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# Decreasing of Multiple Clean Water Parameters in River Water Treatment

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**Abstract**
The Characters of river water Surabaya, East Java, Indonesia at the time and specific location of Fe content up to 39.28 ppm, turbidity reach 345 NTU, DO 4.55-12.42 ppm, BOD is up to 12.48, COD 20-260 ppm TSS reach 2116.7 mg/l, detergent: 0.346 mg/l, bacteria E. Coli there were 50,000 MPN/100 ml, while samples of Bengawan Solo's river, Central Java, Indonesia Boron exposure to 0.57 ppm, Cadmium 0.10 ppm, and Lead 0.442 ppm. That Parameters are not safe enough for quality standard of river water, especially as a clean water criteria. The decreasing of multiple parameters that refer to clean water criteria which can be done with a series of Coagulant Aid treatment, Silica Sand, Ferrolite, Manganese Greensand, and synthetic resins (cation anion) are performed in bath reactor .The research purposes is: decreasing of multiple clean water parameters in river water treatment using Coagulant Aid treatment, Silica Sand, Ferrolite, Manganese Greensand, and synthetic resins (cation anion) Findings; In the river water treatment, parameters; Turbidity, Color, Iron, Total Hardness, Zinc, Organic Matter, Detergent, Total coliforms can be derived using Coagulant Aid treatment, Silica Sand, Ferrolite, Manganese Greensand, and synthetic resins (cation anion)
**Keywords**: River water, clean water parameters, coagulant aid, absorption, ion exchanger

## 1. Introduction

Some areas in East Java, Indonesia still many who rely on river water as a feedstock for clean water needs. The river water is also a mainstay of raw materials for Drinking Water Company in Indonesia. This is because the interrelationship of three things mutually supportive, namely; 1). Sufficient quantity, 2). The quality is better (than sea water), and 3). Flow rate fluctuations are relatively still meeting the sustainability of production. The content of the mud, a substance dissolved solids (TDS), and high turbidity in the river water is a major problem in terms of initial processing for clean water purposes.

The conditions of river water Surabaya, East Java, Indonesia (time and specific location) of Fe content 0.75-39.28 ppm, turbidity 71-345 NTU, DO 4.55-12.42 ppm, BOD 6.24 to 12.48 , COD 20-260 ppm according to (Putri e*t al*. 2013). A different location was reported (Priyono e*t al*. 2013); TSS (Total Suspended Solid) 2116.7 mg/l, Detergent 0.346 mg/l, Bacteria E. Coli 50,000 MPN/100 ml sample. Samples of Bengawan Solo river, Central Java, Indonesia, exposure to Boron 0.57 ppm, Cadmium 0.10 ppm, Iron 0.442 ppm, Lead 0.442 ppm by (Sulistiyanto *et al*. 2007).

Purwoto *et al*. (2014) conclude that; removal of clean water parameters using Sediment Poly Propylene treatment, Carbon Block, Manganese Zeolite, Ion Exchange, and Reverse Osmosis (RO) is; Total Disolved Solid (TDS) 2686 ppm, Total Hardness 371.43 mg/L CaCO3, Chloride 1144 ppm, Total Coliform 4 MPN/100 mL, Iron 0:18 ppm, Sodium 737.70 ppm, Zinc 0:08 ppm, Sulfate 24.56 ppm, Organic Substances 15:03 mg/L KMnO4, and Detergent 0:10 mg/L LAS. The study results of (Purwoto 2008) Synthetic Resin treatment may removal salinity brackish water 484 mg/L from salinity of water samples 1988 mg/L, and 457 mg/L for the salinity of water samples 994 mg/L.

While the quality standard requirements for clean water according to regulations health minister Republic of Indonesia (1990) Maximum Turbidity 25 NTU scale, Color 50 PtCo units, Iron 1 mg/L Fe, Total Hardness 500 mg/L CaCO3, Zinc 15 mg/L Zn, Organic Matter 10 mg/L KMnO4, Detergent 0.5 mg/L LAS, Total Coliforms 50 per 100 ml (MPN).

According to Montgomery (2005) demineralization principles can be carried out by: ion exchange resins, deionization, membrane transfer distillation, flash evaporation, and reverse osmosis (RO).

Referring to previous studies and preliminary research, then to decrease clean water parameters can be done by initial treatment; coagulant aid, silica sand, ferrolite and manganese greensand. Whereas for the purpose of removal cation anion, reduction of detergents and other clean water parameters further processing is done using a synthetic resin (cation anion).

The solution in question has been stated as the problem in this study, that is: "How large is the capacity of clean water removal parameters in river water treatment using Coagulant Aid treatment, Silica Sand, Ferrolite, Manganese Greensand, and synthetic resins (cation anion)".

Logical reason as a hypothesis, that: "After Coagulant Aid treatment, Silica Sand, Ferrolite, Manganese

 

Greensand, and synthetic resins (cation anion) for processed materials river water can removal mineral that refers to clean water parameter".

Demineralized river water if it's done by treatment: coagulant aid, Silica Sand, Ferrolite, Manganese Greensand, Synthetic Resins of cation and anion on an isolated or separated, then each has weakness. Weakness each encountered are:

a) Coagulant aid is coagulant treatment to produce destabilization of colloidal particles and suspended fine solids, and are not able to perform ion exchange such as resins Synthetic.
b) Ferrolite as removal Fe and Mn in the river water is not capable of decreasing in hardness.
c) Manganese Greensand as iron and manganese Adsorbent, in which the reaction of $Fe^{2+}$ and $Mn^{2+}$ in the water can be optimized if aided by ion exchange by synthetic resin
d) Resin synthetic as an ion exchanger (ion exchanger), which is the principle of electrostatic forces where cation anion contained in the resin exchanged by the anion cation that's in the water, has a disadvantage not match incurred costs by the results of ion exchanger, due to low capacity of ion exchange synthetic resins.

To overcome that disadvantages of these weaknesses, then do a combination of (engineering) treatment, where Coagulant Aid and Silica Sand as Pre Treatment, followed by Real Treatment; Ferrolite, Manganese Greensand, Synthetic Resin anions and cations in series of reactors by step stages :

1) coagulation of large molecules, especially discrete particles with coagulant aid treatment
2) deposition of silt contained in river water using silica sand
3) to strengthen the performance decline Fe, and Mn used double treatment, that are; Ferrolite and Manganese Greensand
4) The use of anion resin as ion exchanger to decrease cations in the water.
5) Penggunaan resin kation sebagai penukar kation untuk penurunan anion dalam air.
6) The use of kation resin as ion exchanger to decrease anions in the water.

## 2. Materials and Methods

### *2.1. Equipment and materials research*

The main tool used in river water treatment in this study are; suction pumps, submersible pumps, filter cartridges, filter housing, and the print cartridge Fibre- Reinforced Plastic (FRP). Substance use treatment that is; Coagulant Aid, Silica Sand, Ferrolite, Manganese Greensand, and synthetic resins (cation and anion)

### *2.2.Treatment research*

Table 1. Treatment Used Material Specifications

| *Treatment* | *Function* | *Description* |
|---|---|---|
| Coagulant Aid | Sedimentation, coagulation | colorless and odorless; pH at a temperature of 20$^{o}$C for 11-11.5; the specific gravity of 1.35 g/cm$^3$. ; $Al_2O_3$ content is 4.66%; pH solution 2% (pH soluble 2% in water) 3.553; the part that is not soluble in water 0.060% |
| Silica sand | Mud filtration, filtration dissolved solids | Material from sand that contains silica and siliceous high quality |
| Ferrolite | Removal of Fe and Mn in water | Ferrolite porous granules have the advantage of making it easy to absorb iron and manganese and is very stable as a filter media, both physically and chemically |
| Mangan Greensand | Absorption of iron and manganese | The reaction of $Fe^{2+}$ and $Mn^{2+}$ in water with high manganese oxide (higher manganese oxide) to produce filtrate containing ferric-oxide and manganese-dioxide is insoluble in water and can be separated by sedimentation and filtration. Removal $Mn^{2+}$ can be done with adsorbs by Manganese oxide manganese oxide coated zeolite (MOCZ) (Taffarel e*t al.* 2010) |
| Anion resin | Anion exchanger (decrease cations in water) | Thickness of 60 cm |
| Cation resin | Cation exchanger (anion decrease in water) | Thickness of 60 cm |

Referring to Table 1., the study treatment was done in a way; combination treatment, which Coagulant Aid and Silica Sand as Pre Treatment and Real Treatmentnya is; Ferrolite, Manganese Greensand, anion Synthetic Resin and Synthetic Resin kation in series in the circuit Bath reactor. Procedure Processing is done by using treatment: coagulation using Coagulant Aid, filtration of dissolved solids by silica sand, Removal of Fe and Mn

 

using Ferrolite and Manganese Greensand, anion exchanger (decrease cations in water) using anion resin, Cations exchanger (decrease anions in water) using cation resin.

*2.3. Research treatment groove*

According to Figure 1, shown a series of water treatment equipment river in Bath reactor in series. Design model of river water treatment based on the criteria of clean water parameters by a series of six treatments, that is; tank Coagulant Aid and Silica Sand in the filter housing as Pre Treatment, followed by Real Treatment using Ferrolite, Manganese Greensand, resin cation and anion resin (fourth using FRP tubes).

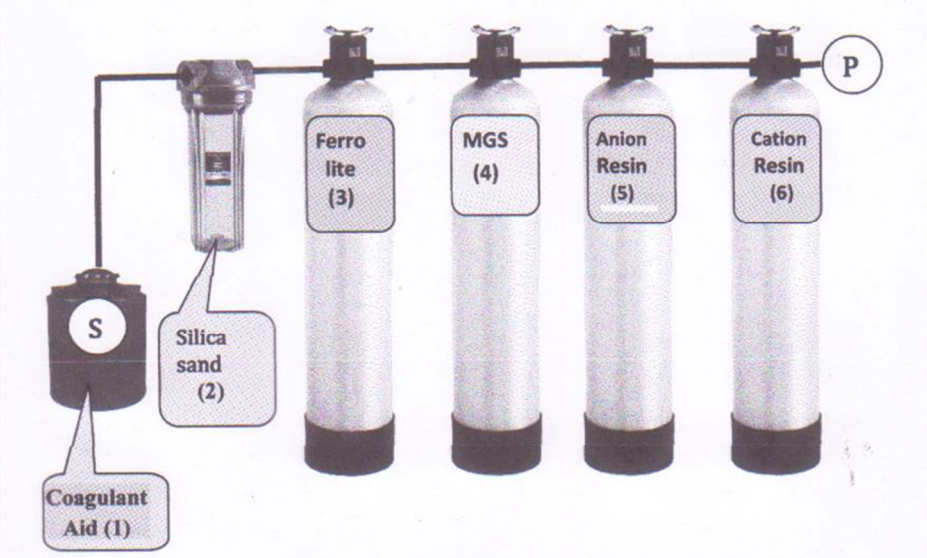


Figure 1. Model Design River Wastewater Treatment

(1) = Coagulant Aid treatment in the Raw water processed reservoir
(2) = Silica sand treatment on the filter cartridge in the filter housing tube
(3) = Ferrolite treatment on FRP tubes
(4) = Manganese Greensand treatment on FRP tubes
(5) = anion resin treatment at FRP tubes
(6) = Cation resin Treatment in the FRP tubes
S = Submersible Pump ; P = Product

Flow refers to the water treatment process in Figure 1, where the river water as raw water preceded by affixing Coagulant Aid in the water tank (1), then Silica Sand treatment to the filter cartridge in the filter housing tube (2). Further consecutive treatment; Ferrolite on FRP tubes (3), Manganese Greensand in FRP tubes (4), anion resin in the FRP tubes (5), and cation resin in the FRP tube (6).

*2.4. Analysis of the laboratory tests results*

Test parameters is done for; (Two) samples of raw water, and (b) The results of treatment.

## 3. Results And Discussion

*3.1. Research*

After the raw water treatment is done by; Coagulant Aid, Silica Sand, Ferrolite, Manganese Greensand, and synthetic resins (cation anion) in series in the circuit Bath reactor, conducted to analysis of laboratory tests treatment results, in which (a) Samples of raw water, and (b) The results of treatment.

Analysis of the laboratory tests results are presented in Table 2.

 

Table 2. Data Recap Lab Test Results Referring On Parameter Standard Water.

| *No* | *Parameter* | *Unit* | *Terms Water *)* | *Raw water* | *Treatment* |
|---|---|---|---|---|---|
| | ***A. PHYSICS*** | | | | |
| 1 | Smell | - | odorless | Not Smelled | Not Smelled |
| 2 | Total Disolved Solid (TDS) | mg/L | 1500 | 304 | 2280 |
| 3 | Turbidity | NTU scale | 25 | 154 | 5.98 |
| 4 | Flavor | - | tasteless | - | - |
| 5 | Temperature | $^{o}$C | air temperature $\pm$ 3$^{0}$C | 25 | 25 |
| 6 | Color | Unit PtCo | 50 | 200 | 52 |
| | ***B. CHEMISTRY*** | | | | |
| | ***a. Inorganic Chemistry*** | | | | |
| 1 | Mercury | mg/L Hg | 0.001 | 0 | 0 |
| 2 | Arsen | mg/L As | 0.05 | 0 | 0 |
| 3 | Iron | mg/L Fe | 1 | 8.88 | 0.14 |
| 4 | Fluoride | mg/L F | 1.5 | 0.46 | 0.63 |
| 5 | Cadmium | mg/L Cd | 0.005 | 0 | 0 |
| 6 | Total Hardness | mg/L CaCO3 | 500 | 178.57 | 142.86 |
| 7 | Chloride | mg/L Cl | 600 | 48 | 960 |
| 8 | Chromium VI | mg/L Cr | 0.05 | 0 | 0 |
| 9 | Mangan | mg/L Mn | 0.5 | 0 | 6.89 |
| 10 | Nitrate | mg/L NO3-N | 10 | 2.47 | 23.45 |
| 11 | Nitrite | mg/L NO2-N | 1 | 0 | 0.07 |
| 12 | pH | - | 6,5 - 9,0 | 7 | 5.98 |
| 13 | Selenium | mg/L Se | 0.01 | 0 | 0 |
| 14 | Zinc | mg/L Zn | 15 | 0.12 | 0.09 |
| 15 | Cyanide | mg/L CN | 0.1 | 0 | 0 |
| 16 | Sulfate | mg/L SO4 | 400 | 47.18 | 544.4 |
| 17 | Lead | mg/L Pb | 0.05 | 0 | 0 |
| | ***b. Organic Chemistry*** | | | | |
| 1 | Organic Substances | mg/L KMnO4 | 10 | 13.37 | 0.58 |
| 2 | Detergent | mg/L LAS | 0.5 | 0.38 | 0.12 |
| | ***c. MICROBIOLOGY*** | | | | |
| 1 | Total Coliform (MPN) | Number per 100 ml | Not water piping 50 | 1700000 | 1700 |

*Note ; According to Permenkes Republic of Indonesia Number: *) 416/Menkes/Per/IX/1990 on Clean Water Quality Requirements*

Description for the above table

The results of analysis criteria clean water parameters to river water samples based on parameters after treatment Coagulant Aid, Silica Sand, Ferrolite, Manganese Greensand, and synthetic resins (cation anion) findings obtained the following findings:

Referring to Table 2., it appears that in the water sample turbidity level is very high (that is 154 NTU Scale), much larger than water quality standard (only 25). This makes the raw water is not feasible as clean water.

Overview according to raw water parameters that exceeding value quality standards, it appears that; Turbidity, Color, Iron, Organic Matter and Total Coliforms are all higher than the threshold value permitted as clean water (Table 3).

*3.2. Discussion*

Interpretation of laboratory data test;

Table 3. Raw Water Parameters Values That Exceed Water Quality Standards

| *No* | *Parameters* | *Unit* | *Terms Water *)* | *Raw water* |
|---|---|---|---|---|
| 1. | Turbidity | NTU | 25 | 154 |
| 2. | Color | PtCo Unit | 50 | 200 |
| 3. | Iron | mg/L Fe | 1 | 8.88 |
| 4. | Organic substances | mg/L KMnO4 | 10 | 13.37 |
| 5. | Total Coliform (MPN) | Number per 100 ml | Not water piping 50 | 1.700.000 |

In Table 3, it appears that Total coliform is very high (it's about 1.700.000 MPN/100 ml). This condition indicates that river water is very risky in terms coli bacteria, so in the use of river water for consumption as clean water treatment must be done to decrease e-coli content.

 

Treatment Coagulant Aid, Silica Sand, Ferrolite, Manganese Greensand, and synthetic resins (cation anion) in this study as many as 8 item removal parameters that refer to clean water, are presented in Table 4.

Table 4. Parameters Removal Water Treatment Results Coagulant Aid, Silica Sand, Ferrolite, Manganese Greensand, and synthetic resins (cation anion)

| *No* | *Parameters* | *Unit* | *Raw Water* | *Treatment* | *Removal* |
|---|---|---|---|---|---|
| 1. | Turbidity | NTU Scale | 154 | 5.98 | 148.02 |
| 2. | Color | PtCo Unit | 200 | 52 | 148.00 |
| 3. | Iron | mg/L Fe | 8.88 | 0.14 | 8.74 |
| 4. | Total Hardness | mg/L CaCO3 | 178.57 | 142.86 | 35.71 |
| 5. | Zinc | mg/L Zn | 0.12 | 0.09 | 0.03 |
| 6. | Organic Substances | mg/L KMnO4 | 13.37 | 0.58 | 12.79 |
| 7. | Detergent | mg/L LAS | 0.38 | 0.12 | 0.26 |
| 8. | Total Coliform (MPN) | Number per 100 ml | 1700000 | 1700 | 1,698,300 |

Coagulant Aid treatment performance capabilities, Silica Sand, Ferrolite, Manganese Greensand, and Ion exchange resin in the form of anion and cation resin according to Table 4 .., capable of lowering parameters of physical parameters, chemical, Organic Matter and Total coliforms.

Organic substances above a threshold (13.37 mg/L KMnO4 higher than 10) indicates that sample of river water contains a lot of animal or human feces. Treatment in this study were able to lower the Organic Matter of 12.79 mg/L KMnO4 to qualify as clean water.

Table 2, Table 3 and Table 4, give an idea that has a lot of decrease parameters in the reference parameter water performance results of treatments in this study. However, when compared with the additional treatment of Reverse Osmosis (RO), a decrease in some parameters still lower in comparison. It is found in (Purwoto *et al*. 2014) stated that Treatment: Poly Propylene Sediment, Carbon Block, Manganese Zeolite, Ion Exchange and Reverse Osmosis (RO) can meet the requirements as clean water is Able to reduce some parameters (amount); Total Disolved Solid (TDS) 2686 ppm, Total Hardness 371.43 mg/L CaCO3, Zinc 0:08 ppm, and 24.56 ppm sulfate. But for the Iron, the result of the decrease was higher in this study (at 8.74 mg/L Fe) compared with 12:18 mg/L Fe, as well as for Detergent 0:26 mg/L LAS greater than 0:10 in (Purwoto *et al.* 2014).

According Nurhayati & Purwoto (2014) capacity of Iron removal by using treatments combination of coagulant aid, Filtration sediment polipropylena (SPP), and manganese greensand absorption, followed by Ion Exchangers at 0:22 ppm, less than the removal of results of this study (amounting to 8.74 mg/L Fe).

Findings Sugito & Sembodo (2014) in the processing of water based on membrane permeable Ion Exchange combined with Electrodeionization (EDI) obtained values decline: Total Disolved Solid (TDS) 752 ppm, hardness 457.24 mg/L CaCO3, Nitrite 0:49 mg/L NO2-N and Zinc 0:07 ppm. (Higher than the results of this study). In the case of removal Detergent, turbidity, color, iron, and sulfate in this research result is greater compared with Sugito, (2014), that is; Detergent 0:26 mg/L LAS (greater than 0:06 mg/L LAS), 148.02 turbidity NTU scale (greater than 4.94), the color 148.00 PtCo unit (greater than 40), and Iron 8.74 mg/L Fe (more greater than 0:55).

Treatment blend spray aerator, zeolite, resin anion - cation with injected steam boiler outlet to remove pH, 1.24%, M alkali; 87.41%, Total Hardness; 99.02%, Ca Hardness; 99.31%, Chloride: 27.44%, 11.84% TDS, Iron; 33.17% , Mn, 96.78%, Conductivity: 1.56% by (Purwoto *et al.* 2011).

Referring to the comparison of findings in the three journals above, about Iron substances decrease in this research result is greater. This is possible because of Ferrolite treatment as treated in this study, and was not used in the treatment in the third referral.

Judging from the large decrease in the number Coli Bacteria (from 1.700.000 live in 1700), this is very representatip because coli bacteria do not support health. Iron compounds in small amounts in the human body serves as the forming of red blood cells, which the body requires 7-35 mg/day which is partly derived from the water. But Fe substances that exceed the dosage needed by the body can cause health problems. This is because the human body can not secrete Fe, so for those who often get a blood transfusion his skin color to black because of Fe accumulation. Drinking water containing iron tends to cause nausea if consumed. In addition, in large doses can damage the intestinal wall. Death is often caused by damage to the intestinal wall. Fe content of more than 1 mg / l will cause irritation to the eyes and skin. If the solubility of iron in water exceeds 10 mg/l will cause the water smell like rotten eggs.

## 4. Conclusion

On the river water treatment using Coagulant Aid treatment, Silica Sand, Ferrolite, Manganese Greensand, and synthetic resins (cation anion), decreased consecutive clean water parameters are: Turbidity 148.02 NTU Scale, Color 148 PtCo Unit, Iron 8.74 mg/L Fe, Total Hardness 35.71 mg/L CaCO3, Zinc 0.03 mg/L Zn, Organic Matter 12.79 mg/L KMnO4, Detergent 0.26 mg/L LAS, Total coliforms 1.6983 million Number per 100 ml (MPN)

 

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