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Effect Of Chlorine Application In Simple Water Filtration Process On Iron Content Reduction In Groundwater

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ABSTRACT

Introduction: *Chlorine Ca(OCl)2 is another compound of chlor that can also remove various kinds of organic and inorganic substances, where these substances have oxidizing and reducing abilities. Two-valence iron (Fe2+) contained in groundwater is caused by the dissolution of water that seeps into the soil, so that the groundwater contains ferrous bicarbonate [Fe(HC03)2], where the water when used will harm the user. This experimental study aims to determine the effect of the dose of chlorine as an oxide in a simple water filtration process on reducing iron (Fe) levels in groundwater using water samples from the borehole complex of the Tanjungkarang Health Polytechnic, Department of Environmental Health.*
Method: *The research was conducted in the laboratory of the Environmental Health Department of Tanjungkarang Health Polytechnic, by making several doses of chlorine treatment in 1,000 ml of raw water, namely P1 = 0.5 gr, P2 = 1.0 gr, P3 = 1.5 gr, P4 = 2.0 gr and P0 without chlorine as a control. The treatment process is carried out by dosing chlorine, stirring (V = 70 rpm, t = 5 minutes), settling (t = 5 minutes) and filtering with a sand filter (0 = 0.1 - 1.5 mm, h = 20 cm) at a discharge of 100 ml / minute.*
Results: *The research results from 5 experiments showed the following experimental results of chlorine 0.0 gr (70.00%); 0.5 gr (84%); 1.0 gr (90%); 1.5 gr (97%) and 2.0 gr (98%).*
Conclusion: *The statistical test used is the analysis of variance, where the hypothesis of the experimental results is rejected, which means that there is a significant difference in the effect of dosage as an oxidizer in a simple water filtration process on reducing iron (Fe) content in groundwater. Further research is needed for maximum results.*

Introduction

Clean water quality requirements include physical, chemical, biological and radioactive requirements must be met so that clean water is suitable for daily use. One of the chemical requirements for water quality is the iron (Fe) parameter, the maximum allowable limit is a maximum of 0.2 mg/l (Ministry of Health, 2023).

Iron levels are often found in residents' well water, especially in swampy areas, rivers, areas that have iron sand and areas around industry according to Djana, 2023 residents' wells in Natar Hajimena District, South Lampung 75% of Iron (Fe) levels exceed the established quality standards, according to Larasati, 2023 borehole water in Sukarame sub-district, Bandar Lampung City from 37 samples examined 4% of borehole water Iron (Fe) levels do not meet the requirements, this was also revealed by Asmawati et al, 2021 Iron (Fe) levels in dug well water located in Suka Maju Village, Sidomulyo District reached 0.5 mg/l.

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Excess iron (Fe) in the body can cause organ damage, including liver, heart pancreas and metabolic disorders (Nurmawi, 2024) Iron (Fe) in water can disturb the taste to be unpleasant, and when distributed by pipelines can cause blockages and rust (Slamet Juli Soemirat, 2018).

Several ways of water treatment to reduce iron (Fe) in groundwater can be done by chlorination. Chlorine is applied to water with the aim of oxidizing iron (Fe) levels in the water to Fe(OH)¬3 because hypochlorite ions (OCl), Chlorine (Cl) and other strong oxidizers can oxidize quickly even in low pH environments with little dissolved oxygen. (Sari, 2024).

The purpose of this study was to determine the effect of chlorine as an oxidizer on reducing iron (Fe) content in groundwater in a simple water filtration process. "Is there an effect of chlorine as an oxidizer in a simple water filtration process on reducing iron (Fe) content in groundwater?".

The scope of this research is limited to a laboratory scale and the chlorine used comes from the compound Ca (Ocl) 2 with 70% active clor and the dose of chlorine applied in this study includes: 0.5 gr/l; 1.0 gr/l; 1.5 gr/l, 2.0 gr/l and without chlorine as a control treatment on groundwater containing iron (Fe) at levels of more than 1.0 mg/l.

Methods

This research is a real experimental study conducted on a laboratory scale taking groundwater sourced from the borehole of the Tanjungkarang Health Polytechnic Complex, Department of Environmental Health with a pretest-postest design with control group design,. Chlorine used in the process of reducing iron content in groundwater has 70% active chlorine, with doses of 0.5 gr/l; 1.0 gr/l; 1.5 gr/l and 2.0 gr/l and without affixation as a control.

While the sand filter used in the simple water filtration process is local sand that first goes through washing and sieve analysis so as to obtain a sand diameter of 0.1 - 1.5 mm and a filter thickness of 20 cm.

The variables of this study include: Independent variables are various doses of chlorine that are applied to groundwater, so that it is expected that the oxidation - reduction process can accelerate the process of reducing iron (Fe) content in groundwater. Dependent variables include water quality parameters including iron (Fe) content, acidity (pH) and temperature and Intervering variables include: sand filters used, contact time, stirring speed, active chlor content, which in the absence of other treatments will be able to affect the experimental process above, controlled by means of all these variables equalized conditions.

The hypothesis in this study was determined based on the different doses of chlorine as an oxidizer used. It is expected that with different doses of chlorine as an oxidizer, there will be differences in the effect of reducing iron (Fe) content in groundwater.

The research data are presented in the form of tables and graphs, while data analysis to test the hypothesis in the study will use the Analysis of Variance statistical test.

Results

The experiment was conducted to determine the effect of various doses of chlorine as an oxidizer on the process of reducing iron (Fe) content in groundwater from boreholes with dose variations in 1,000 ml of water are: P1 = 0.5 gr; P2 = 1.0 gr; P3 = 1.5 gr; P4 = 2.0 gr and P0 without affixation as control. The results of the experiment are presented in Tables 1 to 4 as follows:

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Table 1. Examination of Iron (Fe) parameters in water before and after the water filtration process with the addition of chlorine.

Experiment	Iron (Fe) content					
	Raw water (before treatment)	Chlorine and filtration treatment				
		0	1	2	3	4
		(0 gr/l)	(0.5 gr/l)	(1 gr/l)	(1.5 gr/l)	(2 gr/l)
1	4.85	1.20	0.73	0.47	0.16	0.09
2	4.56	1.18	0.75	0.45	0.15	0.10
3	4.28	1.24	0.70	0.42	0.11	0.08
4	4.90	1.76	0.74	0.48	0.12	0.10
5	4.86	1.68	0.75	0.50	0.14	0.08
Average	4.69	1.41	0.73	0.46	0.14	0.09

Table 2. Examination of the parameter Degree of Acidity (pH) in water before and after the water filtration process with the addition of chlorine

Experiment	Degree of acidity (pH)					
	Raw water (before treatment)	Chlorine and filtration treatment				
		0	1	2	3	4
		(0 gr/l)	(0.5 gr/l)	(1 gr/l)	(1.5 gr/l)	(2 gr/l)
1	6.79	6.97	8.46	8.62	9.62	10.0
2	6.72	6.95	8.51	9.22	9.74	10.0
3	6.73	7.15	8.13	9.65	9.98	10.0
4	6.74	6.95	8.45	9.44	9.78	10.0
5	6.78	7.15	8.50	9.54	9.76	10.0
Average	6.752	7.034	8.410	9.294	9.776	10.000

Table 3. Examination of Temperature parameters (°C) in water before and after the water filtration process with the addition of chlorine.

Experiment	Temperature (°C)					
	Raw water (before treatment)	Chlorine and filtration treatment				
		0	1	2	3	4
		(0 gr/l)	(0.5 gr/l)	(1 gr/l)	(1.5 gr/l)	(2 gr/l)
1	29	30	31	32	32	32
2	29	30	31	32	32	32
3	30	31	31	32	32	32
4	30	31	31	31	31	31
5	29	30	30	31	31	31
Average	29.4	30.4	30.8	31.6	31.6	31.6

Table 4. Examination of residual chlorine parameters in water before and after the water filtration process with the addition of chlorine.

Experiment	Residual Chlor (mg/l)					
	Raw water (before treatment)	Chlorine and filtration treatment				
		0	1	2	3	4
		(0 gr/l)	(0.5 gr/l)	(1 gr/l)	(1.5 gr/l)	(2 gr/l)
1	0	0	0.5	6.0	5.0	8.0
2	0	0	0.9	7.0	7.0	10.0
3	0	0	1.5	7.5	6.0	7.0
4	0	0	0.9	4.0	6.0	8.0

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5	0	0	1.4	5.0	7.0	9.0
Average	0	0	1.04	5.9	6.2	8.4

From the experiment, there are changes in water quality before and after the process including acidity (pH). temperature and residual chlorine which has increased. while the iron (Fe) content decreased with a decrease in efficiency presented in table 9 below;

Table 5. Decrease in Iron (Fe) parameter content in water before and after the water filtration process with the addition of chlorine.

Experiment	Reduction in Iron (Fe) content (%)					
	Raw water (before treatment)	Chlorine and filtration treatment				
		0	1	2	3	4
		(0 gr/l)	(0.5 gr/l)	(1 gr/l)	(1.5 gr/l)	(2 gr/l)
1	4.85	1.20 (75%)	0.73 (85%)	0.47 (90%)	0.16 (97%)	0.09 (98%)
2	4.56	1.18 (74%)	0.75 (84%)	0.45 (90%)	0.15 (97%)	0.10 (98%)
3	4.28	1.24 (71%)	0.70 (84%	0.42 (90%)	0.11 (97%)	0.08 (98%)
4	4.90	1.76 (64%)	0.74 (85%)	0.48 (90%)	0.12 (98%)	0.10 (98%)
5	4.86	1.68 (65%)	0.75 (85%)	0.50 (90%)	0.14 (97%)	0.08 (98%)
Average	4.69	1.41 (70%)	0.73 (84%)	0.46 (90%)	0.14 (97%)	0.09 (98%)

Discussion

Chlorine Ca (OCl) 2 is another compound of chlor that can also remove various kinds of organic and inorganic substances, where the substance has the ability to oxidize and reduce.

Chlorine compounds. when dissolved in water the following reaction will occur;

$Ca(OCl)_2 + 2H_2O$ ----------> $Ca(OH)_2 + 2HOCl$ (9)

$HOCl$ ----------> $H^+ + OCl^-$ (10)

Chlorine when added to water containing iron (Fe) will react as follows;

$Ca(OCl)_2 + 4Fe(HCO_3)_2 + 4H_2O$ ---------->

$Ca(OH)_2 + 4Fe(OH)_3 + 2HCl + 8CO_2$ (11)

Based on the experimental data, the graphs were analyzed to determine the trend of iron (Fe) content decrease and changes in acidity (pH) of groundwater. The analysis is presented in Graph 1 to Graph 4 as follows;

Graph 1.Decrease in the content of Iron (Fe) parameters in water before and after the water filtration process with the addition of chlorine

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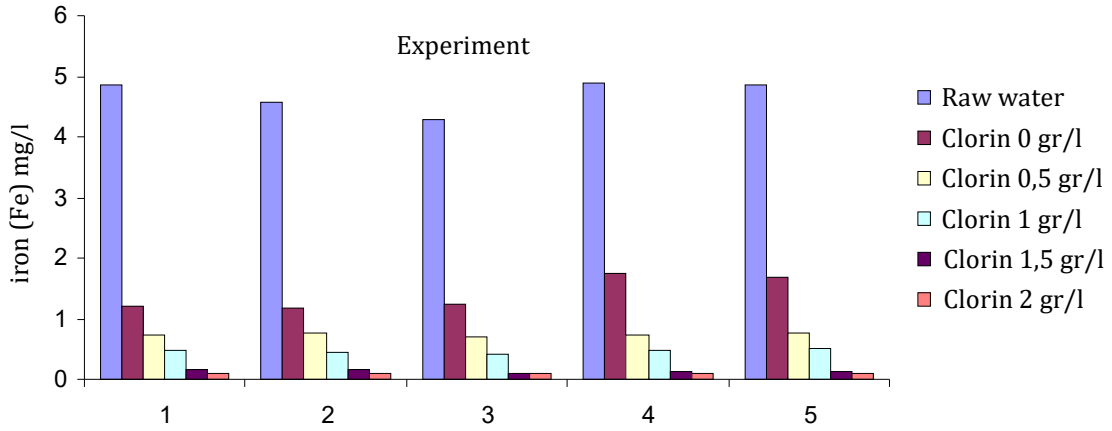
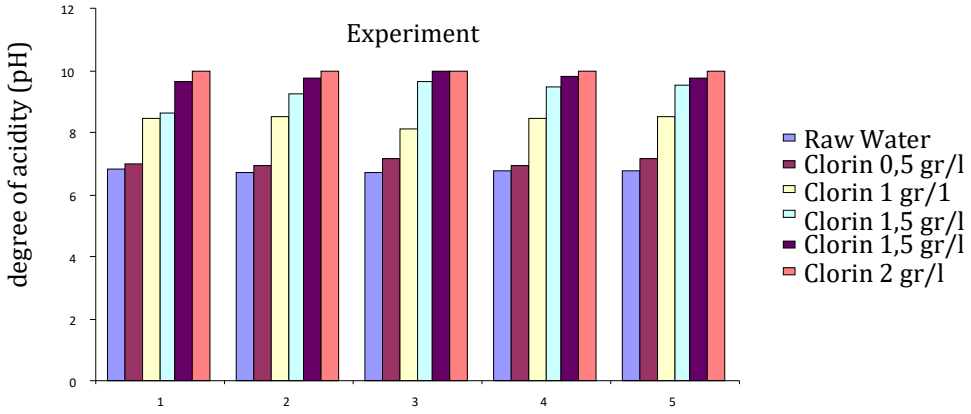


Graph 1 shows the effect of chlorine dose on reducing iron (Fe) content in groundwater. where the higher the dose of chlorine the greater the decrease.

Another effect of the chlorine dose that was observed was the degree of acidity (pH). temperature and residual chlorine where as a result of the process the pH. temperature and residual chlorine increased which can be shown in Graphs 2. 3 and 4

Graph 2: Changes in degree of acidity (pH) in water before and after the water filtration process with the addition of chlorine



Graph 3. Temperature changes in water before and after the water filtration process with the addition of chlorine

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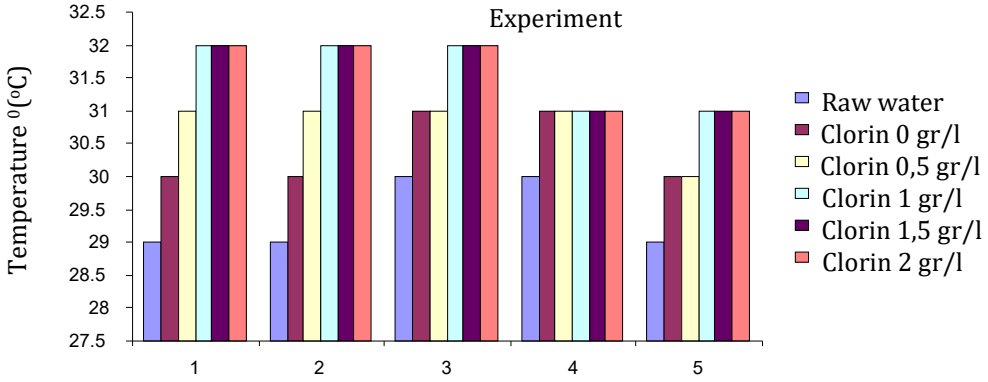
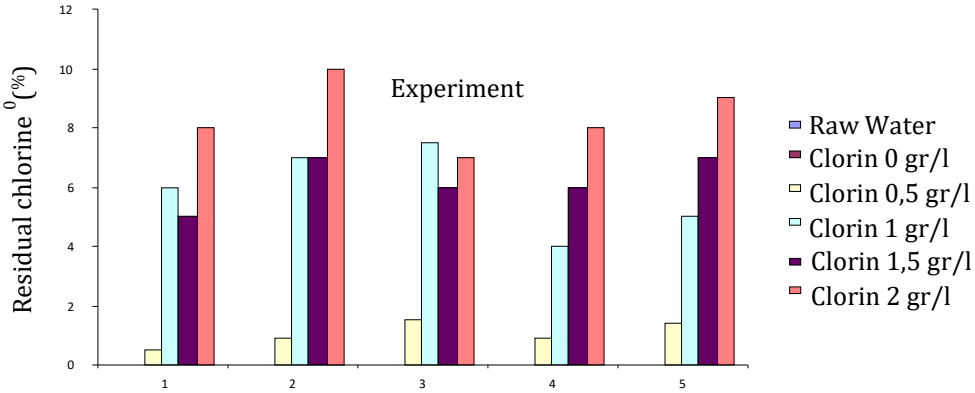


Graph 4: Changes in residual chlorine in water before and after the water filtration process with the addition of chlorine.



This experimental process resulted in a decrease in iron (Fe) content in water at chlorine doses of 0.0 gr (70%); 0.5 gr (84%); 1.0 gr (90%); 1.5 gr (97%) and 2.0 gr (98%). This shows a decrease in iron (Fe) content due to filtering even without the addition of chlorine, while after the addition of chlorine the decrease is getting bigger. The greater the amount of chlorine applied, the greater the decrease in iron (Fe) content in water. However, one day a saturation point will be found, where the iron (Fe) content can no longer be reduced even though excessive doses are given and will have an impact on the remaining chlorine contained which has an impact on the water is not good for consumption.

Analysis of variance was used to test the hypothesis whether there is a difference in the effect of chlorine as an oxidizer in the simple water filtration process on the reduction of iron (Fe) in groundwater. The calculation is presented as follows;

Table 6. Description of the results of the calculation of the analysis of variance in the experiment on the effect of chlorine as an oxidizer in a simple water filtration process on the reduction of iron (Fe) in groundwater.

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
0.00	5	1.4120	0.28341	0.12674	1.0601	1.7639	1.18	1.76
0.50	5	0.7340	0.02074	0.00927	0.7083	0.7597	0.70	0.75
1.00	5	0.4640	0.03050	0.01364	0.4261	0.5019	0.42	0.50

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1.50	5	0.1360	0.02074	0.00927	0.1103	0.1617	0.11	0.16
2.00	5	0.0900	0.01000	0.00447	0.0776	0.1024	0.08	0.10
Total	25	0.5672	0.50654	0.10131	0.3581	0.7763	0.08	1.76

Table 7. Homogeneity test of the experiment on the effect of chlorine as an oxidizer in a simple water filtration process on the reduction of iron (Fe) in groundwater

Levene Statistic	df1	df2	Sig.
54.141	4	20	.000

Table 8. The results of the calculation of the analysis of variance in the experiment on the effect of chlorine as an oxidizer in a simple water filtration process on the reduction of iron (Fe) in groundwater.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.829	4	1.457	88.631	0.000
Within Groups	0.329	20	0.016		
Total	6.158	24			

Because P value is 0.000 less than 0.05 or F count = 88.631 greater than F table = 2.87, the null hypothesis is rejected. Thus, there is a significant difference in the effect of chlorine as an oxidizer in the simple water filtration process on the reduction of iron (Fe) in groundwater.

Conclusion

1. The addition of chlorine as an oxidizer in a simple water filtration process can increase the reduction of iron (Fe) content in water.
2. Different doses of chlorine have a significant difference in the level of iron (Fe) content of groundwater.
3. The process of stirring and filtering groundwater can reduce iron content in groundwater.
4. The lowest chlorine dosage of 0.5 gr/l still gets more than 0.2 mg/l chlorine residual required in clean water.

Acknowledgments

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