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An Environmental Concern Through Clean Water Treatment Based on Polypropylene Sediment Treatment, Ferrolite, Manganese Greensand, and Ion Exchange Resin

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A B S T R A C T

In a community with a dense population, there are problems related to the availability of clean water. This is due to a straight comparison with population growth. The more the population, the more clean water is needed for daily needs. The problem taken in this research is groundwater or drilled wells in Junwangi Village, Krian District, Sidoarjo Regency, East Java, in providing clean water not through treatment, so that people complain about the quality of pure water distributed to the community. One alternative is to use water treatment technology using Polypropylene Sediment, Ferrolite, Manganese Greensand, and Ion Exchange. The purpose of this study was to determine the results of groundwater parameters before and after treatment, to assess the level of effectiveness in reducing Hardness, Turbidity and TDS by using Sediment Poly Propylene, Ferrolite, Manganese Greensand and Ion Exchange Resin both with 10-inch Housing and 20-inch Housing. The application of micro filter technology with a 10-inch Reactor Housing can reduce Mn 92.7%, from 2.07 mg/L to 0.15 mg/L, TDS 71.6% from 2.053 mg/L to 583 mg/L and Turbidity 98.05% from 26.7 NTU to 0.52 NTU and 20 inch housing can reduce Mn 85.5%, from 2.07 mg/L to 0.30 mg/L, TDS 79.44% of 2.053 mg/L to 422 mg/L and Turbidity 98.16% from 26.7 NTU to 0.49 NTU. The higher the volume of the filtration media, the higher the decrease in Mn, TDS, and Turbidity.

Keywords: Environmental Concern, Clean Water, Filtration, Manganese Greensand, Resin, Polypropylene Sediment

1. Introductiom

In general, groundwater has good quality, And when the taking is done well and free from the muscle can be used directly. Groundwater is any form of rainwater. Flowing under the surface soil as a result of the structure geology, different potential of soil moisture, and the earth's gravitational force. Water down This surface can be known as groundwater (Asdak, 2018). Because of its very important role, proper planning should be carried out to meet the availability of clean water. The local government initiated a drinking water supply program for the community, which was carried out in Junwanigi Village. This program has been operating from February 2020 until now and has more than 200 customers. The provision of drinking water is taken directly from drilled wells without going through filtration first and is directly distributed to the community, so that in its operation it causes problems where the water condition contains Mn, TDS, and Turbidity which, when analyzed in the laboratory, exceeds by the Minister of Health Regulation Number 32 of 2017 Concerning Environmental Health Quality Standards and Health Requirements for Sanitary Hygiene, Solus/Aqua Swimming Pools, and Public Baths. To increase the basic needs of the community regarding the need for clean water, it is necessary to adjust the technology according to the level of mastery of technology in the community itself. One alternative is to use simple water treatment technology by filtration using ferrolite, polypropylene sediment, manganese greensand, and ion exchange resins that can remove turbidity, color, manganese, and other metals (Purwoto et al., 2016). In providing clean water for the community, there need to be the latest technological innovations that are effective and efficient and by the state of the community itself. One alternative is to use water treatment technology using Ferrolite, Polypropylene Sediment, Manganese Greensand, and Ion Exchange. This is supported by research conducted by Purwoto et al. (2016) in improving groundwater quality that, using technology Polypropylene Sediment, Ferrolite, Manganese Zeolite, Anion Resin, and Cation Resin can reduce the content of TDS 20 mg/L, Turbidity 30.36 NTU, and Mn 6.18 mg/L. Filter with a combination of media lower roof tile-zeolite can decrease the efficiency of $CaCO_3$ to 81%, and coliform bacteria with efficiency reached 58% (Rahmawati et al., 2016). Ultraviolet rays combined with Zeolite, Anion Resin, and Cation Resin can reduce *E.coli* up to 99% with an exposure time of 60 minutes (Setiawan et al., 2019). Water purification can be done as an environmentalist learning and improving human resources in terms of applying appropriate technology.

Ion exchange is when one form of ion in a compound is exchanged for several forms, i.e. cation exchanges with cations and anions exchange with anions. Ion exchange happens reversibly and can be generated or filled with desired ions through washing with excess ions. The process of ion exchange occurs continuously until the resin is saturated with interchangeable ions. Therefore, If the resin is saturated with the exchanged ions, it can be regenerated with acids or bases (Ulfin, 2013). The ion exchange process involves a chemical reaction between ions in the liquid phase and ions in the solid phase. Specific ions in solution are more easily absorbed by reliable ion exchange, and because electroneutrality must be maintained, ion exchange on ion removal and ionexchange in solution. In the demineralization process, for example; Na^+ cations and Cl^- anions are removed from the water, and ions lose solid resin H^+ to be exchanged for Na^+ ions, and also OH^- exchange with Cl^- from water so that the Na^+ and Cl^- content in water is reduced or lost (Nurhayati et al., 2014). Adsorption is the process by which molecules touch and adhere to the surface of a solid. Adsorption is a physical phenomenon that occurs when gas or liquid molecules are brought into contact with a solid surface. The molecules on the surface of a solid or liquid have an unbalanced (unbalanced) force that tends to be attracted inward (cohesion force > adhesion force) (Atmoko, 2012). The water treatment process to get better quality can be done with the following steps:

1) Sedimentation and coagulation for discrete particle deposition using sucolite coagulant (Purwoto et al., 2018).
2) Filtration of sludge and dissolved solids using silica sand (Purwoto et al., 2020a).
3) Reduction of Fe and Mn using ferrolite (Purwoto et al., 2016).
4) The process of softening the hardness and absorbing Fe and Mn binding using Manganese Greensand (Purwoto et al., 2016).
5) Anion exchange (reduction of cations in water) using anion resin (Purwoto et al., 2020a).
6) Cation exchange (reduction of anions in water) using cations resin (Purwoto et al., 2020a).
7) Reduction of coliform bacteria using *Reverse Osmosis* (RO) membrane (Purwoto et al., 2020b).
8) Use of UV light (Purwoto et al., 2020b).

2. Method

This study begins with taking raw water samples obtained from wells in Junwangi Village, Sidoarjo, East Java, Indonesia. Then the raw water in the reservoir is pumped by a submersible pump with an inch PVC pipe equipped with a stop faucet and connected to a flow meter to regulate the speed of groundwater flow. Then micro filter treatment through ferrite, polypropylene sediment, manganese Geen Sand and ion exchange resin. In this design, the Bound Variables are the parameters of Iron (Fe), Manganese (Mn), Total Dissolved Solid (TDS), and Turbidity. In contrast, the independent variables are Micro Filter Housing 10 inch media consisting of 03µ Polypropylene Sediment, Manganese Greensand (0.83 L), Ferrolite (0.83 L), Anion Resin (0.83 L), Cation Resin (0.83 L), 05µ Polypropylene Sediment, and Micro Filter Housing 20 inch media consisting of 03µ Polypropylene Sediment, Manganese Greensand (1.68 L), Ferrolite (1.68 L), Anion Resin (1.68 L), Cation Resin (1.68 L), and 05µ Polypropylene Sediment. The sample used in this study was drilled well water taken from water reservoirs and taken from resident's Home Connections. Sequentially the processing stages are presented in full in Fig 1.

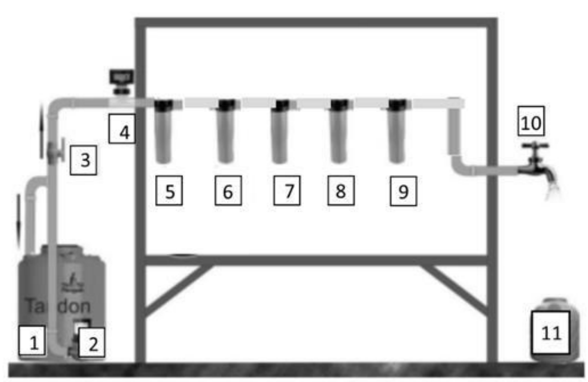

Fig. 1 – Technology Ferrolite, Polypropylene Sediment, Manganese Greensand, and Ion Exchange

Description of Fig 1:

1. Raw Water (Sample)
2. Submersible Pump
3. Stop Faucet
4. Flow Meter (Water Speed Controller)

5. Polypropylene Sediment 0.3 µm
6. Ferrolite
7. Manganese Greensand
8. Ion Exchange (Anion Resin and Cation Resin)
9. Polypropylene Sediment 0.5 µm
10. Stop Faucet
11. Treatment Tank

The function of each filter media is as follows:

1. Sediment Polypropylene. Micro Filter functions to filter (Filtration) and Adsorption the content of mud, sand, soil to produce clear water. Size from 1 micron to 10 microns.
2. Ferrolite functions as Filtration and Adsorption to remove iron (Fe), Manganese (Mn), and yellow colour in water.
3. Manganese Greensand, functions as filtration and absorbent of iron and manganese, where the reaction of Fe and Mn produces a filtrate that has insoluble ferric-oxidation and oxidized manganese.
4. Ion binding resins as Filtration and Adsorption Cations can exchange positive/negative ions from water.

The description of the image above can be explained by number sequence as follows:
(1) Raw water reservoir (2) Submersible Pump (3) Stop Faucet (4) Flow meter (5) 10 inch and 20-inch housing with 03µ. Polypropylene Sediment media (6) Filter housing with Ferrolite media (7) Filter housing with Manganese Greensand (8) Filter housing with Ion exchange resin (9) Filter housing with polypropylene Sediment media 05µ (10) Stop faucet (11) treatment tank. The water treatment process (running reactor) begins with storing raw materials into a reservoir, then pumping it up through a flow meter to get the specified flow rate and going to treatment one housing (5) filter for 03µm Polypropylene Sediment. Continue to the second treatment on the filter housing (6), which contains ferrite. Continue to the third treatment on the filter housing (7), which contains Manganese Greensand. Continue to the fourth treatment on the filter housing (7) containing the Ion Exchange Resin (8). Continue to fifth treatment on the filter housing (9), which contains 0.5 µm Polypropylene Sediment. Treatment is carried out continuously, so that good water results are obtained. Sequentially the installation of micro filtration are presented full in Fig 2.

Fig. 2 – Installation of Micro Filtration

3. Results and Discussion

3.1 Results Research

The results of the research on clean water treatment based on 0.3 µm Polypropylene Sediment, Ferrolite, Manganese Greensand, Ion Exchange, and 0.5 µm Polypropylene Sediments before being processed can be seen in full in Table 1.

Table 1 – Results of Analyzed Raw Water Before Filtration

Parameter	Unit	Laboratory Result	
		Reservoir	Home Connections
TDS	mg/L	189.6	219.3
TSS	mg/L	26	23
Mn	mg/L	2.07	2
Turbidity	NTU	26.7	27.2

The results of the research after treatment can be seen from the results of laboratory analysis taken from several samples. From several sampling points taken for processing raw water samples from the reservoir, it can be seen in full in Table 2.

Table 2 – Results of Raw Water Reservoir Filtration with Housing

Parameter	Unit	Laboratory Result Reservoir	
		10 inch	20 inch
TDS	mg/L	53.1	34.6
TSS	mg/L	2	2
Mn	mg/L	0.42	0.3
Turbidity	NTU	0.8	0.6

From several sampling points taken for the treatment of samples from Home Connections, it can be seen in full in Table 3.

Table 3 – Result of Home Connections Raw Water Filtration with Housing

Parameter	Unit	Laboratory Result Home Connections	
		10 inch	20 inch
TDS	mg/L	39.5	23.8
TSS	mg/L	2	2
Mn	mg/L	0.15	0.49
Turbidity	NTU	0.52	0.6

The results of Micro Filter research with 10 inch Filter Housing and 20 inch Filter Housing show that there is a decrease in TSS, TDS, Mn, and Turbidity parameters. The reduction of the parameters of the two variables is fully presented in Fig 3.

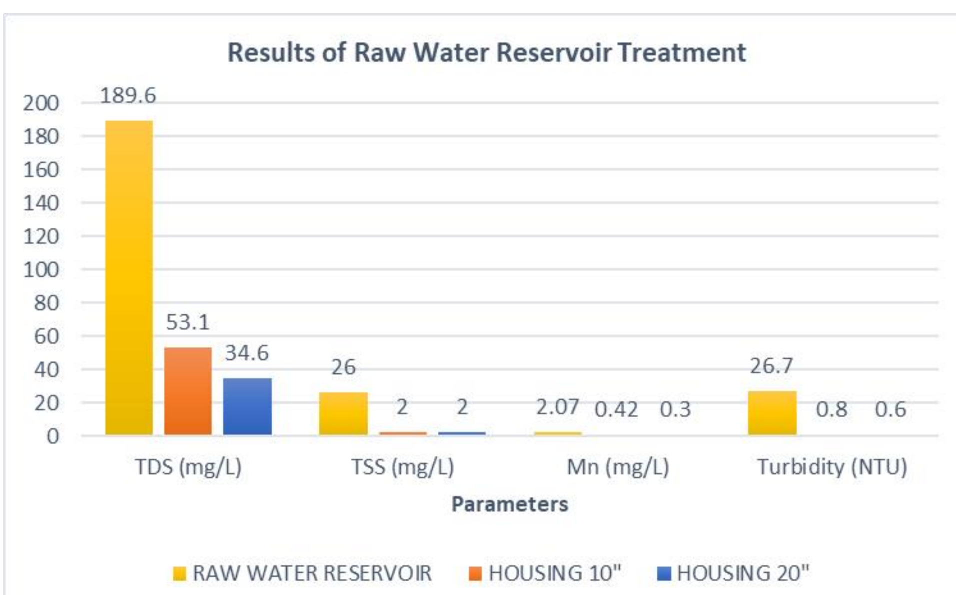

Fig. 3 – Results of Raw Water Reservoir with Treatment Housing 10 and 20 inch

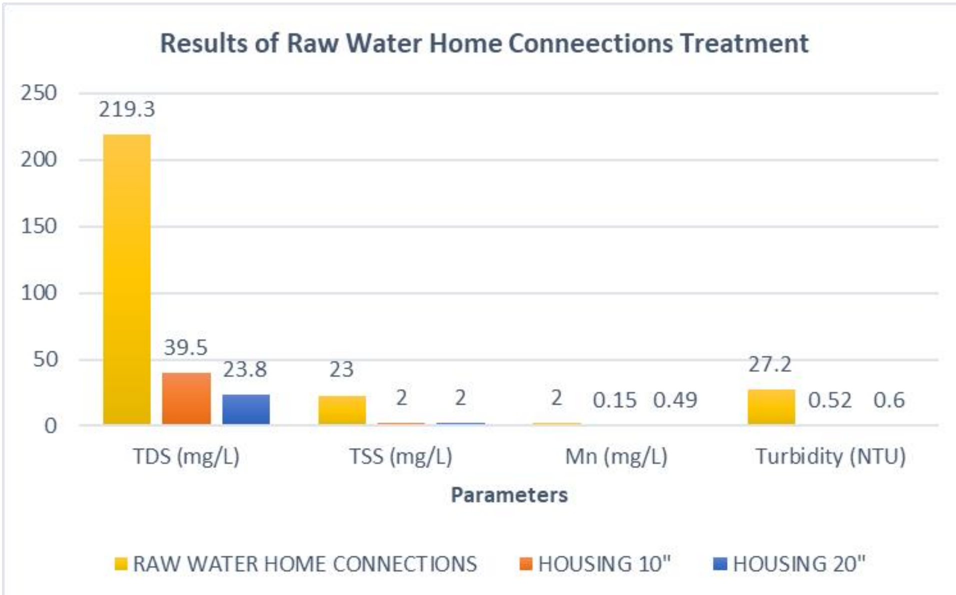

Fig. 4 – Results of Raw Water Home Connection with Treatment Housing 10 and 20 inch

3.2 Discussiom

Generally, health risks related to pollutants are caused by industrial and agricultural activities, while bacteria E.coli is a parameter in water use (Purwoto et al., 2019). Preliminary lab test results at the first point in the Pamsimas reservoir yielded iron metal content values of 1.0688 mg/L (Max 0.3 mg/L), manganese metal of 1.007 mg/L (Max 0.4 mg/L) and for turbidity is 9.0 mg/L (max 5 mg/L). At the second point at the customer's house who using the reservoir system, the iron content value is 1.0685 mg/l (Max 0.3 mg/L), Mn is 1.007052 mg/L (Max 0.4 mg/L) and for turbidity is 188 mg/L (Max 5 mg/L). The sampling points are located in raw water 1 (Storage Tank), raw water 2 (Home Connection), The treatment results from each raw water (1 and 2) using a combination of 0.3 µm Polypropylene Sediment, Ferrolite, Manganese Greensand, Anion Resin, and Cation Resin, 0.5 µm Polypropylene Sediment with Housing 10 and 20 inch, respectively, were taken in Replication 1 on April 18, 2021, Replication 2 on May 18, 2021, and Replication 3 on May 19, 2021. The complete results of replication are presented in Table 4.

Table 4 – Results of Replication Raw Water After Treatment

No.	Sample	Parameters				
		Fe	**Mn**	**Turbidity**	**TDS**	**TSS**
		mg/L	mg/L	NTU	mg/L	mg/L
	Quality Standard	1.0	0.5	25	1000	-
	Replication 1 (April 18, 2021)					
1	Raw Water (Storage Tank)		0.78		904	60
2	Treatment Housing 10 inch		0.185		593	44
3	Treatment Housing 20 inch		0.113		421	40
4	Raw Water (Home Connection)		0.638		896	80
5	Treatment Housing 10 inch		0.022		539	60
6	Treatment Housing 20 inch		<0.01079		257	36
	Replication 2 (May 18, 2021)					
1	Raw Water (Storage Tank)	<0.0688	2.7	26.7	1897	26
2	Treatment Housing 10 inch	<0.0688	0.474	0.8	531	<2
3	Treatment Housing 20 inch	<0.0688	0.302	0.6	346	<2
4	Raw Water (Home Connection)	<0.0688	2.00	27.2	2193	23
5	Treatment Housing 10 inch	<0.0688	0.150	0.52	394	<2
6	Treatment Housing 20 inch	<0.0688	0.104	0.49	238	<2
	Replication 3 (May 19, 2021)					
1	Raw Water (Storage Tank)	<0.0688	2.49	12.4	2053	42
2	Treatment Housing 10 inch	<0.0688	2.33	0.9	520	8
3	Treatment Housing 20 inch	<0.0688	1.11	0.41	419	2
4	Raw Water (Home Connection)	<0.0688	2.42	28.1	2731	41
5	Treatment Housing 10 inch	<0.0688	1.75	0.6	583	4
6	Treatment Housing 20 inch	0.071	1.10	0.47	422	2

Notes: Quality Standard by the Minister of Health Regulation Number 32 of 2017

The results of the analysis have shown that the concentration of Mn, TDS, Turbidity in raw water exceeds the quality standard according to the Minister of Health Regulation Number 32 of 2017, namely Mn > 0.5 mg/L, TDS > 1000 mg/L, and Turbidity > 25 NTU. Thus, further processing is carried out so that it is suitable as a source of clean water. The study results showed that Fe did not decrease because the inlet in the study had reached the limit of the test, so it is not known how much the decrease in Fe concentration was in this study. Meanwhile, the parameters of Mn, TDS and turbidity decreased.

From the results of the study, the highest TDS parameter was in Home Connection raw water in the third replica on May 19, 2021, the decrease in parameters from 2,731 mg/L in Treatment with Housing 20 inch could decrease to 238 mg/L, a significant decrease in parameters one of the TDS elements came from "Mud" or Solid Pollutants from distribution pipeline lines. The highest Mn parameter in the reservoir raw water sample is 2.49 mg/L on the third replica on 19 May 2021, the lowest parameter decrease in the sample treatment with Housing 20 inch is 0.30 mg/L. Eliminating Fe and Mn parameters using Ferrolite, decreasing hardness using Manganese Greensand, reducing cations using anion resin, and reducing anions using cation resin. Microfiltration using RO membrane and a water sterilizer using UV rays (Purwoto et al., 2020b).

4. Conclusion

This study concluded that the micro-filtration method with a combination of Polypropylene Sediment, Ferrolite, Manganese Greensand, Cation Resin, and Anion Resin in a 10-inch reactor housing can reduce Mn 92.7%, from 2.07 mg/L to 0.15 mg/L, TDS 71.6% from 2.053 mg/L to 583 mg/L and Turbidity 98.05% from 26.7 NTU to 0.52 NTU and 20-inch housing can reduce Mn 85.5%, from 2.07 mg/L to 0.30 mg/L, TDS 79.44% of 2.053 mg/L to 422 mg/L and Turbidity 98.16% from 26.7 NTU to 0.49 NTU. The higher the volume of the filtration media, the higher the decrease in Mn, TDS, and Turbidity..

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