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Removal Parameters of Clean Water using Treatment; Sediment Poly Propylene, Carbon Block, Manganese Zeolite, Ion Exchange, and Reverse Osmosis (RO)

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Abstract
The combination treatment ; filtration using sediment poly propylene, absorption by carbon block and manganese zeolite, ion exchanger using synthetic anion resin and cation resin by depth of 70 cm, and then followed by Reverse Osmosis (RO) is a series of water treatment processes in order to reduce substances concentration which is a parameter for clean water. Treatment : Sediment Poly Propylene, 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, Electrical Conductivity (EC) 4478 mhos/cm, Hardness Total 371.43 mg/L CaCO3, Chloride 1144 ppm, Coliform Total 4 MPN/100 mL, Turbidity 2.02 NTU Scale, color 37 units PtCo, Ammonia 1.35 ppm, Iron 0.18 ppm, Fluoride 0.46 ppm, Sodium 737.70 ppm, Nitrate 0.40 ppm, Nitrite 0.28 ppm, Zinc 0.08 ppm, Sulfate 24.56 ppm, Organic Substances 15.03 mg/L KMnO4, and Detergent 0.10 mg/L LAS.
Keywords : reduce parameter, filtration , absorbsi , ion exchanger , reverse osmosis, clean water

1. Introduction

One of example of brackish water conditions in Gresik's coastal areas - East Java - Indonesia, reported that: Cl^- = 1140 ppm, Na^+ > 200 ppm, total hardness = 892.86 ppm, total coliforms = 26 MPN/100 mL, sense = brackish, and TDS = 2478 ppm (Purwoto 2009). All of this conditions can not be recommended as clean water, especially drinking water. According to Permenkes Republic of Indonesia Number: 416 / Menkes / Per / IX / 1990 on Clean Water Quality Requirements and Permenkes number: 492 / Menkes / Per / IV / 2010 on Drinking Water Quality Requirements, Total dissolved solids (TDS) clean water 1000 Mg/L, drinking water 500 Mg/L. clean water color 50 TCU, drinking water 15 TCU, clean water turbidity 25 NTU, drinking water 5 NTU, clean water Iron 1.0 mg/L, drinking water 0.3 mg/L. Clean water Manganese 0.5 mg/L, drinking water of 0.4 mg/L. Clean water Chloride 600 mg/L, drinking water 250 mg/L. Hardness (CaC03) clean water 500 mg/L, drinking water 500 mg/L. Total Coliform Bacteria for clean water 10 (Number per 100 ml sample) on piped water, for drinking water should be zero.

The decreasing of cation anion mineral content as a parameter in the brackish water can be done by : filtration and absorption using sediment of poly propylene (SPP), Carbon Block, Manganese Zeolite, Ion Exchanger, then continue with Ion Exchanger treatment using anion resin and cation resin, ending with Reverse Osmosis treatment using Membrane RO. The using of filter media or filter, has a function to separate the mixture of Solida likuida with porous media or other porous materials to separate as much as possible the suspended solids that the most delicate. And this filtering is the separation process between the solids or colloidal with liquids, where its process is carried out as primary treatment. A new technology of pretreatment of well water with high level of iron has been suggested instead of traditional one based on oxidation of iron followed by filtration through quartz sand and active carbon (Mitchenko *at al*. 2007). Manganese-zeolite as the formulation; ($K_2Z.MnO.Mn_2O_7$). The reaction of Fe^{2+} and Mn^{2+} in water with higher manganese oxide produces filtrate containing ferri-oxide and manganese-dioxide that insoluble in water and can be separated by sedimentation and filtration. Function of Manganese Zeolite (greensand) to remove the content of Iron and Manganese (Fe^{2+} and Mn^{2+}) and the top of oily layer in water as a catalyst and at the same time the iron and manganese that are in water oxidized to form ferri-oxide and mangan-dioxide are insoluble in water. The preparation, characterization, and adsorption properties of Mn^{2+} by manganese oxide coated zeolite (MOCZ) and its ability in removing Mn^{2+} by adsorption were investigated. Characterization analyses were used to monitor the surface properties (and their changes) of the coated layer and metal adsorption sites on the surface of MOCZ. The adsorption experiments were carried out as a function of solution pH, adsorbent concentration and contact time (Taffarel *at* *al*. 2010).

Reverse osmosis technology as related to the major issues of concern in this rapidly growing desalination method. These issues include membrane fouling studies and control techniques, membrane characterization methods as well as applications to different water types and constituents present in the feed water (Malaeb *at al*. 2011). Optimization design of reverse osmosis-based water treatment systems is important (Karuppiah *at al*. 2012). Reverse osmosis desalination is one of the main technologies for producing fresh waterfrom seawater and other saline water sources. The membrane properties greatly affect the water productivity and energy costs in the reverse osmosis desalinatin processes (Li *at al*. 2010). Brackish water (BW) desalination is a primary path to relieve the shortage of water. As one of the BW desalination methods, reverse osmosis technology has advantage for both technology and process procedure (Zhang *at al*. 2013).

Performance resin is process of ion exchange between cation-anion in resin with anion-cation resin which contained in the treated solution. The principle of reducing salt concentration by means of ion-exchange is the exchange of ions between existing cation-anion in solution or water with existing cation-anion in the ion-exchange resin (ion exchange media). The strength of cation expulsion its preference is structured as follows: $Ba^{2+} > Pb^{2+} > Sr^{2+} > Ca^{2+} > Ni^{2+} > Cd^{2+} > Cu^{2+} > Co^{2+} > Zn^{2+} > Mg^{2+} > Ag^{+} > Cs^{+} > K^{+} > NH_4^{+} > Na^{+} > H^{+}$. The order of strength is to strong acid resin which has a robust reactive site such as sulfonate groups (- SO_3H^+). Cation resin binder is also called cation resin. To eliminate the Cl^- ion from brackish water, based on the order of strength of anion expulsion as follows: $SO_4^{2-} > NO_3^- > CrO_4^{2-} > Br^- > Cl^- > OH^-$, The series is for a strong base that has strong reactive site such as quaternary ammonium groups ($-CH_2N{:}(CH_3)_3OH^-$). A binder anion resin also called anion resin (Montgomery 1985). The ion exchange reactions are classified as the topochemical reaction or the host-guest reaction in which neither the bond formation nor the bond breaking occurs. The unique property of such reaction is that the free energy change is rather small in contrast to the ordinary chemical reaction as well as that neither the guest molecule nor the host compound suffers from chemical change. In such reactions, the small free energy change causes the large selectivity change (Kanzaki *at al*. 2001). The resin has been made successfully in pilot batches and is being tested in standard pilot-scale ion-exchange equipment. Field trials are showing considerable promise and are continuing on this resin with surface and underground waters (Battaerd *et al*. 2001).

Brackish water (BW) desalination is a primary path to relieve the shortage of water. As one of the BW desalination methods, reverse osmosis (RO) technology has advantage for both technology and process procedure (Zhang *at al*. 2013). In Dowex-type ion exchangers, the ionogenic groups are osmotically inactive and unhydrated. Thus, the resin phase behaves like single ion solution and properties of single ions can be studied over a wide range of concentration (~2 mol dm 3 to 28 mol dma), without the interference of the cosphere-cosphere interactions (Venkataramani 2003). The research compared pretreatments by anion exchange, cation exchange, and combined ion exchange to a natural groundwater before RO in order to determine which ion exchange process showed the greatest reduction in RO membrane fouling, quantitatively determined by flux decline (Indarawis 2014).

2. Materials And Methods

2.1. Tools and Materials Research

The main tool used in brackish water treatment in this study are: cartridge filter housing, print tube Fibre-Reinforced Plastic (FRP), and cartridge RO housing. Processing procedure performed by using material treatment such as: absorbent Poly Propylene Sediment (PPS), Carbon Block, Zeolite and Manganese Green Sand, anion resin and cation resin and also reverse osmosis membranes (Reverse Osmosis).

2.2.Treatment Research

Treatment research is done by; incorporation filtration treatment, ion exchanger, and reverse osmosis (RO). The processing procedure can be done in three stages, where the early stages are: filtration and absorption using poly propylene sediment (PPS) and Carbon Block using Cartridge Filter Housing, and Manganese Green Sand in print tube Fibre Reinforced Plastic (FRP). The second stage, is Ion Exchanger treatment using anion resin and cation resin in the print tube Fibre Reinforced Plastic (FRP) with a depth of 70 cm. The third stage is reverse osmosis treatment (Reverse Osmosis) using RO Membrane.

Table 1. Criteria of Prototype Reactor Water Treatment

No.	Item	Criteria
1.	Reactor materials	a Fibre-Reinforced Plastic (FRP) print cartridge b.Filter Housing Cartridge c. RO Housing Cartridge
2.	Flow model	Up-flow with a model of by-pass flow entering the nozle
3.	Tube size	FRP 12 X 54 inc.
4.	Strip inlet	setting installation; PVC pipe, elastic hose with fitting system water-mur
5.	Pipeline	Pipeline from the side and bottom
6.	supply pump	Using Submersible-Pump plastic material to avoid corrosion
7.	adapter	24 V DC ; 5 A
8.	RO Pump	RO Booster Pump 24 V DC ; 1,56 A
9.	Temperature treatment	The ambient temperature
10.	Setting the tube	Treatment =Series ; Housing RO = parallel, series

2.3. Research Treatment Groove

According to Figure 1, there is shown a series of brackish water treatment equipment made from natural water carried in a series of reactor water treatment.

Water treatment process begins with raw water as natural brackish water samples drawn from the raw water reservoir using submersible pump (P) to flow into Cartridge Filter tube (1) which contains fittin fabrics for filtration of discrete particles or coarse particles. The next steps is filtering small particles using Poly Propylene Sediment (PPS) 1 micron in series on Cartridge Filter (2) and (3), and odor absorption process using the Carbon Block in Cartridge Filter (4) and (5). The processing forwarded by hardness absorption treatment using Zeolite Filter Cartridge tube (6), followed by Manganese Green Sand treatment on print tube Fibre Fibre-Reinforced Plastic (FRP) (7) which has the function to bind Iron substances (Fe) and manganese (Mn). The results processing from tube (7) followed by cation exchange treatment (reduction of anions in water) on the print cartridge Fibre-Reinforced Plastic (FRP) (8) which contains a synthetic resin cation with a thickness of 70 cm with flow system upwards and followed by binding cations in water using synthetic resin anion, and followed by binding cations in water using synthetic resin anion in print tube Fibre-Reinforced Plastic (FRP) (9) with thickness of 70 cm with flow system upwards. From the results of ion exchange process, so that RO membrane performance is not too heavy, then done second filter on the tube (10). For removal of bacteria, used reverse osmosis filter (RO Membrane -100) (11) arranged in parallel by means of encouragement Booster Pump RO. The result filtration from RO membrane is output processing.

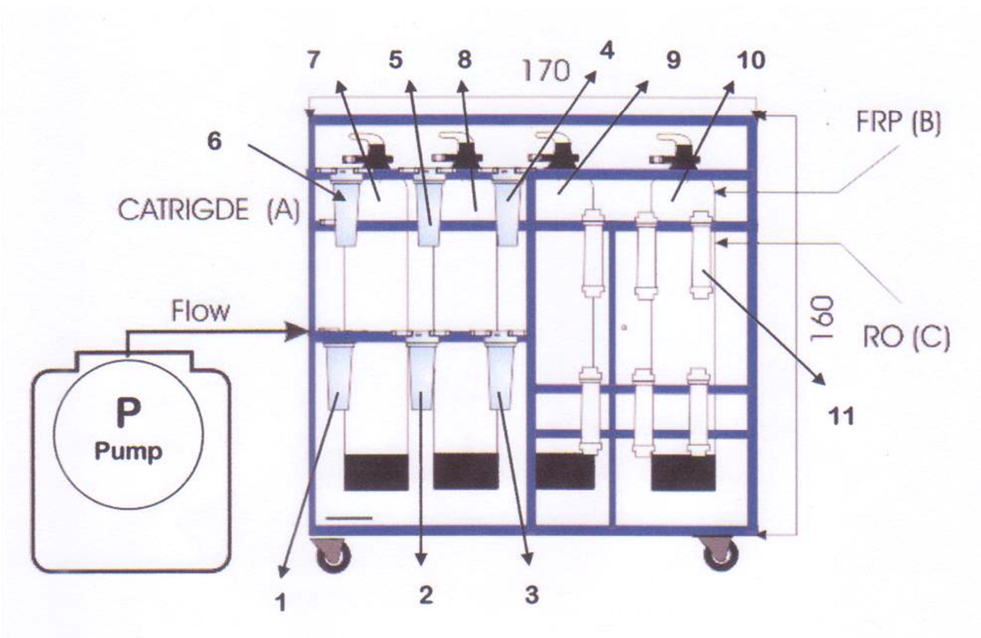

Figure 1. Circuit Brackish Water Treatment Technology In;
Filtration, Ion Exchangers, and Reverse Osmosis (RO)

2.4. Analysis of The Laboratory Tests Results

Parameters test is done for; (A) Samples of raw water, (B) The results of treatment, and (C) RO Membrane filter product.

3. Results And Discussion

3.1. Research

After the raw water treatment is done by; Filter Poly Propylene Sediment (PPS), Zeolite, Manganese Green Sand, Carbon Block, anion resin, cation resin, and RO membrane as compact portable assembly of brackish water treatment reactors (Figure 1), conducted to analysis of laboratory tests treatment results, in which (A) sample is Raw water, (B) sample is treatment result, and (C) sample is the result of reverse osmosis membrane filtration (RO).

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

Table 2. Analysis Result of Parameter Test Mineral Content Rifers to Parameters Clean Water and Drinking Water Standard

No	Parameters	Units	terms of clean water *)	drinking water requirements **)	Raw Water (A)	Treatment (C)	Removal A-C
	A. PHYSICS						
1	Odor	-	odorless	-	odorless	odorless	
2	Total Disolved Solid (TDS)	mg/L	1500	500	2964	278	2686
3	Turbidity	NTU scale	25	5	2.24	0.22	2.02
4	Taste	-	tasteless	-	-	-	
5	Temperature	oC	t air ± 3°C	Air temperature	25	25	0
6	Color	PtCo Unit	50	15	40	3	37
7	Electrical Conductivity (EC)	mhos/cm	-	-	4940	462	4478
	B. CHEMICAL						
	a. Inorganic Chemistry						
1	Mercury	mg/L Hg	0.001	0,001	0	0	0
2	Aluminium	mg/L Al	-	0,2	0	0	0
3	Ammonia	mg/L NH3-N	-	1,5	1.35	0	1.35
4	Arsen	mg/L As	0.05	0,01	0	0	0
5	Barium	mg/L Ba	-	0,7	0	0	0
6	Iron	mg/L Fe	1	0,3	0.42	0.24	0.18
7	Boron	mg/L B	-	0,5	0	0	0
8	Fluoride	mg/L F	1.5	1,5	0.82	0.36	0.46
9	Cadmium	mg/L Cd	0.005	0,003	0	0	0
10	Total Hardness	mg/L CaCO3	500	500	371.43	0	371.43
11	Chloride	mg/L Cl	600	250	1304	160	1144
12	Cromium, (VI)	mg/L Cr	0.05	0,05	0	0	0
13	Manganese	mg/L Mn	0.5	0,4	0	0	0
14	Sodium	mg/L Na	-	200	840.5	102.8	737.70
15	Nickel	mg/l Ni	-	0,07	0	0	0
16	Nitrate	mg/L NO3-N	10	50	1.17	0.77	0.40
17	Nitrite	mg/L NO2-N	1	3	0.29	0.006	0.28
18	Silver	mg/L Ag		0,001	0	0	0
19	pH	-	6,5 - 9,0	6,5 - 8,5	7.9	8.1	-0.20
20	Selenium	mg/L Se	0.01	0,01	0	0	0
21	Zinc	mg/L Zn	15	3	0.12	0.04	0.08
22	Cyanide	mg/L CN	0.1	0,07	0	0	0
23	Sulphate	mg/L SO4	400	250	24.56	0	24.56
24	Sulfide	mg/L H2S	-	0,05	0	0	0
25	Copper	mg/L Cu	-	2	0	0	0
26	Lead	mg/L Pb	0.05	0,05	0	0	0
27	Free of Chlorine	mg/L Cl2	-	5	0	0	0
	b. Organic Chemistry						
1	Organic Substance	mg/L KMnO4	10	10	15.03	0	15.03
2	Detergent	mg/L LAS	0.5	0,05	0.12	0.02	0.10
	C.BACTERI OLOGY						
1	Total Coliform	MPN/100 mL	50 (not piping)	0	4	0	4

Note ; According to Permenkes Republic of Indonesia Number: ***)** *416/Menkes/Per/IX/1990 on Clean Water Quality Requirements and Permenkes number:* ****)** *492/Menkes/Per/IV/2010 on Drinking Water Quality Requirements*

3.2. Discussion

Interpretation of laboratory test data;

Total Disolved Solid (TDS); TDS decreased significantly (from 2964 ppm down to 278 ppm) or having removal 2686 ppm. TDS rate of decline is very significant. This suggests that the decreaseing concentration of dissolved solids is very large. *Turbidity*; Decreasing turbidity in the processed water by 2.02 scale NTU.

This means that substances suspended wane. *Color*; color decline is significant, is equal to 37 units

PtCo, which gives meaning that substances suspended have much absorbed in the treatment process to RO. *Electrical Conductivity (EC);* The treatment result has smaller electrical conductivity than raw water, down as much as 4478 mhos/cm. fell as much as 4478 mhos / cm. These numbers indicate that mineral levels in water process has decreased very large. *Iron*; Treatment in this study were able to reduce 0.18 ppm iron substance, it means manganese green sand treatment has worked well as absorbance Fe-Mn.

Total Hardness; Decreasing hardness total showed the number of 371.43 ppm; this suggests that Mg and Ca cation as measurable parameters of hardness has decreased quite large. *Chloride*; water processed from the samples with a salinity of 1304 ppm down to 160 ppm.Chloride decline is about 1144 mg/L (greater than; Purwoto (2009) is 484 mg/L).

pH; the pH of the water yield slightly increased in the processing of 0.2 units. It is possible presence of residual alkaline substances in treatment material or container. *Sulfate*; decreased by 24.56 ppm. *Sodium*; Sodium content of the original 840.5 ppm in water samples can be reduce much as 737.70 ppm. Na's figure decline is very significant. *Organic substances*;

The results of lab tests for organic substances show zeros of levels 15.03mg/L KMnO4 (raw water). This means that the organic substances in the aggregate (general, without known compounds) have been cleared of water processed as a whole. *Detergent*; Treatment processing in this study is able to reduce detergent content at 0.10 mg/L LAS. *Total Coliform*; Water samples with a total number of Coliform as much as 4 MPN/100 mL has been absorbed as a whole in the processing to zero.

Refers to; parameters clean water requirements and parameter drinking requirements, overall the condition of "meet requirements" (The main decrease occurred in : Total Disolved Solid (TDS), color, Iron, Chloride, Sodium, Organic Matter, Detergent, and Total Coliform (from raw water that does not meet the requirements down to meet the quality standards for drinking water permitted). Therefore, the removal of divalent cations, in particular calcium, from a high hardness water by cation exchange showed a greater reduction in fouling of RO compared with the removal of natural organic matter by anion exchange (Indarawis 2014).

4. Conclusion

Treatment : Sediment Poly Propylene, 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, Electrical Conductivity (EC) 4478 mhos/cm, Total Hardness 371.43 mg/L CaCO3, Chloride 1144 ppm, Total Coliform 4 MPN/100 mL, Turbidity 2.02 NTU Scale, color 37 units PtCo, Ammonia 1.35 ppm, Iron 0.18 ppm, Fluoride 0.46 ppm, Sodium 737.70 ppm, Nitrate 0.40 ppm, Nitrite 0.28 ppm, Zinc 0.08 ppm, Sulfate 24.56 ppm, Organic Substances 15.03 mg/L KMnO4, and Detergent 0.10 mg/L LAS.

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