1. [EEJET] Submission Acknowledgement

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Inbox

Frolova Liliia **eejet@entc.com.ua** **via** **journals.uran.ua** Tue, Sep 28, 2021, 11:00 AM

to me

Mastiadi Tamjidillah:

Thank you for submitting the manuscript, "Characteristics of Raw Water Sources and Determination of the Optimal Model of the Mixing Process with Parameter Design in Clean Water Pump Installations: Characteristics of Raw Water Sources and Determination of the Optimal Model of the Mixing Process with Parameter Design in Clean Water Pump Installations" to Eastern-European Journal of Enterprise Technologies. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

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If you have any questions, please contact me. Thank you for considering this journal as a venue for your work.

Frolova Liliia

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Comments:

From Reviewer

#1

The remarks to the figures: the numerical values in the figures are very small, you need to increase the text and parameter values.

#2

The article is interesting, but there are several remarks. They are inserted in the text of the article. After elimination of these remarks, the article can be viewed again for the final decision on the possibility of publication in the "Eastern-European Journal of Enterprise Technologies"

UDC 621

CHARACTERISTICS OF RAW WATER SOURCES AND ANALYSIS OF THE OPTIMAL MODEL OF THE MIXING PROCESS WITH PARAMETER DESIGN IN CLEAN WATER PUMP INSTALLATIONS

Mastiadi Tamjidillah, Muhammad Nizar Ramadhan, Muhammad Farouk Setiawan, Jerry Iberahim

To investigate and find the quality characteristics of raw water sources in the regional integrated drinking water supply system (SPAM) of Banjarbakula to maintain the supply of drinking water quantity and quality in accordance with drinking water standards. Selection and determination of the optimum model for the mixing process of raw water and poly aluminum chloride (PAC) and pump stroke for input of water sources from rivers to obtain a composition setting that is in accordance with the raw water sources of each region in the region. So that it is known the optimum parameter setting model between alum water, raw water and pump stroke for each raw water source and is regionally integrated as a result of a comprehensive study. The integration of Taguchi parameter design and response surface can complement each other and become two methods that go hand in hand in the process of optimizing clean water products. Parameter design provides a very practical optimization step, the basis for this formation refers to the factorial fractional experimental design. However, the absence of statistical assumptions that follow the stages of analysis makes this method widely chosen by researchers and practitioners. With the experimental design of the raw water mixing process (turbidity) such as 5 lt/sec, 10 lt/sec, 15 lt/sec, 20 lt/sec and 25 lt/sec and % PAC concentration 5 ppm, 10 ppm, 15 ppm, 20 ppm and 25 ppm with a pump stroke installation of 5 %, 10 %, 15 %, 20 % and 25 %. In the process of adding PAC, *always pay attention and observe the behavior of the attractive force of the floating particles (flock). The particles were then subjected to SEM (scanning electron microscope) to determine the dimensions of the flock grains deposited*

Keywords: characteristics, parameters, setting, supply, turbidity, mixing, concentration, pump, behavior, clean water

1. Introduction

The need for raw water (water supply) is very necessary to ensure availability for the clean water treatment process. With good raw water quality, it describes good natural conditions, so it needs to be maintained to maintain quantity and continuity. Good and sufficient raw water is the hope of the clean water industry and society as consumers for a healthier life. However, the processing process is important so that the quality is always maintained with raw water conditions that vary in quality. It is everyone's effort to use efficient clean water to keep it always available, because water is a basic need that must be maintained for survival.

The characteristics of raw water quality vary, because the source comes from rivers with high turbidity levels above 5 NTU (nephelometric turbidity unit), so a water treatment process is needed to reduce the turbidity level. To meet the community's need for clean water that meets health standards, an adequate supply of raw water is needed to maintain the quality and availability for human life. Water sources from upstream must be considered so that these resources are sustainable by taking into account renewable environmental factors that are useful for other activities such as the use of other energy resources.

The quality of raw water decreases because it is caused by household activities, soil pollution, water pollution, logging activities and plantation land clearing. In addition to the decrease in the quality of raw water, it also causes an increase in temperature, sedimentation and organic content due to the opening of new land for agriculture and plantations in the upstream part of the river. The influence of activities upstream of the river causes the quality of raw water to decrease which will be used as input for processing into clean water. So that an integrated treatment process is needed according to these conditions to get good quality clean water.

The clean water treatment process at the SPAM in the Banjarbakula region continues to be carried out for each region, from the processing installation only PDAM Bandarmasih which has a population of almost 200 thousand people which has been served by 99 % of the community. While the City of Banjarbaru and Kab.

Banjar until the end of 2020 with the number of customers reaching 625,000 people with a service coverage of around 80 %. Likewise Kab. Barito Kuala and Kab. Tanah Laut is still below the national target, which is 68 % and the PBB MDGs (Millennium Development Goals) target of 80 %.

Clean water treatment to reduce the level of turbidity from the water supply, it is necessary to add an appropriate coagulant process to reduce it according to clean water standards. To determine the estimated dose of coagulant is also done by using a parameter design with a variety of settings adopting the Taguchi method. For local Indonesia, the raw water source is from the river, it is different from other countries with the same water source, because forest conditions and environmental factors in the upstream of the river greatly affect the level of turbidity.

By improving the mixing process with various variations to get the optimum setting. With Taguchi's approach to lowering turbidity, accelerates the formation of floating flocks during the mixing process. The coagulation process aims to reduce turbidity, color and odor through a chemical process used to remove colloidal particles that can disturb the environment. Colloidal particles cannot settle, there must be a suitable coagulant such as PAC to destabilize the particles so that microflocs are formed. With the coagulation and flocculation processes in the clean water treatment process with the main parameter setting lowering the turbidity level, it will produce quality water according to health standards.

In the mixing process at the pump installation, it is necessary to set the appropriate parameters to reduce the level of turbidity before and after the mixing process with variations in the addition of coagulant. Optimal settings will be obtained in this process, a positively charged coagulant is used to attract negatively charged colloid particles as a flock which will settle to the bottom of the channel, the behavior of the coagulant that catches floating colloid particles is observed and a scanning electron microscope (SEM) is performed to determine the dimensions of the flock grains. the result of the deposition process of mixing with various content of its compounds.

The contribution of this research is to get the turbidity level before and after the mixing process, the optimal parameter setting model to reduce the turbidity level and to observe and investigate the behavior of flock process in the mixing process.

This is superfluous, because this section of the article did not need to annotate the article. It was necessary to justify the relevance of this problem in modern times. Therefore, you can remove this part of the text.

To finish this section of the article you need this text:

Therefore, studies that are devoted are….. scientific relevance

That is, it is necessary to inform not about the relevance of this work, but about the relevance of scientific problems

2. Literature review and problem statement

Mixing process with various variations to get optimal setting with parameter setting approach to reduce turbidity level and observe flock behavior that floats during the process. In this mixing process, the coagulation process occurs, aiming to reduce turbidity, color and smell which is through chemical process used to remove colloidal particles that can interfere with the environment. Parameter setting is the main factor in the mixing process to get good quality, but it is necessary to use a network system to detect waste water in the water supply [1], assessment of the quality of water sources from rivers is always evaluated and the value of turbidity and sediment aspects [2] These colloidal particles cannot settle on their own and are difficult to handle physically, the addition of PAC coagulant destabilizes the particles to form microflocs [3]. The microflocs then agglomerate into macroflocs which can be deposited through the flocculation process. The coagulation process is time dependent and slow stirring in water. Generally, the flocculation period occurs for 10-30 minutes after the coagulation process [4]. The faster the mixing time, the larger the floc formed with the characteristics of the raw water source, stirring conditions, flocculation time, selected coagulant, and variations in the addition of coagulation consentration will affect the performance of coagulation. The fast stirring process in the ink industry is faster to reduce and reduce waste water [5], while the beverage industry pays attention to the decrease in sediment by setting ppm coagulant [6].

In this clean water treatment plant, the water supply is from a river with a high turbidity above 5 NTU, so it is necessary to add an appropriate coagulant process to reduce turbidity and waste [7]. Many researchers use the addition of conventional coagulant variations with the Jartest method carried out in the process of decreasing turbidity [8], to find out the estimated coagulant dose is also carried out using genetic algorithms and artificial neural network methods to find approaches between water quality parameters and coagulant doses that are more efficient and effective. economical [9]. However, it is necessary to propose an improvement method to design the quality of the clean siren from the beginning with parameter settings that adopt the Taguchi method [10], the green approach to the mixing process at various levels of turbidity by paying attention to waste reduction and minimization. The use of chitosan is useful in reducing waste water and color from industry [11], but for water sources from rivers because organic is used other coagulants such as PAC [12]. For local Indonesia, the raw water source from the river is different from other countries with the same water source, because forest conditions and environmental factors in the upstream river greatly affect the level of turbidity. The choice of coagulant is different for each water supply from rivers or other water sources, with the jartest technique can reduce turbidity, but the use of PAC is even faster in the mixing process [13], with chitosan on coagulation and flocculation reduces color at pH below 5, while river water tends to be above 5 [14].

Colloidal particles that are small and fine are generally negatively charged because river water contains organic or inorganic compounds that cannot be removed by ordinary sedimentation. PAC as a drinking water purification coagulant has a good speed in forming new flocs in the process of mixing clean water. As a basic element, aluminum forms repeating units in long molecular chains which have a high positive charge and large molecular weight and can reduce flocs in purified water even in certain doses [15]. Thus PAC combines neutralization and the ability to bridge flock particles so that coagulation takes place more efficiently [16]. PAC can easily neutralize the electric charge on the flock surface and can overcome and reduce the electrostatic repulsion between particles to as small as possible, thus allowing the flock to approach each other (covalent attractive forces) and form larger masses. PAC selection coagulants can reduce floating flocks in the water supply from rivers, and accelerate sedimentation and reduce waste water non oily from clean water treatment to customers [17], with the use of PAC above 10 ppm it can reduce waste water rather than the use of ultraviolet and chlorine disinfectants [18].

For scenarios of environmentally friendly conditions as a form of sustainable use, natural resources are preserved by taking into account the hydrological cycle of water resources. The use of water resources, especially those from rivers, is very high and worrying, the availability of water supply and its safety is approaching the gray zone and continues to increase, with factor analysis contributing to urban water management [19]. By using fuzzy and TOPSIS can provide information on the availability and contribution of options for the use of water resources [20], water quality is strongly influenced by the condition of the river upstream, either organic or inorganic, waste. There are several scenarios to make water available for downstream industrial inputs such as drinking water needs. However, the quality of drinking water needed must be feasible for consumers by reducing disinfectants which are waste. there are several decision-making criteria to reduce the waste, among others, paying attention to the processing/treatment.

The quality characteristics have been widely studied, both in the manufacturing industry, the water industry and the chemical industry, in the opinion that water sources from upstream must be considered so that the availability and quality of water is better. However, this resource must be sustainable by taking into account renewable environmental factors that are useful for other activities such as the use of other energy resources, the quantity factor must be considered to ensure the availability of raw water [21].

Research on the relationship between raw water quality parameters, chlorine requirements and disinfectant content of drinking water has been carried out [22]. The use of appropriate chlorine will minimize disinfectants so that the quality of drinking water supplied to customers will be maintained according to standards. The model obtained for clean/drinking water treatment conditions in Malaysia shows that there is a relationship between the need for chlorine to reduce disinfectants and improve product quality, the parameters of raw water content also affect the final product and require treatment in its processing.

In the mixing process at the pump installation, it is necessary to set the appropriate parameters to reduce the level of turbidity before and after the mixing process with variations in the addition of coagulant. Optimal settings will be obtained in this process, a positively charged coagulant is used to attract negatively charged colloid particles as a flock which will settle to the bottom of the channel, the behavior of the coagulant that catches floating colloid particles is observed and a scanning electron microscope (SEM) is performed to determine the dimensions of the flock grains. the result of the deposition process of mixing with various content of its compounds.

The contribution of this research is to get the turbidity level before and after the mixing process, the optimal parameter setting model to reduce the turbidity level and to observe and investigate the behavior of flock process in the mixing process.

The review aims to identify the outstanding parts of the problem. Therefore, it is necessary to improve the section by introducing a critical analysis of these sources. That is, it was necessary not only to describe the issues considered in the mentioned works, but to point out those parts of the problem that are not covered in them. It is necessary to refine the section in this direction.

You have to say about each source of literature: which problems were studied in them, which part of the problem remained unexplored, why this part of the problem has not been studied? Can it be objective reasons, methodological or mathematical difficulties, etc.? You must say this specifically.

The last paragraph as a conclusion to the review should also be corrected. It is necessary not just have to say that something is being done in the article. It is necessary to justify why the objective of the research, stated in section 3, is promising. And this should be justified by a critical analysis of the sources.

3. The aim and objectives of the study

The aim of the present research is to investigate the characteristics of water quality in clean water treatment plant.

To accomplish the set aim, the following tasks were set and identified:

– the turbidity characteristics of water before and after the mixing process;

– optimal parameter setting in the mixing process of PAC (coagulant), raw water and pump stroke;

– to determine the behavior of the flow and floating flock, as well as to determine the microstructure of the mixing process.

4. Materials and methods

The dosing pump is designed to drain the PAC coagulant flow fluid into the water fluid. This pump generates a coagulant flow rate by the mixing method set from the valve to deliver the liquid PAC discharge into the dosed reservoir. This pump is very helpful in the process of mixing clean water treatment for coagulant variations which are controlled internally to vary the flow rate and dosage amount.

Taguchi's method is used for parameter setting and integration of the most influential waste output to improve the quality of clean water products, reduce turbidity levels with variations in coagolan doses, optimal mixing process. The target of this method is to make clean water products less sensitive to noise, so it is called a robust design [26] like the concept below:

– the turbidity characteristics of water before and after the mixing process, with the experimental design of the raw water mixing process (turbidity) such as 5 lt/sec, 10 lt/sec, 15 lt/sec, 20 lt/sec and 25 lt/sec and % PAC concentration 5 ppm, 10 ppm, 15 ppm, 20 ppm and 25 ppm with a pump stroke installation of 5 %, 10 %, 15 %, 20 % and 25 %;

– by the parameter settings above, the optimal parameter settings are obtained to reduce the level of turbidity;

– observing and identifying the behavior of floating flocks to sedimentation for SEM.

According to [23], explained that the advantages of the Taguchi method compared to other experimental designs are because it is more efficient in experiments involving many factors but the number of experimental units required is relatively small, the product is more consistent and less sensitive (robust) to variability caused by factors that cannot be controlled (noise). The objective function of the Taguchi method for a robust design that is resistant to noise is derived from measuring product quality using a quadratic loss function in a broader definition to produce an optimal design or parameter setting. Signal to ratio (SNR) in the experimental design system of this method provides a comparison of quantitative values for response variations to determine the optimum parameter settings.

The most important hope in the robust design of the Taguchi method, especially parameter setting, is to examine the effect of variability on factors and experimental levels using statistical tools as a tool. To help fully factorial large, time-consuming and costly experiments, Taguchi suggests using orthogonal arrays (OA) to represent the range of possible experiments. After conducting the experiment, all experimental data were evaluated using analysis of variance (ANOVA) to determine the optimum parameter settings [24, 25].

This method is to determine the factors that influence an optimum response with its characteristics. The Smaller The Better (STB) quality characteristic indicates that the smaller the characteristic parameter, the better the quality. Larger The Better (LTB) indicates that the larger the characteristic parameter, the better the quality will be, and the Nominal The Better (NTB) quality characteristic means that the quality will be said to be getting better if it is close to the nominal (target) that has been set through parameter design and response. for clean water with various concentrations and levels [26, 27].

The conceptual development of the model structure based on the setting of clean water parameters and the optimization model for the mixing process can be seen in Fig. 1 below.

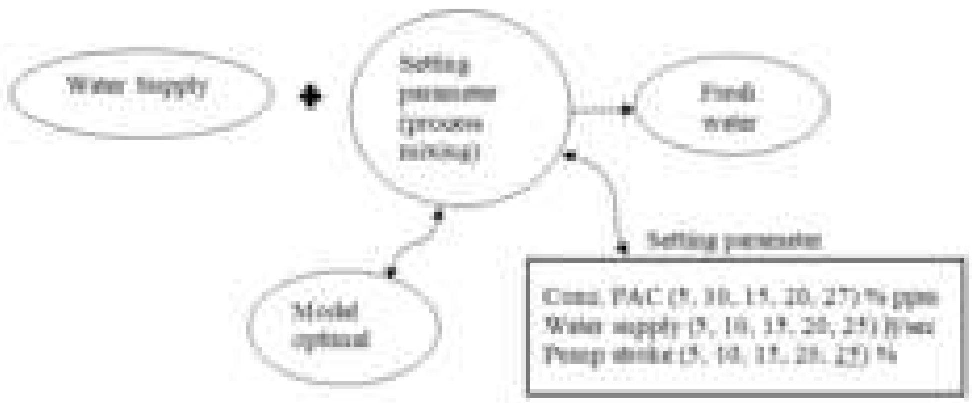


Fig. 1. Setting parameter model in process mixing

In parameter setting there is coagulation to remove and separate colloidal particles from natural organic minerals such as mud. These colloidal particles cannot settle naturally having a diameter of less than 1 mm causing color and turbidity. In Fig. 2 below, it can be seen that section 3 is the mixing process for the PAC variation to reduce the level of turbidity, to observe the behavior of the floating flock in section 4 there is an attractive force that tends to form aggregates while the repulsive force causes a stable colloidal dispersion.

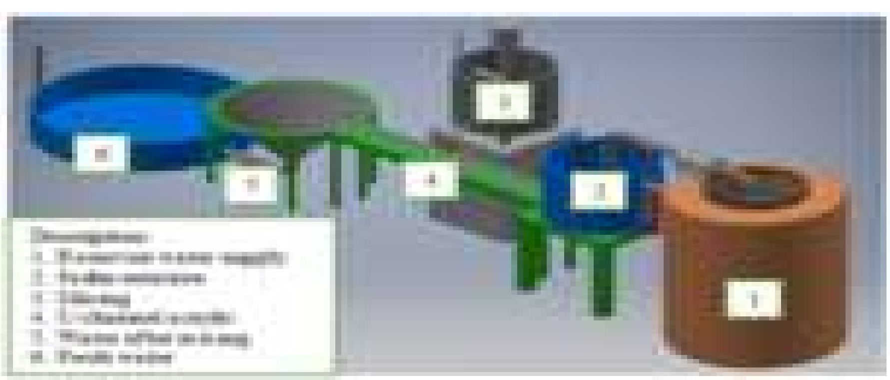


Fig. 2. Research Installation

The water supply contained in section 1 is flowed to section (2) naturally precipitated by gravity, flowing through a transparent glass channel which is dripped with coagulant with the specified setting. The quality of clean water can be seen in section (5, 6), then in the laboratory test to get the level of turbidity according to health standards.

5. Results **Research results of…??** This section title should be clarified

The title should answer the question "What are the results of the research?"

Normality test and turbidity contour level were used to test the data whether the data were normally distributed for the turbidity parameter and information on the distribution of the data, while the counter explained the position of the data distribution in sampling which was determined about the raw water turbidity parameters and the turbidity of the mixing process. This text should be moved to section 4

5. 1. The turbidity characteristics of water before and after the mixing process

Parameter setting conducted in mixing process, as shown in Fig. 3 below, shows that the turbidity value of water supply is above 5 NTU (nephelometric turbidity unit) – which is the standard value for clean water. With the medium level of concentration (11 to 15 ppm), it in shown that the decrease of turbidity value is at the range of 4–5 NTU at pH 7.1. The turbidity value of water supply and mixing process can also be seen in contour plot, Fig. 4 which presents the dispersion of turbidity value with a more detailed range system in the position of turbidity value at each change of PAC concentration.

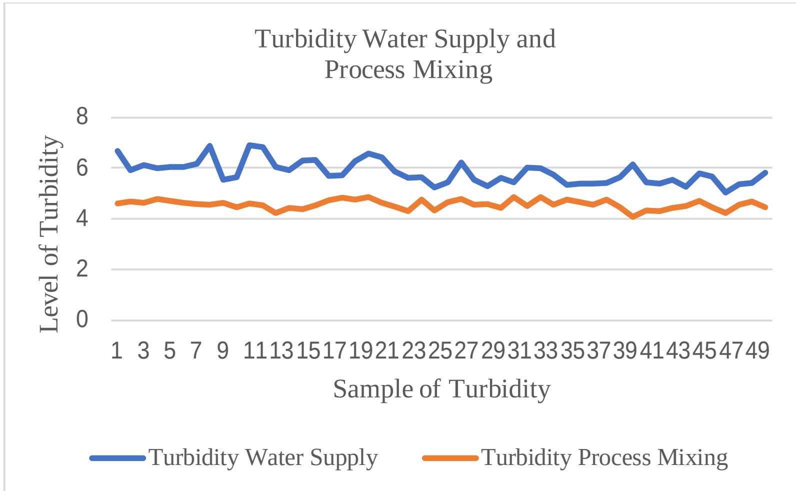


Fig. 3. Level turbidity water supply and turbidity mixing process

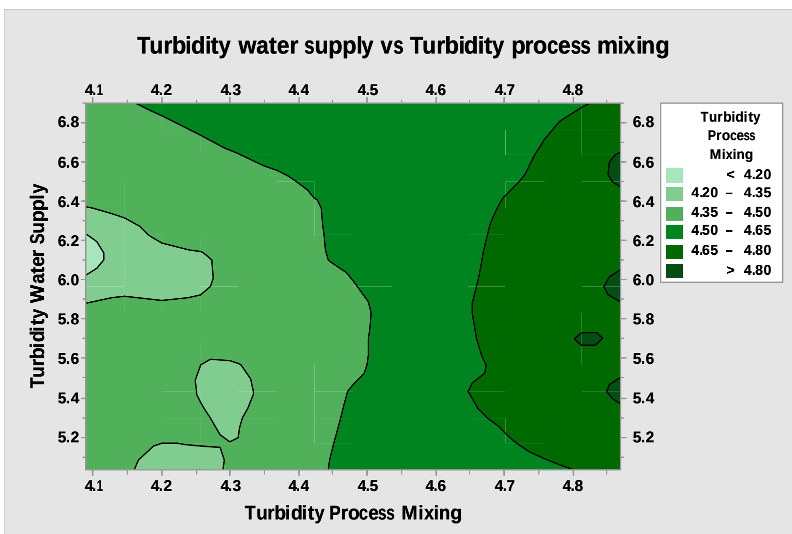
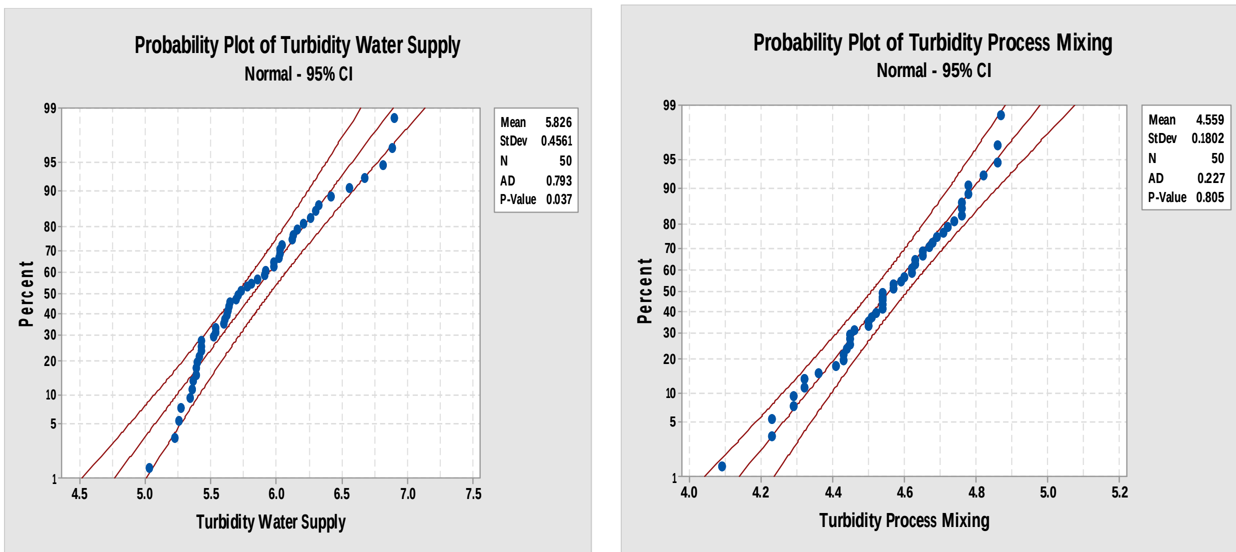


Fig. 4. Contour plot turbidity water supply and turbidity mixing process

Turbidity level of water supply is averagely 5,8 NTU and the reduce of turbidity of mixing process is averagely 4.5 NTU as the addition of medium level in coagulant concentration, but the fluctuation approximates the normal distribution as shown in Fig. 5 below.



a *b*

Fig. 5. Normality turbidity: *a* – water supply; *b* – process mixing

Fig. 5. The variation of turbidity of water supply is influenced by the condition of downstream river, weather and environment of the forest (a) and the decrease of turbidity in the mixing process is due to the coagulant setting process (b). As the ppm coagulant is getting higher, the turbidity would reduce until reaching the optimum concentration level at the medium level in the condition of water supply which is of 5-7 NTU.

5. 2. Optimal parameter setting in the mixing process of PAC (coagulant), raw water and pump stroke

In the mixing process to decrease turbidity with the addition of coagulant variations by setting the parameters of the Taguchi method with Low level (5–10 ppm), medium level (11–15 ppm) and high level (16–20 ppm) as shown in Table 1 below.

Table 1

Level factor

Parameter	Code	Level 1	Level 2	Level 3	Level 4
Conc.alum (% ppm) Water	A	5	10	15	20
Supply (lt/sec)	B	5	10	15	20
Pump stroke (%)	C	15	20	25	30

The change of concentration level of PAC coagulant starts from low level, medium level, and high level simultaneously with the setting of water supply and pump stroke. The decrease of turbidity level seems better as the raise of coagulant concentration level has positive ions. The positive and negative ions depict the effect and response of variable concentration, water supply, and pump stroke as shown in Fig. 6 and Table 2 below. The plot effect of S/N ratio is in the optimum process of parameter design of mixing process at the various concentration level.

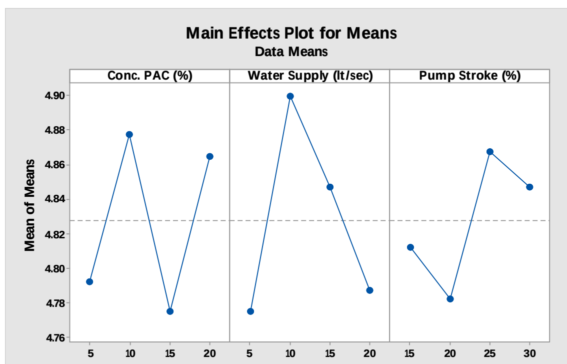


Fig. 6. Response table variable conc PAC, water supply, pump stroke

Table 2

Main effect of process mixing

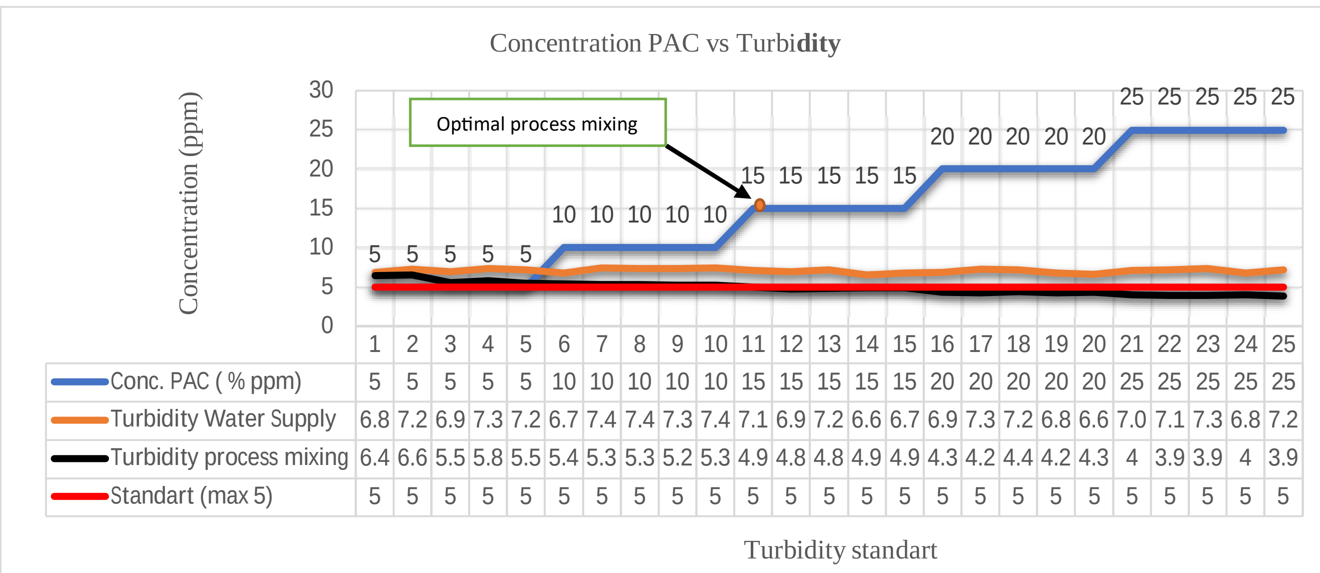
Level	PAC	Water Supply	Pump stroke
1	4.793	4.775	4.813
2	4.877	4.900	4.782
3	4.775	4.848	4.868
4	4.865	4.787	4.848
Delta	0.102	0.125	0.085

Rank	2	1	3

By looking at the fluctuation of water supply turbidity and mixing process, the model of mixing process can be predicted at the medium level of 14 and 15 ppm coagulant. Averagely, the model of prediction of mixing process collects the maximum at medium level which is 15 for the condition of 5-7 NTU.

Optimal process mixing=15 % ppm conc. PAC+15 lt/sec+15 % pump stroke.

Optimal model can be decreased or increased fluctuatively at each 2 point range change of turbidity, for instance 5-7 NTU, 7-9 NTU, and so on. For the more detail, every change of ppm concentration, water supply and pump stroke can be seen in Fig. 7 below. At the position of medium level, it can be seen that the turbidity value of mixing process is at 4.8 NTU and 4.9 NTU which are close to the health standard. The higher % ppm of PAC causes the turibidity to decrease and the water color turn to transparent. The effect of over PAC would not be harmful for human body but with a continuous excessive dosage in a long time, it would cause side effect in form of toxin within human body.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Conc. PAC (% ppm)	5	5	5	5	5	10	10	10	10	10	15	15	15	15	15	20	20	20	20	20	25	25	25	25	25
Turbidity Water Supply	6.8	7.2	6.9	7.3	7.2	6.7	7.4	7.4	7.3	7.4	7.1	6.9	7.2	6.6	6.7	6.9	7.3	7.2	6.8	6.6	7.0	7.1	7.3	6.8	7.2
Turbidity process mixing	6.4	6.6	5.5	5.8	5.5	5.4	5.3	5.3	5.2	5.3	4.9	4.8	4.8	4.9	4.9	4.3	4.2	4.4	4.2	4.3	4	3.9	3.9	4	3.9
Standart (max 5)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

Fig. 7. The variation of PAC concentration at each level

In Fig. 7 above, it can be seen that the concentration of % PAC at medium level 15 produces a turbidity level of 4.9, close to 5 NTU health standards, so that point becomes optimal. If you add more PAC at levels 20 and 25 the clean water is close to white color can be harmful to health if used continuously because of the effect of high coagulant content.

5. 3. To determine the behavior of the flow and floating flock, as well as to determine the microstructure of the mixing process

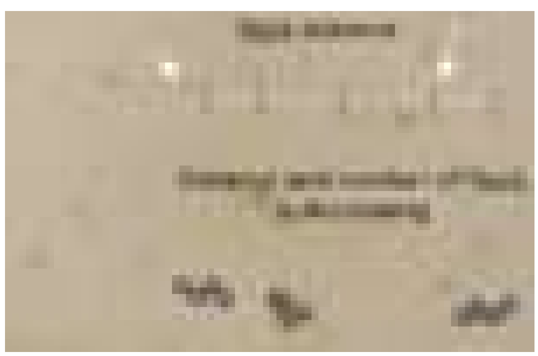
Each change of PAC concentration level causes the change of water turbidity value, colloid behavior and floc formation in mixing process. Coagulant characteristic whose charge is positive ion would attract negatively charged colloid that is often called as the effect of Van der Waals' attractive force. A proper addition of coagulant concentration would reduce the zeta potential repulsive force in the colloid, thus there is more positive ions than negative ions which causes faster floc formation process. With sedimentation process and flock filterization, it would gravitationally percipate at the bottom surface to furthermore be thrown away since the sedimentation is known as waste in the industry of clean water.

In the mixing process, each variation of water supply, ppm PAC and % stroke pump will affect the level of turbidity due to the addition of coagulant which will attract negative ions into flock, with increasing coagulant and pump stroke in the form of pump speed in rpm will accelerate the process of flock formation, Fig. 8a presenting large flocks so that the effect of the van der Waals forces can still be seen, a large attraction by the coagulant will accelerate flock formation.

With the increase of coagulant and pump stroke in the form of pump velocity in rpm, it would fasten the process of floc formation. Fig. 8, *a* represents the big grain-sized flocs in which thus the effect of Van der Waals' force is visible. The great attractive force from coagulant would fasten the floc formation. To observe the Brownian motion, which is in form of zig-zag line or dash line, the portrayal of molecular kinectic flocs in Fig. 8, *b* requires a camera magnification of 1200 with the type of SEM digital. In Fig. 8, *c*, the distance among flocs is getting bigger due to the addition of rpm, then the particle flies slowly to the bottom in groups following the gravitation principle.

a

b



c

d

e

f

Fig. 8. SEM image of flock: *a* – 5 % ppm; *b* – 10 % ppm; *c* – 15 % ppm; *d* – 20 % ppm; *e*,*f* – 25 % ppm

Moreover, in Fig. 8, *d*, flocs start to percipate downward closing by the plat basis together with coagulation and flocculation. In Fig. 8, *e*, colloid and flocs are not visible since the pump rpm of mixing process is of 20 % and 25 % rpm at high level. It can be seen that the small visible flocs are closing by the big floc gap filled by liquid space where viscosity is smaller hence following the big floc pattern by clinging and uniting into big flocs continuously. Meanwhile, in Fig. 8, *f*, the group of flocs is visible until the basic plat with bigger grain and percipates covering almost the whole surface of the basic plat.

6. Discussion of results 6. Discussion of the research results of…??

This section title should be clarified. The title should answer the question "Discussion of the results of the study <u>of what</u>?"

The optimal model obtained and proposed for the mixing process of % PAC, raw water and % pump stroke shows that the existing condition exceeds the established health standard. By using the medium turbidity level parameter setting of 14 and 15 ppm coagulant, the maximum prediction model was taken at 15 ppm for conditions of 5-7 NTU. The model fluctuates every time the turbidity range changes 2 points, for example 5–7 NTU, 7–9 NTU and so on.

At low-level coagulant concentrations the attractive force between coagulant and colloid is not too large, but for medium and high-level coagulants the attraction is stronger because of its positive ion nature, on the other hand the effect of Brownian motion gets smaller with increasing % ppm of coagulant because the water tends to be colored White. If the coagulant concentration is added again in rpm and the appropriate time, the flock-flock by gravity will accumulate at the bottom of the plate in the form of sediment waste which is flowed to the waste processor before being discharged to the final place.

Everything below is good. The text above needs to be concretized (see comments below)

The limitations of the proposed new model in the mixing process are related to the condition of the research object, while the method is also limited in setting parameters using experimental design principles in the early stages of setting. Have not adopted another method to estimate coagulant dose, while the assumption used is that the parameter data is the same every day.

The limitation of this model is related to the resource capacity of the clean water treatment section and the setting of additional equipment. So that a gradual change is needed, conventionally daily sampling in the mixing process describes the parameters that affect water quality. Especially for water sources from rivers that are specifically intruded by swamp water, the turbidity factor is the most influential factor for setting parameters in the mixing process.

For the process of developing clean water treatment processes that are affected by turbidity in river water sources, measurements of the level of turbidity are carried out. This turbidity data is very important in the production process to carry out complex experiments for daily data, but specifically for water sources from rivers that are specifically intruded by swamp water, the turbidity factor is the most influential.

- how can the results be explained? This interpretation part is the first main part of the discussion and there are important nuances of its presentation. It is necessary to explain the results obtained for each research objective, referring to those objects in the article that display the discussed results. Such objects in the general case are analytical expressions, figures, tables. That is, it should be seen which result is being discussed at this point in the section.

- how do the proposed solutions/results allow to close the problem area identified by the author, and if so, in which part and due to what exactly? This is the second main part of the discussion, because it is this that closes the research (feedback): the problem is identified – the aim is set – the results are obtained – the results are explained using some kind of evidence base (section "Discussion ...")

- what can be considered the advantages of this study in comparison with those known on this subject. In this case, it is necessary to indicate alternative solutions and say, thanks to which particular features of the proposed solutions, advantages (or, in general, differences) are provided?

7. Conclusions

1. The variation of turbidity of water supply is influenced by the condition of downstream river and the decrease of turbidity in the mixing process is due to the coagulant setting process. The turbidity would reduce until reaching the optimum concentration level at the medium level in the condition of water supply which is of 5–7 NTU.

2. The decrease in turbidity level in the mixing process is due to changes

in parameter settings, the higher the ppm of coagulant, the turbidity will decrease until it reaches the optimum concentration level at the medium level in raw water turbidity conditions of 5–7 NTU.

3. In low level coagulants the attractive force between coagulant and floc is not too large, but for medium and high level the attraction is stronger because of the nature of the coagulant which has positive ions. On the other hand, the effect of Brownian motion decreases with increasing % ppm of coagulant because the water tends to be white. If the concentration of coagulant is added again, the floc will decrease by gravity and accumulate to the bottom of the plate in the form of sediment waste.

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Comments continued

CHARACTERISTICS OF RAW WATER SOURCES AND DETERMINATION OF THE OPTIMAL MODEL OF THE MIXING PROCESS WITH PARAMETER DESIGN IN CLEAN WATER PUMP INSTALLATIONS

From the title should follow what your research was: development, comparison, implementation, research, analysis, etc.

Mastiadi Tamjidillah, Muhammad Nizar Ramadhan, Muhammad Farouk Setiawan, Jerry Iberahim

To investigate and find the quality characteristics of raw water sources in the regional integrated drinking water supply system (SPAM) of Banjarbakula to maintain the supply of drinking water quantity and quality in accordance with drinking water standards. Selection and determination of the optimum model for the mixing process of raw water and poly aluminum chloride (PAC) and pump stroke for input of water sources from rivers to obtain a composition setting that is in accordance with the raw water sources of each region in the region. So that it is known the optimum parameter setting model between alum water, raw water and pump stroke for each raw water source and is regionally integrated as a result of a comprehensive study. The integration of Taguchi parameter design and response surface can complement each other and become two methods that go hand in hand in the process of optimizing clean water products. Parameter design provides a very practical optimization step, the basis for this formation refers to the factorial fractional experimental design. However, the absence of statistical assumptions that follow the stages of analysis makes this method widely chosen by researchers and practitioners. With the experimental design of the raw water mixing process *(turbidity) such as 5 lt/sec, 10 lt/sec, 15 lt/sec, 20 lt/sec and 25 lt/sec and % PAC concentration 5 ppm, 10 ppm, 15 ppm, 20 ppm and 25 ppm with a pump stroke installation of 5 %, 10 %, 15 %, 20 % and 25 %. In the process of adding PAC, always pay attention and observe the behavior of the attractive force of the floating particles (flock). The particles were then subjected to SEM (scanning electron microscope) to determine the dimensions of the flock grains deposited.*

Keywords: characteristics, parameters, turbidity, mixing, clean water 10 words

1. Introduction

The introduction should provide the reader with the background information needed to understand your research and the reasons for your experiments. Do not write a literature analysis in the introduction.

The clean water treatment process at the SPAM in the Banjarbakula region continues to be carried out for each region, from the processing installation only PDAM Bandarmasih which has a population of almost 200 thousand people which has been served by 99 % of the community. While the City of Banjarbaru and Kab. Banjar until the end of 2020 with the number of customers reaching 625,000 people with a service coverage of around 80 %. Likewise Kab. Barito Kuala and Kab. Tanah Laut is still below the national target, which is 68 % and the PBB MDGs (Millennium Development Goals) target of 80 %.

Mixing process with various variations to get optimal setting with parameter setting approach to reduce turbidity level and observe flock behavior that floats during the process. In this mixing process, the coagulation process occurs, aiming to reduce turbidity, color and smell which is through chemical process used to remove colloidal particles that can interfere with the environment [1, 2]. These colloidal particles cannot settle on their own and are difficult to handle physically, the addition of PAC coagulant destabilizes the particles to form microflocs [3]. The microflocs then agglomerate into macroflocs which can be deposited through the flocculation process. The coagulation process is time dependent and slow stirring in water. Generally, the flocculation period occurs for 10-30 minutes after the coagulation process [4]. The faster the mixing time, the larger the floc formed with the characteristics of the raw water source, stirring conditions, flocculation time, selected coagulant, and variations in the addition of coagulation consentration will affect the performance of coagulation [5, 6].

In this clean water treatment plant, the water supply is from a river with a high turbidity above 5 NTU, so it is necessary to add an appropriate coagulant process to reduce turbidity and waste [7, 8]. Many researchers use the addition of conventional coagulant variations with the Jartest method carried out in the process of decreasing turbidity [9], to find out the estimated coagulant dose is also carried out using genetic algorithms and artificial neural network methods to find approaches between water quality parameters and coagulant doses that are more efficient and effective. economical [10]. However, it is necessary to propose an improvement method to design the quality of the clean siren from the beginning with parameter settings that adopt the Taguchi method [11], the green approach to the mixing process at various levels of turbidity by paying attention to waste reduction and minimization [12, 13]. For local Indonesia, the raw water source from the river is different from other countries with the same water source, because forest conditions and environmental factors in the upstream river greatly affect the level of turbidity [14, 15].

Colloidal particles that are small and fine are generally negatively charged because river water contains organic or inorganic compounds that cannot be removed by ordinary sedimentation. PAC as a drinking water purification coagulant has a good speed in forming new flocs in the process of mixing clean water. As a basic element, aluminum forms repeating units in long molecular chains which have a high positive charge and large molecular weight and can reduce flocs in purified water even in certain doses [16]. Thus PAC combines neutralization and the ability to bridge flock particles so that coagulation takes place more efficiently [17]. PAC can easily neutralize the electric charge on the flock surface and can overcome and reduce the electrostatic repulsion between particles to as small as possible, thus allowing the flock to approach each other (covalent attractive forces) and form larger masses [18, 19].

In the mixing process at the pump installation, it is necessary to set the appropriate parameters to reduce the level of turbidity with variations in the addition of coagulant. The positively charged nature of the coagulant is used to attract the negatively charged colloidal particles to form a flock which will settle to the bottom of the channel, the behavior of the coagulant that catches the colloidal particles that float into the flock will be observed and a scanning electron microscope (SEM) is performed to determine the grain dimensions of the resulting flock. depositional mixing process with various content of its compounds. Contribution in this research is to get clean water quality with input parameter setting to reduce turbidity level and optimal model by paying attention to the behavior of the mixing process.

Please add the relevance of your work in this direction.

2. Literature review and problem statement

How this section should be built: The paper [.] presents the results of research ..., Shown, that..., But there were unresolved issues related to ..., The reason for this may be (objective difficulties associated with ..., fundamental impossibility ..., cost part in terms of ..., which makes relevant research impractical, etc.). A way to overcome these difficulties can be ..., This approach was used in [.], however ..., All this suggests that it is advisable to conduct a study on ...

Use 7–10 references to the literature, each of the used sources should be accompanied by a comment (at least one sentence)

The section of the article "Analysis of literary data" is intended to show (highlight) parts of the problem that are not solved by other scientists. The outcome of the review is the identification of a "niche" of research that is not occupied by other scientists in this problem. This section is written on the basis of publications of **periodical scientific publications** (books, textbooks, monographs do not belong to those). A review of periodicals on a problem investigated by the author should include sources no more than 5–10 years old, and a review of foreign scientific periodicals on the problem investigated by the author of study.

For scenarios of environmentally friendly conditions as a form of sustainable use, natural resources are preserved by taking into account the hydrological cycle of water resources [20, 21] **There should be a critical analysis of each source**

There are several scenarios to make water available for downstream industrial inputs such as drinking water needs. However, the quality of drinking water needed must be feasible for consumers by reducing disinfectants which are waste. there are several decision-making criteria to reduce the waste, among others, paying attention to the processing / treatment [22].

The quality characteristics have been widely studied, both in the manufacturing industry, the water industry and the chemical industry, such as [23] in the opinion that water sources from upstream must be considered so that the availability and quality of water is better. However, this resource must be sustainable by taking into account renewable environmental factors that are useful for other activities such as the use of other energy resources, the quantity factor must be considered to ensure the availability of raw water [24].

Research on the relationship between raw water quality parameters, chlorine requirements and disinfectant content of drinking water has been carried out [24]. The use of appropriate chlorine will minimize disinfectants so that the quality of drinking water supplied to customers will be maintained according to standards. The model obtained for clean/drinking water treatment conditions in Malaysia shows that there is a relationship between the need for chlorine to reduce disinfectants and improve product quality, the parameters of raw water content also affect the final product and require treatment in its processing.

Research on optimization involving several parameters and many attributes resulting in multiple responses is proposed [25]. In addition to setting appropriate and optimal parameters for all responses, it also pays attention to equipment/installation conditions, equipment failure factors and equipment reliability that will affect the production process including the mixing process by minimizing waste. All of these production processes must pay attention to evaluation at each stage of the initial design (quality by design) to obtain good product quality by taking into account the multi criteria of various alternative management options in making decisions in drinking water production. All of the above efforts are made to obtain quality products for consumer needs by always making continuous improvements.

3. The aim and objectives of the study

The aim of the study is ……

~~The purpose of this research is to produce optimal parameter settings in the mixing process of PAC (coagulant), raw water and pump stroke that can be used as a reference for the Banjarbakula drinking water supply system (SPAM) and drinking water companies whose raw water sources are acidic and cloudy rivers. The mixing process aims to determine the behavior of the flow and floating flock, as well as to determine the microstructure of the mixing process that produces clean water quality in accordance with health standards.~~

To achieve this aim, the following objectives are accomplished:

(Objectives should answer the question "What to do?")

– … …

– … …

– … …

4. Materials and methods

This section should mention only about the way the research was carried out: theoretical methods, software and hardware, conditions of the experiment and validation of the proposed solutions (adequacy of the proposed models, etc.). Thus, everything should be noted about obtaining results, but no result is given in this section.

This section is irrelevant to the problem statement in section 3, as the problem in section 3 is relevant to section 5. "Research results...".

The dosing pump is designed to drain the PAC coagulant flow fluid into the water fluid. This pump generates a coagulant flow rate by the mixing method set from the valve to flow the liquid PAC discharge into the dosed reservoir. This pump is very helpful in the process of mixing clean water treatment for coagulant variations which are controlled internally to vary the flow rate and dosage amount.

Taguchi's method is used for parameter setting and integration of the most influential waste output to improve the quality of clean water products, reduce turbidity levels with variations in coagolan doses, optimal mixing process. The target of this method is to make clean water products less sensitive to noise, so it is called a robust design [26] like the concept below:

1. 1. Clean water quality must be designed from the start, not just checking it.
2. The best quality is achieved by minimizing the deviation from the target, the product must be designed so that it is robust against environmental factors that cannot be controlled.
3. The cost of quality should be measured as a function of deviation from a certain standard and losses should be measured at all stages of the product.

According to [27], the advantages of the Taguchi method compared to other experimental designs are because it is more efficient in experiments involving many factors but the number of experimental units required is relatively small, the product is more consistent and less sensitive (robust) to the variability caused by different factors. uncontrollable (noise). The objective function of the Taguchi method for a robust design that is resistant to noise is derived from measuring product quality using a quadratic loss function in a broader definition to produce an optimal design or parameter setting. Signal to ratio (SNR) in the experimental design system of this method provides a comparison of quantitative values for response variations. To maximize the results of SNR is the minimization of response variations and performance parameter settings that are firmly on target for the best quantification of the mean squared deviation (MSD) in the performance of the mixing process.

The most important hope in the robust design of the Taguchi method, especially parameter setting, is to examine the effect of variability on factors and experimental levels using statistical tools as a tool. To help fully factorial large, time-consuming and costly experiments, Taguchi suggests using orthogonal arrays (OA) to represent the range of possible experiments. After conducting the experiment, all experimental data were evaluated using analysis of variance (ANOVA) to determine the optimum parameter settings [28, 29].

This method is to determine the factors that influence an optimum response with its characteristics. The Smaller The Better (STB) quality characteristic indicates that the smaller the characteristic parameter, the better the quality. Larger The Better (LTB) indicates that the larger the characteristic parameter, the better the quality will be, and the Nominal The Better (NTB) quality characteristic means that the quality will be said to be getting better if it is close to the nominal (target) that has been set through parameter design and response. for clean water with various concentrations and levels [30, 31].

The conceptual development of the model structure based on the setting of clean water parameters and the optimization model for the mixing process can be seen in Fig. 1 below.

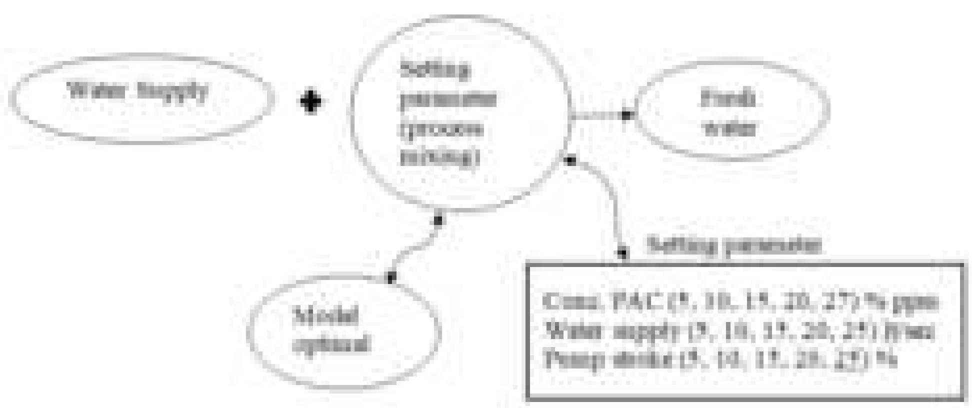


Fig. 1. Setting parameter model in process mixing

In the parameter settings there is coagulation to remove and separate colloidal particles from natural organic minerals such as mud. These colloidal particles cannot settle naturally having a diameter of less than 1 mm causing color and turbidity. The particles attract each other is called the Van Der Waals force and the repulsive particles are called zeta potential forces which have the same charge mass which clump together to form flocks. The attractive force tends to form aggregates while the repulsive force causes the stability of the colloidal dispersion. Stability of colloids can be removed by adding a dose of PAC coagulant whose electrolyte charge is opposite to that of the colloid. Coagulation is a process of deterioration of stability by the addition of a coagulant followed by rapid stirring to neutralize the colloid charge and agglomerate to form a large precipitate, see Fig. 2 below on clean water treatment plants.

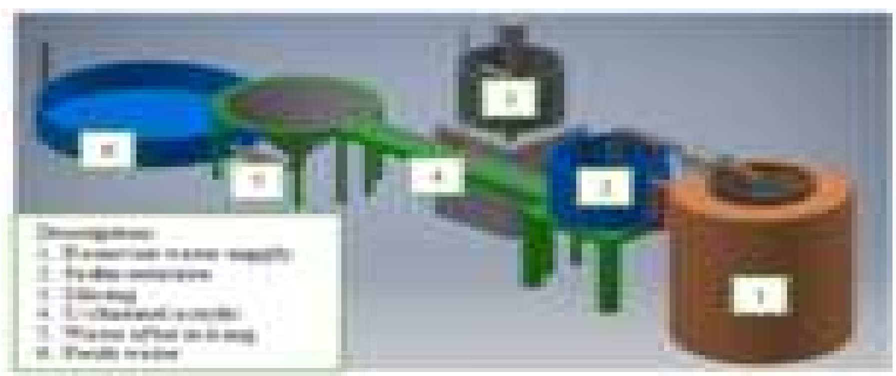


Fig. 2. Research Installation

ENDING THE SECTION BY THE FIGURE IS INCORRECTLY, NEED AN ANY INTERPRETATION

5. **Results**

Structure the "Research results" section according to the task at hand (section 3):

5.1….

5.2…..

number of tasks (Section 3) = number of subsections Result

In the mixing process to decrease turbidity with the addition of coagulant variations by setting the parameters of the Taguchi method with Low level (5-10 ppm), medium level (11-15 ppm) and high level (16-20 ppm) as shown in Tables 1, 2 below.

The table should not consist of a single row of values

Tabel Table 1

Parameter respon

Response	**Response Quality**
Concentration PAC (% ppm)	Fresh water quality

Tabel 2

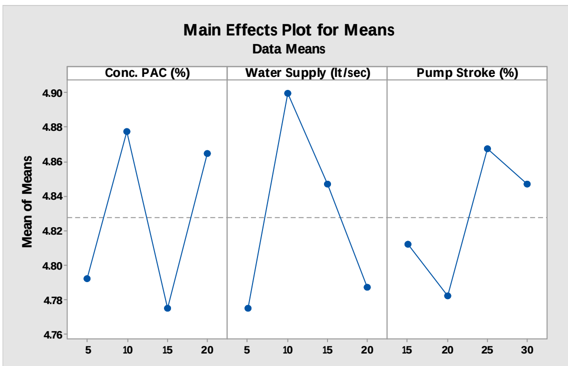
Level factor

Parameter	Code	Level 1	Level 2	Level 3	Level 4
Conc.alum (% ppm) Water supply (lt/sec) Pump stroke (%)	A B C	5 5 15	10 10 20	15 15 25	20 20 30

The change of concentration level of PAC coagulant starts from low level, medium level, and high level simultaneously with the setting of water supply and pump stroke. The decrease of turbidity level seems better as the raise of coagulant concentration level has positive ions. The positive and negative ions depict the effect and response of variable concentration, water supply, and pump stroke as shown in

Fig. 3 below. The plot effect of S/N ratio is in the optimum process of parameter design of mixing process at the various concentration level.

The Fig. should be in one piece



Response Table for Means

Level	Conc. PAC	Water Supply	Pump Stroke
1	4.793	4.775	4.813
2	4.877	4.900	4.782
3	4.775	4.848	4.868
4	4.865	4.787	4.848
Delta	0.102	0.125	0.085
Rank	2	1	3

Fig 3. Main effect and resoonse table variable conc PAC, water supply, pump stroke

Parameter setting conducted in mixing process, as shown in Fig. 4 below, shows that the turbidity value of water supply is above 5 NTU (nephelometric turbidity unit) - which is the standard value for clean water. With the medium level of concentration (11 to 15 ppm), it in shown that the decrease of turbidity value is at the range of 4 – 5 NTU at pH 7.1. The turbidity value of water supply and mixing process can also be seen in contour plot, Figure 5 which presents the dispersion of turbidity value with a more detailed range system in the position of turbidity value at each change of PAC concentration.

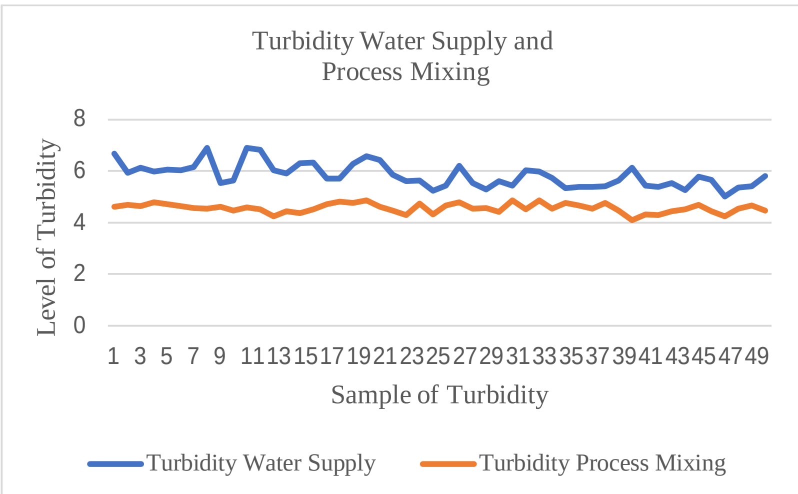


Fig 4. Level turbidity water supply and turbidity mixing process

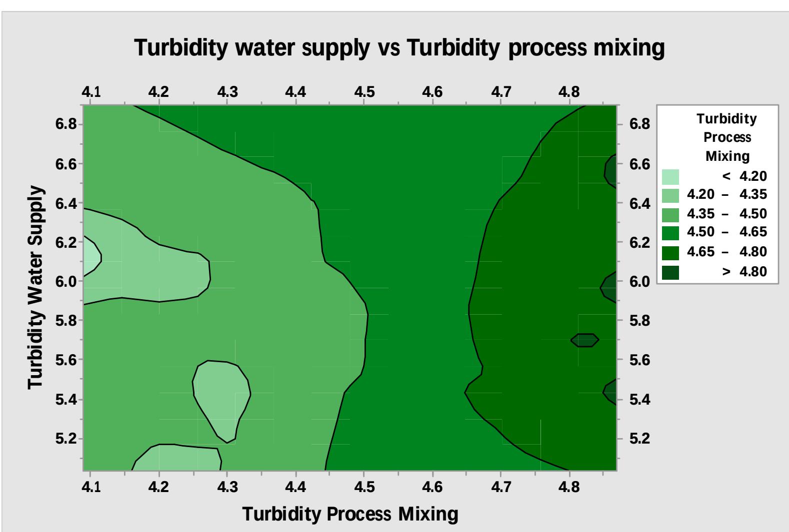
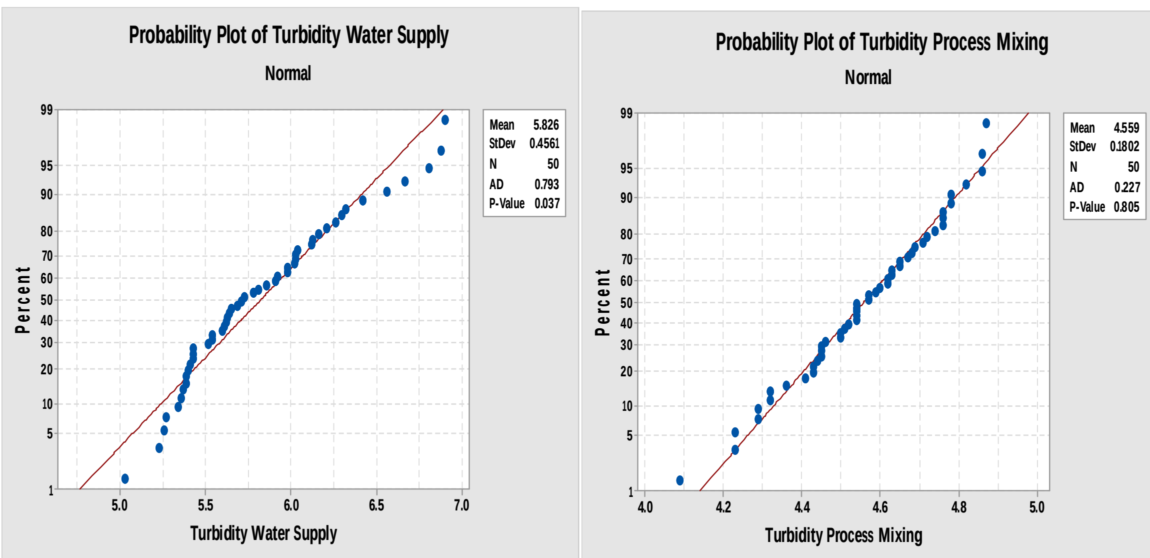


Fig. 5. Contour plot turbidity water supply and turbidity mixing process

Turbidity level of water supply is averagely 5,8 NTU and the reduce of turbidity of mixing process is averagely 4.5 NTU as the addition of medium level in coagulant concentration, but the fluctuation approximates the normal distribution as shown in Fig. 6 below. The variation of turbidity of water supply is influenced by the condition of downstream river, weather and environment of the forest. Meanwhile, the decrease of turbidity in the mixing process is due to the coagulant setting process. As the ppm coagulant is getting higher, the turbidity would reduce until reaching the optimum concentration level at the medium level in the condition of water supply which is of 5-7 NTU.



a b

Sign by example:

Fig. 2. The main signature: *a* – .....; *b* – ....

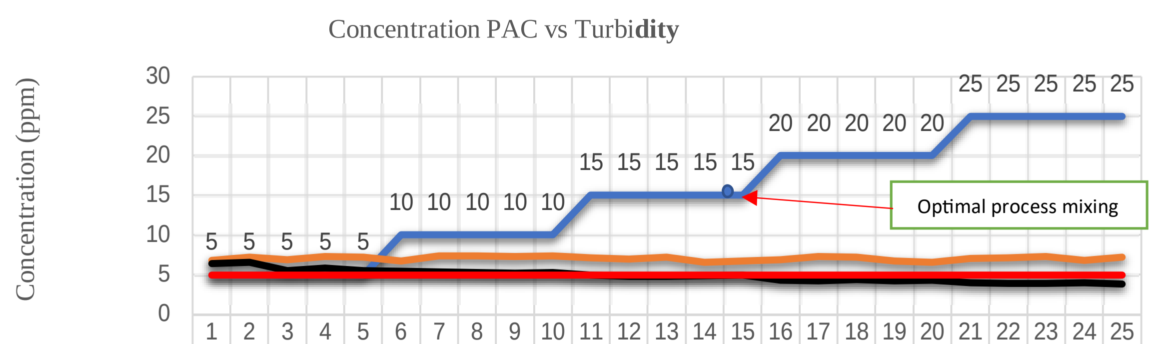
Fig. 6. Normality turbidity water supply and process mixing

By looking at the fluctuation of water supply turbidity and mixing process, the model of mixing process can be predicted at the medium level of 14 and 15 ppm coagulant. Averagely, the model of prediction of mixing process collects the maximum at medium level which is 15 for the condition of 5-7 NTU.

Optimum process mixing =

15 % ppm conc. PAC + 15 lt/sec + 15 % pump stroke

Optimal model can be decreased or increased fluctuatively at each 2 point range change of turbidity, for instance 5-7 NTU, 7-9 NTU, and so on. For the more detail, every change of ppm concentration, water supply and pump stroke can be seen in Fig. 7 below. At the position of medium level, it can be seen that the turbidity value of mixing process is at 4.8 NTU and 4.9 NTU which are close to the health standard. The higher % ppm of PAC causes the turibidity to decrease and the water color turn to transparent. The effect of over PAC would not be harmful for human body but with a continuous excessive dosage in a long time, it would cause side effect in form of toxin within human body.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Conc. PAC (% ppm)	5	5	5	5	5	10	10	10	10	10	15	15	15	15	15	20	20	20	20	20	25	25	25	25	25
Turbidity Water Supply	6.8	7.2	6.9	7.3	7.2	6.7	7.4	7.4	7.3	7.4	7.1	6.9	7.2	6.6	6.7	6.9	7.3	7.2	6.8	6.6	7.0	7.1	7.3	6.8	7.2
Turbidity process mixing	6.4	6.6	5.5	5.8	5.5	5.4	5.3	5.3	5.2	5.3	4.9	4.8	4.8	4.9	4.9	4.3	4.2	4.4	4.2	4.3	4	3.9	3.9	4	3.9
Standart (max 5)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

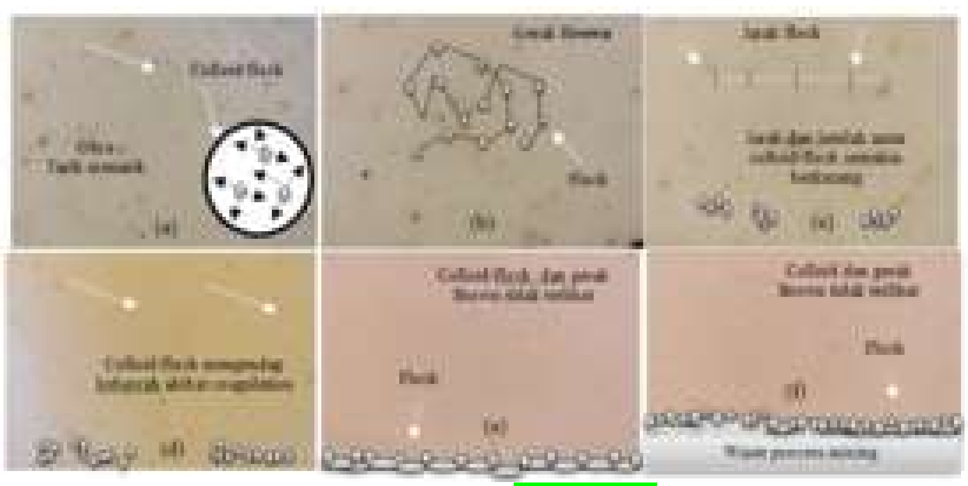
Fig. 7. The variation of PAC concentration at each level

Each change of PAC concentration level causes the change of water turbidity value, colloid behavior and floc formation in mixing process. Coagulant characteristic whose charge is positive ion would attract negatively charged colloid that is often called as the effect of Van der Waals' attractive force. A proper addition of coagulant concentration would reduce the zeta potential repulsive force in the colloid, thus there is more positive ions than negative ions which causes faster floc formation process. With sedimentation process and flock filterization, it would gravitationally percipate at the bottom surface to furthermore be thrown away since the sedimentation is known as waste in the industry of clean water.

Before the Fig. should be a link to the Fig. (in the same section)

Split into 6 separate figures, signing them with the text a, b, c, d…

each of the subpictures should be a separate picture



a b c…

Sign by example:

Fig. 2. The main signature: *a* – .....; *b* – ....

Fig. 8. SEM image of flock or colloid (arrow sign) turbidity < 5 NTU after being mixed with coagulant (*PAC*): 5 % ppm, (b) 10 % ppm, (c) 15 % ppm, (d) 20 % ppm, (e,f) 25 % ppm

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6. Discussion of results

Build a section according to this scheme:

1. The answer to the question, what explains the results.

2. What are the features of the proposed method and the results obtained in comparison with existing

3. What are the limitations of this study?

4. What disadvantages of this study can be noted and how can they be eliminated in the future.

5. What can be the development of this research and what difficulties (mathematical, experimental or any other kind) can be encountered

In mixing process, each variation of water supply, ppm PAC and % pump stroke would be influential at turbidity level due to the addition of coagulant that would attract negative ion into flock. With the increase of coagulant and pump stroke in the form of pump velocity in rpm, it would fasten the process of floc formation. Figure 8a represents the big grain-sized flocs in which thus the effect of Van der Waals' force is visible. The great attractive force from coagulant would fasten the floc formation. To observe the Brownian motion, which is in form of zig-zag line or dash line, the portrayal of molecular kinectic flocs in Figure 8b requires a camera magnification of 1200 with the type of SEM digital. In Figure 8c, the distance among flocs is getting bigger due to the addition of rpm, then the particle flies slowly to the bottom in groups following the gravitation principle. Moreover, in Figure 8d, flocs start to percipate downward closing by the plat basis together with coagulation and flocculation. In Figure 8e, colloid and flocs are not visible since the pump rpm of mixing process is of 20 % and 25 % rpm at high level. It can be seen that the small visible flocs are closing by the big floc gap filled by liquid space where viscosity is smaller hence following the big floc pattern by clinging and uniting into big flocs continuously. Meanwhile, in Figure 8f, the group of flocs is visible until the basic plat with bigger grain and percipates covering almost the whole surface of the basic plat.

7. Conclusions number of objectives=number of conclusions

In this section, describe in the conclusions the solution of the tasks that you set for yourself in section 3, but do not repeat the problems literally - this should be a description of the solutions of the problems.

As a result of the research:

1. ... with indication of qualitative or quantitative indicators of research results

2. ... with indication of qualitative or quantitative indicators of research results
3. ... with an indication of qualitative or quantitative indicators of research results

~~By setting the parameters of the Taguchi method, optimal mixing process at medium levels of 14 and 15 % ppm obtained turbidity values of 4.8 and 4.9 NTU close to the health standard of 5 NTU. The decrease in the level of turbidity occurs if the level of coagolant concentration is gradually increased from low, medium and high levels, at each increase in these levels there will be a strong positive ion attraction to the negative ions in the colloid. At low-level coagulants the attractive force between coagulants and colloids is not too large, but for medium and high-level coagulants the attraction is stronger because of their positive ion properties, on the other hand the effect of Brownian motion gets smaller with increasing % ppm of coagulant because the water tends to be colored. White. If the coagulant concentration is increased in rpm and the appropriate time, the flock-flock by gravity will accumulate at the bottom of the plate in the form of sediment waste which is flowed to the waste processor before being discharged to the final place. Finally, the results of parameter settings get optimal parameter settings at levels of 14 and 15 % ppm to reduce turbidity levels below 5 NTU according to health standards.~~

Acknowledgments

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Comments continued:

CHARACTERISTICS OF RAW WATER SOURCES AND ANALYSIS OF THE OPTIMAL MODEL OF THE MIXING PROCESS WITH PARAMETER DESIGN IN CLEAN WATER PUMP INSTALLATIONS

By improving the mixing process with various variations to get the optimum setting. With Taguchi's approach to lowering turbidity, accelerates the formation of floating flocks during the mixing process. The coagulation process aims to reduce turbidity, color and odor through a chemical process used to remove colloidal particles that can disturb the environment. Colloidal particles cannot settle, there must be a suitable coagulant such as PAC to destabilize the particles so that microflocs are formed. [2–7]

All sources of information used should be cited in the text of the article, in order, for example 1 to 10

In the mixing process at the pump installation, it is necessary to set the appropriate parameters to reduce the level of turbidity before and after the mixing process with variations in the addition of coagulant. Optimal settings will be obtained in this process, a positively charged coagulant is used to attract negatively charged colloid particles as a flock which will settle to the bottom of the channel, the behavior of the coagulant that catches floating colloid particles is observed and a scanning electron microscope (SEM) is performed to determine the dimensions of the flock grains. the result of the deposition process of mixing with various content of its compounds.

The contribution of this research is to get the turbidity level before and after the mixing process, the optimal parameter setting model to reduce the turbidity level and to observe and investigate the behavior of flock process in the mixing process.

2. Literature review and problem statement

Use 7–10 references to the literature, each of the used sources should be accompanied by a comment (at least one sentence)

Mixing process with various variations to get optimal setting with parameter setting approach to reduce turbidity level and observe flock behavior that floats during the process. In this mixing process, the coagulation process occurs, aiming to reduce turbidity, color and smell which is through chemical process used to remove colloidal particles that can interfere with the environment [1, 2]. **There should be a critical analysis of each source** These colloidal particles cannot settle on their own and are difficult to handle physically, the addition of PAC coagulant destabilizes the particles to form microflocs [3]. The microflocs then agglomerate into macroflocs which can be deposited through the flocculation process. The coagulation process is time dependent and slow stirring in water. Generally, the flocculation period occurs for 10-30 minutes after the coagulation process [4]. The faster the mixing time, the larger the floc formed with the characteristics of the raw water source, stirring conditions, flocculation time, selected coagulant, and variations in the addition of coagulation consentration will affect the performance of coagulation [5, 6]. **There should be a critical analysis of each source**

In this clean water treatment plant, the water supply is from a river with a high turbidity above 5 NTU, so it is necessary to add an appropriate coagulant process to reduce turbidity and waste [7]. Many researchers use the addition of conventional coagulant variations with the Jartest method carried out in the process of decreasing turbidity [8], to find out the estimated coagulant dose is also carried out using genetic algorithms and artificial neural network methods to find approaches between water quality parameters and coagulant doses that are more efficient and effective. economical [9]. However, it is necessary to propose an improvement method to design the quality of the clean siren from the beginning with parameter settings that adopt the Taguchi method [10], the green approach to the mixing process at various levels of turbidity by paying attention to waste reduction and minimization [11, 12]. **There should be a critical analysis of each source** For local Indonesia, the raw water source from the river is different from other countries with the same water source, because forest conditions and environmental factors in the upstream river greatly affect the level of turbidity [13, 14]. **There should be a critical analysis of each source**

Colloidal particles that are small and fine are generally negatively charged because river water contains organic or inorganic compounds that cannot be removed by ordinary sedimentation. PAC as a drinking water purification coagulant has a good speed in forming new flocs in the process of mixing clean water. As a basic element, aluminum forms repeating units in long molecular chains which have a high positive charge and large molecular weight and can reduce flocs in purified water even in certain doses [15]. Thus PAC combines neutralization and the ability to bridge flock particles so that coagulation takes place more efficiently [16]. PAC can easily neutralize the electric charge on the flock surface and can overcome and reduce the electrostatic repulsion between particles to as small as possible, thus allowing the flock to approach each other (covalent attractive forces) and form larger masses [17, 18].

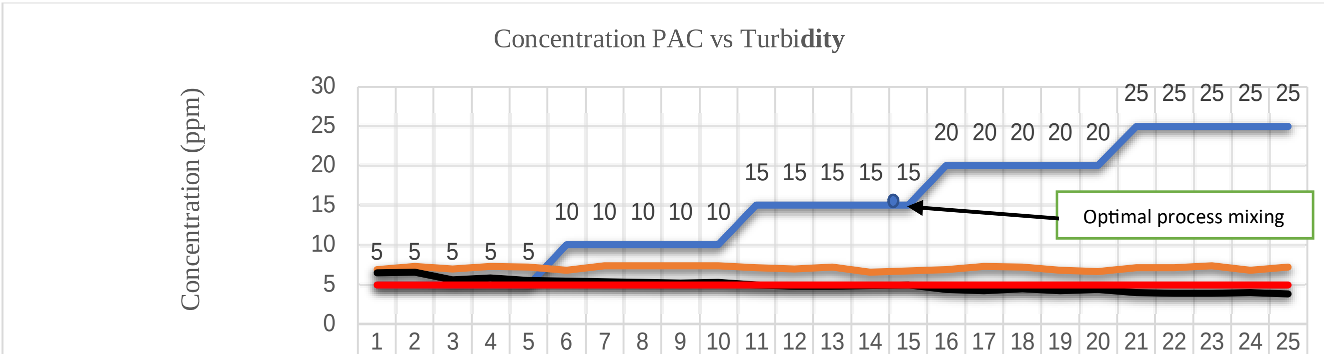
For scenarios of environmentally friendly conditions as a form of sustainable use, natural resources are preserved by taking into account the hydrological cycle of water resources [19, 20]**,** water quality is strongly influenced by the condition of the river upstream, either organic or inorganic, waste. There are several scenarios to make water available for downstream industrial inputs such as drinking water needs. However, the quality of drinking water needed must be feasible for consumers by reducing disinfectants which are waste. there are several decision-making criteria to reduce the waste, among others, paying attention to the processing / treatment.

4. Materials and methods

The dosing pump is designed to drain the PAC coagulant flow fluid into the water fluid. This pump generates a coagulant flow rate by the mixing method set from the valve to deliver the liquid PAC discharge into the dosed reservoir. This pump is very helpful in the process of mixing clean water treatment for coagulant variations which are controlled internally to vary the flow rate and dosage amount.

Taguchi's method is used for parameter setting and integration of the most influential waste output to improve the quality of clean water products, reduce turbidity levels with variations in coagolan doses, optimal mixing process. The target of this method is to make clean water products less sensitive to noise, so it is called a robust design.[26] like the concept below:

4. 1. The turbidity characteristics of water before and after the mixing process, with the experimental design of the raw water mixing process (turbidity) such as 5 lt/sec, 10 lt/sec, 15 lt/sec, 20 lt/sec and 25 lt/sec and % PAC concentration 5 ppm, 10 ppm, 15 ppm, 20 ppm and 25 ppm with a pump stroke installation of 5 %, 10 %, 15 %, 20 % and 25 %.
5. By the parameter settings above, the optimal parameter settings are obtained to reduce the level of turbidity.
6. Observing and identifying the behavior of floating flocks to sedimentation for SEM



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Conc. PAC (% ppm)	5	5	5	5	5	10	10	10	10	10	15	15	15	15	15	20	20	20	20	20	25	25	25	25	25
Turbidity Water Supply	6.8	7.2	6.9	7.3	7.2	6.7	7.4	7.4	7.3	7.4	7.1	6.9	7.2	6.6	6.7	6.9	7.3	7.2	6.8	6.6	7.0	7.1	7.3	6.8	7.2
Turbidity process mixing	6.4	6.6	5.5	5.8	5.5	5.4	5.3	5.3	5.2	5.3	4.9	4.8	4.8	4.9	4.9	4.3	4.2	4.4	4.2	4.3	4	3.9	3.9	4	3.9
Standart (max 5)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

Fig. 7. The variation of PAC concentration at each level

ENDING THE SECTION BY THE FIG. IS INCORRECTLY, NEED AN ANY INTERPRETATION

f

Sign by example:

Fig. 2. The main signature: *a* – .....; *b* – ....

Fig. 8. SEM image of flock (arrow sign) turbidity < 5 NTU after being mixed with

coagulant (*PAC*): 5 % ppm, (b) 10 % ppm, (c) 15 % ppm, (d) 20 % ppm, (e,f) 25 % ppm

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It is recommended that at least 60% of the references should be to English-language sources included in the Scopus and Web of Science citation databases, which is not the case in your article.

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How do you see this source? Do you have access on the Internet?

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3. **Mastiadi Tamjidillah** <mastiadit@ulm.ac.id>

Oct 4, 2021, 10:24 PM

to Oksana

Dear General Manager,
Dear Editor EEJET

Thank you for the revisions and suggestions for improving our article, we apologize for being a bit late in sending the revised edition.
we hope to be published in volume No. 5 (113). 2021

We look forward to further the news, hopefully, according to your suggestions.

Thank You

Best Regards

Mastiadi Tamjidillah

4. **Oksana Nikitina** <0661966nauka@gmail.com>

Oct 5, 2021, 12:03 AM

to me

Good day!
The article has been sent to the editor for checking.
We wish you a great day and a good mood!
If you have any questions, call or write, we will be happy to answer them.

With best regards, Oksana

Oct 5, 2021, 12:03 AM

Comment continued

Received date: 28.09.2021

Accepted date:

CHARACTERISTICS OF RAW WATER SOURCES AND ANALYSIS OF THE OPTIMAL MODEL OF THE MIXING PROCESS WITH PARAMETER DESIGN IN CLEAN WATER PUMP INSTALLATIONS

Mastiadi Tamjidillah, Muhammad Nizar Ramadhan, Muhammad

Farouk Setiawan, Jerry Iberahim

To investigate and find the quality characteristics of raw water sources in the regional integrated drinking water supply system (SPAM) of Banjarbakula to maintain the supply of drinking water quantity and quality in accordance with drinking water standards. Selection and determination of the optimum model for the mixing process of raw water and poly aluminum chloride (PAC) and pump stroke for input of water sources from rivers to obtain a composition setting that is in accordance with the raw water sources of each region in the region. So that it is known the optimum parameter setting model between alum water, raw water and pump stroke for each raw water source and is regionally integrated as a result of a comprehensive study. The integration of Taguchi parameter design and response surface can complement each other and become two methods that go hand in hand in the process of optimizing clean water products. Parameter design provides a very practical optimization step, the basis for this formation refers to the factorial fractional experimental design. However, the absence of statistical assumptions that follow the stages of analysis makes this method widely chosen by researchers and practitioners. With the experimental design of the raw water mixing process (turbidity) such as 5 lt/sec, 10 lt/sec, 15 lt/sec, 20 lt/sec and 25 lt/sec and % PAC concentration 5 ppm, 10 ppm, 15 ppm, 20 ppm and 25 ppm with a pump stroke installation of 5 %, 10 %, 15 %, 20 % and 25 %. In the process of adding PAC, always pay attention and observe the behavior of the attractive force of the floating particles (flock). The particles were then subjected to SEM (scanning electron microscope) to determine the dimensions of the flock grains deposited

Keywords: characteristics, parameters, setting, supply, turbidity, mixing, concentration, pump, behavior, clean water

All sources of information used should be cited in the text of the article, in order, for example 1 to 10

1. Introduction

The need for raw water (water supply) is very necessary to ensure availability for the clean water treatment process. With good raw water quality, it describes good natural conditions, so it needs to be maintained to maintain quantity and continuity. Good and sufficient raw water is the hope of the clean water industry and society as consumers for a healthier life. However, the processing process is important so that the quality is always maintained with raw water conditions that vary in quality. It is everyone's effort to use efficient clean water to keep it always available, because water is a basic need that must be maintained for survival.

The characteristics of raw water quality vary, because the source comes from rivers with high turbidity levels above 5 NTU (nephelometric turbidity unit), so a water treatment process is needed to reduce the turbidity level. To meet the community's need for clean water that meets health standards, an adequate supply of raw water is needed to maintain the quality and availability for human life. Water sources from upstream must be considered so that these resources are sustainable by taking into account renewable environmental factors that are useful for other activities such as the use of other energy resources.

The quality of raw water decreases because it is caused by household activities, soil pollution, water pollution, logging activities and plantation land clearing. In addition to the decrease in the quality of raw water, it also causes an increase in temperature, sedimentation and organic content due to the opening of new land for agriculture and plantations in the upstream part of the river. The influence of activities upstream of the river causes the quality of raw water to decrease which will be used as input for processing into clean water. So that an integrated treatment process is needed according to these conditions to get good quality clean water.

The clean water treatment process at the SPAM in the Banjarbakula region continues to be carried out for each region, from the processing installation only PDAM Bandarmasih which has a population of almost 200 thousand people which has been served by 99 % of the community. While the City of Banjarbaru and Kab. Banjar until the end of 2020 with the number of customers reaching 625,000 people with a service coverage of around 80 %. Likewise Kab. Barito Kuala and Kab. Tanah Laut is still below the national target, which is 68 % and the PBB MDGs (Millennium Development Goals) target of 80 %.

Clean water treatment to reduce the level of turbidity from the water supply, it is necessary to add an appropriate coagulant process to reduce it according to clean water standards. To determine the estimated dose of coagulant is also done by using a parameter design with a variety of settings adopting the Taguchi method. For local Indonesia, the raw water source is from the river, it is different from other countries with the same water source, because forest conditions and environmental factors in the upstream of the river greatly affect the level of turbidity.

By improving the mixing process with various variations to get the optimum setting. With Taguchi's approach to lowering turbidity, accelerates the formation of floating flocks during the mixing process. The coagulation process aims to reduce turbidity, color and odor through a chemical process used to remove colloidal particles that can disturb the environment. Colloidal particles cannot settle, there must be a suitable coagulant such as PAC to destabilize the particles so that microflocs are formed. With the coagulation and flocculation processes in the clean water treatment process with the main parameter setting lowering the turbidity level, it will produce quality water according to health standards. [2–7].

In the mixing process at the pump installation, it is necessary to set the appropriate parameters to reduce the level of turbidity before and after the mixing process with variations in the addition of coagulant. Optimal settings will be obtained in this process, a positively charged coagulant is used to attract negatively charged colloid particles as a flock which will settle to the bottom of the channel, the behavior of the coagulant that catches floating colloid particles is observed and a scanning electron microscope (SEM) is performed to determine the dimensions of the flock grains. the result of the deposition process of mixing with various content of its compounds.

The contribution of this research is to get the turbidity level before and after the mixing process, the optimal parameter setting model to reduce the turbidity level and to observe and investigate the behavior of flock process in the mixing process.

2. Literature review and problem statement

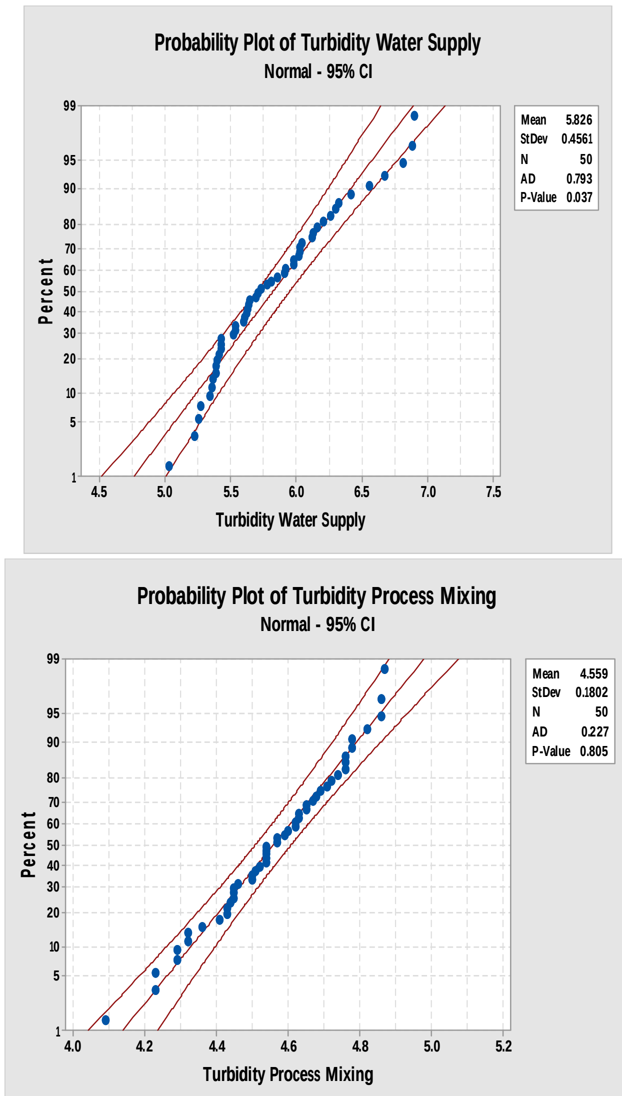
Use 7–10 references to the literature, **each of the used sources should be accompanied by a comment (at least one sentence)**

Mixing process with various variations to get optimal setting with parameter setting approach to reduce turbidity level and observe flock behavior that floats during the process. In this mixing process, the coagulation process occurs, aiming to reduce turbidity, color and smell which is through chemical process used to remove colloidal particles that can interfere with the environment. Parameter setting is the main factor in the mixing process to get good quality, but it is necessary to use a network system to detect waste water in the water supply [1], assessment of the quality of water sources from rivers is always evaluated and the value of turbidity and sediment aspects [2] [1, 2]. **There should be a critical analysis of each source** These colloidal particles cannot settle on their own and are difficult to handle physically, the addition of PAC coagulant destabilizes the particles to form microflocs [3]. The microflocs then agglomerate into macroflocs which can be deposited through the flocculation process. The coagulation process is time dependent and slow stirring in water. Generally, the flocculation period occurs for 10-30 minutes after the coagulation process [4]. The faster the mixing time, the larger the floc formed with the characteristics of the raw water source, stirring conditions, flocculation time, selected coagulant, and variations in the addition of coagulation consentration will affect the performance of coagulation. The fast stirring process in the ink industry is faster to reduce and reduce waste water [5], while the beverage industry pays attention to the decrease in sediment by setting ppm coagulant [6]. [5, 6]. **There should be a critical analysis of each source**

In this clean water treatment plant, the water supply is from a river with a high turbidity above 5 NTU, so it is necessary to add an appropriate coagulant process to reduce turbidity and waste [7]. Many researchers use the addition of conventional coagulant variations with the Jartest method carried out in the process of decreasing turbidity [8], to find out the estimated coagulant dose is also carried out using genetic algorithms and artificial neural network methods to find approaches between water quality parameters and coagulant doses that are more efficient and effective. economical [9]. However, it is necessary to propose an improvement method to design the quality of the clean siren from the beginning with parameter settings that adopt the Taguchi method [10], the green approach to the mixing process at various levels of turbidity by paying attention to waste reduction and minimization. The use of chitosan is useful in reducing waste water and color from industry [11], but for water sources from rivers because organic is used other coagulants such as PAC [12]. [11, 12]. **There should be a critical analysis of each source** For local Indonesia, the raw water source from the river is different from other countries with the same water source, because forest conditions and environmental factors in the upstream river greatly affect the level of turbidity. The choice of coagulant is different for each water supply from rivers or other water sources, with the jartest technique can reduce turbidity, but the use of PAC is even faster in the mixing process [13], with chitosan on coagulation and flocculation reduces color at pH below 5, while river water tends to be above 5 [14] [13, 14]. **There should be a critical analysis of each source**

Colloidal particles that are small and fine are generally negatively charged because river water contains organic or inorganic compounds that cannot be removed by ordinary sedimentation. PAC as a drinking water purification coagulant has a good speed in forming new flocs in the process of mixing clean water. As a basic element, aluminum forms repeating units in long molecular chains which have a high positive charge and large molecular weight and can reduce flocs in purified water even in certain doses [15]. Thus PAC combines neutralization and the ability to bridge flock particles so that coagulation takes place more efficiently [16]. PAC can easily neutralize the electric charge on the flock surface and can overcome and reduce the electrostatic repulsion between particles to as small as possible, thus allowing the flock to approach each other (covalent attractive forces) and form larger masses. PAC selection coagulants can reduce floating flocks in the water supply from rivers, and accelerate sedimentation and reduce waste water non oily from clean water treatment to customers [17], with the use of PAC above 10 ppm it can reduce waste water rather than the use of ultraviolet and chlorine disinfectants [18]. [17, 18].

For scenarios of environmentally friendly conditions as a form of sustainable use, natural resources are preserved by taking into account the hydrological cycle of water resources. The use of water resources, especially those from rivers, is very high and worrying, the availability of water supply and its safety is approaching the gray zone and continues to increase, with factor analysis contributing to urban water management [19]. By using fuzzy and TOPSIS can provide information on the availability and contribution of options for the use of water resources [20], [19, 20]**,** water quality is strongly influenced by the condition of the river upstream, either organic or inorganic, waste. There are several scenarios to make water available for downstream industrial inputs such as drinking water needs. However, the quality of drinking water needed must be feasible for consumers by reducing disinfectants which are waste. there are several decision-making criteria to reduce the waste, among others, paying attention to the processing/treatment.



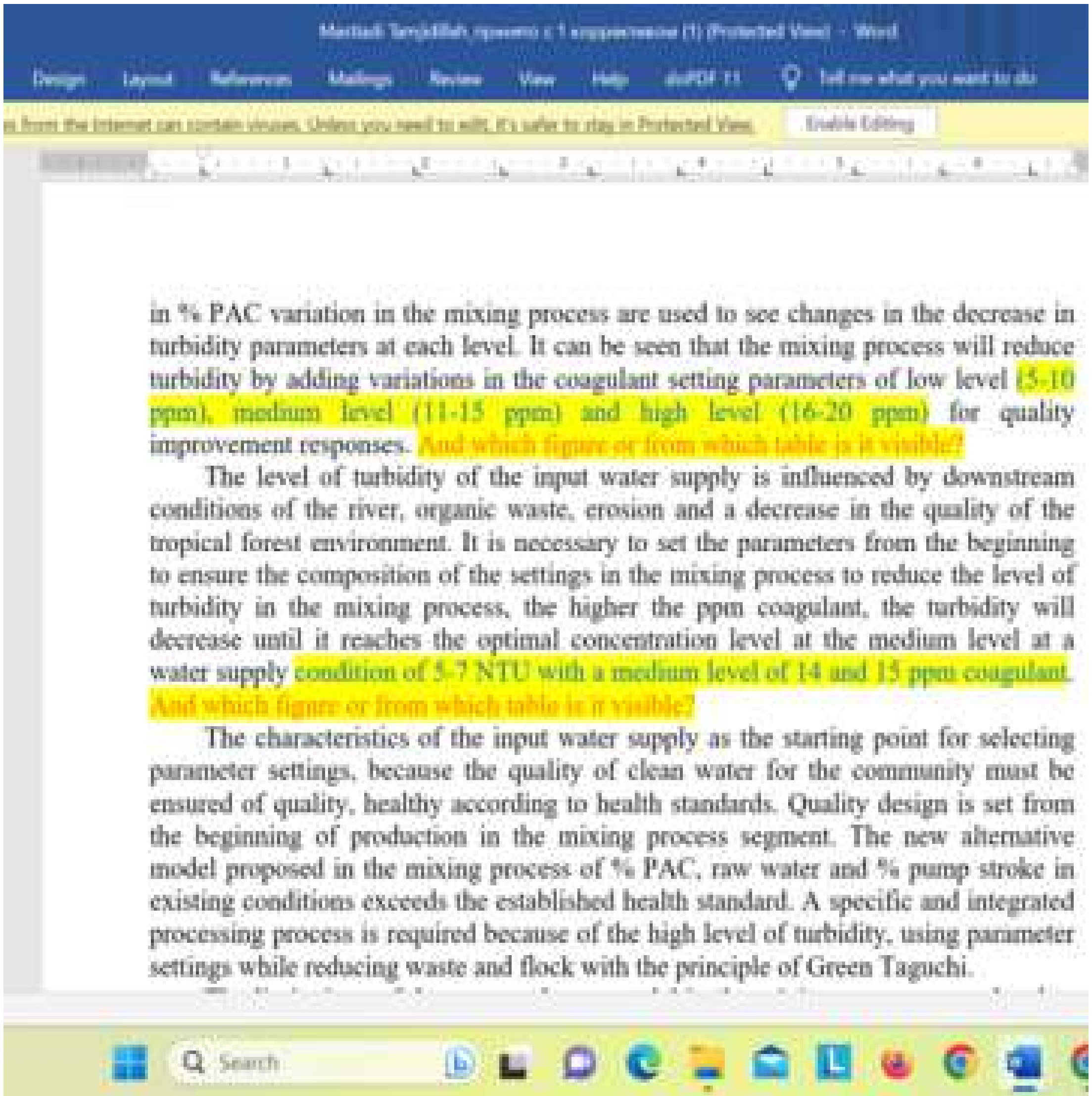
a *b*

Sign by example:

Fig. 2. The main signature: *a* – .....; *b* – ....

Fig. 5. Normality turbidity: *a*- water supply; *b*- process mixing

Comment continued



in % PAC variation in the mixing process are used to see changes in the decrease in turbidity parameters at each level. It can be seen that the mixing process will reduce turbidity by adding variations in the coagulant setting parameters of low level (5-10 ppm), medium level (11-15 ppm) and high level (16-20 ppm) for quality improvement responses. And which figure or from which table is it visible?

The level of turbidity of the input water supply is influenced by downstream conditions of the river, organic waste, erosion and a decrease in the quality of the tropical forest environment. It is necessary to set the parameters from the beginning to ensure the composition of the settings in the mixing process to reduce the level of turbidity in the mixing process, the higher the ppm coagulant, the turbidity will decrease until it reaches the optimal concentration level at the medium level at a water supply condition of 5-7 NTU with a medium level of 14 and 15 ppm coagulant. And which figure or from which table is it visible?

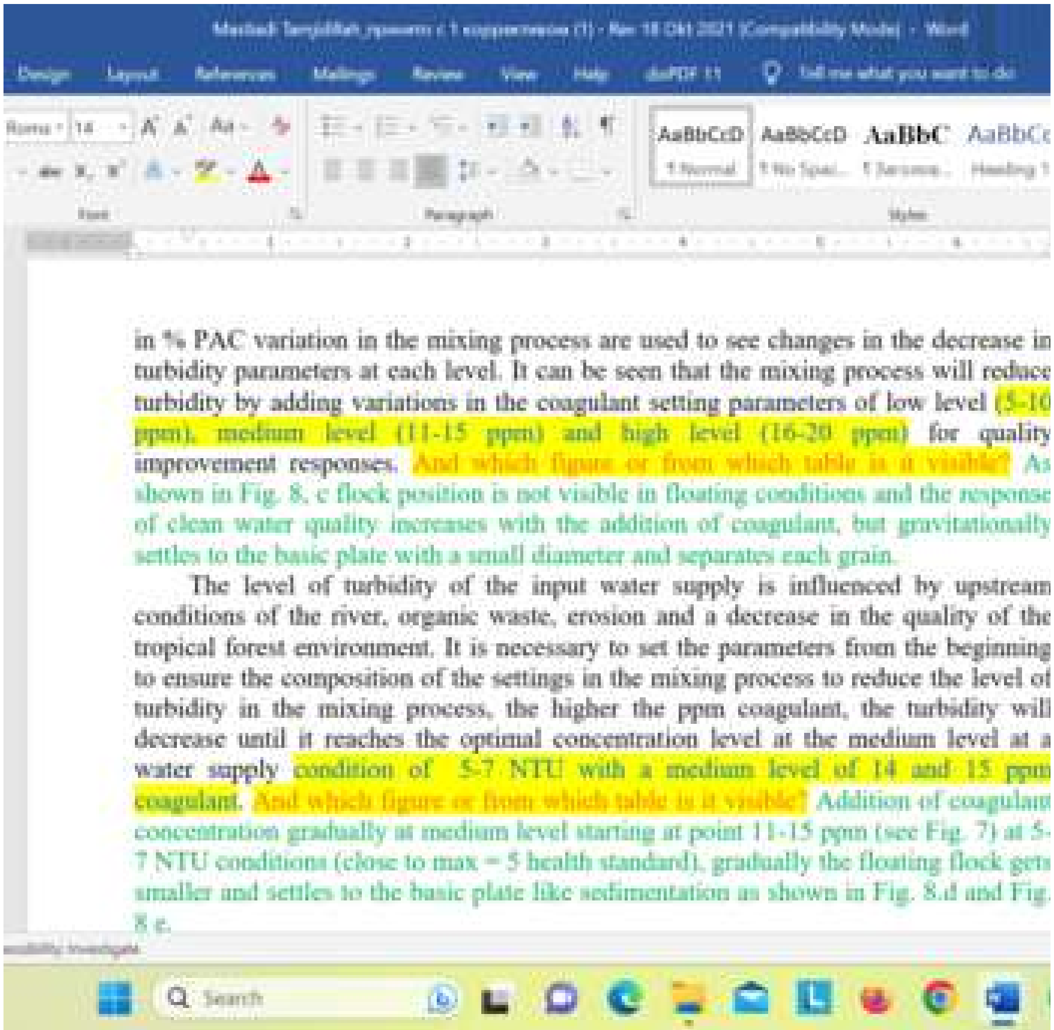
The characteristics of the input water supply as the starting point for selecting parameter settings, because the quality of clean water for the community must be ensured of quality, healthy according to health standards. Quality design is set from the beginning of production in the mixing process segment. The new alternative model proposed in the mixing process of % PAC, raw water and % pump stroke in existing conditions exceeds the established health standard. A specific and integrated processing process is required because of the high level of turbidity, using parameter settings while reducing waste and flock with the principle of Green Taguchi.

Comment section discussion:

6. Discussion of the research results of characteristics of raw water sources

In the mixing process by setting parameters with factors and levels to get the optimal turbidity conditions of organic waste. The level of turbidity will affect the addition of coagulant, the duration of the mixing process and the waste removed. Thus, turbidity conditions and processing in the mixing process greatly affect the quality of clean water. So we need a quality design from the start in the mixing process to get clean water that is good, fast, economical, efficient and according to consumer desires.

By setting the optimal parameters in the mixing process between % ppm PAC, raw water (lt/s) and % pump stroke. Levels and factors are carried out to obtain results that are in accordance with research conditions or input water supply. Changes in % PAC variation in the mixing process are used to see changes in the decrease in turbidity parameters at each level. It can be seen that the mixing process will reduce



in % PAC variation in the mixing process are used to see changes in the decrease in turbidity parameters at each level. It can be seen that the mixing process will reduce turbidity by adding variations in the coagulant setting parameters of low level (5-10 ppm), medium level (11-15 ppm) and high level (16-20 ppm) for quality improvement responses. And which figure or from which table is it visible? As shown in Fig. 8, c flock position is not visible in floating conditions and the response of clean water quality increases with the addition of coagulant, but gravitationally settles to the basic plate with a small diameter and separates each grain.

The level of turbidity of the input water supply is influenced by upstream conditions of the river, organic waste, erosion and a decrease in the quality of the tropical forest environment. It is necessary to set the parameters from the beginning to ensure the composition of the settings in the mixing process to reduce the level of turbidity in the mixing process, the higher the ppm coagulant, the turbidity will decrease until it reaches the optimal concentration level at the medium level at a water supply condition of 5-7 NTU with a medium level of 14 and 15 ppm coagulant. And which figure or from which table is it visible? Addition of coagulant concentration gradually at medium level starting at point 11-15 ppm (see Fig. 7) at 5-7 NTU conditions (close to max = 5 health standard), gradually the floating flock gets smaller and settles to the basic plate like sedimentation as shown in Fig. 8.d and Fig. 8 e.

5. **Oksana Nikitina** <0661966nauka@gmail.com>

to me

Good day!
The article has been sent to the editor for checking.
We wish you a great day and a good mood!
If you have any questions, call or write, we will be happy to answer them.

With best regards, Oksana

from "Eastern-European Journal of Enterprise Technologies" (confirm receipt)_Mastiadi Tamjidillah - acknowledge receipt

External

Inbox

Oksana Nikitina <0661966nauka@gmail.com> Thu, Sep 30, 2021, 5:49 PM

to me

Good day!

The article was accepted for consideration of the possibility of publication in (No. 5 (113).2021).

Invoice No 1403/8-105-2021 on **50 euro** (type of payment: article processing charges (APCs) № 104/105).

Please be sure to indicate the invoice number No 1403/8-105-2021 - THIS IS NECESSARY AND IMPORTANT! Otherwise, the amounts without specifying the invoice number are sent before clarification and the clarification period is up to 2 weeks. By this, either the article is removed, because the advance payment or the amount for the publication was not paid on time, or is transferred to another issue of the journal.

Pay immediately (as soon as you receive the receipt). Payment must be made strictly on your behalf. As soon as you have made the payment, you can send us a scanned receipt by e-mail. We warn you that the payment should be made within 1-3 days. The advance payment will be deducted from the total amount at the 6-th stage if your article will be accepted, but if you are refused - the deposit will not be refunded (detailed information on the journal's website http://jet.com.ua/en/publication-terms/rules-for-submitting). We warn you immediately that at this stage you confirm that the payment will be made by an individual (on your behalf) and not by a legal entity, according to the details that will be provided to you upon acceptance of the article.

The application contains a package of documents that you need **to fill out before 04.10.2021,** and we are waiting for you to pay.

We are in touch 24/7.

with respect, general manager
Oksana Nikitina

6. **Mastiadi Tamjidillah** <mastiadit@ulm.ac.id> Oct 1, 2021, 5:17 PM

to Oksana

Dear General Manager,

Dear Editor EEJET

Thanks for the information and confirmation of our article on EEJET, we hope to be published in volume No. 5 (113). 2021). About the section in this publication we thank the slots in Mechanical Engineering. Attached is proof of payment of APC 50 EUR with Invoice No. 1403/8-105-2021 and 104/105

Thank You

Best Regards

Mastiadi Tamjidillah

7. **Oksana Nikitina** **<0661966nauka@gmail.com>** Tue, Oct 5, 2021, 1:33 AM

to me

Good afternoon, dear authors, this is a reminder letter that we are expecting a license agreement from you **no later than October 06, 2021.**
We wish you a great day and a good mood!
We are always ready to help you!
With best regards, Oksana

пт, 1 окт. 2021 г. в 12:17, Mastiadi Tamjidillah <mastiadit@ulm.ac.id>:

--
with respect, general manager
Oksana Nikitina

8. **Mastiadi Tamjidillah** **<mastiadit@ulm.ac.id>** Tue, Oct 5, 2021, 9:59 PM

to Oksana

Dear General Manager,
Dear Editor EEJET

Sorry for the late attachment of the license agreement, yesterday the focus was on APC invoices and article revisions.
Here is the attached file.

Thank You

Best Regards

Mastiadi Tamjidillah

from "Eastern-European Journal of Enterprise Technologies" - Mastiadi Tamjidillah (stage 3, October)

External

Inbox

Tue, Oct 5, 2021, 7:39 PM

9. **Oksana Nikitina <0661966nauka@gmail.com>**

to me, nizarramadhan, mfarouksetiawan, jerryiberahim

Good afternoon, dear authors.

The article was accepted for consideration of the possibility of publication in (No. 5 (113).2021).

At the 3 - stage of editing, please take into account the comments of the editor (article in the application, color notes are highlighted).

We ask you to right strictly in the option which is in the attachment (see attachment).

We ask you not to delete the comments so that we can see all your edits. All corrections by the author, please highlight in green.

Please provide an edited version of the article **by 07.10.2021.**

We work 24/7 and are ready to help you around the clock!

with respect, general manager
Oksana Nikitina

Received date: 28.09.2021

Accepted date:

Comment after accepted with revised

UDC 621

CHARACTERISTICS OF RAW WATER SOURCES AND ANALYSIS OF THE OPTIMAL MODEL OF THE MIXING PROCESS WITH PARAMETER

DESIGN IN CLEAN WATER PUMP INSTALLATIONS

Mastiadi Tamjidillah, Muhammad Nizar Ramadhan, Muhammad Farouk Setiawan, Jerry Iberahim

The conceptual development of the model structure based on the setting of clean water parameters and the optimization model for the mixing process can be seen in Fig. 1 below.

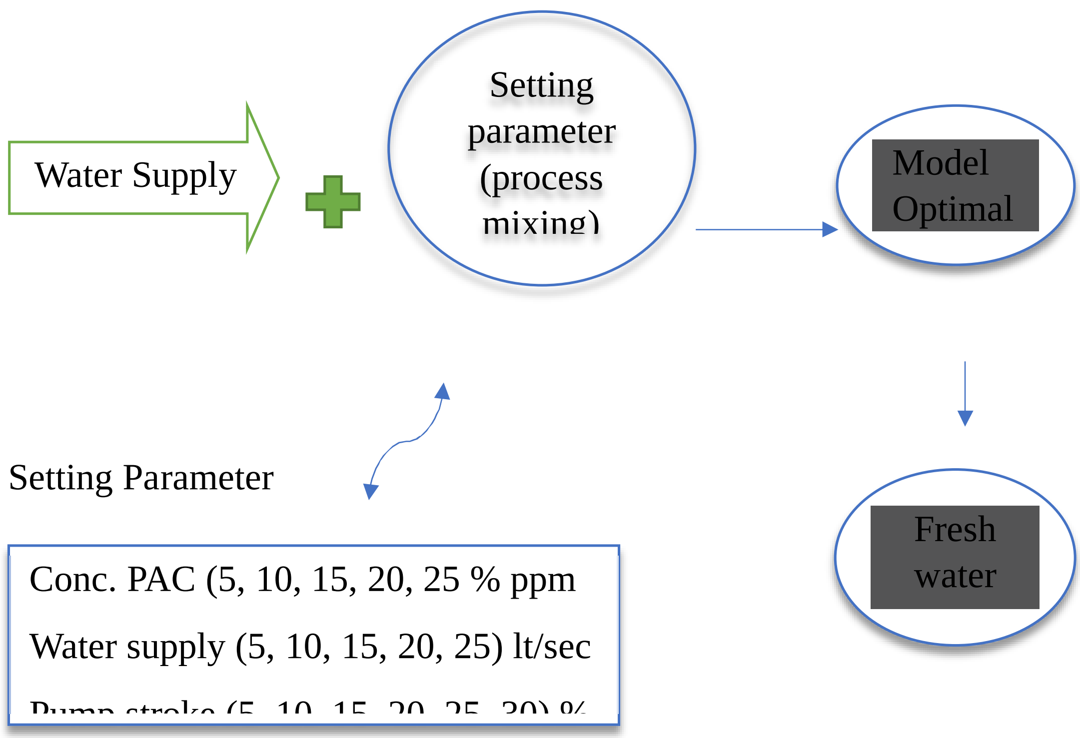


Fig. 1. Setting parameter model in process mixing

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AutoCAD, cdr for CorelDRAW etc) and print your figure to pdf (use File->Print of [ctrl]+[P] for it). Then resave pdf to tiff using Photoshop or another editor (be sure that resolution at least 300 dpi). Send me this and original files.

Correct ↑time roman 14 in figure, this file original

In parameter setting there is coagulation to remove and separate colloidal particles from natural organic minerals such as mud. These colloidal particles cannot settle naturally having a diameter of less than 1 mm causing color and turbidity. In Fig. 2 below, it can be seen that section 3 is the mixing process for the PAC variation to reduce the level of turbidity, to observe the behavior of the floating flock in section 4 there is an attractive force that tends to form aggregates while the repulsive force causes a stable colloidal dispersion.

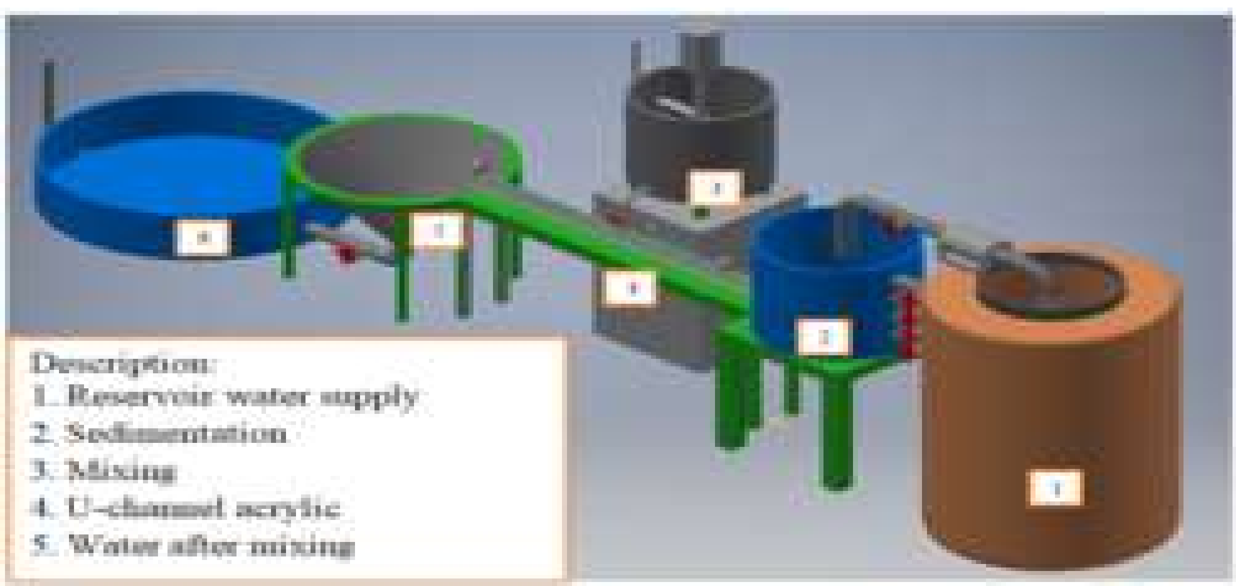

Fig. 2. Research Installation

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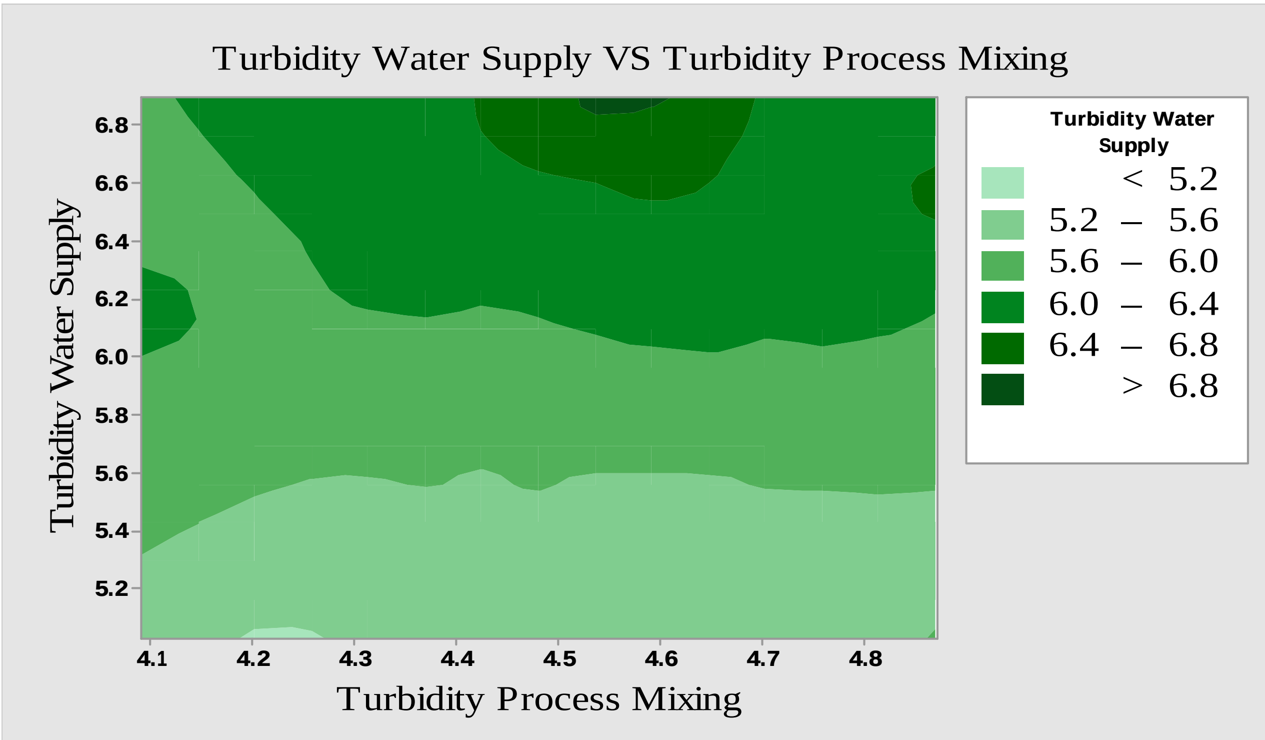

Fig. 4. Contour plot turbidity water supply and turbidity mixing process

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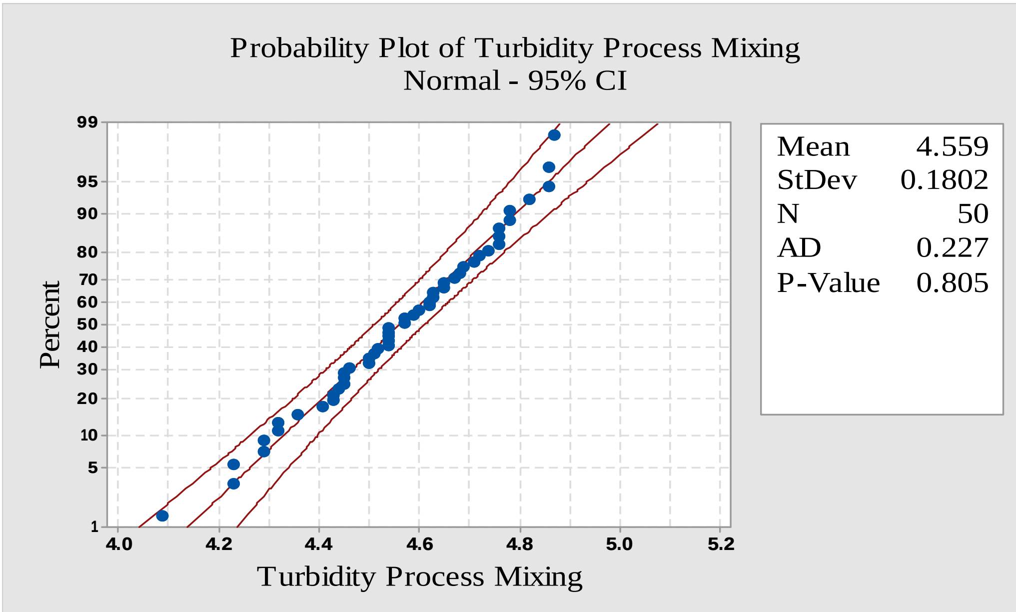
Turbidity level of water supply is averagely 5,8 NTU and the reduce of turbidity of mixing process is averagely 4.5 NTU as the addition of medium level in coagulant concentration, but the fluctuation approximates the normal distribution as shown in Fig. 5 below.

a



b

Fig. 5. Normality turbidity: *a* – water supply; *b* – process mixing

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Fig. 5. The variation of turbidity of water supply is influenced by the condition of downstream river, weather and environment of the forest (*a*) and the decrease of turbidity in the mixing process is due to the coagulant setting process (*b*). As the ppm coagulant is getting higher, the turbidity would reduce until reaching the optimum concentration level at the medium level in the condition of water supply which is of 5–7 NTU.

5. 2.

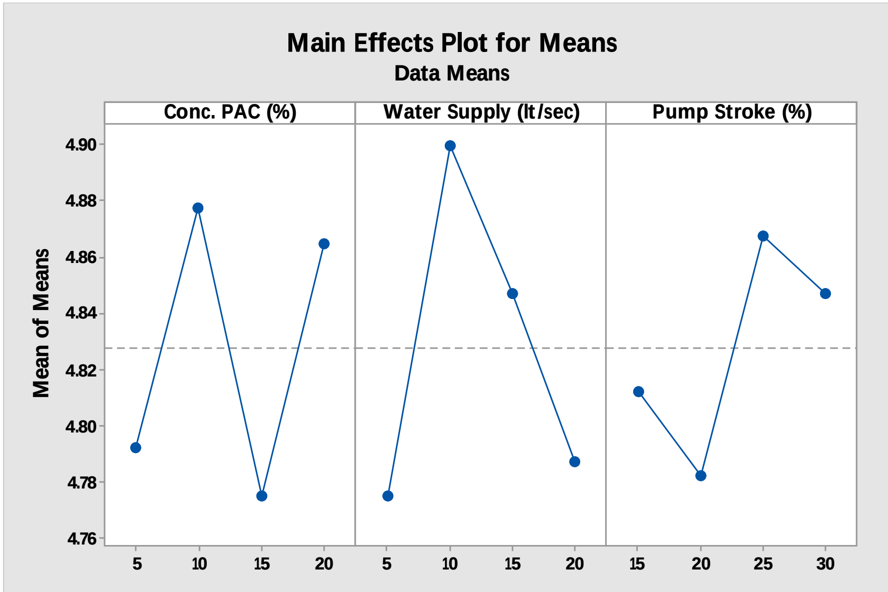

Fig. 6. Response table variable conc PAC, water supply, pump stroke

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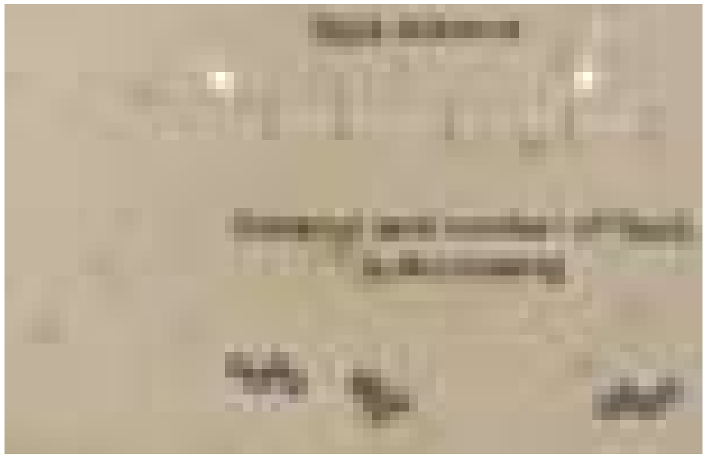
a



b

c

d

e

Fig. 8. SEM image of flock: *a* – 5 % ppm; *b* – 10 % ppm; *c* – 15 % ppm; *d* – 20 % ppm; *e* – 25 % ppm

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The fonts used in figures should match the font Times New Roman 14.

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Moreover, in Fig. 8, *c*, flocs start to percipate downward closing by the plat basis together with coagulation and flocculation. In Fig. 8, *d*, colloid and flocs are not visible since the pump rpm of mixing process is of 20 % and 25 % rpm at high level. It can be seen that the small visible flocs are closing by the big floc gap filled by liquid space where viscosity is smaller hence following the big floc pattern by clinging and uniting into big flocs continuously. Meanwhile, in Fig. 8, *e*, the group of flocs is visible until the basic plat with bigger grain and percipates covering almost the whole surface of the basic plat.

10. **Mastiadi Tamjidillah** <mastiadit@ulm.ac.id> Wed, Oct 6, 2021, 11:26 PM

to Oksana

Dear General Manager,
Dear Editor EEJET

Thank you for the revisions and suggestions for improving our article, we apologize for being a bit late in sending the revised edition
Thank you, our article was accepted for consideration of the possibility of publication in (No. 5 (113).2021).

We look forward to furthering the news, hopefully, according to your suggestions.

Thank You

Best Regards

Mastiadi Tamjidillah

11. **Oksana Nikitina** <0661966nauka@gmail.com> Oct 7, 2021, 2:05 AM

to me

Received, thank you.

12. **Oksana Nikitina** <0661966nauka@gmail.com> Thu, Oct 7, 2021, 3:01 PM

to me, nizarramadhan, mfarouksetiawan, jerryiberahim

Good afternoon, dear authors.

The article was accepted for consideration of the possibility of publication in (No. 5 (113).2021).

At the 4 - stage of editing, please take into account the comments of the editor (article in the application, color notes are highlighted).

We ask you to right strictly in the option which is in the attachment (see attachment).

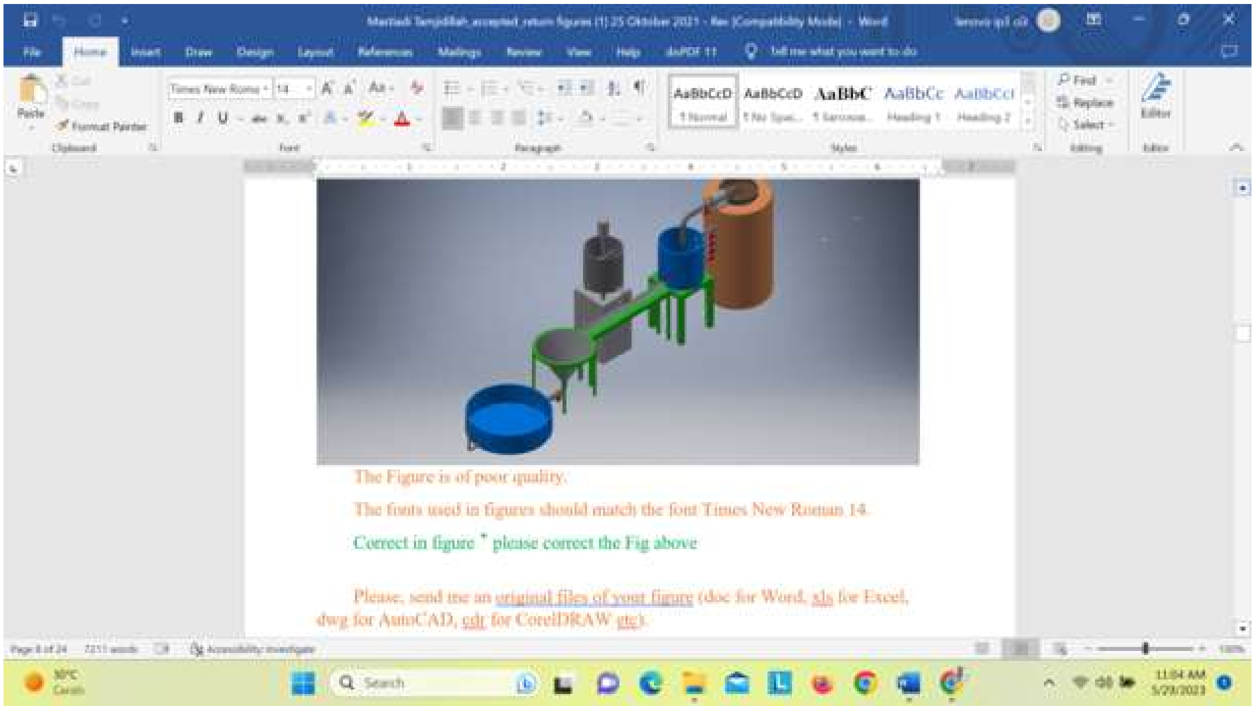
We ask you not to delete the comments so that we can see all your edits. All corrections by the author, please highlight in green.

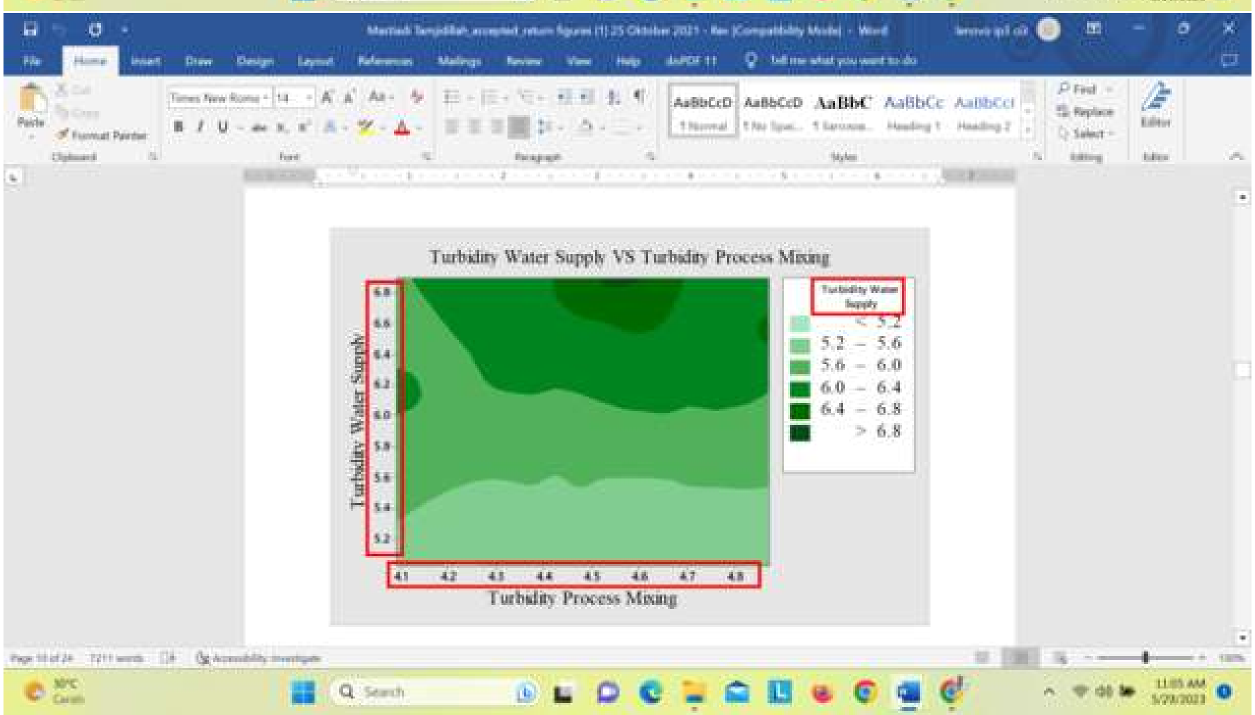
Please provide an edited version of the article **by 08.10.2021.**

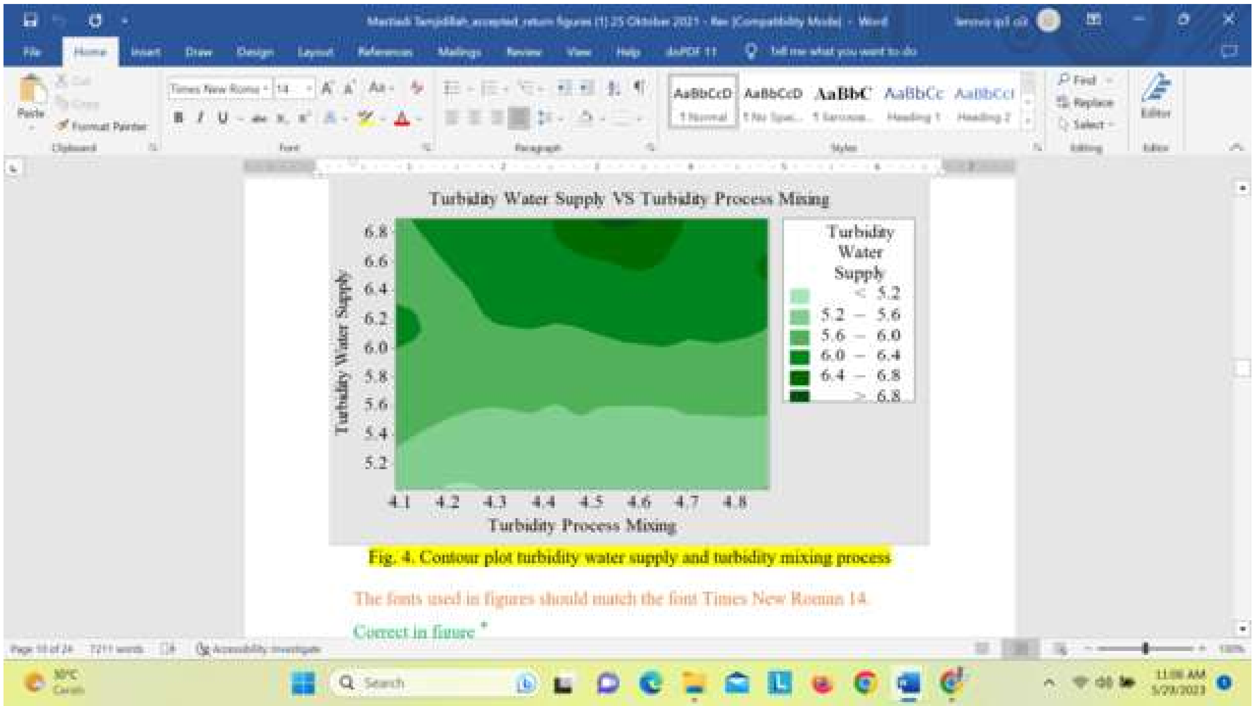
We work 24/7 and are ready to help you around the clock!

with respect, general manager
Oksana Nikitina

Comment continued






Turbidity Water Supply VS Turbidity Process Mixing
Turbidity Water Supply
Turbidity Process Mixing
Turbidity Water Supply
< 5.2
5.2 – 5.6
5.6 – 6.0
6.0 – 6.4
6.4 – 6.8
> 6.8
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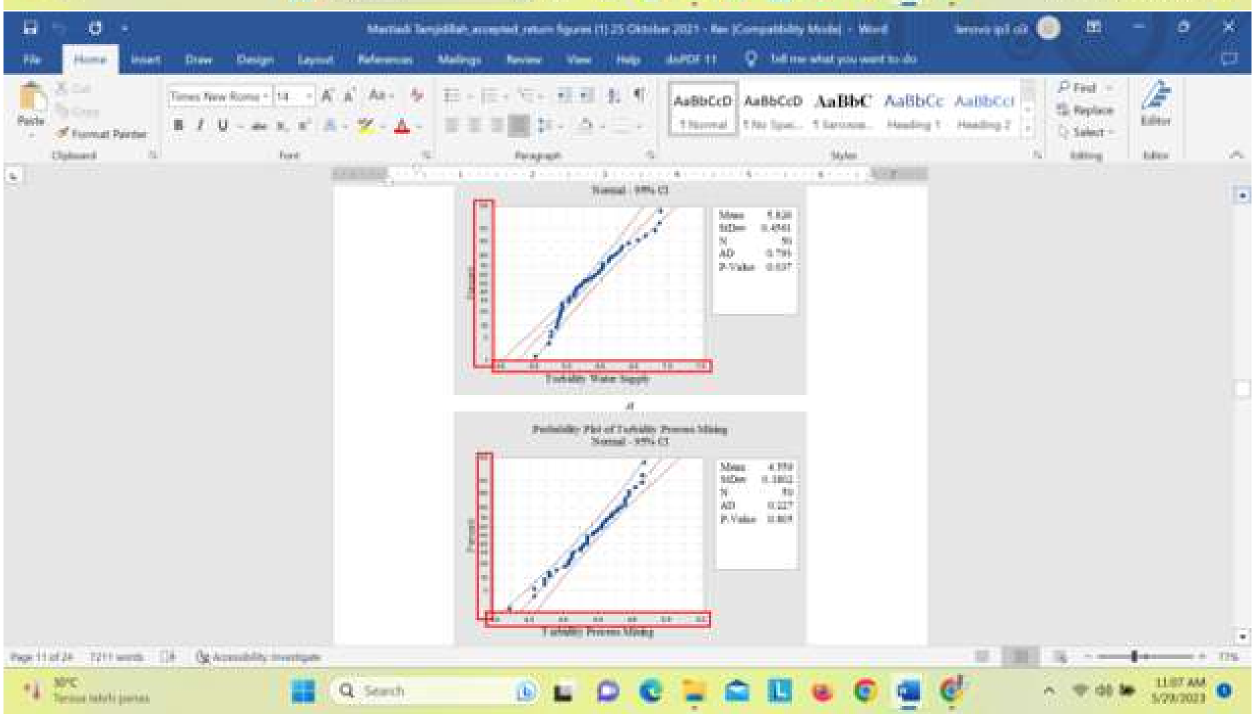
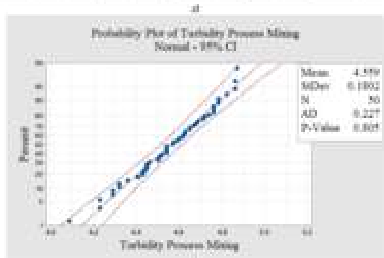

Normal - 95% CI
Turbidity Water Supply
Probability Plot of Turbidity Process Mixing
Normal - 95% CI
Turbidity Process Mixing

a



b

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Fig. 6. Response table variable conc PAC, water supply, pump stroke

The fonts used in figures should be the same. On axis font is smaller while "Main Effects Plot for Means" is bigger than other font on figure.

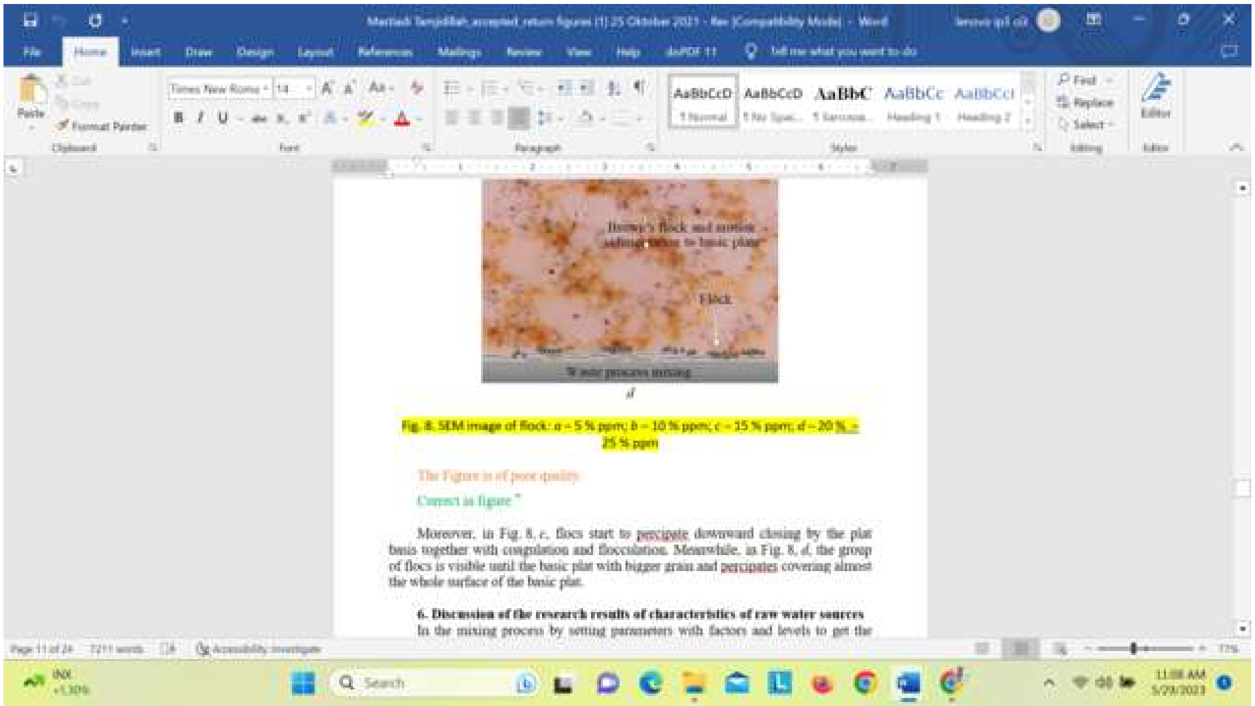
Table 2
Main effect of process mixing

Level	PAC	Water Supply	Pump stroke
1	4.793	4.775	4.813
2	4.877	4.900	4.782
3	4.775	4.848	4.868
4	4.865	4.787	4.848
Delta	0.102	0.125	0.085
Rank	2	1	3

By looking at the fluctuation of water supply turbidity and mixing process, the model of mixing process can be predicted at the medium level of 14 and 15 ppm coagulant. Averagely, the model of prediction of mixing process collects the maximum at medium level which is 15 for the condition of 5–7 NTU.

Optimal process mixing=15 % ppm conc. PAC+15 lt/sec+15 % pump stroke.

Optimal model can be decreased or increased fluctuatively at each 2 point range change of turbidity, for instance 5–7 NTU, 7–9 NTU, and so on. For the more detail, every change of ppm concentration, water supply and pump stroke can be seen in Fig. 7 below. At the position of medium level, it can be seen that the turbidity value of mixing process is at 4.8 NTU and 4.9 NTU which are close to the health standard. The higher % ppm of PAC causes the turbidity to decrease and the water color turn to transparent. The effect of over PAC would not be harmful for human body but



d

Fig. 8. SEM image of flock: a – 5 % ppm; b – 10 % ppm; c – 15 % ppm; d – 20 % – 25 % ppm

The Figure is of poor quality

Correct in figure *

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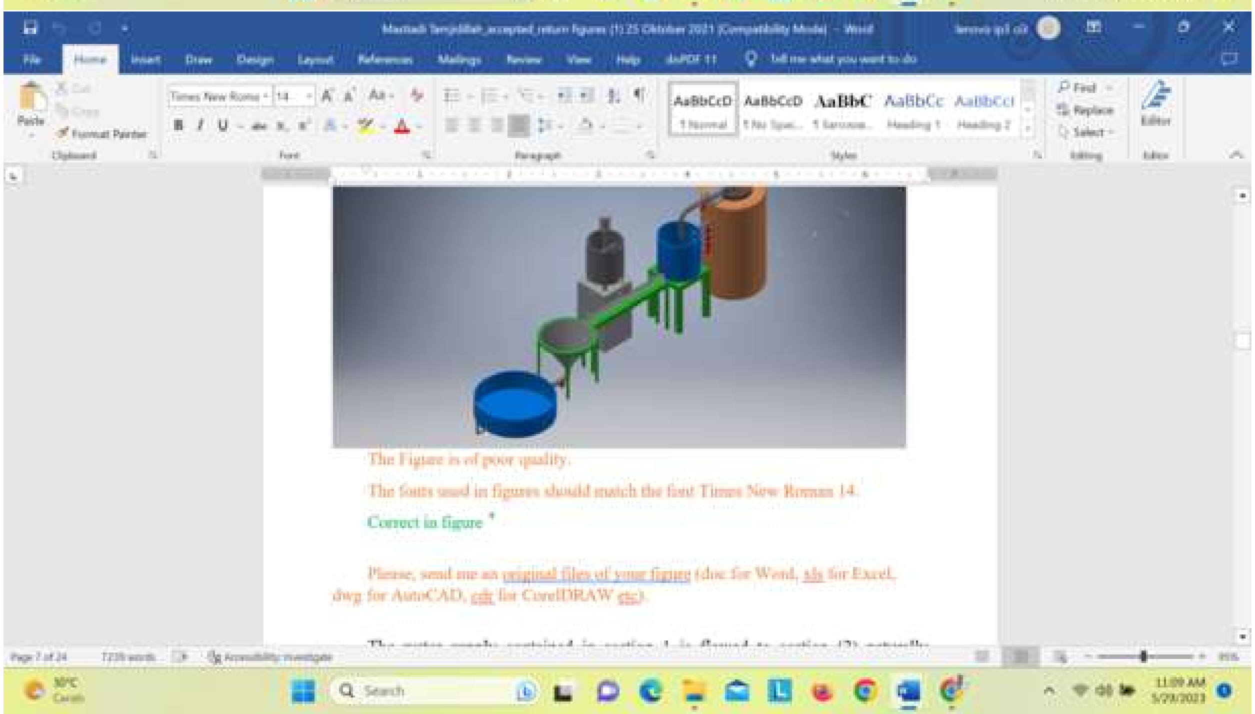
6. Discussion of the research results of characteristics of raw water sources

In the mixing process by setting parameters with factors and levels to get the



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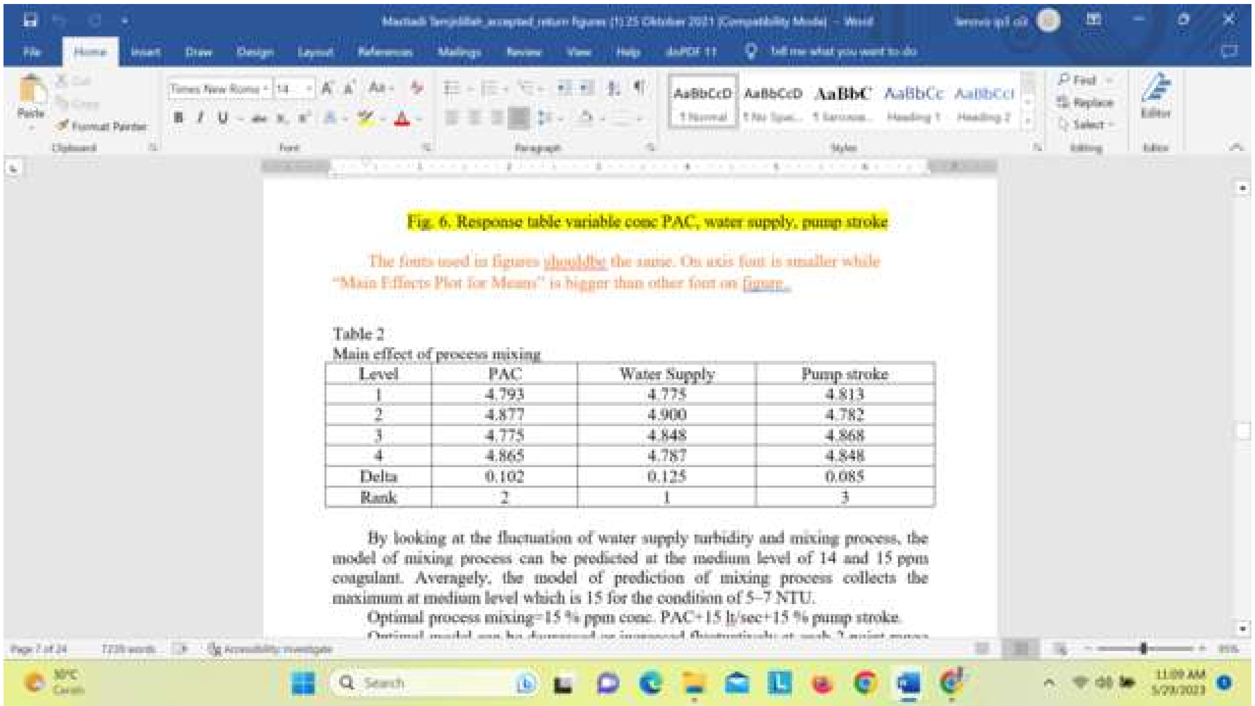
The water supply contained in section 1 is flowed to section (2) naturally



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13. **Mastiadi Tamjidillah** <mastiadit@ulm.ac.id> Thu, Oct 7, 2021, 11:53 PM

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Thank You

Best Regards

Mastiadi Tamjidillah

Received date: 28.09.2021

Accepted date:

UDC 621

CHARACTERISTICS OF RAW WATER SOURCES AND ANALYSIS OF THE OPTIMAL MODEL OF THE MIXING PROCESS WITH PARAMETER DESIGN IN CLEAN WATER PUMP INSTALLATIONS

Mastiadi Tamjidillah, Muhammad Nizar Ramadhan, Muhammad Farouk Setiawan, Jerry Iberahim

To investigate and find the quality characteristics of raw water sources in the regional integrated drinking water supply system (SPAM) of Banjarbakula to maintain the supply of drinking water quantity and quality in accordance with drinking water standards. Selection and determination of the optimum model for the mixing process of raw water and poly aluminum chloride (PAC) and pump stroke for input of water sources from rivers to obtain a composition setting that is in accordance with the raw water sources of each region in the region. So that it is known the optimum parameter setting model between alum water, raw water and pump stroke for each raw water source and is regionally integrated as a result of a comprehensive study. The integration of Taguchi parameter design and response surface can complement each other and become two methods that go hand in hand in the process of optimizing clean water products. Parameter design provides a very practical optimization step, the basis for this formation refers to the factorial fractional experimental design. However, the absence of statistical assumptions that follow the stages of analysis makes this method widely chosen by researchers and practitioners. With the experimental design of the raw water mixing process (turbidity) such as 5 lt/sec, 10 lt/sec, 15 lt/sec, 20 lt/sec and 25 lt/sec and % PAC concentration 5 ppm, 10 ppm, 15 ppm, 20 ppm and 25 ppm with a pump stroke installation of 5 %, 10 %, 15 %, 20 % and 25 %. In the process of adding PAC, always pay attention and observe the behavior of the attractive force of the floating particles (flock). The particles were then subjected to SEM (scanning electron microscope) to determine the dimensions of the flock grains deposited

Keywords: characteristics, parameters, setting, supply, turbidity, mixing, concentration, pump, behavior, clean water

1. Introduction

The need for raw water (water supply) is very necessary to ensure availability for the clean water treatment process. With good raw water quality, it describes good natural conditions, so it needs to be maintained to maintain quantity and continuity. Good and sufficient raw water is the hope of the clean water industry and society as consumers for a healthier life. However, the processing process is important so that the quality is always maintained with raw water conditions that vary in quality. It is everyone's effort to use efficient clean water to keep it always available, because water is a basic need that must be maintained for survival.

The characteristics of raw water quality vary, because the source comes from rivers with high turbidity levels above 5 NTU (nephelometric turbidity unit), so a water treatment process is needed to reduce the turbidity level. To meet the community's need for clean water that meets health standards, an adequate supply of raw water is needed to maintain the quality and availability for human life. Water sources from upstream must be considered so that these resources are sustainable by taking into account renewable environmental factors that are useful for other activities such as the use of other energy resources.

The quality of raw water decreases because it is caused by household activities, soil pollution, water pollution, logging activities and plantation land clearing. In addition to the decrease in the quality of raw water, it also causes an increase in temperature, sedimentation and organic content due to the opening of new land for agriculture and plantations in the upstream part of the river. The influence of activities upstream of the river causes the quality of raw water to decrease which will be used as input for processing into clean water. So that an integrated treatment process is needed according to these conditions to get good quality clean water.

The clean water treatment process at the SPAM in the Banjarbakula region continues to be carried out for each region, from the processing installation only PDAM Bandarmasih which has a population of almost 200 thousand people which has been served by 99 % of the community. While the City of Banjarbaru and Kab. Banjar until the end of 2020 with the number of customers reaching 625,000 people with a service coverage of around 80 %. Likewise Kab. Barito Kuala and Kab. Tanah Laut is still below the national target, which is 68 % and the PBB MDGs (Millennium Development Goals) target of 80 %.

Clean water treatment to reduce the level of turbidity from the water supply, it is necessary to add an appropriate coagulant process to reduce it according to clean water standards. To determine the estimated dose of coagulant is also done by using a parameter design with a variety of settings adopting the Taguchi method. For local Indonesia, the raw water source is from the river, it is different from other countries with the same water source, because forest conditions and environmental factors in the upstream of the river greatly affect the level of turbidity.

By improving the mixing process with various variations to get the optimum setting. With Taguchi's approach to lowering turbidity, accelerates the formation of floating flocks during the mixing process. The coagulation process aims to reduce turbidity, color and odor through a chemical process used to remove colloidal particles that can disturb the environment. Colloidal particles cannot settle, there must be a suitable coagulant such as PAC to destabilize the particles so that microflocs are formed. With the coagulation and flocculation processes in the clean water treatment process with the main parameter setting lowering the turbidity level, it will produce quality water according to health standards.

In the mixing process at the pump installation, it is necessary to set the appropriate parameters to reduce the level of turbidity before and after the mixing process with variations in the addition of coagulant. Optimal settings will be obtained in this process, a positively charged coagulant is used to attract negatively charged colloid particles as a flock which will settle to the bottom of the channel, the behavior of the coagulant that catches floating colloid particles is observed and a scanning electron microscope (SEM) is performed to determine the dimensions of the flock grains. the result of the deposition process of mixing with various content of its compounds.

Therefore, the clean water treatment process in the WTP (water treatment plant) used for the community and the beverage industry is in accordance with health standards. The characteristics of the input water supply are the basis for determining the selection of coagulant, the input is influenced by organic, inorganic, industrial waste that has not been maximized by implementing waste processing installations in the form of smelly, hazardous and toxic waste. If the water supply is affected by a large amount of organic waste from tropical forests so that the decrease in water quality is caused by high turbidity, then a coagulant is needed that can catch floating flocks before gravity takes the form of sedimentation.

2. Literature review and problem statement

In the process of mixing with water supply which is influenced by organic waste predominantly with high turbidity, it is also necessary to improve the condition of the forest and the environment upstream. This condition affects the quality of the input water supply, so that appropriate parameter settings are needed in the processing process. Parameter setting is the main factor in the mixing process to get good quality, it is necessary to use a network system to detect organic waste in raw water supply [1], assessment of the quality of water sources from rivers is always evaluated and the value of turbidity and sediment aspects [2] These colloidal particles cannot settle on their own and are difficult to handle physically, the addition of PAC coagulant destabilizes the particles to form microflocs [3]. The microflocs then agglomerate into macroflocs which can be deposited through the flocculation process. The coagulation process is time dependent and slow stirring in water. Generally, the flocculation period occurs for 10–30 minutes after the coagulation process [4]. The faster the mixing time, the larger the floc formed with the characteristics of the raw water source, stirring conditions, flocculation time, selected coagulant, and variations in the addition of coagulation consentration will affect the performance of coagulation. The fast stirring process in the ink industry is faster to reduce and reduce waste water [5], while the beverage industry pays attention to the decrease in sediment by setting ppm coagulant [6].

In this clean water treatment plant, the water supply is from a river with a high turbidity above 5 NTU, so it is necessary to add an appropriate coagulant process to reduce turbidity and waste [7]. Many researchers use the addition of conventional coagulant variations with the Jartest method which is carried out in the process of reducing turbidity [8], but it has not been fast and effective to reduce turbidity at 5–10 NTU levels, as well as using genetic algorithm approaches and artificial neural network methods to find an approach mathematical model is still debatable solution [9]. So it is necessary to propose an improvement in the quality of clean water from the start (off-line quality) with parameter settings that adopt the Taguchi method [10], with a green approach to the mixing process at various levels of turbidity by reducing floating organic waste. The use of chitosan is useful in reducing waste water and color from industry [11], but for water sources from rivers because organic is used other coagulants such as PAC [12]. For local Indonesia, the raw water source from the river is different from other countries with the same water source, because forest conditions and environmental factors in the upstream river greatly affect the level of turbidity. The choice of coagulant is different for each water supply from rivers or other water sources, with the jartest technique can reduce turbidity, but the use of PAC is even faster in the mixing process [13], with chitosan on coagulation and flocculation reduces color at pH below 5, while river water tends to be above 5 [14].

Colloidal particles that are small and fine are generally negatively charged because river water contains organic or inorganic compounds that cannot be removed by ordinary sedimentation. PAC as a drinking water purification coagulant has a good speed in forming new flocs in the process of mixing clean water. As a basic element, aluminum forms repeating units in long molecular chains which have a high positive charge and large molecular weight and can reduce flocs in purified water even in certain doses [15]. Thus PAC combines neutralization and the ability to bridge flock particles so that coagulation takes place more efficiently [16]. PAC can easily neutralize the electric charge on the flock surface and can overcome and reduce the electrostatic repulsion between particles to as small as possible, thus allowing the flock to approach each other (covalent attractive forces) and form larger masses. PAC selection coagulants can reduce floating flocks in the water supply from rivers, and accelerate sedimentation and reduce waste water non oily from clean water treatment to customers [17], with the use of PAC above 10 ppm it can reduce waste water rather than the use of ultraviolet and chlorine disinfectants [18].

For scenarios of environmentally friendly conditions as a form of sustainable use, natural resources are preserved by taking into account the hydrological cycle of water resources. The use of water resources, especially those from rivers, is very high and worrying, the availability of water supply and its safety is approaching the gray zone and continues to increase, with factor analysis contributing to urban water management [19]. By using fuzzy and TOPSIS can provide information on the availability and contribution of options for the use of water resources [20], water quality is strongly influenced by the condition of the river upstream, either organic or inorganic, waste. There are several scenarios to make water available for downstream industrial inputs such as drinking water needs. However, the quality of drinking water needed must be feasible for consumers by reducing disinfectants which are waste. there are several decision-making criteria to reduce the waste, among others, paying attention to the processing/treatment.

The quality characteristics have been widely studied, both in the manufacturing industry, the water industry and the chemical industry, in the opinion that water sources from upstream must be considered so that the availability and quality of water is better. However, this resource must be sustainable by taking into account renewable environmental factors that are useful for other activities such as the use of other energy resources, the quantity factor must be considered to ensure the availability of raw water [21].

Research on the relationship between raw water quality parameters, chlorine requirements and disinfectant content of drinking water has been carried out [22]. The use of appropriate chlorine will minimize disinfectants so that the quality of drinking water supplied to customers will be maintained according to standards. The model obtained for clean/drinking water treatment conditions in Malaysia shows that there is a relationship between the need for chlorine to reduce disinfectants and improve product quality, the parameters of raw water content also affect the final product and require treatment in its processing.

In the mixing process at the pump installation, it is necessary to set the appropriate parameters to reduce the level of turbidity before and after the mixing process with variations in the addition of coagulant. Optimal settings will be obtained in this process, a positively charged coagulant is used to attract negatively charged colloid particles as a flock which will settle to the bottom of the channel, the behavior of the coagulant that catches floating colloid particles is observed and a scanning electron microscope (SEM) is performed to determine the dimensions of the flock grains. the result of the deposition process of mixing with various content of its compounds.

With the condition of the input water supply characteristics in clean water treatment, especially the mixing process segment to reduce the level of turbidity due to organic waste, it is necessary to set parameters from the beginning before and after the mixing process.

3. The aim and objectives of the study

The aim of this research is the optimal parameter setting model was obtained to reduce the level of turbidity and investigate the behavior of floating flocks in the mixing process.

To accomplish the set aim, the following tasks were set and identified:

– the turbidity characteristics of water before and after the mixing process;

– optimal parameter setting in the mixing process of PAC (coagulant), raw water and pump stroke;

– to determine the behavior of the flow and floating flock, as well as to determine the microstructure of the mixing process.

4. Materials and methods

Before the mixing process is required normality test and turbidity contour level were used to test the data whether the data were normally distributed for the turbidity parameter and information on the distribution of the data, while the counter explained the position of the data distribution in sampling which was determined about the raw water turbidity parameters and the turbidity of the mixing process. The dosing pump is designed to drain the PAC coagulant flow fluid into the water fluid. This pump generates a coagulant flow rate by the mixing method set from the valve to deliver the liquid PAC discharge into the dosed reservoir. This pump is very helpful in the process of mixing clean water treatment for coagulant variations which are controlled internally to vary the flow rate and dosage amount.

Taguchi's method is used for parameter setting and integration of the most influential waste output to improve the quality of clean water products, reduce turbidity levels with variations in coagolan doses, optimal mixing process. The target of this method is to make clean water products less sensitive to noise, so it is called a robust design [26] like the concept below:

– the turbidity characteristics of water before and after the mixing process, with the experimental design of the raw water mixing process (turbidity) such as 5 lt/sec, 10 lt/sec, 15 lt/sec, 20 lt/sec and 25 lt/sec and % PAC concentration 5 ppm, 10 ppm, 15 ppm, 20 ppm and 25 ppm with a pump stroke installation of 5 %, 10 %, 15 %, 20 % and 25 %;

– by the parameter settings above, the optimal parameter settings are obtained to reduce the level of turbidity;

– observing and identifying the behavior of floating flocks to sedimentation for SEM.

According to [23], explained that the advantages of the Taguchi method compared to other experimental designs are because it is more efficient in experiments involving many factors but the number of experimental units required is relatively small, the product is more consistent and less sensitive (robust) to variability caused by factors that cannot be controlled (noise). The objective function of the Taguchi method for a robust design that is resistant to noise is derived from measuring product quality using a quadratic loss function in a broader definition to produce an optimal design or parameter setting. Signal to ratio (SNR) in the experimental design system of this method provides a comparison of quantitative values for response variations to determine the optimum parameter settings.

The most important hope in the robust design of the Taguchi method, especially parameter setting, is to examine the effect of variability on factors and experimental levels using statistical tools as a tool. To help fully factorial large, time-consuming and costly experiments, Taguchi suggests using orthogonal arrays (OA) to represent the range of possible experiments. After conducting the experiment, all experimental data were evaluated using analysis of variance (ANOVA) to determine the optimum parameter settings [24, 25].

This method is to determine the factors that influence an optimum response with its characteristics. The Smaller The Better (STB) quality characteristic indicates that the smaller the characteristic parameter, the better the quality. Larger The Better (LTB) indicates that the larger the characteristic parameter, the better the quality will be, and the Nominal The Better (NTB) quality characteristic means that the quality will be said to be getting better if it is close to the nominal (target) that has been set through parameter design and response. for clean water with various concentrations and levels [26, 27].

The conceptual development of the model structure based on the setting of clean water parameters and the optimization model for the mixing process can be seen in Fig. 1 below.

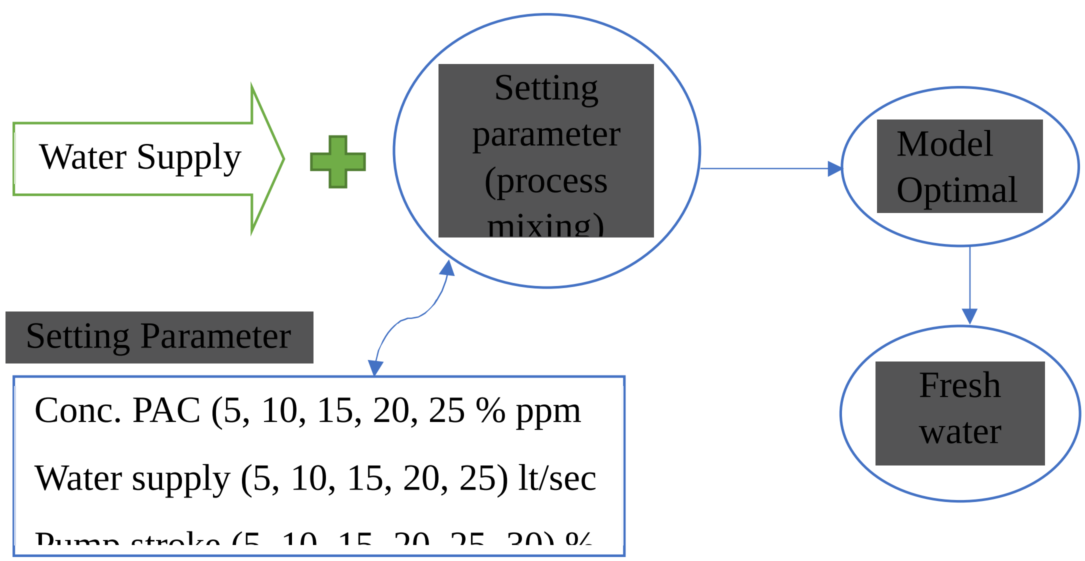

Fig. 1. Setting parameter model in process mixing

In parameter setting there is coagulation to remove and separate colloidal particles from natural organic minerals such as mud. These colloidal particles cannot settle naturally having a diameter of less than 1 mm causing color and turbidity. In Fig. 2 below, it can be seen that section 3 is the mixing process for the PAC variation to reduce the level of turbidity, to observe the behavior of the floating flock in section 4 there is an attractive force that tends to form aggregates while the repulsive force causes a stable colloidal dispersion.

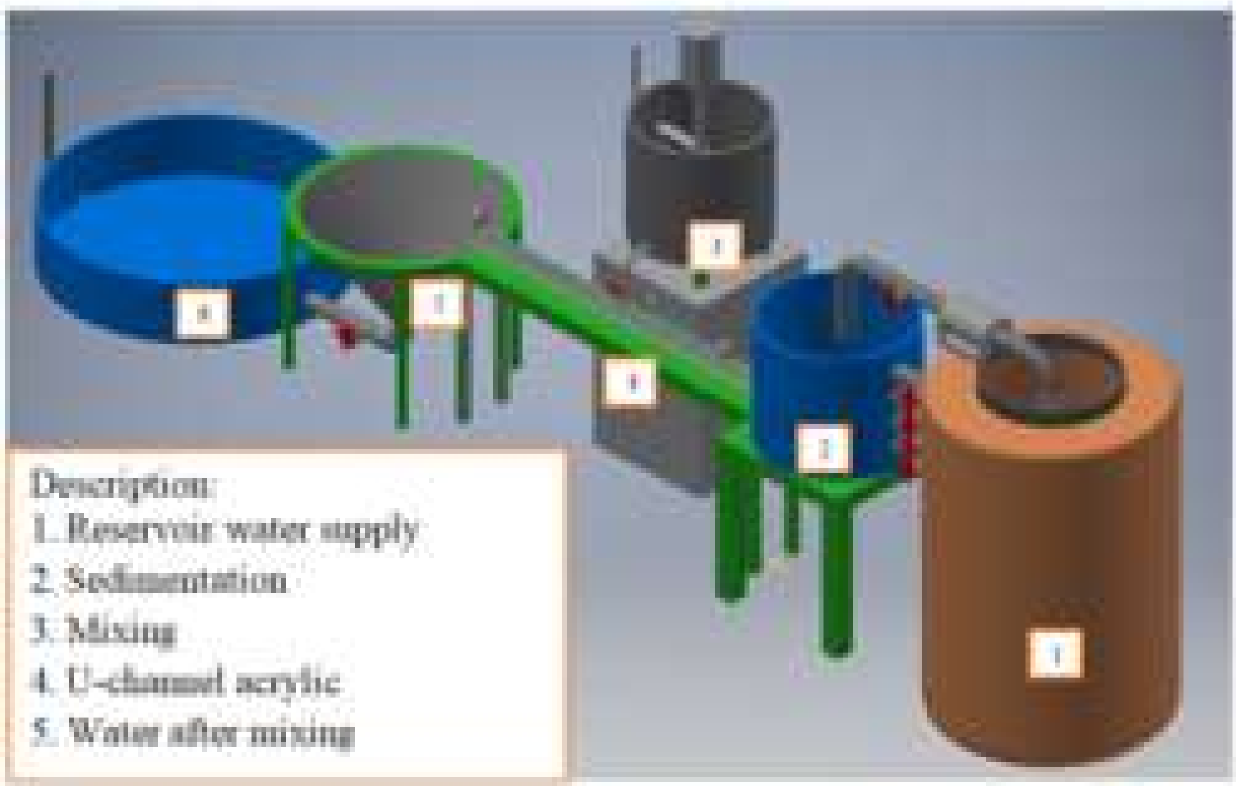

Fig. 2. Research Installation

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Please, send me an original files of your figure (doc for Word, xls for Excel, dwg for AutoCAD, cdr for CorelDRAW etc).

The water supply contained in section 1 is flowed to section (2) naturally precipitated by gravity, flowing through a transparent glass channel which is dripped with coagulant with the specified setting. The quality of clean water can be seen in section (5, 6), then in the laboratory test to get the level of turbidity according to health standards.

5. Research results of the characteristics of water quality in clean water treatment plant

5. 1. The turbidity characteristics of water before and after the mixing process

Parameter setting conducted in mixing process, as shown in Fig. 3 below, shows that the turbidity value of water supply is above 5 NTU (nephelometric turbidity unit) – which is the standard value for clean water. With the medium level of concentration (11 to 15 ppm), it in shown that the decrease of turbidity value is at the range of 4–5 NTU at pH 7.1. The turbidity value of water supply and mixing process can also be seen in contour plot, Fig. 4 which presents the dispersion of turbidity value with a more detailed range system in the position of turbidity value at each change of PAC concentration.

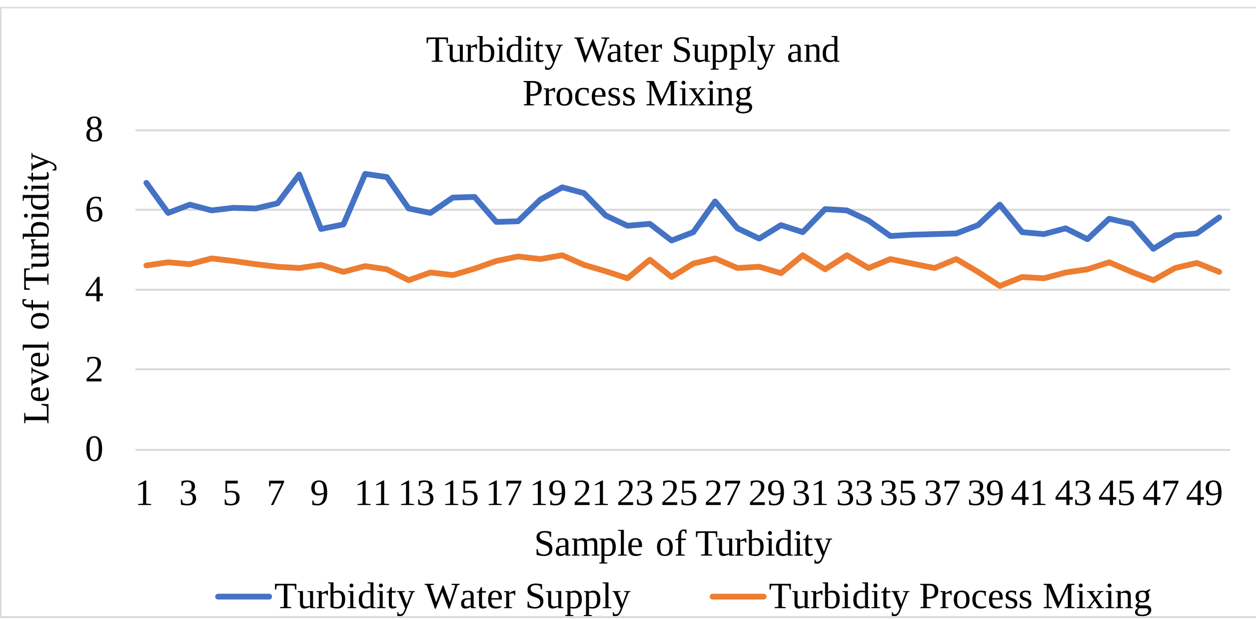

Fig. 3. Level turbidity water supply and turbidity mixing process

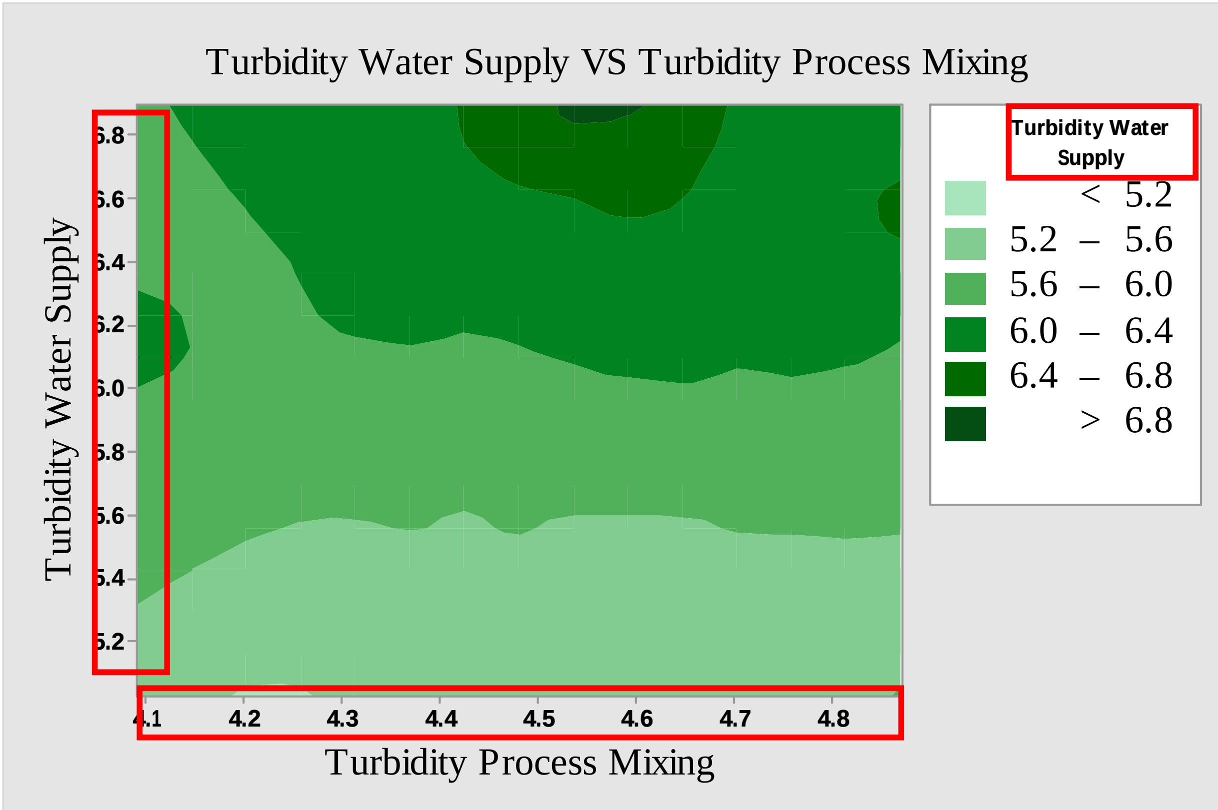

Fig. 4. Contour plot turbidity water supply and turbidity mixing process

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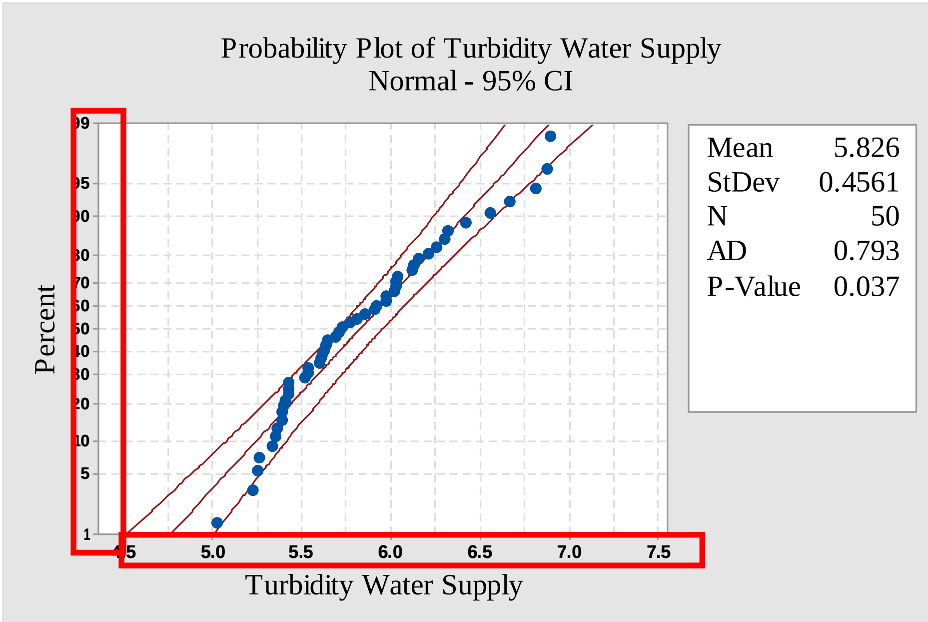
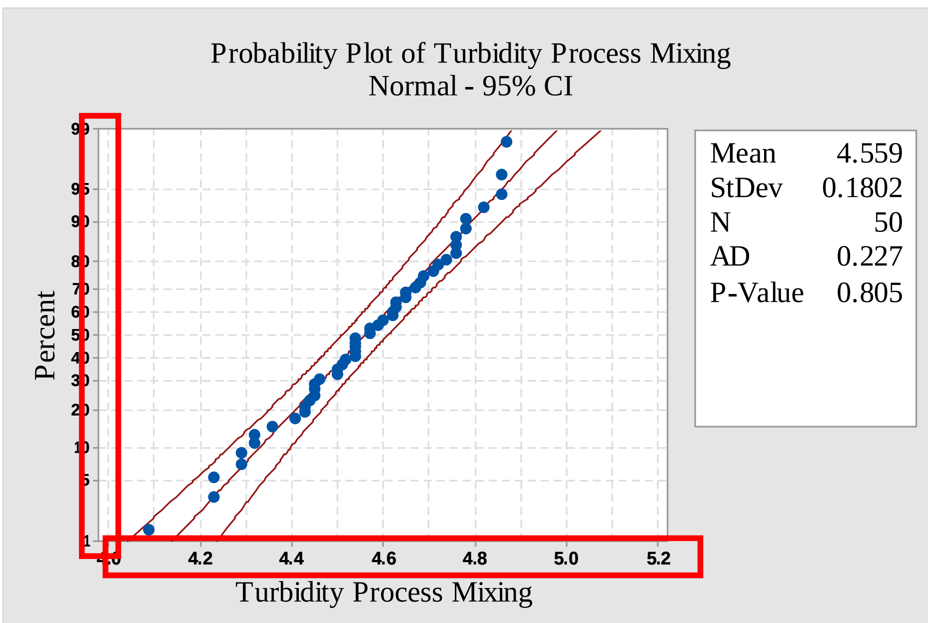
Turbidity level of water supply is averagely 5,8 NTU and the reduce of turbidity of mixing process is averagely 4.5 NTU as the addition of medium level in coagulant concentration, but the fluctuation approximates the normal distribution as shown in Fig. 5 below.



a



b

Fig. 5. Normality turbidity: *a* – water supply; *b* – process mixing

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Fig. 5. The variation of turbidity of water supply is influenced by the condition of downstream river, weather and environment of the forest (*a*) and the decrease of turbidity in the mixing process is due to the coagulant setting process (*b*). As the ppm coagulant is getting higher, the turbidity would reduce until reaching the optimum concentration level at the medium level in the condition of water supply which is of 5–7 NTU.

5. 2. Optimal parameter setting in the mixing process of PAC (coagulant), raw water and pump stroke

In the mixing process to decrease turbidity with the addition of coagulant variations by setting the parameters of the Taguchi method with Low level (5–10 ppm), medium level (11–15 ppm) and high level (16–20 ppm) as shown in Table 1 below.

Table 1

Level factor

Parameter	Code	Level 1	Level 2	Level 3	Level 4
Conc.alum (% ppm)	A	5	10	15	20
Water Supply (lt/sec)	B	5	10	15	20
Pump stroke (%)	C	15	20	25	30

The change of concentration level of PAC coagulant starts from low level, medium level, and high level simultaneously with the setting of water supply and pump stroke. The decrease of turbidity level seems better as the raise of coagulant concentration level has positive ions. The positive and negative ions depict the effect and response of variable concentration, water supply, and pump stroke as shown in Fig. 6 and Table 2 below. The plot effect of *S*/*N* ratio is in the optimum process of parameter design of mixing process at the various concentration level.

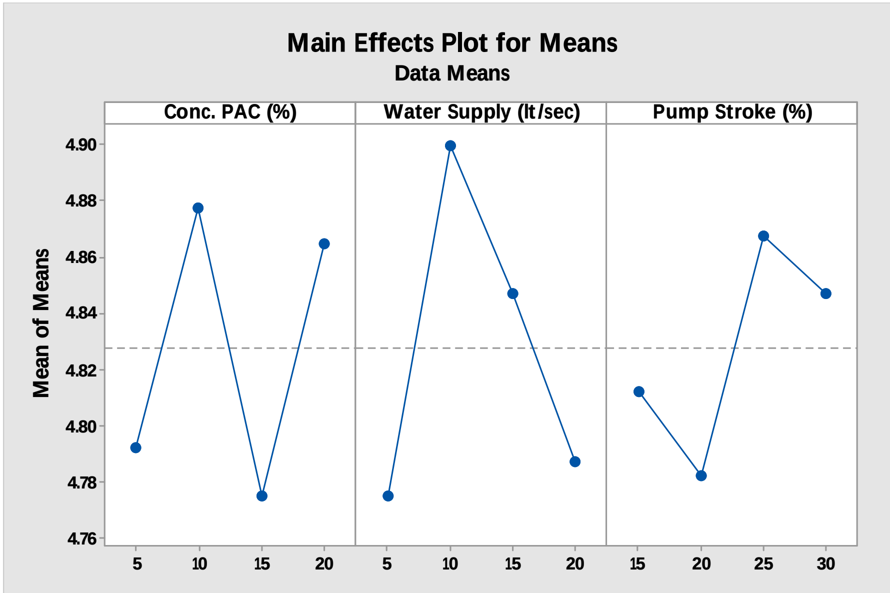

Fig. 6. Response table variable conc PAC, water supply, pump stroke

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Table 2

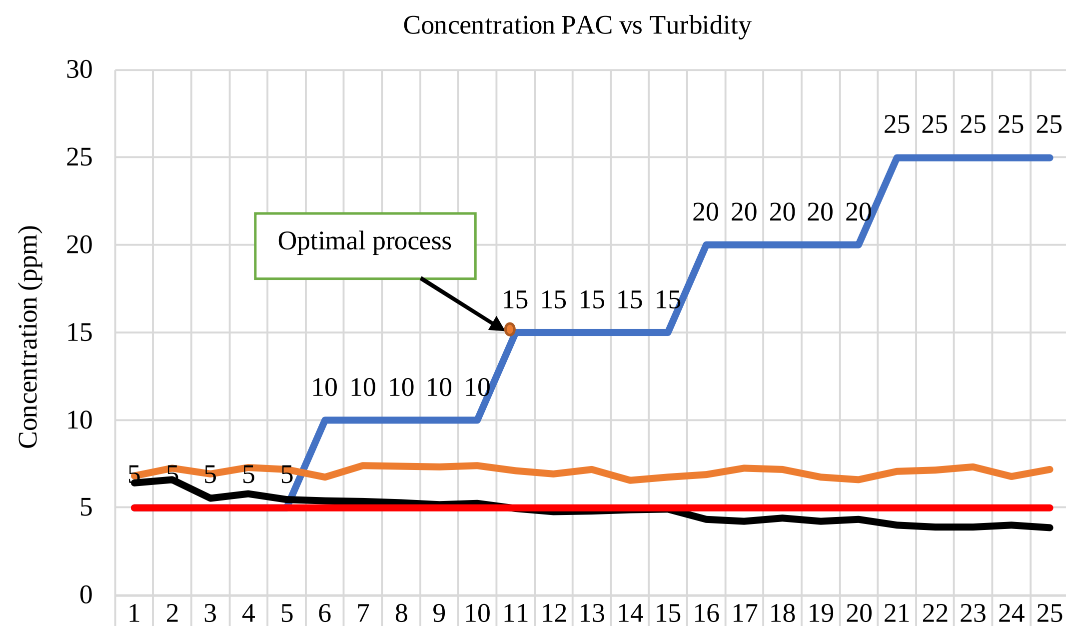
Main effect of process mixing

Level	PAC	Water Supply	Pump stroke
1	4.793	4.775	4.813
2	4.877	4.900	4.782
3	4.775	4.848	4.868
4	4.865	4.787	4.848
Delta	0.102	0.125	0.085
Rank	2	1	3

By looking at the fluctuation of water supply turbidity and mixing process, the model of mixing process can be predicted at the medium level of 14 and 15 ppm coagulant. Averagely, the model of prediction of mixing process collects the maximum at medium level which is 15 for the condition of 5–7 NTU.

Optimal process mixing=15 % ppm conc. PAC+15 lt/sec+15 % pump stroke.

Optimal model can be decreased or increased fluctuatively at each 2 point range change of turbidity, for instance 5–7 NTU, 7–9 NTU, and so on. For the more detail, every change of ppm concentration, water supply and pump stroke can be seen in Fig. 7 below. At the position of medium level, it can be seen that the turbidity value of mixing process is at 4.8 NTU and 4.9 NTU which are close to the health standard. The higher % ppm of PAC causes the turibidity to decrease and the water color turn to transparent. The effect of over PAC would not be harmful for human body but with a continuous excessive dosage in a long time, it would cause side effect in form of toxin within human body.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Conc. PAC (% ppm)	5	5	5	5	5	10	10	10	10	10	15	15	15	15	15	20	20	20	20	20	25	25	25	25	25
Turbidity Water Supply	6.8	7.2	6.9	7.3	7.2	6.7	7.4	7.4	7.3	7.4	7.1	6.9	7.2	6.6	6.7	6.9	7.3	7.2	6.8	6.6	7.0	7.1	7.3	6.8	7.2
Turbidity process mixing	6.4	6.6	5.5	5.8	5.5	5.4	5.3	5.3	5.2	5.3	4.9	4.8	4.8	4.9	4.9	4.3	4.2	4.4	4.2	4.3	4	3.9	3.9	4	3.9
Standart (max 5)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

Fig. 7. The variation of PAC concentration at each level

In Fig. 7 above, it can be seen that the concentration of % PAC at medium level 15 produces a turbidity level of 4.9, close to 5 NTU health standards, so that point becomes optimal. If you add more PAC at levels 20 and 25 the clean water is close to white color can be harmful to health if used continuously because of the effect of high coagulant content.

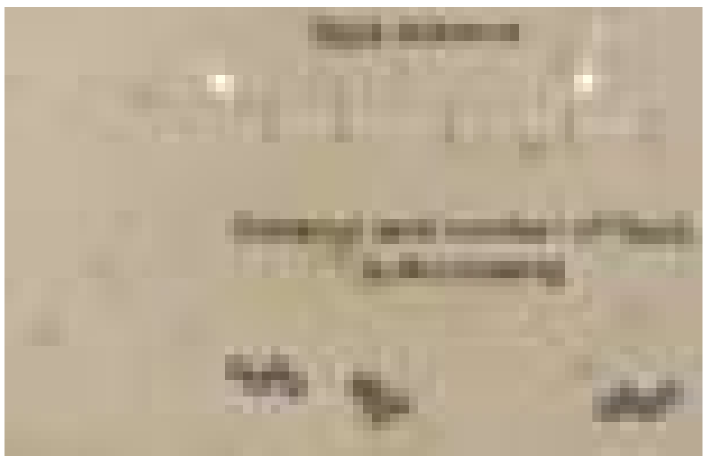
5. 3. To determine the behavior of the flow and floating flock, as well as to determine the microstructure of the mixing process

Each change of PAC concentration level causes the change of water turbidity value, colloid behavior and floc formation in mixing process. Coagulant characteristic whose charge is positive ion would attract negatively charged colloid that is often called as the effect of Van der Waals' attractive force. A proper addition of coagulant concentration would reduce the zeta potential repulsive force in the colloid, thus there is more positive ions than negative ions which causes faster floc formation process. With sedimentation process and flock filterization, it would gravitationally percipate at the bottom surface to furthermore be thrown away since the sedimentation is known as waste in the industry of clean water.

In the mixing process, each variation of water supply, ppm PAC and % stroke pump will affect the level of turbidity due to the addition of coagulant which will attract negative ions into flock, with increasing coagulant and pump stroke in the form of pump speed in rpm will accelerate the process of flock formation, Fig. 8a presenting large flocks so that the effect of the van der Waals forces can still be seen, a large attraction by the coagulant will accelerate flock formation.

With the increase of coagulant and pump stroke in the form of pump velocity in rpm, it would fasten the process of floc formation. Fig. 8, *a* represents the big grain-sized flocs in which thus the effect of Van der Waals' force is visible. The great attractive force from coagulant would fasten the floc formation. To observe the Brownian motion, which is in form of zig-zag line or dash line, the portrayal of molecular kinectic flocs requires a camera magnification of 1200 with the type of SEM digital. In Fig. 8, *b*, the distance among flocs is getting bigger due to the addition of rpm, then the particle flies slowly to the bottom in groups following the gravitation principle.

a



b

c

d

e

Fig. 8. SEM image of flock: *a* – 5 % ppm; *b* – 10 % ppm; *c* – 15 % ppm; *d* – 20 % ppm; *e* – 25 % ppm

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Moreover, in Fig. 8, *c*, flocs start to percipate downward closing by the plat basis together with coagulation and flocculation. In Fig. 8, *d*, colloid and flocs are not visible since the pump rpm of mixing process is of 20 % and 25 % rpm at high level. It can be seen that the small visible flocs are closing by the big floc gap filled by liquid space where viscosity is smaller hence following the big floc pattern by clinging and uniting into big flocs continuously. Meanwhile, in Fig. 8, *e*, the group of flocs is visible until the basic plat with bigger grain and percipates covering almost the whole surface of the basic plat.

6. Discussion of the research results of characteristics of raw water sources

In the mixing process by setting parameters with factors and levels to get the optimal turbidity conditions of organic waste. The level of turbidity will affect the addition of coagulant, the duration of the mixing process and the waste removed. Thus, turbidity conditions and processing in the mixing process greatly affect the quality of clean water. So we need a quality design from the start in the mixing process to get clean water that is good, fast, economical, efficient and according to consumer desires.

By setting the optimal parameters in the mixing process between % ppm PAC, raw water (lt/s) and % pump stroke. Levels and factors are carried out to obtain results that are in accordance with research conditions or input water supply. Changes in % PAC variation in the mixing process are used to see changes in the decrease in turbidity parameters at each level. It can be seen that the mixing process will reduce turbidity by adding variations in the coagulant setting parameters of low level (5–10 ppm), medium level (11–15 ppm) and high level (16–20 ppm) for quality improvement responses. As shown in Fig. 8, c flock position is not visible in floating conditions and the response of clean water quality increases with the addition of coagulant, but gravitationally settles to the basic plate with a small diameter and separates each grain.

The level of turbidity of the input water supply is influenced by upstream conditions of the river, organic waste, erosion and a decrease in the quality of the tropical forest environment. It is necessary to set the parameters from the beginning to ensure the composition of the settings in the mixing process to reduce the level of turbidity in the mixing process, the higher the ppm coagulant, the turbidity will decrease until it reaches the optimal concentration level at the medium level at a water supply condition of 5–7 NTU with a medium level of 14 and 15 ppm coagulant. Addition of coagulant concentration gradually at medium level starting at point 11–15 ppm (see Fig. 7) at 5–7 NTU conditions (close to max=5 health standard), gradually the floating flock gets smaller and settles to the basic plate like sedimentation as shown in Fig. 8, *d*, *e*.

The characteristics of the input water supply as the starting point for selecting parameter settings, because the quality of clean water for the community must be ensured of quality, healthy according to health standards. Quality design is set from the beginning of production in the mixing process segment. The new alternative model proposed in the mixing process of % PAC, raw water and % pump stroke in existing conditions exceeds the established health standard. A specific and integrated processing process is required because of the high level of turbidity, using parameter settings while reducing waste and flock with the principle of Green Taguchi.

The limitations of the proposed new model in the mixing process are related to the condition of the research object, while the method is also limited in setting parameters using experimental design principles in the early stages of setting. Have not adopted another method to estimate coagulant dose, while the assumption used is that the parameter data is the same every day.

The limitation of this model is related to the resource capacity of the clean water treatment section and the setting of additional equipment. So that a gradual change is needed, conventionally daily sampling in the mixing process describes the parameters that affect water quality. Especially for water sources from rivers that are specifically intruded by swamp water, the turbidity factor is the most influential factor for setting parameters in the mixing process.

For the process of developing clean water treatment processes that are affected by turbidity in river water sources, measurements of the level of turbidity are carried out. This turbidity data is very important in the production process to carry out complex experiments for daily data, but specifically for water sources from rivers that are specifically intruded by swamp water, the turbidity factor is the most influential.

7. Conclusions

1. The variation of turbidity of water supply is influenced by the condition of downstream river and the decrease of turbidity in the mixing process is due to the coagulant setting process. The turbidity would reduce until reaching the optimum concentration level at the medium level in the condition of water supply which is of 5–7 NTU.

2. The decrease in turbidity level in the mixing process is due to changes in parameter settings, the higher the ppm of coagulant, the turbidity will decrease until it reaches the optimum concentration level at the medium level in raw water turbidity conditions of 5–7 NTU.

3. In low level coagulants the attractive force between coagulant and floc is not too large, but for medium and high level the attraction is stronger because of the

nature of the coagulant which has positive ions. On the other hand, the effect of Brownian motion decreases with increasing % ppm of coagulant because the water tends to be white. If the concentration of coagulant is added again, the floc will decrease by gravity and accumulate to the bottom of the plate in the form of sediment waste.

Acknowledgments

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ECOLOGY

The quality characteristics of raw water sources in the regional integrated drinking water supply system (SPAM) of Banjarbakula were investigated and found to maintain the supply of drinking water quantity and quality in accordance with drinking water standards. The optimum model for the mixing process of raw water and poly aluminum chloride (PAC) and pump stroke for the input of water sources from rivers to obtain a composition setting that is in accordance with the raw water sources of each region in the region was selected and determined. So the optimum parameter setting model between alum water, raw water and pump stroke for each raw water source is known and is regionally integrated as a result of a comprehensive study. The integration of Taguchi parameter design and response surface can complement each other and become two methods that go hand in hand in the process of optimizing clean water products. Parameter design provides a very practical optimization step, the basis for this formation refers to the factorial fractional experimental design. However, the absence of statistical assumptions that follow the stages of analysis makes this method widely chosen by researchers and practitioners. With the experimental design of the raw water mixing process, turbidity such as 5 lt/sec, 10 lt/sec, 15 lt/sec, 20 lt/sec and 25 lt/sec and % PAC concentration 5 ppm, 10 ppm, 15 ppm, 20 ppm and 25 ppm with a pump installation stroke of 5 %, 10 %, 15 %, 20 % and 25 % were used. In the process of adding PAC, always pay attention and observe the behavior of the attractive force of the floating particles (flock). The particles were then subjected to SEM (scanning electron microscopy) to determine the dimensions of the flock grains deposited

Keywords: characteristics, parameters, setting, supply, turbidity, mixing, concentration, pump, behavior, clean water

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CHARACTERISTICS OF RAW WATER SOURCES AND ANALYSIS OF THE OPTIMAL MODEL OF THE MIXING PROCESS WITH PARAMETER DESIGN IN CLEAN WATER PUMP INSTALLATIONS

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1. Introduction

Raw water (water supply) is very necessary to ensure availability for the clean water treatment process. Good raw water quality describes good natural conditions, so it needs to be maintained to maintain quantity and continuity. Good and sufficient raw water is the hope of the clean water industry and society as consumers for a healthier life. However, the treatment process is important so that the quality is always maintained with raw water conditions that vary in quality. It is everyone's effort to use clean water efficiently to keep it always available, because water is a basic need that must be maintained for survival.

The characteristics of raw water quality vary, because the source comes from rivers with high turbidity levels above 5 NTU (nephelometric turbidity unit), so a water treatment process is needed to reduce the turbidity level. To meet the community's need for clean water that meets health standards, an adequate supply of raw water is needed to maintain the quality and availability for human life. Water sources from upstream must be considered so that these resources are sustainable by taking into account renewable environmental factors that are useful for other activities such as the use of other energy resources.

The quality of raw water decreases due to household activities, soil pollution, water pollution, logging activities and plantation land clearing. In addition to the decrease in raw water quality, this also causes an increase in temperature, sedimentation and organic content due to the opening of new land for agriculture and plantations in the upstream part of the river. The influence of activities upstream of the river causes the quality of raw water to decrease, which will be used as input for processing into clean water. So that an integrated treatment process is needed according to these conditions to get good quality clean water.

The clean water treatment process at the SPAM in the Banjarbakula region continues to be carried out for each region, from the treatment installation only PDAM Bandarmasih, which has a population of almost 200 thousand people, which has been served by 99 % of the community. While the City of Banjarbaru and Kab. Banjar until the end of 2020 with the number of customers reaching 625,000 people with a service coverage of around 80 %. Likewise Kab. Barito Kuala and Kab. Tanah Laut is still below the national target, which is 68 % and the PBB MDGs (Millennium Development Goals) target of 80 %.

In clean water treatment, to reduce the level of turbidity from the water supply, it is necessary to add an appropriate coagulant process to reduce it according to clean water standards. The dose of coagulant is determined using a parameter design with a variety of settings adopting the Taguchi method. For local Indonesia, the raw water source is from the river. It is different from other countries with the same water source, because forest conditions and environmental factors in the upstream of the river greatly affect the level of turbidity.

By improving the mixing process with various variations to get the optimum setting, the Taguchi's approach to lowering turbidity accelerates the formation of floating flocks during the mixing process. The coagulation process aims to reduce turbidity, color and odor through a chemical process used to remove colloidal particles that can disturb the environment. Colloidal particles cannot settle, there must be a suitable coagulant such as PAC to destabilize the particles so that microflocs are formed. The coagulation and flocculation processes in the clean water treatment process with the main parameter setting lowering the turbidity level will produce quality water according to health standards.

In the mixing process at the pump installation, it is necessary to set appropriate parameters to reduce the level of turbidity before and after the mixing process with variations in coagulant addition. Optimal settings will be obtained in this process. A positively charged coagulant is used to attract negatively charged colloidal particles as a flock, which will settle to the bottom of the channel. The behavior of the coagulant that catches floating colloidal particles is observed and scanning electron microscopy (SEM) is performed to determine the dimensions of the flock grains. The results of the deposition process of mixing with various contents of its compounds are given.

Therefore, the clean water treatment process in the WTP (water treatment plant) used for the community and the beverage industry is in accordance with health standards. The characteristics of the input water supply are the basis for determining the selection of coagulant. The input is influenced by organic, inorganic, industrial waste that has not been maximized by implementing waste treatment installations in the form of smelly, hazardous and toxic waste. If the water supply is affected by a large amount of organic waste from tropical forests so that the decrease in water quality is caused by high turbidity, then a coagulant is needed that can catch floating flocks before gravity takes the form of sedimentation.

2. Literature review and problem statement

In the process of mixing with water supply, which is influenced by organic waste predominantly with high turbidity, it is also necessary to improve the condition of the forest and the environment upstream. This condition affects the quality of the input water supply, so appropriate parameter settings are needed in the treatment process. Parameter setting is the main factor in the mixing process to get good quality. It is necessary to use a network system to detect organic waste in raw water supply [1], assess the quality of water sources from rivers and the value of turbidity and sediment aspects [2]. These colloidal particles cannot settle on their own and are difficult to handle physically. The addition of PAC coagulant destabilizes the particles to form microflocs [3]. The microflocs then agglomerate into macroflocs, which can be deposited through the flocculation process. The coagulation process is time-dependent and slow stirring in water. Generally, the flocculation period occurs for 10–30 minutes after the coagulation process [4]. The faster the mixing time, the larger the floc formed with the characteristics of the raw water source, stirring conditions, flocculation time, selected coagulant, and variations in the coagulation concentration will affect the performance of coagulation. The stirring process in the ink industry is faster to reduce waste water [5], while the beverage industry pays attention to the decrease in sediment by setting coagulant ppm [6].

In this clean water treatment plant, the water is supplied from a river with high turbidity above 5 NTU, so it is necessary to add an appropriate coagulant process to reduce turbidity and waste [7]. Many researchers use the addition of conventional coagulant variations with the Jartest method, which is carried out in the process of reducing turbidity [8], but it has not been fast and effective to reduce turbidity at 5–10 NTU levels, as well as using genetic algorithm approaches and artificial neural network methods to find an approach mathematical model is still debatable solution [9]. So it is necessary to propose an improvement in the quality of clean water from the start (off-line quality) with parameter settings that adopt the Taguchi method [10], with a green approach to the mixing process at various levels of turbidity by reducing floating organic waste. The use of chitosan is useful in reducing waste water and color from industry [11], but for water sources from rivers because organic is used other coagulants such as PAC [12]. For local Indonesia, the raw water source from the river is different from other countries with the same water source, because forest conditions and environmental factors in the river upstream greatly affect the level of turbidity. The choice of coagulant is different for each water supply from rivers or other water sources, with the Jartest technique can reduce turbidity, but the use of PAC is even faster in the mixing process [13], with chitosan on coagulation and flocculation reduces color at pH below 5, while river water tends to be above 5 [14].

Colloidal particles that are small and fine are generally negatively charged because river water contains organic or inorganic compounds that cannot be removed by ordinary sedimentation. PAC as a drinking water purification coagulant has a good speed in forming new flocs in the process of mixing clean water. As a basic element, aluminum forms repeating units in long molecular chains, which have a high positive charge and large molecular weight and can reduce flocs in purified water even in certain doses [15]. Thus, PAC combines neutralization and the ability to bridge flock particles so that coagulation takes place more efficiently [16]. PAC can easily neutralize the electric charge on the flock surface and can overcome and reduce the electrostatic repulsion between particles to as small as possible, thus allowing flocks to approach each other (covalent attractive forces) and form larger masses. PAC coagulants can reduce floating flocks in the water supply from rivers, and accelerate sedimentation and reduce non-oily waste water from clean water treatment to customers [17]. The use of PAC above 10 ppm can reduce waste water rather than the use of ultraviolet and chlorine disinfectants [18].

For scenarios of environmentally friendly conditions as a form of sustainable use, natural resources are preserved by taking into account the hydrological cycle of water resources. The use of water resources, especially those from rivers, is very high and worrying. The availability of water supply and its safety are approaching the gray zone and continue to increase, with factor analysis contributing to urban water management [19]. Using fuzzy and TOPSIS can provide information on the availability and contribution of options for the use of water resources [20]. Water quality is strongly influenced by the condition of the river upstream, either organic or inorganic waste. There are several scenarios to make water available for downstream industrial inputs such as drinking water needs. However, the quality of drinking water must be feasible for consumers by reducing disinfectants, which are waste. There are several decision-making criteria to reduce the waste, among others, paying attention to the processing/treatment.

The quality characteristics have been widely studied, both in the manufacturing industry, the water industry and the chemical industry, in the opinion that water sources from upstream must be considered so that the availability and quality of water are better. However, this resource must be sustainable by taking into account renewable environmental factors that are useful for other activities such as the use of other energy resources. The quantity factor must be considered to ensure the availability of raw water [21].

Research on the relationship between raw water quality parameters, chlorine requirements and disinfectant content of drinking water has been carried out [22]. The use of appropriate chlorine will minimize disinfectants so that the quality of drinking water supplied to customers will be maintained according to standards. The model obtained for clean/drinking water treatment conditions in Malaysia shows that there is a relationship between the need for chlorine to reduce disinfectants and improve product quality, the parameters of raw water content also affect the final product and require treatment in its processing.

In the mixing process at the pump installation, it is necessary to set appropriate parameters to reduce the level of turbidity before and after the mixing process with variations in coagulant addition. Optimal settings will be obtained in this process. A positively charged coagulant is used to attract negatively charged colloidal particles as a flock, which will settle to the bottom of the channel. The behavior of the coagulant that catches floating colloidal particles is observed and scanning electron microscopy (SEM) is performed to determine the dimensions of the flock grains. The results of the deposition process of mixing with various content of its compounds are given.

With the condition of the input water supply characteristics in clean water treatment, especially the mixing process segment to reduce the level of turbidity due to organic waste, it is necessary to set parameters from the beginning before and after the mixing process.

3. The aim and objectives of the study

The aim of the study is to obtain the optimal parameter setting model was to reduce the level of turbidity and investigate the behavior of floating flocks in the mixing process.

To accomplish the aim, the following objectives were set:

– to determine the turbidity characteristics of water before and after the mixing process;

– to determine optimal parameter setting in the mixing process of PAC (coagulant), raw water and pump stroke;

– to determine the behavior of the flow and floating flocks, as well as to determine the microstructure of the mixing process.

4. Materials and methods

Before the mixing process, normality test and turbidity contour level were used to test the data whether the data were normally distributed for the turbidity parameter and information on the distribution of the data, while the counter explained the position of the data distribution in sampling, which was determined about the raw water turbidity parameters and the turbidity of the mixing process. The dosing pump is designed to drain the PAC coagulant flow fluid into the water fluid. This pump generates a coagulant flow rate by the mixing method set from the valve to deliver the liquid PAC discharge into the dosed reservoir. This pump is very helpful in the process of mixing clean water treatment for coagulant variations, which are controlled internally to vary the flow rate and dosage amount.

Taguchi's method is used for parameter setting and integration of the most influential waste output to improve the quality of clean water products, reduce turbidity levels with variations in coagulant doses, optimal mixing process. The target of this method is to make clean water products less sensitive to noise, so it is called a robust design [26] like the concept below:

– the turbidity characteristics of water before and after the mixing process, with the experimental design of the raw water mixing process (turbidity) such as 5 lt/sec, 10 lt/sec, 15 lt/sec, 20 lt/sec and 25 lt/sec and % PAC concentration 5 ppm, 10 ppm, 15 ppm, 20 ppm and 25 ppm with a pump installation stroke of 5 %, 10 %, 15 %, 20 % and 25 %;

– by the parameter settings above, the optimal parameter settings are obtained to reduce the level of turbidity;

– observing and identifying the behavior of floating flocks to sedimentation for SEM.

According to [23], the advantages of the Taguchi method compared to other experimental designs are because it is more efficient in experiments involving many factors but the number of experimental units required is relatively small, the product is more consistent and less sensitive (robust) to variability caused by factors that cannot be controlled (noise). The objective function of the Taguchi method for a robust design that is resistant to noise is derived from measuring product quality using a quadratic loss function in a broader definition to produce an optimal design or parameter setting. Signal to noise ratio (SNR) in the experimental design system of this method provides a comparison of quantitative values for response variations to determine the optimum parameter settings.

The most important hope in the robust design of the Taguchi method, especially parameter setting, is to examine the effect of variability on factors and experimental levels using statistical tools. To help full factorial, large, time-consuming and costly experiments, Taguchi suggests using orthogonal arrays (OA) to represent the range of possible experiments. After conducting the experiment, all experimental data were evaluated using analysis of variance (ANOVA) to determine the optimum parameter settings [24, 25].

This method is to determine the factors that influence an optimum response with its characteristics. The Smaller The Better (STB) quality characteristic indicates that the smaller the characteristic parameter, the better the quality. Larger The Better (LTB) indicates that the larger the characteristic parameter, the better the quality will be, and the Nominal The Better (NTB) quality characteristic means that the quality will be said to be getting better if it is close to the nominal (target) that has been set through parameter design and response for clean water with various concentrations and levels [26, 27].

The conceptual development of the model structure based on the setting of clean water parameters and the optimization model for the mixing process can be seen in Fig. 1 below.

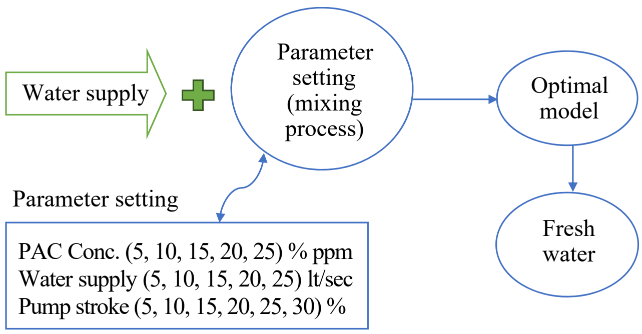


Fig. 1. Parameter setting model in the mixing process

In parameter setting, there is coagulation to remove and separate colloidal particles from natural organic minerals such as mud. These colloidal particles cannot settle naturally having a diameter of less than 1 mm causing color and turbidity. In Fig. 2 below, it can be seen that section 3 is the mixing process for the PAC variation to reduce the level of turbidity, to observe the behavior of the floating flock. In section 4, there is an attractive force that tends to form aggregates while the repulsive force causes a stable colloidal dispersion.

The water supply contained in section 1 flows to section (2) naturally precipitated by gravity, flowing through a transparent glass channel, which is dripped with coagulant with the specified setting. The quality of clean water can be seen in section (5, 6), then in the laboratory test to get the level of turbidity according to health standards.

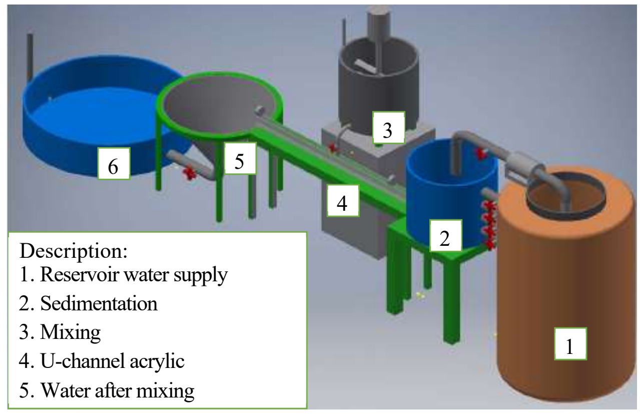


Fig. 2. Research installation

5. Research results of the characteristics of water quality in the clean water treatment plant

5. 1. Turbidity characteristics of water before and after the mixing process

Parameter setting conducted in the mixing process, as shown in Fig. 3 below, shows that the turbidity value of water supply is above 5 NTU (nephelometric turbidity unit), which is the standard value for clean water. With the medium level of concentration (11 to 15 ppm), it is shown that the decrease of turbidity value is in the range of 4–5 NTU at pH 7.1. The turbidity value of water supply and mixing process can also be seen in the contour plot (Fig. 4), which presents the dispersion of turbidity values with a more detailed range system in the position of turbidity value at each change of PAC concentration.

The turbidity level of water supply is averagely 5.8 NTU and the reduction of turbidity of the mixing process is averagely 4.5 NTU as the addition of medium level in coagulant concentration, but the fluctuation approximates the normal distribution as shown in Fig. 5 below.

The variation of turbidity of water supply is influenced by the condition of downstream river, weather and environment of the forest (*a*) and the decrease of turbidity in the mixing process is due to the coagulant setting process (*b*). As the coagulant ppm is getting higher, the turbidity would reduce until reaching the optimum concentration level at the medium level in the condition of water supply, which is 5–7 NTU.

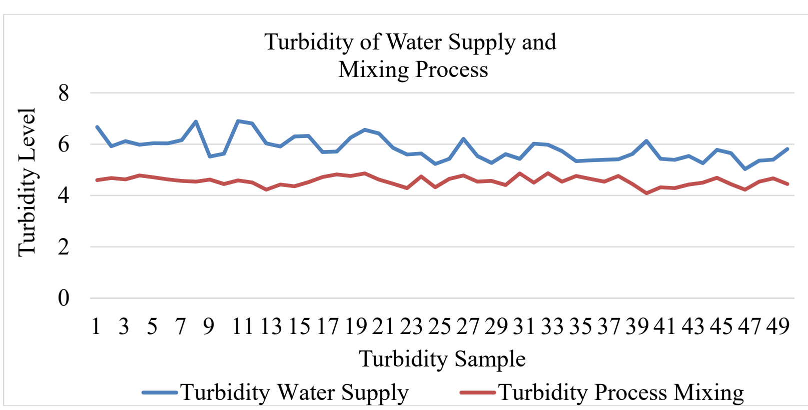


Fig. 3. Turbidity level of water supply and mixing process

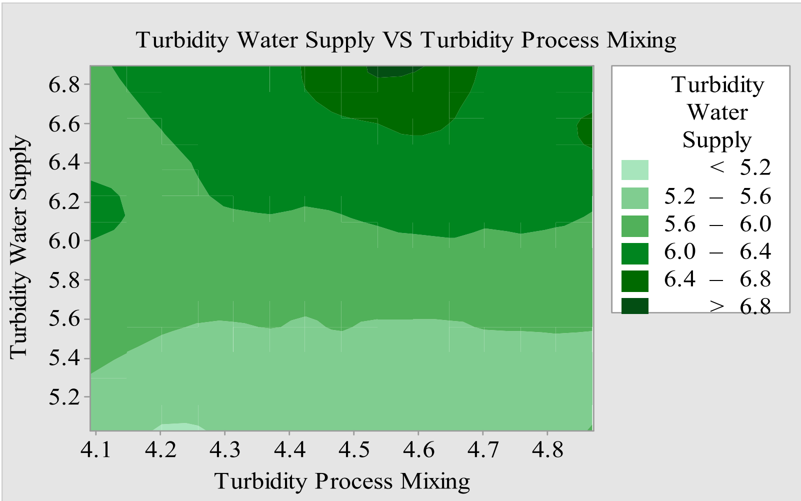
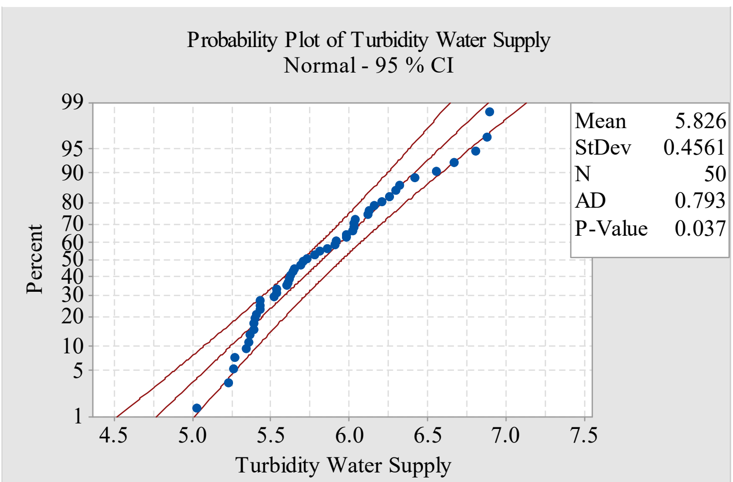
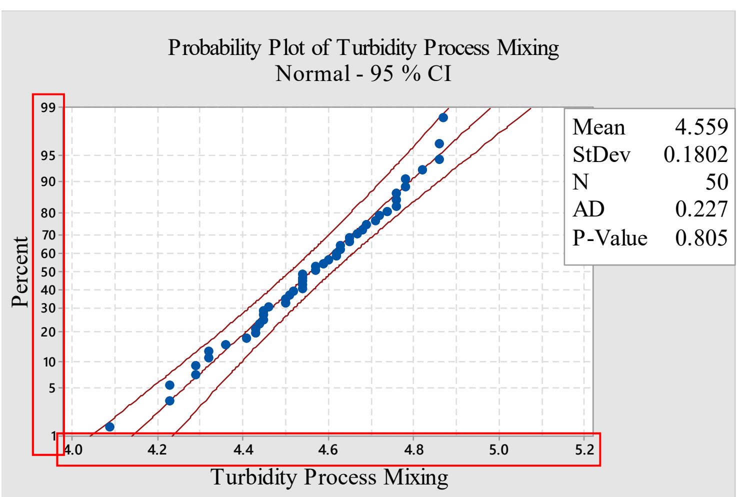


Fig. 4. Contour plot of turbidity of water supply and mixing process



a



b

Fig. 5. Normal turbidity: *a* – water supply; *b* – mixing process

5. 2. Optimal parameter setting in the mixing process of PAC (coagulant), raw water and pump stroke

In the mixing process, turbidity is decreased with the addition of coagulant variations by setting the parameters of the Taguchi method with low level (5–10 ppm), medium level (11–15 ppm) and high level (16–20 ppm) as shown in Table 1 below.

Table 1

Level factor

Parameter	Code	Level 1	Level 2	Level 3	Level 4
Alum conc. (% ppm)	A	5	10	15	20
Water supply (lt/sec)	B	5	10	15	20
Pump stroke (%)	C	15	20	25	30

The change in the concentration level of PAC coagulant starts from low level, medium level, and high level simultaneously with the setting of water supply and pump stroke. The decrease of turbidity level seems better as the raise of coagulant concentration level has positive ions. The positive and negative ions depict the effect and response of variable concentration, water supply, and pump stroke as shown in Fig. 6 and Table 2 below. The plot effect of S/N ratio is in the optimum process of parameter design of the mixing process at various concentration levels.

Table 2

Main effect of the mixing process

Level	PAC	Water supply	Pump stroke
1	4.793	4.775	4.813
2	4.877	4.900	4.782
3	4.775	4.848	4.868
4	4.865	4.787	4.848
Delta	0.102	0.125	0.085
Rank	2	1	3

By looking at the fluctuation of water supply and mixing process turbidity, the model of the mixing process can be predicted at the medium level of 14 and 15 ppm coagulant. Averagely, the prediction model of the mixing process collects the maximum at medium level, which is 15 for the condition of 5–7 NTU.

Optimal mixing process =15 % ppm conc. PAC+15 lt/sec+15 % pump stroke.

The optimal model can be decreased or increased fluctuatively at each 2 point range change of turbidity, for instance 5–7 NTU, 7–9 NTU, and so on. For more detail, every change of ppm concentration, water supply and pump stroke can be seen in Fig. 7 below. At the position of medium level, it can be seen that the turbidity value of the mixing process is at 4.8 NTU and 4.9 NTU, which are close to the health standard. The higher % ppm of PAC causes the turbidity to decrease and the water color turn to transparent. The effect of over PAC would not be harmful to the human body but with a continuous excessive dosage, it would cause side effects in the form of toxins within the human body.

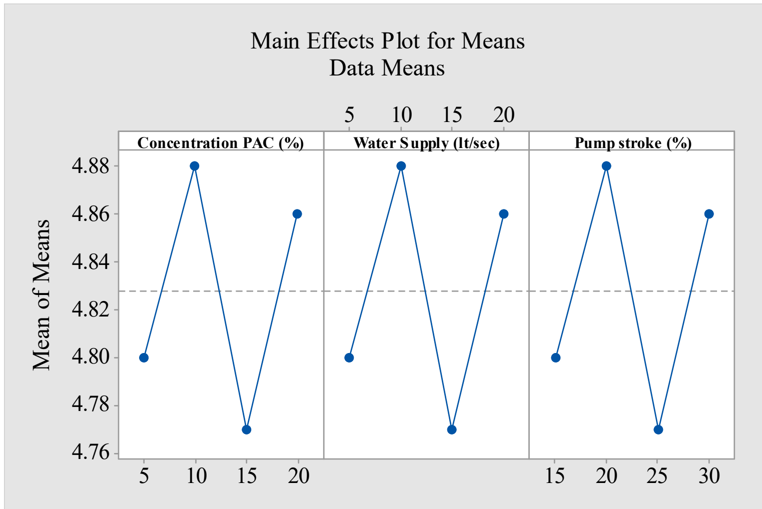


Fig. 6. Response table of variable PAC concentration, water supply, pump stroke

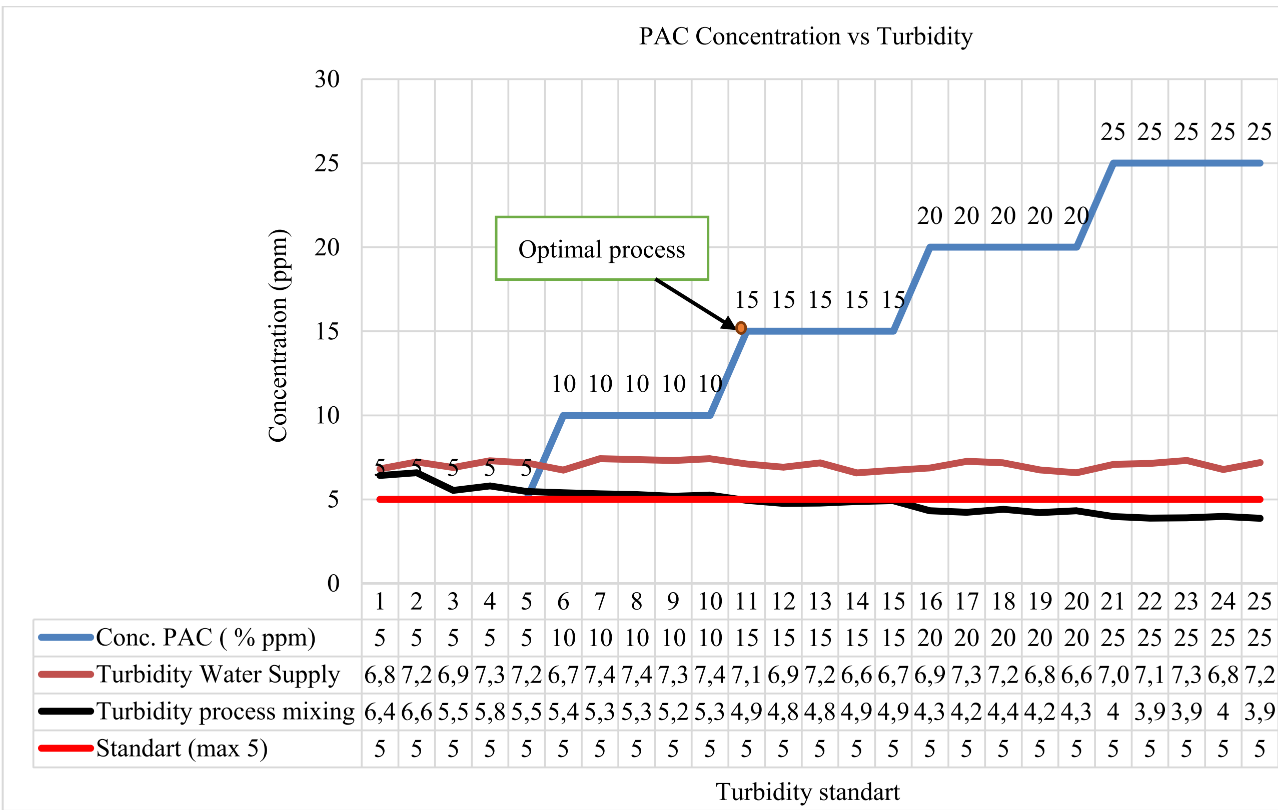


Fig. 7. Variation of PAC concentration at each level

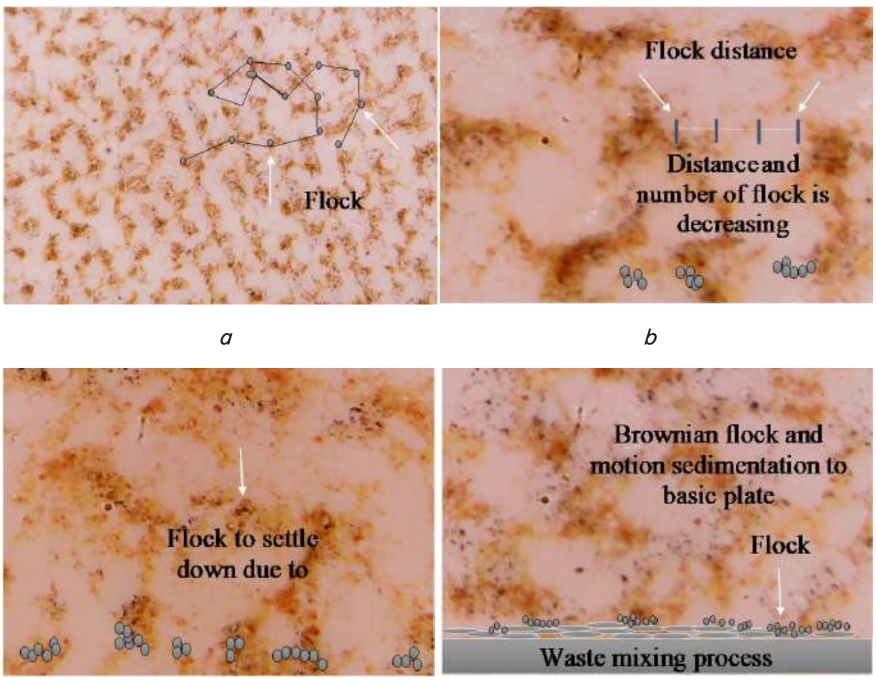
In Fig. 7 above, it can be seen that the PAC concentration % at medium level 15 produces a turbidity level of 4.9, close to 5 NTU health standards, so that point becomes optimal. If you add more PAC at levels 20 and 25, the clean water is close to white color, which can be harmful to health if used continuously because of the effect of high coagulant content.

5. 3. Determination of the behavior of the flow and floating flock, as well as determination of the microstructure of the mixing process

Each change of PAC concentration level causes the change of water turbidity value, colloid behavior and floc formation in the mixing process. Coagulant characteristic whose charge is positive ion would attract negatively charged colloid that is often called as the effect of Van der Waals' attractive force. Proper addition of coagulant concentration would reduce the zeta potential repulsive force in the colloid, thus there are more positive ions than negative ions, which causes a faster floc formation process. With sedimentation process and flock filtration, it would gravitationally precipitate at the bottom surface to furthermore be thrown away since the sedimentation is known as waste in the industry of clean water.

In the mixing process, each variation of water supply, PAC ppm and % pump stroke will affect the level of turbidity due to the addition of coagulant, which will attract negative ions into the flock. Increasing coagulant and pump stroke in the form of pump speed in rpm will accelerate the process of flock formation. Fig. 8, a presents large flocks so that the effect of Van der Waals forces can still be seen. A large attraction by the coagulant will accelerate flock formation.

To observe the Brownian motion, which is in the form of zig-zag line or dash line, the portrayal of molecular kinetic flocs requires a camera magnification of 1000 with the type of digital SEM. In Fig. 8, b, the distance among flocs is getting bigger due to the addition of rpm, then the particle flies slowly to the bottom in groups following the gravitation principle.



a *b*

c *d*

Fig. 8. SEM image of flock: *a* – 5 % ppm; *b* – 10 % ppm; *c* – 15 % ppm; *d* – 20 %–25 % ppm

Moreover, in Fig. 8, *c*, flocs start to precipitate downward closing by the basic plate together with coagulation and flocculation. Meanwhile, in Fig. 8, *d*, the group of flocs is visible until the basic plate with bigger grain and precipitates covering almost the whole surface of the basic plate.

6. Discussion of the research results of characteristics of raw water sources

In the mixing process by setting parameters with factors and levels to get the optimal turbidity conditions of organic waste. The level of turbidity will affect the addition of coagulant, the duration of the mixing process and the waste removed. Thus, turbidity conditions and processing in the mixing process greatly affect the quality of clean water. So we need a quality design from the start in the mixing process to get clean water that is good, fast, economical, efficient and meets consumer desires.

By setting the optimal parameters in the mixing process between % ppm PAC, raw water (lt/s) and % pump stroke. Levels and factors are carried out to obtain results that are in accordance with research conditions or input water supply. Changes in % PAC variation in the mixing process are used to see changes in the decrease in turbidity parameters at each level. It can be seen that the mixing process will reduce turbidity by adding variations in the coagulant setting parameters of low level (5–10 ppm), medium level (11–15 ppm) and high level (16–20 ppm) for quality improvement responses. As shown in Fig. 8, c, flock position is not visible in floating conditions and the response of clean water quality increases with the addition of coagulant, but gravitationally settles to the basic plate with a small diameter and separates each grain.

The level of turbidity of the input water supply is influenced by upstream conditions of the river, organic waste, erosion and a decrease in the quality of the tropical forest environment. It is necessary to set the parameters from the beginning to ensure the composition of the settings in the mixing process to reduce the level of turbidity in the mixing process. The higher the coagulant ppm, the lower the turbidity until it reaches the optimal concentration level at the medium level at a water supply condition of 5–7 NTU with a medium level of 14 and 15 ppm coagulant. Addition of coagulant concentration gradually at medium level starting at point 11–15 ppm (see Fig. 7) at 5–7 NTU conditions (close to max=5 health standard), gradually the floating flock gets smaller and settles to the basic plate like sedimentation as shown in Fig. 8, *d*.

The characteristics of the input water supply as the starting point for selecting parameter settings, because the quality of clean water for the community must be ensured according to health standards. Quality design is set from the beginning of production in the mixing process segment. The new alternative model proposed in the mixing process of % PAC, raw water and % pump stroke in existing conditions exceeds the established health standard. A specific and integrated processing process is required because of the high level of turbidity, using parameter settings while reducing waste and flock with the principle of Green Taguchi.

The limitations of the proposed new model in the mixing process are related to the condition of the research object, while the method is also limited in setting parameters using experimental design principles in the early stages of setting. Have not adopted another method to estimate coagulant dose, while the assumption used is that the parameter data is the same every day.

The limitation of this model is related to the resource capacity of the clean water treatment section and the setting of additional equipment. So that a gradual change is needed, conventionally daily sampling in the mixing process describes the parameters that affect water quality. Especially for water sources from rivers that are specifically intruded by swamp water, the turbidity factor is the most influential factor for setting parameters in the mixing process.

For the process of developing clean water treatment processes that are affected by turbidity in river water sources, measurements of the turbidity level are carried out. This turbidity data is very important in the production process to carry out complex experiments for daily data, but specifically for water sources from rivers that are specifically intruded by swamp water, the turbidity factor is the most influential.

7. Conclusions

1. The variation of turbidity of water supply is influenced by the condition of downstream river and the decrease of turbidity in the mixing process is due to the coagulant setting process. The turbidity would reduce until reaching the optimum concentration level at the medium level in the condition of water supply, which is 5–7 NTU.

2. The decrease in turbidity level in the mixing process is due to changes in parameter settings, the higher the ppm of coagulant, the lower the turbidity until it reaches the optimum concentration level at the medium level in raw water turbidity conditions of 5–7 NTU.

3. In low level coagulants, the attractive force between coagulant and floc is not too large, but for medium and high level, the attraction is stronger because of the nature of the coagulant, which has positive ions. On the other hand, the effect of Brownian motion decreases with increasing % ppm of coagulant because the water tends to be white. If the concentration of coagulant is added again, the floc will decrease by gravity and accumulate to the bottom of the plate in the form of sediment waste.

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