

Effect Of Venturi Aerator, Pressurized Water Filtration And Magnetic Media In One Unit Of Equipment On Reduction Of Fe Concentration In Clean Water

Dwi Sudiarto*

Departement of Environmental Health, Politeknik Kesehatan Aceh, Kementerian Kesehatan, Aceh Besar, Aceh, 23231, Indonesia Email: dwisdt@poltekkesaceh.ac.id
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Abstract

Objective: One of the aeration processes is to reduce excess mineral content in raw water for drinking, such as iron (Fe) content. The decrease in iron content is difficult to remove by a single chemical method, so it is necessary to add water treatment processes, one of which is an aeration unit. Various kinds of clean water treatment techniques that we can use including coagulation, filtration, sedimentation and aeration, one of the easiest and most frequently used ways is to make a water filter. To determine the Effect of Venturi Aerator, Pressurized Water Filtration and Magnetic Media in One Unit of Equipment on the Decrease of Fe Concentration in Clean Water.

Methods: The method used is a quasi-experimental method by means of aeration with a venturi system, pressurized filtration and the use of magnetic media. The population in this study was all water containing Fe in the district of Darul Kamal, Aceh Besar. The sample in this study was part of the population according to research needs.

Results: There is an effect of a processing unit consisting of a manufactured or artificial venturi, baffle pipe, magnetic or non-magnetic deposition and a 15 cm or 20 cm thick filter. There was no significant difference in Fe levels without magnets and using magnets and 15 cm and 20 cm thickness. The stability of the decrease in Fe content occurs with the use of magnets and the filter thickness is 20 cm.

Conclusion: processing using the manufacturer's venturi, using magnets is very effective in reducing the Fe Concentration of Clean Water at a filter thickness of 20 cm

Keywords: Venturi Aerator, Pressurized Water Filtration, Magnetic Media, Equipment on Reduction

INTRODUCTION

The problem of lack of clean water is a common problem in urban areas, especially in densely populated settlements in the middle of the city 1,2,3. The World Water Forum II stated that Indonesia is one of the countries projected to experience water crisis in 2025, the cause of which is water management, one of which is the inefficient use of water 4. According to data released by Maps of World in 2014, Indonesia has water reserves of 2,019 km³/yr. The Indonesian Institute of Sciences (LIPI) in 2018, noted that Indonesia was ranked the worst in terms of providing clean and suitable water for consumption 5,6. Only 29 percent of Indonesians can access clean water through pipes. This figure is still far below the government's target for 2019, which is 100 percent 7,8. Meanwhile, groundwater is of good quality but the quantity is often very limited. The rapid population growth in Indonesia, especially in big cities, has prompted an increase in the need for housing and the fulfillment of the need for clean water. Surface water and ground water are water sources that are widely used by the community 9.

In general, iron in water can be dissolved as Fe²⁺ (ferrous) or Fe³⁺ (ferry); suspended as colloidal grains (diameter <1 m) or larger, such as Fe₂O₃, FeO, Fe(OH)₂, Fe(OH)₃ and so on; combined with organic substances or inorganic solids (such as clay). In surface water, Fe levels are rarely higher than 1 mg/l, but in groundwater Fe levels can be much higher. Water with an iron content of more than 0.3 mg/l is no longer suitable for domestic use, because it can cause rust marks on clothes and porcelain and cause an unpleasant taste in drinking water as well as excessive use of soap and so on 10. Consuming water with high iron content continuously will interfere with kidney health 11,12. However, Fe in water can usually be reduced by aeration of water at pH > 7. Another process is to bind Fe with a cation exchanger. Both methods require expensive facilities, equipment and materials, whereas conventional filtration uses sand and can improve water physical qualities such as turbidity. Fe levels that are more than 1 mg/l cause irritation to the eyes and skin [13]. The solubility of iron in water exceeds 10 mg/l will cause the water to smell like rotten eggs. There are various kinds of clean water treatment techniques that we can use including coagulation, filtration, sedimentation and aeration, one of the easiest and most frequently used methods is to make a water filter. By combining two clean water treatment techniques, namely a simple

sand filter technique with aeration technique to get clean water and meet health requirements. Based on the problems above, this study aims to determine whether there is an effect of Venturi Aerator, Pressurized Water Filtration and Magnetic Media in One Unit of Equipment on the Decrease of Fe Concentration in Clean Water

METHODS

This type of research is included in research Quasi Experimental Design. With Time Series Design. In this design, the groups used for the study cannot be chosen randomly. Before being given treatment, the group was given a pretest up to four times in order to determine the stability and clarity of the group's condition before being given treatment. If the results of the pretest four times have different values, it means that the group is unstable, uncertain, and inconsistent. After the stability of the group's condition can be clearly identified, then the treatment is given. This research design uses only one group, so it does not require a control group. The population in this study was all water containing Fe in the district of Darul Kamal, Aceh Besar. The sample in this study was part of the population according to research needs. stages research includes preparation is the implementation of making a series of unit filter devices consisting of 6 Venturi Aerators, pressurized water filters, Stop Faucets according to the needs and sizes of pipes, Installing bar magnets and water pumping machines. Experiment drawing plan:

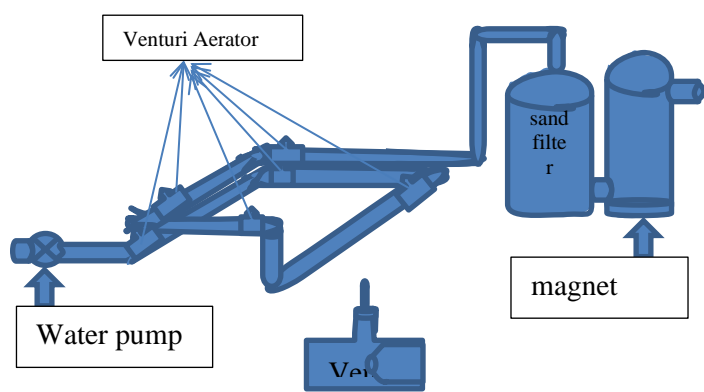


Figure 1 Data analysis was preceded by grouping univariate data from each variable, then bivariate table data was made and analyzed using statistical tools using bivariate techniques and one-way Anova.

RESULTS

There are 2 types of experimental tools, namely experimental tools using venturi made by the factory and experimental tools using venturi with their own modifications



Figure 2. The unit for reducing the level of Fe which consists of a manufacturer's venturi, baffle, temporary deposition and filtering is seen from the left side



Figure 3 Fe level reduction unit consisting of factory venturi, buffle, temporary deposition and filtering viewed from the front.



Figure 4. The unit for reducing the level of Fe which consists of a manufacturer's venturi, buffle, temporary deposition and filtering is seen on the right side



Figure 5 The unit for reducing Fe levels consisting of artificial venturi, buffle, temporary deposition and filtering is seen from the left side



Figure 6 Unit of Fe reduction device consisting of artificial venturi, baffle, temporary deposition and filtering seen from the front



Figure 7 Unit of Fe reduction device consisting of artificial venturi, baffle pipe, temporary deposition and filtering, seen from the right side.

Venturi Aerator

This study uses two types of venturi, namely venturi that has been made from the factory and the other is a venturi that is made by myself. The results of the LSD test showed that all levels of Fe through the venturi aerator from the manufacturer showed significant differences from the levels of Fe before treatment. The meaning of this difference when viewed from the average fe content which shows a higher difference before treatment than the fe venturi aerator level. For more details, see the picture 8

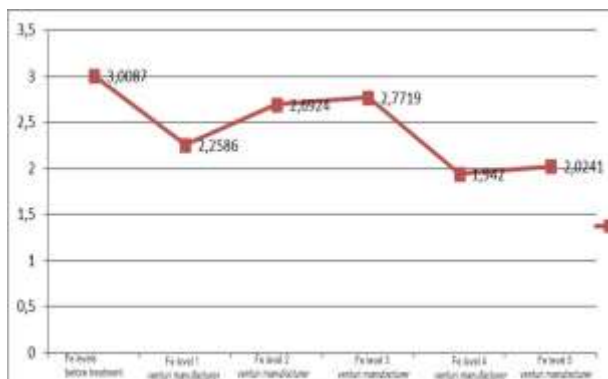


Figure 8 Graph of Mean Fe Content Before Treatment With Several Venturi Aerators

Figure 8 also shows a trend that decreases with increasing venturi, although 2 venturi and 3 venturi show an increase but it is still below the pre-treatment level. The levels of Fe produced by artificial venturi varied, but most of them were below the level of Fe

before treatment, only one which exceeded the levels before treatment, although later it showed a significant decrease. For more details can be seen in Figure 9.

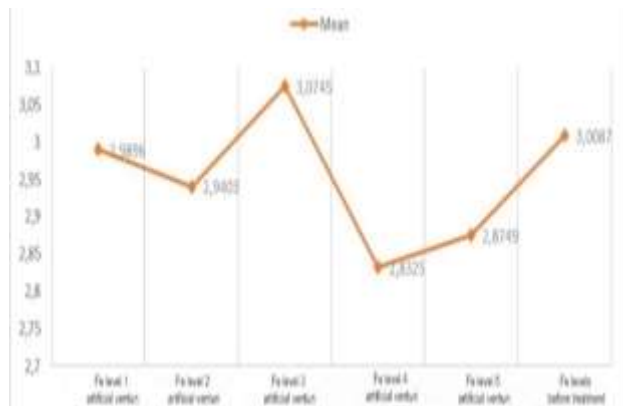


Figure 9 Graph of Mean Fe Content from Artificial Venturi with Pre-treatment.

Figure 9 shows that only 1 treatment showed results of Fe levels that were higher than before treatment, namely in 3 artificial venturi. Comparison of Fe content between factory and artificial venturi for more details can be seen in Figure 10.

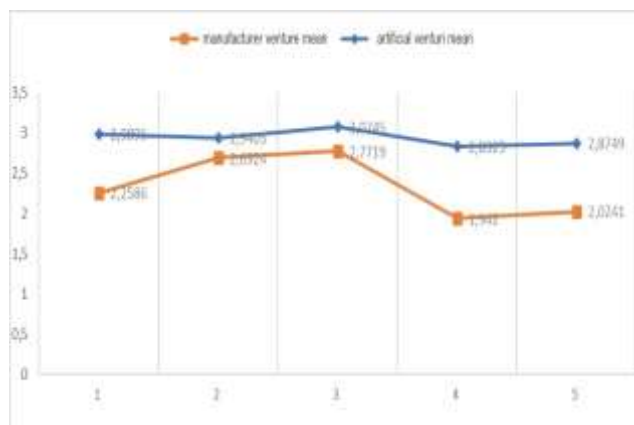


Figure 10 Graph of Mean Fe Content from Manufacturing Venturi and Artificial Venturi

Figure 10 clearly shows the difference in Fe content produced by factory and artificial venturi. The Fe content of the artificial venturi was higher than the Fe content of the factory venturi. This basis indicates that the manufacturer's venturi has a better effect than the artificial venturi. The LSD test results showed that artificial venturi 1 to 5 did not have a significant difference with the manufacturer's venturi 1-3, the rest had a significant difference. This, artificial venturi is still not optimal in reducing Fe levels, but if there is no artificial venturi in the manufacturer, it can be used as a backup for water treatment containing Fe. Venturi uses Bernoulli's principle which is applied to venturi pipes, ie when fluid flows in sections of pipe that are almost the same height. When the fluid passes through a section of the pipe with a small cross-section, the fluid velocity increases (from the continuity equation). According to Bernoulli's principle, the fluid pressure in a narrow section of the pipe is less when the fluid flow rate is greater. Because the amount of fluid entering and leaving the same if the fluid flow rate is high, the fluid pressure becomes small. The low pressure on the venturi neck from environmental pressure is the key to this technology where air can enter the venturi through holes in the venturi neck. (Primary, P. 2010). Air intake (oxygen) can cause aeration which will convert Fe²⁺ ions to Fe³⁺. This Fe³⁺ ion will settle so that it will reduce the solubility of iron in water, so that the level of Fe in the water will decrease.

2. Magnets

This study uses magnets to increase the decrease in Fe levels in water, the use of magnets is installed in temporary deposition using pipes. The results of measuring Fe levels after going through a magnetic field are as shown in Tables 1 – 5. To see the difference in the use of magnets in the processing stages, see Figure 11.

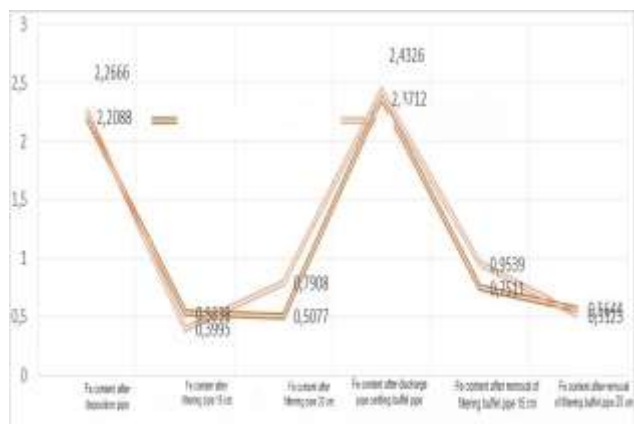


Figure 11 Graph of Fe content at the processing stage using magnets and not

If seen from the graph in Figure 18 of the 6 stages of treatment there are 4 levels of Fe which are better than without using a magnet. seen from the LSD test did not show a significant difference between the two. so it is recommended in the treatment to use a magnet to get maximum results. The use of this magnet can affect the decrease in Fe levels, this is in accordance with the expert opinion that Magnets are iron objects that can attract metal another or an ion that has the property of attracting or repelling an ion of the opposite or the same nature. Magnets have poles that are different from north to south, these two poles will cause a reaction that repels each other when they are brought close to a similar pole, whereas when they are brought close to a dissimilar pole they attract each other. Compounds that have unpaired electrons on the USUU diagram of their separation are paramagnetic and will be attracted by a magnetic field. Meanwhile, compounds that do not have unpaired electrons in their separation diagram are diamagnetic and will be repelled by magnetic fields 14,15.

3. Pressurized sea sand filter

The pressurized sea sand filter in this study is divided into 4 types, namely:

- 15 cm thick sea sand filter with magnet
- 15 cm thick sea sand filter without magnet
- 20 cm thick sea sand filter with magnet
- b. Sea sand filter thickness of 20 cm without magnet

The LSD test results showed that the treatment between sea sand filters with a thickness of 15 cm with a magnet, without a magnet, a thickness of 20 cm with a magnet and without a magnet, was not significantly different. For a clearer comparison, it can be seen in Figure 19.

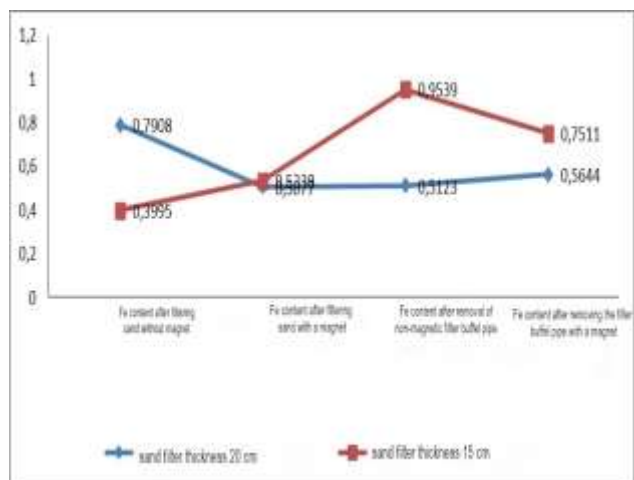


Figure 12. Line Graph of Fe content in sand filter with thickness of 20 cm and 15 cm at various stages of treatment

Figure 12. shows that of the 4 treatments, 3 of them showed a thickness of 20 cm deeper to reduce Fe content so that the use of a filter with a thickness of 20 cm was recommended. This decrease in Fe content is in line with the theory that the filter media or filter because it is a filtration device or filter separates a mixture of liquid solids with porous media or other porous materials in order to separate as much of the finer suspended solids as possible.

CONCLUSION

The number of venturi aerators that are effective in reducing the Fe concentration in clean water is 4. There is an effect of the number of venturi aerators and pressurized filtration on the decrease in Fe concentration in clean water. The number of venturi aerators and pressurized filtration to reduce Fe concentration in clean water which is effective is filtering sea sand with a thickness of 20 cm. There is an effect of the number of venturi aerators and pressurized filtration and magnetic media on the decrease in Fe concentration in clean water. The number of venturi aerators and pressurized filtration as well as magnetic media that are effective in reducing Fe concentration in clean water is the number of factory venturies 4, using magnets and a filter thickness of 20 cm. The large influence of the number of venturi aerators and pressurized filtration and magnetic media on the decrease in Fe concentration in clean water can reduce the average = 83% (from 3.007 mg/l to 0.5077 mg/l)

CONFLICT OF INTEREST

The author declares no conflict of interest

REFERENCES

1. Chalchisa, D., Megersa, M. & Beyene, A. Assessment of the quality of drinking water in storage tanks and its implication on the safety of urban water supply in developing countries. *Environ Syst Res* 6, 12 (2018). <https://doi.org/10.1186/s40068-017-0089-2>
2. Mueller JT, Gasteyer S. The widespread and unjust drinking water and clean water crisis in the United States. *Nat Commun*. 2021;12(1):3544. Published 2021 Jun 22. doi:10.1038/s41467-021-23898-z
3. Fulazzaky, M.A. Challenges of Integrated Water Resources Management in Indonesia. *Water* 2014, 6, 2000-2020. <https://doi.org/10.3390/w6072000>
4. Prayoga R, Nastiti A, Schindler S, Kusumah SWD, Sutadian AD, Sundana EJ, Simatupang E, Wibowo A, Budiwanto B, Sedighi M. Perceptions of Drinking Water Service of the 'Off-Grid' Community in Cimahi, Indonesia. *Water*. 2021; 13(10):1398. <https://doi.org/10.3390/w13101398>
5. Sungkar, S., Pohan, A.P.N., Ramadani, A. *et al.* Heavy burden of intestinal parasite infections in Kalena Rongo village, a rural area in South West Sumba, eastern part of Indonesia: a cross sectional study. *BMC Public Health* 15, 1296 (2015). <https://doi.org/10.1186/s12889-015-2619-z>
6. Agustina R, Sari TP, Satroamidjojo S, Bovee-Oudenhoven IM, Feskens EJ, Kok FJ. Association of food-hygiene practices and diarrhea prevalence among Indonesian young children from low socioeconomic urban areas. *BMC Public Health*. 2013;13:977. Published 2013 Oct 19. doi:10.1186/1471-2458-13-977
7. Sutiono AB, Qiantori A, Suwa H, Ohta T. Characteristics and risk factors for typhoid fever after the tsunami, earthquake and under normal conditions in Indonesia. *BMC Res Notes*. 2010;3:106. Published 2010 Apr 17. doi:10.1186/1756-0500-3-106
8. Atabati H, Kassiri H, Shamloo E, *et al.* The association between the lack of safe drinking water and sanitation facilities with intestinal Entamoeba spp infection risk: A systematic review and meta-analysis. *PLoS One*. 2020;15(11):e0237102. Published 2020 Nov 4. doi:10.1371/journal.pone.0237102
9. Mar, KK, Karnawati, D., Putra, DPE, Igarashi, T., & Tabelin, CB . Comparison of Arsenic adsorption on lignite, bentonite, shale, and iron sand from Indonesia. *Procedia Earth and Planetary Science*. 2013; 6, 242-250.
10. Winkel, L., Berg, M., Stengel, C., & Rosenberg, T. Hydrogeological survey assessing arsenic and other groundwater contaminants in the lowlands of Sumatra, Indonesia. *Applied Geochemistry*.2008; 23(11), 3019-3028.
11. Putra, DPE. Estimation, reality and trend of groundwater nitrate concentration under unsewered area of Yogyakarta City–Indonesia. *Journal of Southeast Asian Applied Geology*.2010; 2(1), 20-27.
12. Jayasumana, C., Paranagama, P., Agampodi, S., Wijewardane, C., Gunatilake, S., & Siribaddana, S. Drinking well water and occupational exposure to Herbicides is associated with chronic kidney disease, in Padavi-Sripura, Sri Lanka. *Environmental Health*.2015; 14(1), 1-10.
13. dwi Rohmadiani, L., Sanjaya, BA, & Moekarni, RR. Reduction of Iron Ions (Fe) In Clean Water By Aeration And Sedimentation Using Magnetic Media. *TIME: UNIPA Journal of Engineering*.2012; 10(1), 28-33.
14. Scheibye-Knudsen, M., Tseng, A., Borch Jensen, M., Scheibye-Alsing, K., Fang, EF, Iyama, T., ... & Bohr, VA. Cockayne syndrome group A and B proteins converge on transcription-linked resolution of non-B DNA. *Proceedings of the National Academy of Sciences*. 2016; 113(44), 12502-12507.
15. Kluck, S., Hambitzer, L., Luitz, M. *et al.* Replicative manufacturing of metal moulds for low surface roughness polymer replication. *Nat Commun* 13, 5048 (2022). <https://doi.org/10.1038/s41467-022-32767-2>