Process Condensate System (PCS) High Conductivity Issue

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ABSTRACT – Since 2008, Process Condensate System (Unit-51) in Ammonia Plant is experiencing high conductivity at average 65 µS/cm above design value of <50 µS/cm. There is suspicion that PCS design is inadequate due to internal benchmarking showed that peers could meet specification of 30 µS/cm. In view of the issue, investigation using Root Cause Analysis approach was performed and PCS adequacy in term of sizing and hydraulic were evaluated using process simulation tools i.e. Symmetry (iCON) and PROMAX v5, KG Tower Software (by Koch Glitsch) and guideline from PTS 16.52.06, Column Internals. Based on the analysis, design stripping efficiency is not achieved and presence of additional ion from external sources beyond design specifications were identified as immediate causes for PCS could not maintained conductivity <50 µS/cm. Key challenges included high CO2 at inlet, low stripping steam to feed process condensate ratio, poor internal conditions, leaking of downstream exchangers, presence of additional ion from degradation of neutralizing amine for pH control. In order to eradicate the issue, key recommendations proposed were pH control chemical need to be avoided by replacing CS to SS at PCS bottom outlet piping and increasing steam to feed ratio up to 8830kg/h in operating procedure.

1. INTRODUCTION

PETRONAS Chemicals Ammonia Sdn. Bhd. (PCASB) had encountered Stripped Condensate (SC) high conductivity issue at 65 µS/cm in average; at QIA-5101 from Process Condensate System (PCS) since year 2008. Previously before year 2008, lower conductivity can be achieved at approximately 40 - 50 µS/cm. In view of the issue, Group Technical Solutions (GTS) is engaged to conduct design review on PCS (Unit-51) under suspicion of inadequate design of system to meet lower conductivity at approximately 30 µS/cm as per benchmarking data with ABFSB and PCFKSB. Based on validation with PCASB documents and confirmation by Haldor Topsoe, PCASB PCS conductivity limit of < 50 µS/cm has been confirmed. **TWO (2)** main objectives of this study are as following:

i. To identify root cause of high conductivity issue for Stripped Condensate.
ii. To propose recommendations and way forward to address high conductivity issue for Stripped Condensate.

2. METHODOLOGY

Methodology adopted for this study are as following:

i. To evaluate Process Condensate Stripper Column (C3-5101) performance at Design and Actual conditions using process simulation tools, i.e. Symmetry (iCON) and PROMAX version 5.0.
ii. To review C3-5101 internal design using KG Tower Software (by Koch Glitsch) and guideline from **PTS 16.52.06**, Column Internals.
iii. To identify root cause of high conductivity issue at PCS using RCFA tools such as Event & Condition and Cause & Effect Diagram.

3. RESULT AND DISCUSSION

3.1. Event & Condition Chart

Event and Condition chart has been developed to understand the issues at PCS by the identification of Unwanted Event (UE) and Unwanted Condition (UC) related to high conductivity issue. Based on Figure 1 and Figure 2, the main issues at PCS represented by UE and UC are high stripped condensate conductivity and heat exchangers related issues.

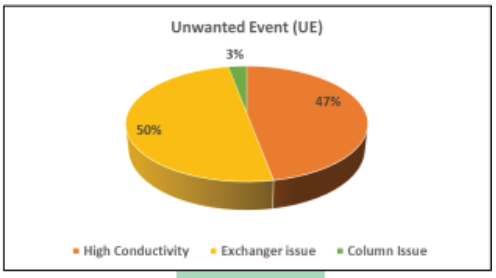

Figure 1 Detail on Unwanted Event

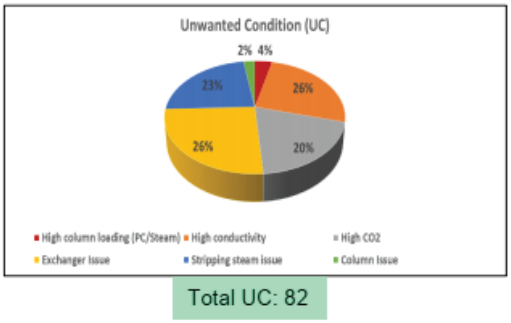

Figure 2 Detail on Unwanted Condition

3.2. Root Cause Failure Analysis (RCFA)

Based on the RCFA, **THREE (3)** root cause categories have been identified as following:

Table 1 Summary of Root Cause Count and Category

Root Cause Category	Root Cause Count	Root Cause Percentage (%)	Remarks
Governance Issue	19	58	Related to incompliance to procedure, incompliance to design limit and delay in problem rectification at PCS unit.
Operating Issue	11	33	Related to inefficiency of operation and improper maintenance at PCS unit.
Design Issue	3	9	Referring to changes in the design basis of composition at PCS inlet[1] and inadequate design of support saddle for heat exchanger E3-5101 ABCD.
Total	33	100	

Based on Table 1, Governance issue is identified as Primary Root Cause which contributed to high conductivity issue at PCS.

4. CONCLUSIONS

Following are the conclusions which can be derived based on PCASB PCS high conductivity issue:

1. Since PCASB commissioning in year 2001, conductivity limit of Stripped Condensate at QIA-5101 could not be maintained consistently at < 50 µS/cm due to **TWO (2)** Direct Causes as below:
   i. Design stripping efficiency at Stripper Column (C3-5101) is not achieved.
   ii. Presence of additional ion from external sources beyond stripping capability of C3-5101 column.
2. Based on the Cause & Effect Diagram findings, 33 numbers of root causes were identified whereby the most identified issue are related to Governance (58%), followed by operating (33%) and design issue (9%).
3. Hence, Governance issue is identified as the Primary Root Cause that led to high conductivity issue at PCASB PCS; which include items related to incompliance to procedure, incompliance to design limit and delay in problem rectification at PCS unit.

5. RECOMMENDATIONS AND WAY FORWARD

Table 2 shows the details of the key recommendation and way forward in short term and long term for PCASB PCS operation.

Table 2 Key short and long term recommendations

No	Areas	Short Term	Long Term
1	Conductivity limit at QIA-5101	< 50 µS/cm	< 30 µS/cm
2	Design change	NIL (Meet original basis)	a) Replace CS to SS piping for stripped condensate section b) Increase steam inlet nozzle from 4" to 6"
3	Revise SOP a) Steam / PC ratio	Include steam / PC (Process Condensate) ratio on top of steam flow to meet targeted conductivity limit. Maximum steam flow is 8830 kg/h based on calculated tray hydraulic limit.	
	b) pH control	Include chemical injection rate to meet targeted pH.	NIL
4	Revise APC set point	Revise APC set point to meet targeted conductivity limit	
5	pH analyser (QI-5102) and DP transmitter (PDIA-5102)	Rectify pH analyser and DP transmitter and maintain reliability for all instrumentations at all time.	Maintain reliability for all instrumentations at all time.
6	Chemical injection pump (P3-5208 B)	Rectify marking speed at P3-5208 B or switch to P3-5208 A	NIL
7	PCS operation for reduction of OPEX on Demin water make up and condensate recovery	To maintain current operation of sending all Turbine Condensate Return (TCR) to Deaerator and stripped condensate to Back Wash Water Pit (T3-2701) and to comply with Standard B / DBE effluent limit (which ever more stringent) for discharge to Storm Water Drain.	

6. REFERENCES

[1] Robert, A., Anders, A., Sebastian, F., Rasmus, H., and Olle, S. Investigation of process condensate treatment of a methane steam reforming plant, pp. 1–46, 2019.