JISS Journal of Indonesian Social Science

Vol. 5, No. 4, April 2024
E-ISSN: 2723-6692
P-ISSN: 2723-6595
http://jiss.publikasiindonesia.id/

Silica Filter Membrane by Utilizing Palm Oil Empty Bunches Waste

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KEYWORDS
Silica; Palm Oil Blank Mark; Water Manager; Fouling

ABSTRACT
Keramasan Gas and Steam Power Plant uses river water as raw material after going through treatment in the WTP system. To overcome the problem of high silica value in demin water, a ceramic filter membrane device was developed from empty palm oil bunch waste that reduced silica content to standards. This research aims to improve water treatment efficiency to meet the established water quality standards. Keramasan Gas and Steam Power Plant uses river water sources as raw materials, which are processed through the WTP (Water Treatment Plant) system to produce demineralized water as the main supply in the HRSG water filler system. However, the water treatment process has not been optimal because the silica content in demin water is still high (>20 PPB), violating the established quality standards (<20 PPB). Therefore, this study proposes an innovation in the form of a ceramic filter membrane from empty palm oil bunch waste to reduce silica content. Tests show a decrease in silica values to standard. These innovations have had a positive impact, including chemical savings, water treatment optimisation, and wastewater reduction. In addition, the use of empty palm oil waste also contributes to efforts to reduce environmental pollution.

1. Introduction

Keramasan Gas and Steam Power Plant (PLTGU Keramasan) which has a power of 2 x 40 MW plays a very important role in supplying electricity needs, especially in the Southern Sumatra region (Adam, 2016; B. N. Adha, 2018). The main water source used by PLTGU Keramasan comes from river water which was previously treated first in the water treatment plant (WTP) system (Andhika, 2021; Pratiwi et al., 2022). The process of processing river water into demin water must be optimal so that the quality of the water produced is in good and normal conditions in accordance with standard values and free from harmful substances. The dissolved content in water includes, silica, calcium carbonate, free CO2, magnesium hydroxide, magnesium phosphate, iron oxide and so on. Silica is one of the elements that can be harmful to industrial equipment, the presence of silica can cause scale or deposits on tubes in HRSG and can cause damage to plant equipment (N. B. Adha, 2018; Andriani, 2004; Pratiwi, 2022).

The process of treating river water into demin water as HRSG (Heat Recovery Steam Generator) filler water is still not optimal because the value of silica in water content is still fluctuating or tends to be high below the standard value (> 20 PPB) which is influenced by various things (Sabar, 2023). To avoid this, efforts need to be made to improve the quality of demin water to match the predetermined standard value, which is < 20 PPB. Therefore, we had the idea to create a tool that can help to accelerate the lowering of silica values according to standard values by utilizing empty palm oil bunch waste. The tool is named "Silica filter membrane to accelerate the lowering of silica by utilizing empty palm oil bunch waste". This membrane technology can reduce organic and inorganic compounds in water content without the use of chemicals in its operation and as an effort to reduce waste pollution of empty oil palm bunches (Abdulsalam et al., 2018; Aprilia & Amin, 2011).

From the above problems, the objectives of this innovation are as follows: Helps reduce the silica content of water according to < 20 PPB standards; Optimize demin water treatment; Save on the use of chemicals; Avoid water drain due to high silica value; Avoid equipment damage caused by high silica values in water; Strive to reduce waste pollution.

2. Materials and Methods

The author uses a structured methodology in the preparation of this paper. First, local observations and surveys were carried out on demin water treatment systems in Steam and Gas Power Plants to identify problems on which the equipment development was based. Furthermore, the improvement idea was designed to focus on reducing silica content in water. The manufacture of tools is carried out by paying attention to the planned design and using materials that are easily available. The next stage is repeated testing of the device to ensure its effectiveness in lowering the value of silica in water. Finally, the report is prepared by compiling five chapters that include introduction, theoretical foundation, discussion, benefits of tools and risk analysis, as well as conclusions and suggestions. With this methodological approach, the authors succeeded in developing a tool that has the potential to overcome water quality problems related to silica content.

3. Result and Discussion

Innovation Discussion

1. Identify the Problem

   According to testing data on the results of demin water production in 2022 in figure 1, it shows that the value of silica in water content is still fluctuating or tends to be high below the standard value (> 20 PPB), resulting in several losses, including:

   a) Demin water plant system is less than optimal (regeneration failure)
   b) Waste of chemical injection during the treatment process to degrade silica
   c) Waste of water for demin water production process
   d) Loss of opportunity in demin water production
   e) The potential for equipment damage due to silica content in water is still high

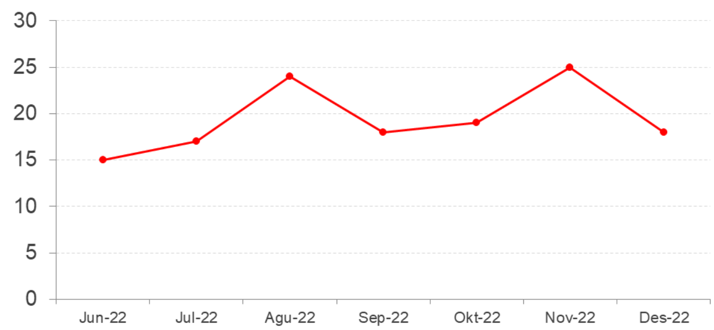


Figure 1 Data on the value of silica content in demin water Steam Gas Power Plant Shampooing

2. Problem Solving Analysis Based on the above problems, a problem-solving analysis was carried out by making RCPS related to reducing the value of silica content in water in accordance with the standard value as shown in figure 2 below.

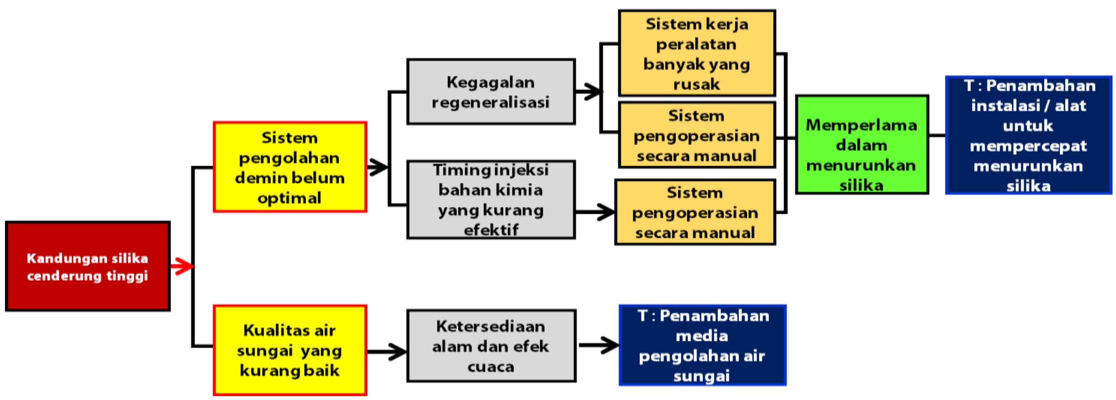


Figure 2 Diagram RCPS

Based on the process of identifying problems through the diagnostic stage with the help of tools such as RCPS diagrams, priority scale matrices and idea generation overview as well as problem impact analysis, the author has several initiatives to make improvements so that this problem can be resolved properly and does not cause losses to PLTGU Keramasan. The improvement initiative offered by the author is a simple solution so that it can be implemented immediately and immediately feel the benefits in the power unit. The improvement initiative or breakthrough that has been made by the author is to make a silica filter membrane tool to reduce silica content by utilising empty palm oil bunch waste (Anisah, 2015; Oyekanmi et al., 2021). The selection of alternative improvements mentioned above is through several considerations, such as determining the level of difficulty of implementation and the impact caused through a priority scale matrix, which is then compiled in an idea generation overview related to the decision of improvement initiatives that can be implemented immediately as shown in figure 3 below.

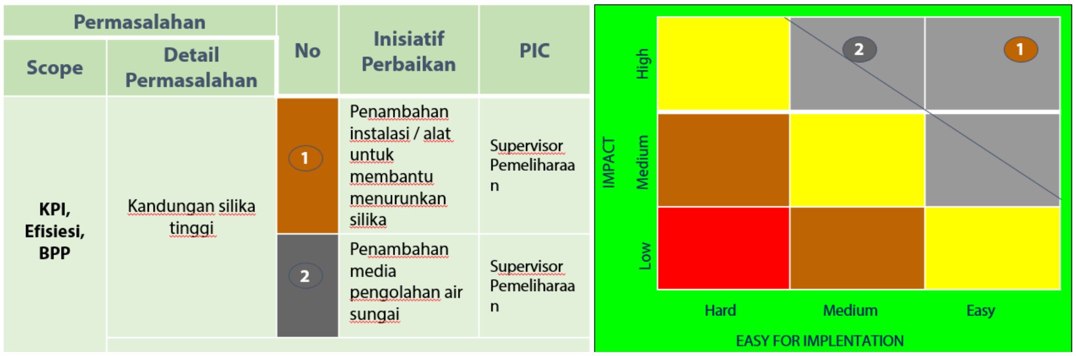


Figure 3 MANFISKA implementation priority idea matrix

3. Design of Innovation Works
   A MANFISKA filter membrane can be made by composing it as specified in Figure 4 below.

Figure 4 The composition of the filter membrane material MANFISK

The tools and materials used to make this innovation, among other things:

Table 1 Tools and materials for making MANFISKA tools

No	Material	Total
1	Empty bunches of oil palm	15 gr
2	Clay	62,5 gr
3	Zeolite	20 gr
4	Iron powder	2,5 gr
5	Filter spon	3 unit
6	PVC Pipe	4 m
7	Measuring cup	1 Piece
8	Scales	1 Piece

The tools and materials provided are made cylindrical by membrane printing and sintering (Kesting, 2006; Qian et al., 2022). The membrane is made from clay, empty oil palm bunches

(EFB), zeolite and iron filings moulded using a cylindrical mould of stainless steel and compacted for 15 minutes (Sandra et al., 2014). This treatment is necessary so that the pressure applied can be evenly distributed on the membrane. The resulting membrane measures 25 cm in length, 7 cm in outer diameter and 5 cm in diameter.

Figure 5 Printed membrane results

1) Principles of Tool Work
Water from the raw water tank is pumped to flow to the train cation, anions and mixed beds to remove the mineral content, if the value of silica content in the water is still high > 20 PPB, the water will flow to the silica filter membrane which serves to help reduce the silica value to < 20 PPB. First, it passes through the housing-1 component which contains a sponge filter with a pore diameter of 0.5 µm, then flows into housing-2 and housing-3 in which each includes a sponge filter with a pore diameter of 0.1 µm and activated carbon, finally the water passes through housing-4 which contains a ceramic membrane TKKS (empty oil palm bunches) then the water is accommodated into the demin water tank (Sari et al., 2012).

Figure 6 MANFISKA tool components

4. Implementation

After assembling a membrane device made from TKKS (empty oil palm bunches), testing was carried out to observe the performance of the tool in reducing the value of silica content in water. The test results can be seen in figure 7 below :

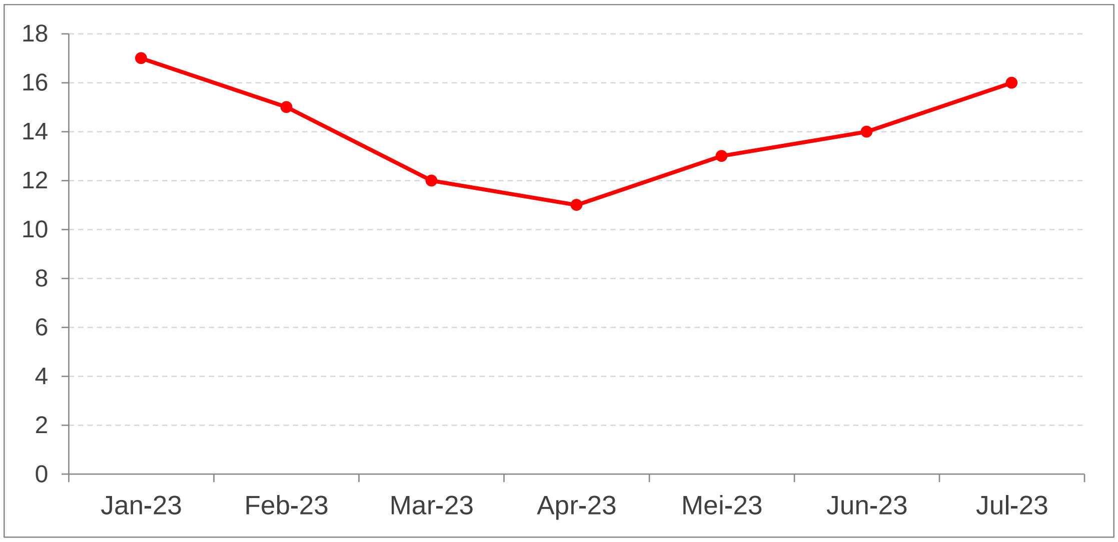


Figure 7 Decrease in silica value after using MANFISKA

From the picture above, it can be seen that the MANFISKA membrane tool has been proven in decreasing silica (Si) in water caused by the phenomenon of concentration polarization, namely the blockage of membrane pores by silica (Si) where the concentration of silica (Si) on the membrane surface is more concentrated than the concentration of silica (Si) passing through the membrane.

5. Evaluation of Implementation Results

The implementation of MANFISKA has had a good impact on the generating unit, especially at PLTGU Keramasan, where the silica value content of filler water can be maintained according to < 20 PPB standards so that it can avoid the silica content contained in the filler water which has an impact on the scale of the Keramasan PLTGU steam turbine.

Benefits of Innovation to Corporations

1. Benefits of innovation to corporate
   a. Financial Benefits

   Financial benefits obtained by calculating chemical *losses* due to regeneration failure due to high silica content:

   1) Potential regeneration failure 1 time for 3 hours:

   Known:
   NaOH price: IDR 12.000/kg
   HCL price: IDR 5450/kg
   NaOH requirement for 1 regeneration = 80 kg x IDR12,000 = IDR 1,080,000

kebutuhan HCL untuk 1 kali regenerasi = 160 kg x IDR 5,450 = IDR 872,000
Total *chemical* losses = IDR 1,080,000 + IDR 872,000
= IDR 1,952,000

2) Cost of manufacturing MANFISKA membranes :
Clay price: IDR 1000/kg
Zeolite price : IDR 1500/kg
Membrane printing price: IDR 75,000
PVC pipe price 4 meters: IDR 74,400
- Clay composition = 0,0625 kg x IDR 1000/kg = IDR 62.5
- The composition of zeolite = 0,020 kg x Rp 1500/kg = Rp 30

The total manufacture of MANFISKA tools is :
= IDR 75,000 + IDR 74,400 + IDR 62.5 + IDR 30
= IDR 149,492

3) The total savings obtained by using MANFISKA to help reduce silica are:

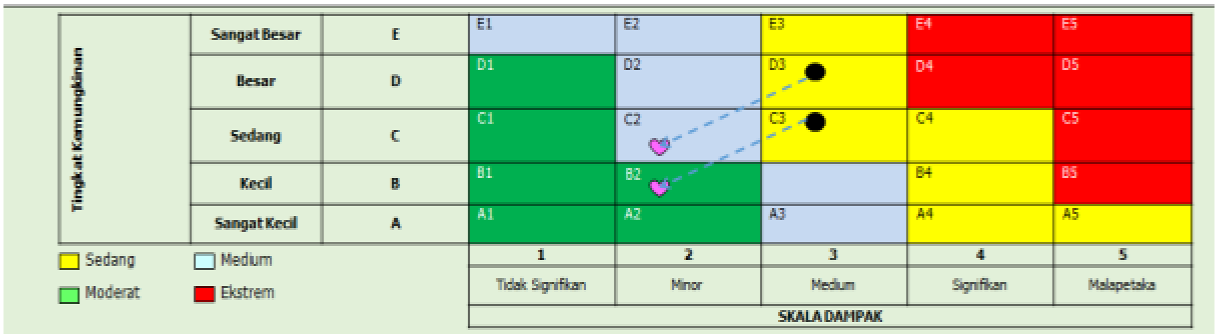
= IDR 1,952,000 - IDR 149,492 = IDR 1,802,508 / 1 regeneration failure
If in 1 month there are about 9 times failed regen due to the high value of silica, it is IDR 16,222,572 / month or Rp 194,670,864 / year.

b. Non-Financial Benefits
The non-financial benefits obtained from this innovation are as follows:
a) Helps in devaluing silica content.
b) Optimizing the demin water treatment system
c) Avoid water waste (*drain*) during the water treatment process
d) In an effort to reduce waste pollution.

c. Risk Analysis

After a risk assessment of the implementation of this innovation, several possible risks that occur and their mitigation are obtained, as shown in the table below.

Table 2 Risk Table



No	RESIKO YANG TERIDENTIFIKASI		LEVEL RESIKO PASCA KONTROL EXISTING		
	Deskripsi Resiko	Level Resiko	Tingkat Kemungkinan	Skala Dampak	Level Resiko
1	Kandungan silika melewati standar	D3/Tinggi	C/Sedang	2/Minor	C2/Moderat
2	Sistem demin plant kurang optimal	C3/Tinggi	B/Kecil	2/Minor	B2/Rendah

4. Conclusion

The use of MANFISKA tools has been proven effective in reducing the value of silica content in water, resulting in savings in the use of chemicals and increasing the optimality of demin water treatment systems. In addition, utilising empty palm oil bunch waste as raw material for this tool shows the potential for environmentally friendly solutions to water quality problems. For researchers interested in researching the same variables, it is advisable to pay attention to the technical aspects in the development of the tool, conduct more extensive trials to ensure the effectiveness of the tool, as well as consider the environmental and economic implications of using this tool in the long term. Thus, this study confirms that MANFISKA is a potential solution to overcome water quality problems related to silica content, with significant benefits in chemical savings and waste utilisation.

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