"Evaluating Water Quality Improvement In An Industrial Context: The Effectiveness Of Dual Media Filtration At JK Tyre Plant In Chennai"

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Abstract: As the industrial sector continues to expand, the need for effective water treatment solutions becomes increasingly critical. An attempt has been made to study the industrial water quality in JK tyre plant at Chennai. Two number of process water samples i.e. DM Water and Circulation water were obtained from the plant and analyzed for physical and chemical parameters. The circulation water is actually DM water which is in circulation. The result showed that the water DM Water sample having very good quality whereas circulation water is getting contaminated after use in tyre processing. After much deliberation a small capacity dual media filter was introduced and water quality after the filtration was checked. Key parameters such as turbidity, total suspended solids (TSS), chemical oxygen demand (COD), and pH are monitored to assess the efficiency of DMF. The filtrated water was found to be much better quality. The filter almost reduced and there is significant improvement in other parameters as well. The results indicate a significant reduction in turbidity and TSS levels after DMF treatment, with an average removal efficiency of 100% Total suspended solids, 87% reduction in oil and grease and chemical oxygen demand. The study also examines the impact of DMF on water pH and COD levels, highlighting the need for careful monitoring and optimization of the filtration process. Overall, the findings suggest that DMF is an effective method for improving water quality in an industrial context and can contribute to sustainable water management practices.

Keywords: water quality improvement, dual media filter, DM Water, Circulation water.

Introduction:

The rubber industry, a significant player in manufacturing sectors worldwide, faces increasing scrutiny over its environmental impact, particularly concerning water quality. With growing demand for rubber products across various industries, there is a pressing need to examine the potential consequences of rubber production on water resources.

The production of rubber involves the use of various chemicals, including accelerators, antioxidants, and vulcanizing agents, which can pose a significant risk to water quality if not appropriately managed. Improper disposal or inadequate treatment of wastewater generated during rubber manufacturing processes can result in contamination of water bodies, leading to ecosystem disruption, loss of biodiversity, and potential health hazards for both humans and wildlife. Heavy metals, organic compounds, and other pollutants associated with rubber production have the potential to accumulate and persist in water sources, causing long-lasting impacts on surrounding communities and ecosystems.

Understanding the current state of water quality in the rubber industry is crucial for implementing effective measures to mitigate the product defects as well as the potential environmental and health risks associated with rubber production.

This study aims to provide a comprehensive analysis of water quality in Jk tyre and provide techniques for improving the water quality.

Review of literature

M.F. Hamoda *et al.* studied sand filtration of waste water and seen that it is effective in removing TSS, VSS, BOD and COD. Marcio Mesquita *et al.* evaluated the efficiency of sand filters made out of three different sand particle sizes and varying the filtration rate. They found that the removal efficiency of sand filters increases as the filtration rate increases for the water quality used, and sand particle size decreases.M R A A Chan *et al.* studied and compared between the sand filtration and activated carbon filtration system and found that both are impressive in improving the water quality. Anshul Agrawal *et al.* designed an economical slow sand filter for households to improve water quality parameters. Their test results shows that designed sand filter is highly efficient for improving the household water quality parameters. The sand filter removes large number of impurities as compared to other filters and it is socially acceptable.

Fernando Freitas de Oliveira *et al.* investigated that the combination of sand filters of different kinds effectively removes turbidity and other microbial materials. Stanslaus Mtavangu *et al.* also studied effectiveness of sand filters. They used polluted water of around 1000 NTU Turbidity and resultant water of 10-50 NTU they got after the sand filtration process. It was also effective in removal of faecal coliform (FC), chemical oxygen demand (COD), total suspended solids (TSS) and nitrates. Akramul Alam *et al.* studied the effectiveness of pond sand filters. They found that the average turbidity and fecal coliform removal efficiency of the sand filters is 76 and 98% respectively. The sand filter system effectively removed microbes and nutrients as Ari Kauppinen *et al.* investigated.

MATERIALS AND METHODS:

In tyre industry mainly water is demineralized and used for the processing. The water after demineralization process is called as DM water. Then the DM water goes in the process line such as to boiler for generating steam and to tyre processing section for cooling of individual rubber compounds after the hot extrusion process. When the DM water goes in tyre process section it is called the process water.

The quality of DM water has to be very fine to avoid any kind damage to the boiler system such due to corrosion, sedimentation. The process water quality also plays a very significant role as it came directly in contact with the rubber compound in hot condition. The water quality has to be maintained same through the manufacturing process.

The process water at JK tyre industry was found to be rich in chemicals, oil and other metals. Hence, this water cannot be used in the process for further time. There was a need to find out an effective and cost saving technique to improve the water quality so that the same process water can again be reused without any complexity.

The in process water, DM water and after treatment water has been analyzed for the following parameters;

SN	Test Parameter	Standard Method
1	pH @25°C	IS 3025 Part 11: 2017
2	Total Hardness as CaCO3, mg/L	IS 3025 Part 21: 2019
3	Total Dissolved Solids, mg/L	IS 3025 Part 16: 2017
4	Total Suspended Solids, mg/L	IS 3025 part 17: 2012
5	Calcium, mg/L	IS 3025 Part 40: 2019
6	Magnesium, mg/L	APHA section 3120B: 2017
7	Iron, mg/L	IS 3025 Part 2 :2019
8	Copper, mg/L	IS 3025 Part 2 :2019
9	Zinc, mg/L	IS 3025 Part 2 :2019
10	Lead, mg/L	IS 3025 Part 2 :2019
11	Oil and Grease, mg/L	IS 3025 part 39: 2017
12	Chemical Oxygen Demand, mg/L	APHA 5220D :2017
13	Bio-chemical Oxygen Demand, mg/L	APHA 5210 D: 23rd Ed 2017

Table 1 : Test Parameters selected for checking the water quality

RESULTS AND DISCUSSION:

Initially the raw water i.e. DM water and in process water quality has been checked.

SN	Test Parameter	DM Water	In Process Water
1	pH @25°C	6.6	5.8
2	Total Hardness as CaCO3, mg/L	Nil	23.8
3	Total Dissolved Solids, mg/L	8.0	34.4
4	Total Suspended Solids, mg/L	Nil	118.0
5	Magnesium, mg/L	Nil	1.3
6	Iron, mg/L	Nil	1.6
7	Copper, mg/L	Nil	Nil
8	Zinc, mg/L	Nil	Nil
9	Lead, mg/L	Nil	Nil
10	Oil and Grease, mg/L	Nil	73.0
11	Chemical Oxygen Demand, mg/L	300.0	489.0
12	Bio-chemical Oxygen Demand, mg/L	Nil	Nil
13	Calcium, mg/L	Nil	5.2

Table 2: DM water and in-process water quality

The DM water quality was found to be very good whereas when the same DM water is going into process it is getting contaminated. The DM water has pH in the range of 6.5-7.5 and there was no hardness present in the water. There were no traces of metal ions found. The in process water quality was found to be not good. It had high content of suspended particle (TSS: 118 mg/ L), high oil & grease content (73.0 mg/L) and high amount of Chemicals were also present (COD: 489 mg/L). It also had metal ions such as magnesium (1.3 mg/L) and iron (1.6 mg/L) along with total hardness (23.8 mg/L), Total dissolved solids (34.4 mg/L). The pH of the in process water was also found little on the acidic side.

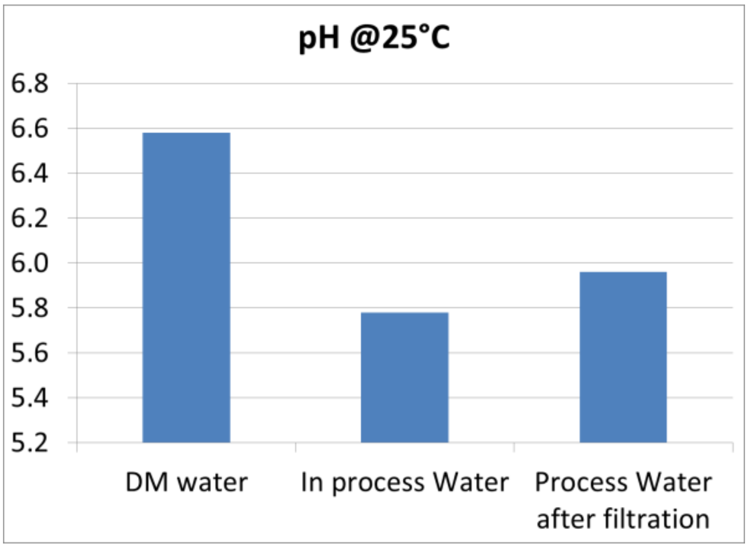
Based on the test results and depending on the water quality it was decided to install a dual media filter in return water line. A sand and pebble filter was installed in the line and filtrated water was tested.

Figure 1: Sand and Pebble Filter

The water quality after filtration is shown below;

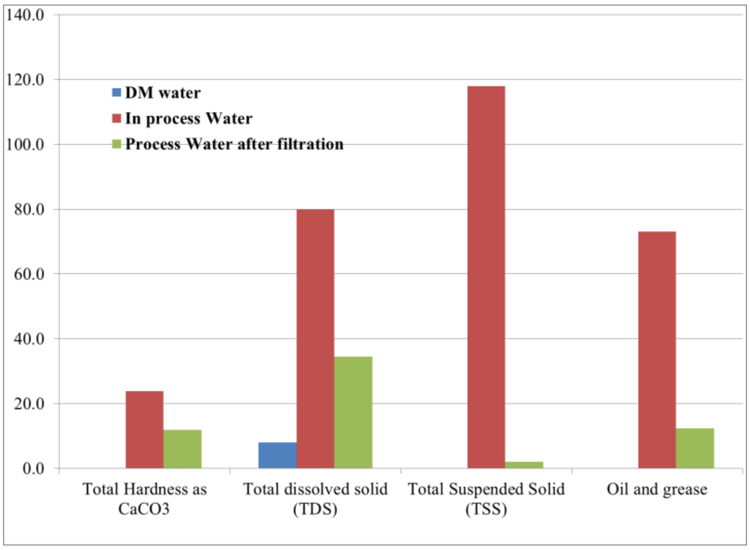
SN	Test Parameter	Process Water after Filtration
1	pH @25°C	6.0
2	Total Hardness as CaCO3, mg/L	11.9
3	Total Dissolved Solids, mg/L	34.4
4	Total Suspended Solids, mg/L	2.0
5	Magnesium, mg/L	0.5
6	Iron, mg/L	0.1
7	Copper, mg/L	Nil
8	Zinc, mg/L	Nil
9	Lead, mg/L	Nil
10	Oil and Grease, mg/L	12.4
11	Chemical Oxygen Demand, mg/L	344.0
12	Bio-chemical Oxygen Demand, mg/L	Nil
13	Calcium, mg/L	1.9

Table 3: Process Water Quality after Filter Installation



Graph .1: Comparison of pH of DM water, in process water and process water after filtration

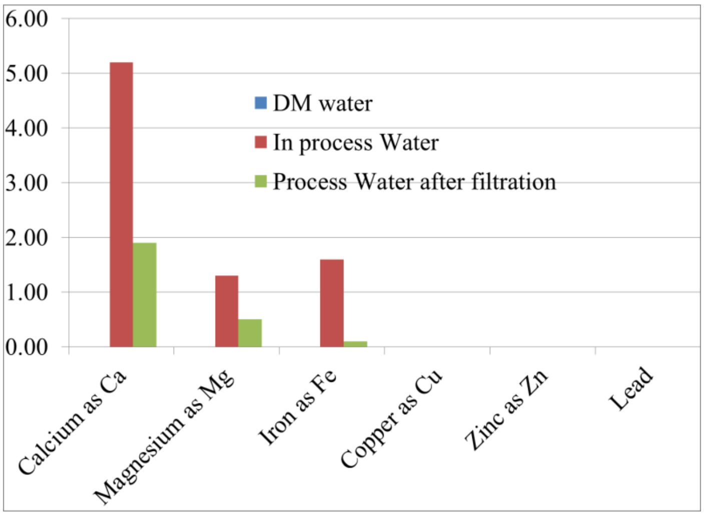
The DM Water had pH of 6.6. The pH of in process water was 5.8 and pH of the filtrated water was found 6.0 which is a good improvement.



Graph .2: Comparison of various parameters of DM water, in process water and process water after filtration

Initially the DM water had no hardness but in process water had 23.8 mg/L total hardness. After filtration the water hardness was reduced from 23.8 mg/L to 11.9 mg/L. Hence, there was 50% reduction in total hardness. In case of total dissolved solids, the DM water had 8.0 mg/L TDS whereas the in-process water had 79.8 mg/L TDS. After filtration the total dissolved solids was found 34.4 mg/L which is a 57% reduction.

The in process water had 118.0 mg/L total suspended solids and after filtration it came down to 2.0 mg/L. Hence, the filtration technique reduced 98% of the total suspended solids. In case of oil and grease, the In process water had 73.0 mg/L oil and grease whereas after filtration it reduced by 83% and came down to 12.4 mg/L.



Graph .3: Comparison of presence of Metals of DM water, in process water and process water after filtration

There is significant reduction in metal content after filtration through sand and pebble filter. The amount of calcium in process water was 5.2 mg/L and after filtration it was found to be 1.9 mg/L (63% reduction). The magnesium in process water was 1.3 mg/L and after filtration it came down to 0.5 mg/L (62 % reduction), Iron in process water was 1.6 mg/L and after filtration it was reduced to 0.1 mg/L (94% reduction). The amount of Copper, Zinc and Lead remained nil in all three types of water i.e. DM water, In-Process water and After filtration water.

CONCLUSION:

The study demonstrates the effectiveness of dual media filtration (DMF) in improving water quality at the JK Tyre plant in Chennai, India. Installation of Sand & Pebble filter improved the quality of the circulating water significantly with special reference to reduction in suspended particle & oil- grease content. The filter almost reduced 100% Total suspended solids, 87% reduction in oil and grease and chemical oxygen demand. The good quality of the water is reflected from the significantly lower COD value. This improved quality of the circulating water is likely to improve the quality of the tyre manufacturing process and its consistency. Over a period of time the efficiency of the filter may get reduced due to deposition. Quality of the water to be checked regularly (at least by visual & pH) and filter cleaning backwash is recommended. Over a six-month period, DMF showed a significant reduction in turbidity and total suspended solids (TSS) levels. The study also highlights the importance of careful monitoring and optimization of DMF operations to maintain water quality parameters such as pH and chemical oxygen demand (COD) within acceptable limits. Overall, the findings suggest that DMF is a valuable tool for sustainable water management in industrial settings, and its integration with other treatment methods can further enhance water quality improvement efforts.

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