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ADOPTING LIFE CYCLE COST IN DECIDING DISINFECTANT METHOD TO CONTROL MICROBIOLOGICAL GROWTH IN COOLING WATER

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ABSTRACT

This paper discusses using the life cycle cost Net Present Value (NPV) method to choose the best economically viable option to manage microbe in cooling water for Ammonia & Utility Cooling Water System at ASEAN Bintulu Fertilizer Sdn Bhd, Bintulu, Sarawak. An analysis was done to study various options. Sensitivity analysis was carried out to simulate the viability of the best options should conditions change. From the life cycle cost analysis, the option to maintain the existing on-site disinfectant generation system with supplementary chlorine tablet dilution (36 kg/day) derived the lowest net present value for the next 10 years.

INTRODUCTION

ASEAN Bintulu Fertilizer Sdn Bhd (ABF) is an Integrated Production Complex located at Bintulu, Sarawak. The plant consists of two main plants producing Ammonia and Urea. These plants are supported by a Utility plant that supplies Cooling water, Demineralisation water, Steam, Electricity and Offsite for Ammonia and Urea Granule sales.

Cooling water is essential in maintaining plant process requirements. A few types of chemicals are used to manage the cleanliness of cooling water, i.e. sodium hypochlorite, chlorine dioxide, chlorine gas, etc. ABF uses sodium hypochlorite as a disinfectant produced by an electrochlorination system to control microbiological growth in cooling water. The block diagram of the system is shown in Figure 1.

Figure 1 Electrochlorination system block diagram

When sodium hypochlorite is dosed in cooling water, it dissociates to form hydrogen ions and free chlorine. Chlorine is emitted to be consumed by impurities before free chlorine appears in cooling water.

BACKGROUND

ABF has been experiencing challenges in sustaining Free Residual Chlorine (FRC) compliance (to meet the minimum average of 85% compliance of more than 0.3 ppm FRC) in treating cooling water in 2016 after switching from a chlorine gas treatment method to an electrochlorination system.

FRC non-compliance is contributed by:

1. Electrochlorination system issues (Equipment Reliability)
2. Ammonia contamination from process heat exchanger tube leak issue increases the FRC demand.

Failure to sustain FRC for a prolonged period will cause a potential Risk of Microbe Induced Corrosion (MIC), especially at low-flow heat exchangers. Deposit tends to accumulate at low-flow heat exchangers, and microbes will accumulate at the prone area. If the condition is not managed, it will lead to heat exchanger tube corrosion.

ABF team conducted an improvement study with options identified below to improve the FRC compliance in treating cooling water.

METHODOLOGY

Life cycle costing is the process of economic analysis to assess the total cost of acquisition, ownership and disposal of an asset, which encompasses identifying and documenting all cost drivers over the expected life of an asset, also often referred to as the Total Cost of Ownership (TCO) [1]. In this context, the term 'asset' is used generically to refer to any physical asset, goods and products. In this increasingly competitive business environment, cost plays an important role in decision-making when acquiring physical assets. The amount of initial capital investment alone does not form the basis for sound decision-making when acquiring assets.

Life cycle costing using net present value analysis is adopted to assess the most cost-effective option for a period of 10 years.
Net present value analysis is chosen over other methods (i.e., payback period, internal rate of return) because the options to improve FRC compliance in treating cooling water focus heavily on cash outflows without considering cash inflows (revenue). Hence, net present value is a more suitable method to determine this study's lowest expenditure over the 10-year life cycle. The analysis was conducted based on the available maintenance, production and original equipment manufacturer's background information.

Net present value in the analysis represents the expenses amount to be incurred for the coming 10 years for the following identified options:

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Option 1: Maintain existing on-site disinfectant generation system (VODES) as the source of main biocide (disinfectant) & with supplementary additional chlorine tablet dilution (24 kg/day)

Option 2: Maintain existing on-site disinfectant generation system (VODES) as the source of main biocide (disinfectant) & with supplementary additional chlorine tablet dilution (36 kg/day)

Option 3: Maintain existing on-site disinfectant generation system (VODES) as the source of main biocide (disinfectant) & supplement with industrial grade sodium hypochlorite (35 liter/ hour (LPH)).

Option 4: Decommission the on-site disinfectant generation system (VODES) and replace it with industrial-grade sodium hypochlorite (75 Litre/ hour (LPH)).

The formula is used to calculate the Present Value of the options [2]:

$$NPV = \sum_{i=0}^{\eta} \frac{c_i}{(1+\tau)^i}$$

where,

C_i = Cash flow at year i
NPV = Net Present Value
r = Discount Rate
η = Number of Years

The following cost elements were considered:

1. Capital expenditure (CAPEX), the initial purchase price to be incurred (once off)
2. VODES operations & maintenance as illustrated in [3] (Average/ year over 10 years)
3. Supplementary usage of chlorine tablet operations & maintenance (Average/year over 10 years)
4. Industrial grade operations & maintenance (Average/year over 10 years)
5. Another chemical dosing (Average/year over 10 years)
6. Water consumption (Average/year over 10 years)
7. VODES decommissioning cost for Option 4.
8. Cost impact due to non-compliance to FRC* (once off)

Sensitivity analysis was carried out based on the following three scenarios:

1. VODES Mean Time Between Failure (MTBF) increased to 10 years after improving the site strategy in maintaining the existing VODES system.
2. The inflation rate increased to 6%
3. Chlorine demand increased by 1 kg/hour chlorine equivalent due to a process leak.

RESULTS AND DISCUSSION

Table 1 Life cycle cost analysis review using NPV ratio

Options/ Cost Considerations	Option 1: AS IS – VODES as main biocide & chlorine tablet supplementary (24 kg/day) – existing	Option 2: VODES as main biocide & chlorine tablet as supplementary (36 kg/day)	Option 3: VODES as main biocide & industrial grade as supplementary (35 LPH)	Option 4: Industrial grade as a main biocide (75 LPH) Base case analysis
Base case analysis	1	0.9	0.92	0.91
Sensitivity 1 - VODES MTBF increased to 10 years after operationalising Equipment Reliability Strategy	1	0.9	0.91	NA
Sensitivity 2 - Inflation Rate from 3% increased to 6%	1	0.89	0.91	0.91
Sensitivity 3 – Chlorine demand increased by1 kg/hour chlorine equivalent due to process leak	1	0.89	0.91	0.9

From the Life cycle analysis as indicated in Table 1, Option 2, i.e., Maintain existing on-site disinfectant generation system (VODES) as the source of main biocide (disinfectant) & with supplementary additional of chlorine tablet dilution (36 kg/day) derived the lowest net present value for the next coming 10 years.

It is recommended to run with Option 2 as the current measure until the end of the life of the VODES system. ABF is recommended to review the Life cycle costing analysis with the latest options whenever consideration changes in the future.

CONCLUSION

Life cycle costing using net present value is useful, considering the costs incurred over the whole life of an asset. It is essential to provide a holistic picture as applied in this case study to decide the most cost-effective microbe/disinfectant method to control microbiological growth in cooling water at ASEAN Bintulu Fertilizer Sdn Bhd. Asset selection should be justified based on life cycle costing or total cost of ownership rather than on the asset's initial purchase price.

REFERENCES

[1] "International Standard Petroleum and natural gas industries-Life cycle costing Part 1: Methodology", *ISO 15663-1*, 2000.

[2] "International Standard Petroleum and natural gas industries-Life cycle costing Part 2: Guidance on the application of methodology and calculation methods", *ISO 15663-2*, 2001.