

Effect Of Acidity And Electromagnetic Field Strengths On Raw Water Treatment (Turbidity And Color)

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Abstract: Water is not only used to help the lives of organism such as bathing and washing, but also for consumption. Water is an important component that must be absorbed by the body of living things, both humans, animals, and plants so that water must have a standard that is safe for consumption. Over time, the quality of water sources has declined, resulting in a decrease in quality. The scarcity and decline in the quality of fresh water is accompanied by an increasing need for society and industry. Based on data from the Regional Water Supply Company (PDAM) Tirta Musi Palembang in December 2019 the turbidity level is more than 1200 NTU [1]. This is due to the subsequent solid particles suspended in the water from upstream and downstream of the river. Raw water treatment requires a fee of Rp 3,390 per one cubic meter of clean water [2]. To reduce the cost of raw water treatment, it is necessary to develop methods that replace the use of chemicals, including using strong electromagnetic fields in the raw water treatment process. A study by treating raw water by comparing two water samples to determine the reduction in turbidity removal efficiency. The variations in the intensity of the magnetic field are 1.38 T, 2.76 T, 4.14 T, 5.52 T, 6.9 T, 8.28 T. Turbidity reduced from 662 NTU to 0.36 NTU and from 45.25 NTU becomes 0 NTU [3]. Meanwhile, in other studies, the results obtained in the form of an increase in turbidity removal efficiency from 60% to 99.48% using magnetic flux density 0.7 T. While the results without using a magnetic field are only 18.19% at 1.5 hours and reach a maximum value by 39.14% [4] Therefore, in this study raw water treatment obtained from the Ogan River using a magnetic field was then observed based on the turbidity and color. The variations used are variations in the pH of raw water of 2, 3, 4, and 5. While in the processing process the magnetic field strength variations are carried out by 15 V, 25 V, 35 V, and 45 V. Sampling is done every 30 minutes 4 times the analysis test is then performed. In observing the turbidity value, the best results were obtained at 1.40 NTU, namely in raw water treatment with a pH of 5 and the use of a magnetic field strength of 45 V. While in observing the color value, the best results were obtained at 3 TCU, namely in processing raw water with pH of 3 and the use of a magnetic field strength of 45 V. For the best duration of processing that is for 120 minutes.

Index Terms: Water, Turbidity, Color, pH, Electromagnetic, Suspended Particles, Process Duration.

1 INTRODUCTION

Water is a major human need that is needed every day, especially water that is used as a source of drinking water. Good drinking water has a guaranteed source of raw water. The sources of raw water are ground water, lakes, reservoirs, rain water and sea water. Over time, the quality of water sources has decreased, resulting in a decrease in quality. Scarcity and decline in the quality of fresh water are accompanied by ever-increasing needs from the community and industry. This has become a major factor, drinking water companies must increase their production by having quality and environmentally friendly water treatment technologies (water purification techniques). The main factors affecting raw water treatment are turbidity. The turbidity level in water is derived from suspended solid particles, which are insoluble in water but have a very small size. These particles consist of two types, namely organic and inorganic. Inorganic particles are usually derived from rocks and metals, whereas organic matter can come from weathered plants or animals. Industrial waste can also cause a source of turbidity. Organic matter can be a food for bacteria, so it supports its breeding. This bacterium is also a suspended substance, so its proliferation also adds to the turbidity of the water. Likewise, algae that breed due to the presence of nutrients N, P, K and will add water turbidity. It is very difficult to disinfect turbid water, because microbes are protected by suspended substances. This is certainly dangerous for health, if microbes are pathogens. The higher the turbidity level of water, the more chemicals will be used for water treatment. This will certainly result in even greater costs required [5]. Drinking water should not be colored because it has an impression that is not safe for the body. Color in water is caused by the content of chemicals or by microorganisms that are colored. Based on research, tannin compounds and humic acids found naturally

in swamp water, cause the water to be light yellow, resembling urine, so humans are afraid to consume it. In addition, if contaminated with chlorine compounds can form toxic chloroform compounds. Color causes also come from industrial waste. The presence of iron oxide causes reddish-colored water, while manganese oxide causes brownish or blackish water. Manganese levels of 0.05 mg/L and Iron levels as much as 0.3 mg/L are sufficient to cause color in the waters [6]. Calcium carbonate from calcareous areas gives rise to a greenish color in the waters. Organic materials, such as tannin, lignin and humic acid derived from decomposition of plants that have died causing a brownish color. Based on data from the Regional Water Supply Company (PDAM) Tirta Musi Palembang in December 2019 the turbidity level is more than 1200 NTU [1]. This is due to the subsequent solid particles suspended in the water from upstream and downstream of the river. Raw water treatment requires a fee of Rp 3,390 per one cubic meter of clean water [2]. To reduce the cost of raw water treatment, it is necessary to develop methods that replace the use of chemicals, including using strong electromagnetic fields in the raw water treatment process. Electromagnetic field strength is in a field produced by the movement of an electric charge (electric current) so that it causes the emergence of force in other moving electric charges. The direction of the magnetic field will be balanced with the direction of the compass needle in the field. A moving charge causes the formation of a magnetic field which exerts a force on another moving charge. Electric current is the amount of electric charge that comes from the movement of electrons flowing through a point in an electric circuit each time unit [7]. Coulomb / sec or Ampere is a unit of electric current. Electric current is already around us such as electric current in body tissue that is very weak in micro Ampere units to a very strong

current in lightning that is 1-200 kilo Ampere (kA). In most direct current circuit it can be assumed that resistance to electric current is constant so resistance will follow Ohm's law and voltage will affect the amount of electric current. Ampere (A) is one of the seven International Units to present the amount of electric current. Ampere unit can be defined as a constant current which, if tested in a vacuum using two straight parallel conductors with a distance of 1 meter where the area of the negligible, will produce a force of 2×10^{-7} Newton. Some previous research has been done to reduce the level of turbidity (turbidity) and general color by using chemicals as a coagulant. This method is less economical to apply to industry because it requires high costs. Therefore, researchers use a process that utilizes the electromagnetic field strengths to minimize the use of chemicals as coagulants so as to reduce the cost of raw water treatment. Research on raw water and wastewater treatment using electromagnetic field processes has been carried out by several researchers before. However, the research has not reviewed the raw water treatment without using chemicals, so it is expected to minimize operational costs. Lili Jiang et al. [4] In the process of hard carbon from calcium carbonate precipitation an investigation was carried out regarding the effect of the use of magnetic fields. Observe the effect of variations in induction time and magnetic flux density used on total alkalinity, electrical conductivity, total turbidity and formation of calcium carbonate precipitation. This study concluded that the use of magnetic flux density of 0.7 T was found to increase turbidity removal efficiency from 60% to 99.48%. While the results obtained without using a magnetic field of 18.19% in the duration of 1.5 hours and the highest value of 39.14% Shang-Lien Lo et al. [8] conducted a study of raw water treatment with high turbidity through a magnetic aggregation method by which it was applied to a magnetic field with its operating parameters being the magnetic particle dose of Fe_3O_4 nanoparticles, Sodium hydroxide and hydrochloric acid used to regulate the pH of the solution. Fe_3O_4 variation is 0.96-4.80 g, mixed with two stages, fast and slow. Fast condition at 100 rpm for 3 minutes, then slowly mixed for 30 minutes at 25 rpm. Magnetic aggregation was carried out for 30 minutes and samples were taken every 2 minutes to measure turbidity. The results obtained were magnetite doses of 2.88-3.36 g/L, turbidity decreased from 130 to 20 NTU. Dose 3.36-4.8 g/L, turbidity decreased from 20 to 18 NTU. Waleed, M, Sh, et al, [3] investigated the effect of reducing the coagulant dosage (optimal dose is around 10 mg / L) and the use of magnetic fields in the coagulation process. The chemical used is aluminum sulfate with several levels of process. As a raw material by comparing two water samples to determine the reduction in turbidity removal efficiency. The variations in the intensity of the magnetic field are 1.38 T, 2.76 T, 4.14 T, 5.52 T, 6.9 T, 8.28 T. Turbidity reduced from 662 NTU to 0.36 NTU and from 45.25 NTU becomes 0 NTU. B. Merzouk et al, [9] using the electrocoagulation (EC) process. To remove organic pollutants, dyes, and reduce sludge deposition, this process is very effective. pH, initial concentration, current density, processing time, conductivity, and the distance between the electrodes are the parameters in the research of synthetic textile waste water treatment with electrocoagulation-electroflotation (EC-EF) in a batch process. The reactor is operated by varying the distance between the electrodes (1, 2, and 3 cm) and the variation in current density (11.55; 18.6; 35.94; 56.64; 74.07; and 91.5 mA / cm²). The solution used is

300 mg/gel. The results obtained are turbidity removal efficiency of 89.54% obtained without coagulant at current density 11.55 mA / cm². Hua Zeng et al. [10] used HGSM (high gradient superconducting magnetic separation) technology, using a 102 mm bore superconductor. Raw water is made with deionized water which is then added to kaolin. To regulate ionic strength, a 0.01 M NaCl solution is used. Furthermore, as magnetic seeding, Fe_3O_4 is used. The magnitude of the magnetite value is around 625×10^{-6} m³/kg below a magnetic field of 160 kA / m. The value of 100 emu/g is the saturation magnetization of Fe_3O_4 . In Poly Aluminum Chloride (PAC) contains more than 29% Al_2O_3 . The length and diameter of the steel wool, fixed in the 102 mm hole system are 100 mm and 96 mm respectively. The length and width of steel wool sections are 0.1 mm and 0.07 mm, respectively. The effects of PAC doses and magnetite on HGSM are set from 0-12 mg/l Al_2O_3 and 0-50 mg/l Fe_3O_4 . Average turbidity was calculated from three samples collected every 10 seconds. The samples were tested using a 2100AN turbidimeter. When the dosage used varies from 0-8.0 mg / l, the turbidity removal efficiency is increased by 70% to 96%. However, when the dose is made greater than 8.0 mg / l, the removal efficiency value is constant. So that this dosage is considered as the optimal dosage for the use of HGSM.

2 MATERIAL AND METHOD

2.1 Material

In this study raw water from Ogan River is used. In addition, nitric acid (HNO_3) is also needed to provide the desired pH variation of the sample in the study. Before carrying out research, raw water analysis is carried out first. This is done to determine the level of contamination of raw water used and as a comparison to the efficiency of the process in the air treatment plant. Following are the results of raw water analysis obtained from the Ogan River.

TABLE 1
Analysis Results of Ogan River water on October 25, 2019

Parameter	Unit	Maximum Levels Allowed	Analysis Results
Odor	-	Odorless	-
Turbidity	NTU	5	14,9
Taste	-	Tasteless	-
Color	TCU	15	30
Conductivity	μs/cm	1250	133,3
TDS	mg/l	500	64,7
Temperature	°C	Air Temperature +/- 3	24,6

From table 1 it can be seen that the turbidity parameter has a value that does not meet the minimum requirements in the Indonesian Minister of Health Regulation number 492 / MENKES / PER / IV / 2010 [11]. Therefore, such handling is needed that can meet the required quality requirements [12].

2.2 Experimental Method

This research is carried out by treating raw water that has varied its pH value of 2, 3, 4, and 5. These samples are then processed into raw water treatment equipment which then varies the magnetic field's strong voltage, which is 15 V, 25 V, 35 V, and 45 V. Then each sample is analyzed to measure turbidity and color before and after processing. For the flow chart and schematic equipment in this research is shown in Figure 1 and Figure 2.

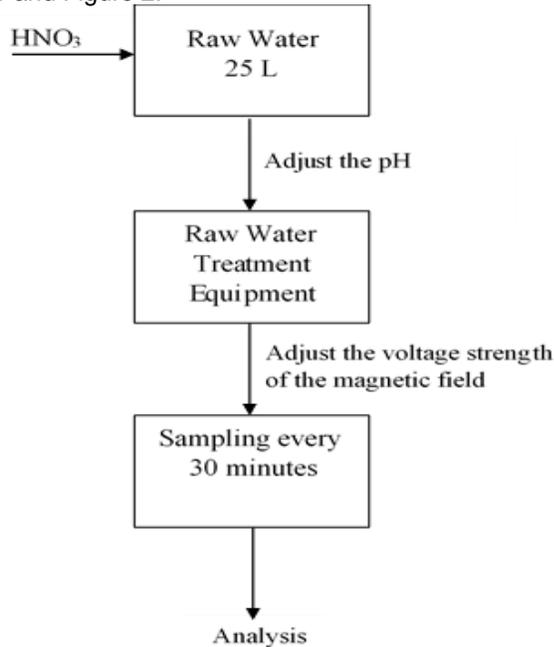


Figure 1. The Research Flow Chart

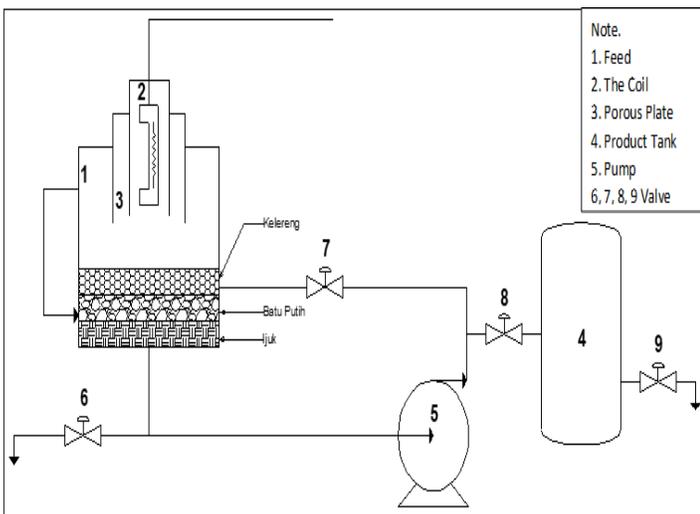


Figure 2. The Raw Water Treatment Process Equipment Scheme with Electromagnetic Field Strength

3 RESULT AND DISCUSSION

3.1 Effect of Water Treatment Process about Turbidity

Turbidity is caused by suspended particles present in water that affect its optical properties. These particles cause the sun's rays to spread and be absorbed, so the water becomes

turbid. The presence of suspended and dissolved organic and inorganic materials (for example mud and fine sand), as well as organic matter in the form of other microorganisms induce turbidity. Water that shows little absorbed light will indicate a low level of turbidity, while a high absorption of light indicates a high turbidity level [13]. Here are the results of the turbidity analysis of raw water that has been processed with various variations of pH, time, and electromagnetic field strengths.

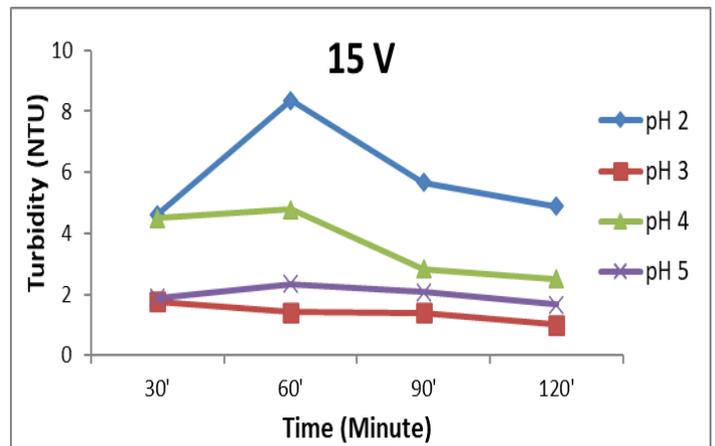


Figure 3. The effect of the use of strong magnetic current 15 V on the turbidity value of the results of raw water treatment

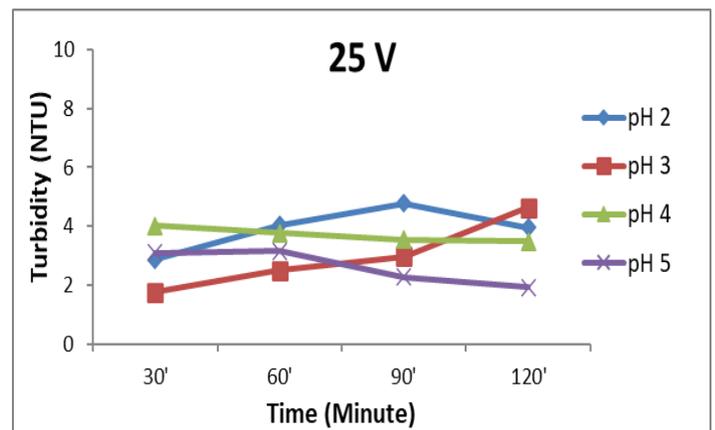


Figure 4. The effect of the use of strong magnetic current 25 V on the turbidity value of the results of raw water treatment

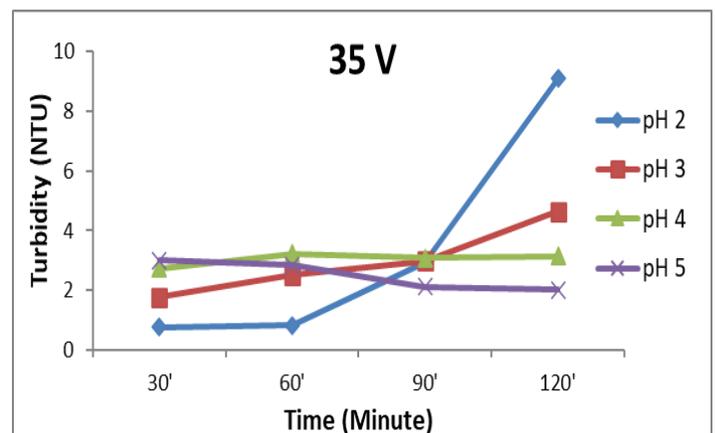


Figure 5. The effect of the use of strong magnetic current 35 V on the turbidity value of the results of raw water treatment

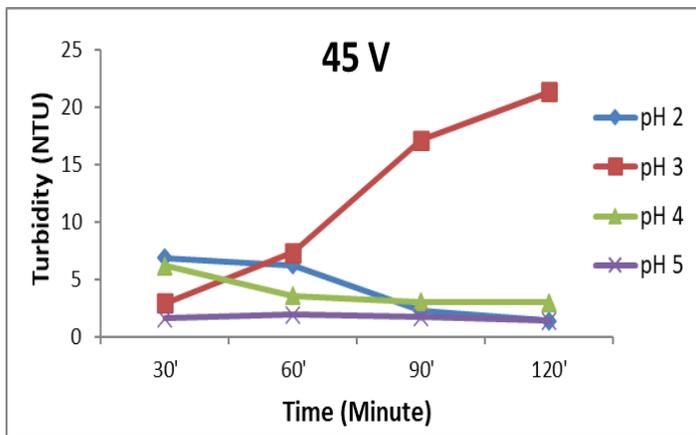


Figure 6. The effect of the use of strong magnetic current 45 V on the turbidity value of the results of raw water treatment

Turbidity data obtained for each variation of voltage, pH and actual time fluctuate, but there is a tendency to obtain the optimum value from the analysis. At a voltage of 15 volts, 25 volts, 35 volts and 45 volts the optimum turbidity value is obtained respectively for 1.67; 1.93; 2.01; 1.40. Each turbidity value was obtained from variations in pH 5 and 120 minutes. In this condition the voltage affects the presence of a magnetic field so as to produce an electric current in the coil of wire. Current indicates the number or number of electrons that move. Changes in the magnetic field can induce electromotive forces (GGL) on the coil of wire. GGL is the energy given to each electric charge to move between two poles of electric power source and has a unit of volts. GGL is what ultimately makes electrons move and produce electricity. When the magnetic field is changed over time, the magnetic field will induce GGL in the wire coil. The optimum turbidity result is 1.40 with a variation of pH 5, a time of 120 minutes and a 45 volts voltage. It means that the higher the voltage, pH and time, the more minimum turbidity results.

3.2 Effect of Water Treatment Process about Color

Color can generally be classified into two, namely visible color (apparent color) and true color. True color is caused by dissolved chemicals. In determining the true color, the suspended materials that cause turbidity are separated first. Visible colors are colors that are not only caused by dissolved material, but also by suspended material. The presence of organic and inorganic materials, plankton ions, humus, and metals (such as iron and manganese) also affect the appearance of color. The presence of iron oxide causes reddish-colored water, while manganese oxide causes brownish or blackish water. Manganese levels of 0,05 mg/liter and iron levels of 0,03 mg/liter are sufficient to cause color. Calcium carbonate from calcareous areas gives rise to a greenish color in the waters. Organic materials, such as yasin, lignin, and humic acid derived from decomposition of plants that have died giving rise to a brownish color. Color can be observed visually (directly) or measured on a platinum cobalt scale (expressed in PtCo units), by comparing the color of the water sample and the standard color. Water that has a low turbidity value will have the same visible color and true color values as standard. Color intensity tends to increase with increasing pH. The color can also be caused by negatively charged colloidal particles, so the addition of positively

charged coagulants, like aluminum and iron can function for color removal [14].

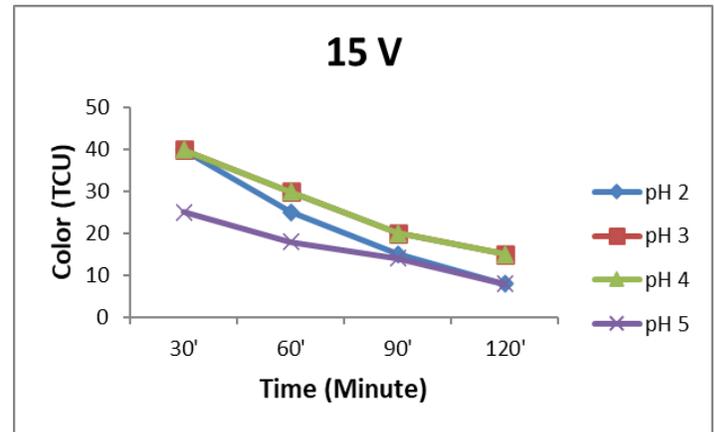


Figure 7. Effect of the use of strong magnetic current 15V on the color of the results of raw water treatment

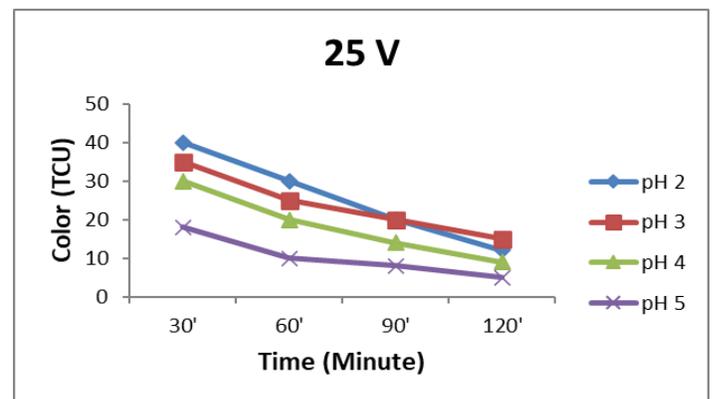


Figure 8. Effect of the use of strong magnetic current 25V on the color of the results of raw water treatment

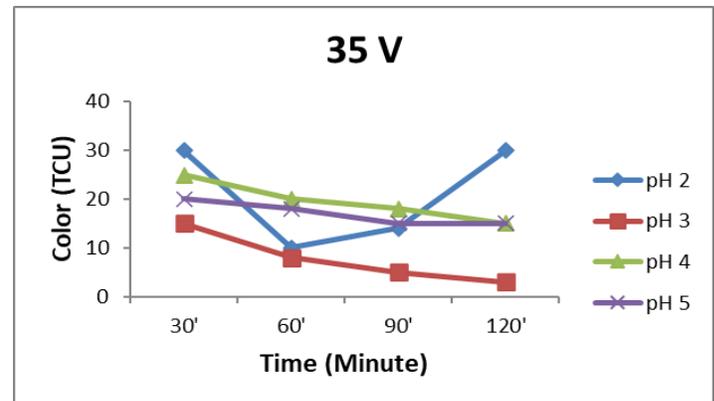


Figure 9. Effect of the use of strong magnetic current 35V on the color of the results of raw water treatment

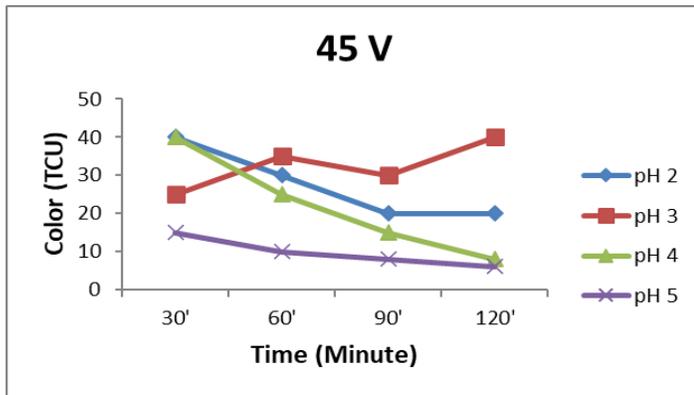


Figure 10. Effect of the use of strong magnetic current 45V on the color of the results of raw water treatment

The color data obtained for each variation of voltage, pH and time fluctuations, but there is a tendency to obtain the optimum value from the results of each analysis, namely at 35 volts, pH 3 and 120 minutes time. As for the voltages of 15 volts, 25 volts and 45 volts the optimum color values, respectively, are 8, 5 and 6. Each color value is obtained from variations in pH 5 and time of 120 minutes. In general, the optimum color is obtained at variations in pH 3 and time for 120 minutes. This means that the higher the pH and time, the more minimum the color yield.

4 CONCLUSION

Variations in the use of strong magnetic fields are used, affecting the quality of water treatment products which are characterized by turbidity and color values. The quality of treated water will be higher if the strength of the magnetic field used is also higher. This shows that more suspended solids are bound by magnetic fields. In addition, water quality will also be better when the pH of raw water is higher and the processing time is longer.

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