the water. This mineral can build scale in piping system and turbine blade. Scaling in pipe will reduce overall heat transfer while scaling in blade turbine will cause unbalance and high vibration. If this happen it can make plant failure so the conductivity need to be maintain.
3. Dissolve oxygen, this parameter has close correlation with Fe_3O_4 that inhibit corrosion on the metal surface, however more oxygen contain lead to higher corrosion rate [7].
4. Chloride level, chloride is agresive ion that creates corrosion cracking in the turbine and in the boilers.
5. Silica content, cause mass unbalance in turbine blade that lead to plant trip due to high vibration
6. Residual chemical content (NH_3, Na_3PO_4, N_2H_4) should be continous monitored in order to maintain pH in water steam cycle.

III. Method

The method of this research can be described as follows:

1. Data collection from process information system.
2. Brainstorming with operation, engineering and instrumentation to improve quality of water for short and long term period of operation.
3. Perform temporary corrective maintenance by operate CBD in higher opening and operate phospate chemical injection manually based on pH set point or regulate based on time.
4. Literature review about logic system of phospate chemical injection in drum.
5. Make a research plan to find source of problem.

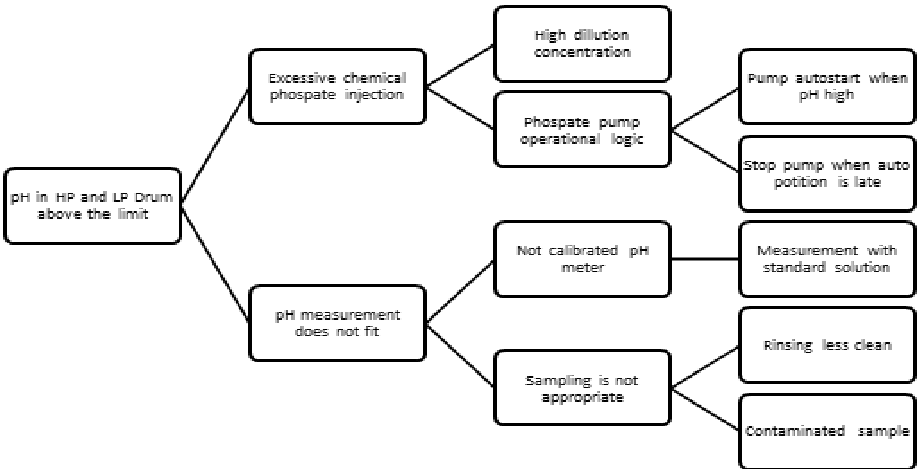

Figure 2. Research Diagram

Problem in Fig. 2 can be tested as follow

Table 1. Suspected Problem and Result

No	Suspected Problem	Test	Result	Conclusion
1	Measurement with high standard solution	Validation with standard solution pH 4,7,9	Small error	Not the cause of problem
2	Rinsing of sample bottle is not clean	Rinsing with correct procedure	pH not change	Not the cause of problem
3	Contaminated sample	Labelling sample bottle		Not the cause of problem
4	Auto start of pump is not correct	Operational monitoring of pump start	Pump operating in high pH 9.7	Can be the problem
5	Pump stop too late	Operational monitoring of pump stop	Pump still operating in high Ph	Can be the problem

From Table 1 can be concluded that the potential problem is phospate pump operational. This potential problem can cause an increase of pH level in drum due to excess phospate injection.

IV. Discussion

4.1. Data pH Drum

pH level in HRSG 5.8 drum in UP Muara Tawar is above the upper limit (shown by data from May 2012).

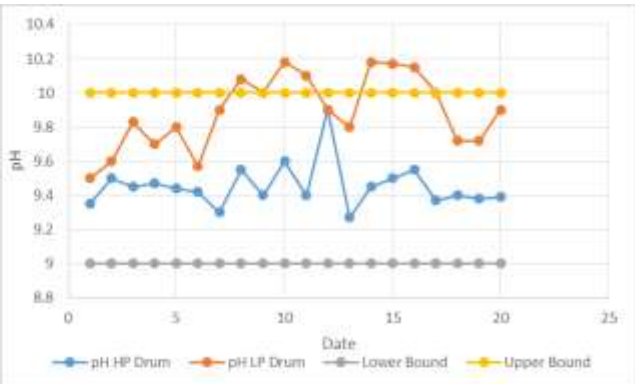

Figure 3. Trend pH LP and HP Drum on May 2012

Fig. 3 show that pH for HP drum 30% above the upper limit. Temporary action to overcome this problem is increase continous blowdown valve opening or open intermitten blowdown to reduce pH level in drum. However, increase in opening of CBD and IBD will proportional with fresh water consumption (64.13 m^3/day).

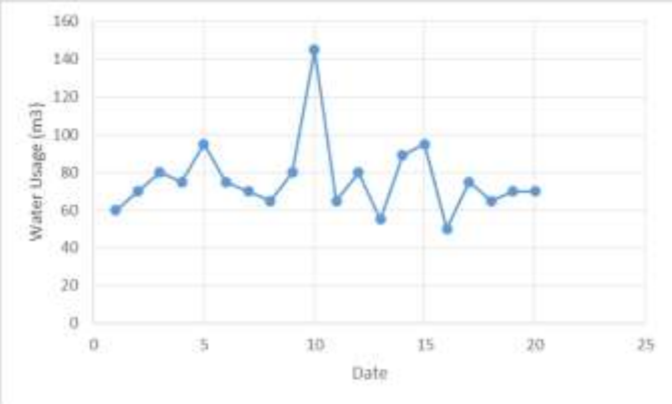

Figure 4. Fresh Water Used in May 2014

4.2. Phospate Injection

From temporary corrective maintenance that has been performed by phospate injection manually (injection pump start in pH 9.1 and stop in pH 9.3) was obtained the performance of pH monitoring as shown in Fig. 5.

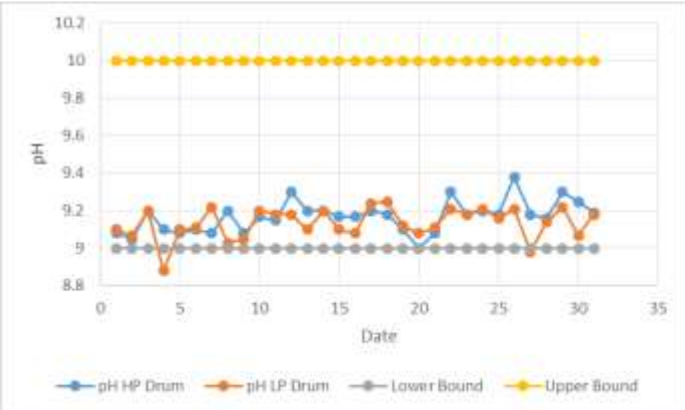

Figure 5. pH in HP And LP Drum on January 2014

Fig. 5 show the pH value has been maintained at the range of 9.0-9.4, It indicate the problem has been solved by operate injection pump manually. There are out of control pH below lower limit. It happen due to sampling time perform every 4 hours. To overcome this non conformance, application of control automatic in injection pump is necessary, by considering the time interval of pump working.

4.3. Improvement in Phospate Injection Pump Logic Diagram

In order the control phospate injection pump automatically, parameter in logic ALSPA (Alstom Product Automation) should be improved as follow:

1. HP Drum

Pump status start if:

- pH (51 QUL 05 CQ 031) = 9.25
- Conductivity (51 QUL 05 CQ 011) = 4.5 µs/cm

Pump status stop if:

- pH(51QULO5CQ 031) = 9.45
- Conductivity (51 QUL 05 CQ 011) = 35 µs/cm

Interlock

If CBD open, pump status on.

2. LP Drum

Pump status start if:
- pH(51QULO5CQO31) = 9.25
- Conductivity (51 QUL 05 CQ 011) = 4.5 µs/cm

Pump status stop if:
- pH (51 QUL 01 CQ 031) = 9.45
- Conductivity (51 QUL 01 CQ 011) = 35 µs/cm

Interlock
If CBD open, pump status on.

Adjustment for logic parameter was performed in 9 October 2014 as follow:
- Changing status of pump on from 9.25 to 9.1
- Changing status of pump on by conductivity value from 4.5 µs/cm to 0 µs/cm
- Changing status of pump off from 9.45 to 9.3
- Remove interlock beetween CBD and pump

Parameter adjustment in logic diagram of injection pump PLC are based on the experimental data obtained from plant operation manually. The performance of the system after adjustment as follows:

1. Actual pH value from the plant HP and LP drum can be shown in Figure 6.

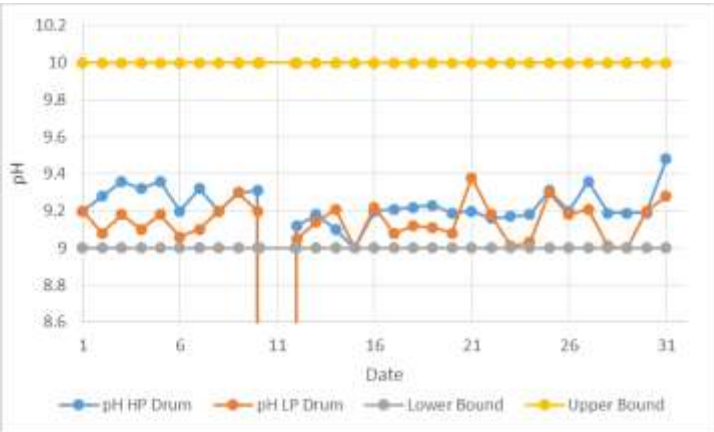

Figure 6. pH in HP and LP Drum on October 2014

Fig. 6 shows the variation of pH value are laid in 9.0-9.4, it mean the value in beetween lower and upper limit. The lower value of pH on 10th – 12th of October due to abnormal operating conditions. In another word this range of pH is laid in non corossive regime based on Kurita Handbook of water treatment.

2. Actual conductivity value from the plant HP and LP drum can be shown in Figure 7.

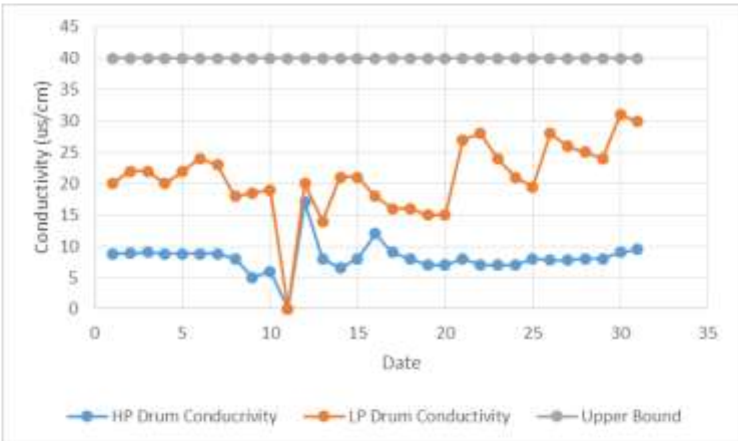

Figure 7. Conductivity in HP and LP Drum on October 2014

Fig. 7 shows the actual conductivity in HP and LP drum are about 7.23 µs /cm and 21.34 µs /cm, respectively. It is match with ABB conductivity limit i.e. maximum 40 µs /cm.

3. Fresh water consumption

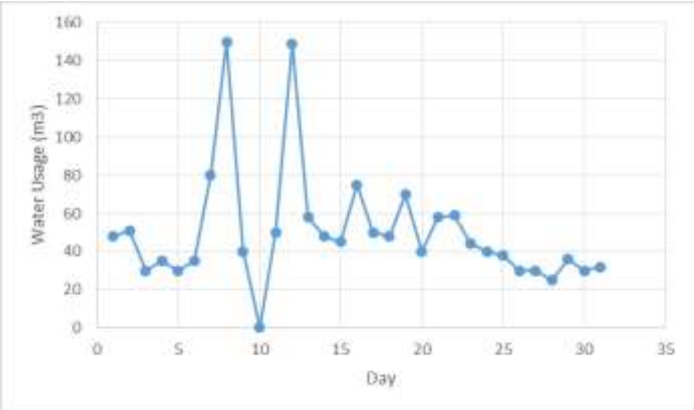

Figure 8. Fresh Water Used on October 2014

Since 9 October – 31 October, water cosnumption slightly stable at the value 45.1 m^3/days. It is mean adjustment in logic diagram of operational injection pump provide saving of water that previously the fresh water consumption is about 6413 m^3/days.

V. Conclusion

Adjustment of logic operational injection pump have been performed and the pH and conductivity value is under control in both higher and lower limit. It is shown that pH value are laid in 9.0-9.4. Moreover, the actual conductivity value are about 7.23 µs /cm and 21.34 µs /cm, respectively. It is match with ABB conductivity limit i.e. maximum 40 µs /cm. Morover, water consumption decrease from 6413 m^3/days to 45.1 m^3/days.

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