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AN OVERVIEW OF NGAGEL WATER TREATMENT PLANT OPERATIONS IN TERMS OF WATER QUALITY EFFICIENCY AND WATER STABILITY

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AN OVERVIEW OF NGAGEL WATER TREATMENT PLANTS OPERATIONS IN TERMS OF WATER QUALITY EFFICIENCY AND WATER STABILITY

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ABSTRACT

Water Treatment Plant (WTP) Ngagel receive the raw water from Kali Surabaya (River), which has been polluted for more than 30 years by different sources, mostly coming from industries. In order to provide better drinking water services in Ngagel, WTP Ngagel with the second large capacity which is 4,450 L/s and as a part of Surya Sembada (PDAM Surabaya) is trying to improve its performance. As a result, there should be an evaluation of the technical performance for WTP Ngagel in terms of water quality efficiency and stability.

Technical evaluation of WTP Ngagel in term of water quality efficiency is done by comparing the quality of raw water to the production water for 3(three) parameters: Turbidity, Organic Substances and Ammonia with reference to the Indonesian standards (Permenkes 492 in 2010). Then, technical evaluation in term of water stability is done by measuring the Langelier Saturation Index (LSI) and Ryznar Saturation Index (RSI). The two water quality indexes, LSI and RSI, were calculated in order to evaluate the chemical stability of the drinking water samples.

The analyses of water quality efficiency shows that WTP Ngagel has a good efficiency to remove Turbidity, Organic Substances and Ammonia from the production water during 2016. It could reach 99.74% for Turbidity, 75.60% for Organic Substances and 100% for Ammonia. The analyses of water stability shows that WTP Ngagel I has an LSI of -0.061, Ngagel II with LSI of -0.27 and Ngagel III has an LSI of -0.033. The three installation of Ngagel has the same RSI of 7.3. Depending on these results it could be known that the quality of production water in Ngagel is corrosive. Chemical stability parameters of water quality in WTP Ngagel can improve drinking water quality. To decrease the corrosion in Ngagel production water and improve its quality, a caustic soda (sodium hydroxide) NaOH will be effective.

Keywords: Chemical Stability, langelier Index, Performance,Removal efficiency, Ryznar Index.

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PREFACE

First of all, I want to Thank God Almighty, because of His blessings and graces that have been delegated to me so that the thesis entitled "An ***OVERVIEW OF NGAGEL WATER TREATMENT PLANTS OPERATIONS IN TERMS OF WATER QUALITY EFFICIENCY AND WATER STABILITY"*** could be finish. This thesis is one of the requirements to complete the study on the Master Program in Environmental Engineering, Faculty of Civil Engineering and Planning, Institut Technologi Sepuluh Nopember (ITS) Surabaya. I owe special gratitude and sincere thanks to:

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Although this research is still far from perfection, I hope it will be useful for all of us.

Surabaya, July 2017

Mehdi Lassoued

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CHAPTER 1
INTRODUCTION

1.1 Background

Water is one of the most important source for humans. Humans can face difficult situations because of the limitations of this resource, on the same time because of the increasing of population needs. The main purpose of providing clean water or drinking water, is to prevent the diseases carried by water. That is why, provision of drinking water should meet the applicable standards. Water resource management in Indonesia faces very complicated and complex problems, since water has several functions both socio- cultural, economic and environmental functions (Sumantri, 2016). Actually, the requirements of drinking water in Indonesia are based on Ministry of Health Regulation No.492/MENKES/PER/2010.

Surabaya's rivers have been used for more than 30 years by 3 million citizens of Surabaya as the raw material for the drinking water treatment plant. These rivers have been polluted for 30 years by domestic, farming and industrial waste (Razif & Persada, 2016).

In Surabaya, drinking water is carried by Water Supply Treatment Company called Surya Sembada or (PDAM Surabaya) which take the raw water from Kali Surabaya, during the last ten (10) years the conditions of this river have become worse (Septine et al. 2003). This is clearly contrary to the requirement of drinking water where drinking water must come from raw materials of water class I while Surabaya River has water class II. The problems that occur not only stop at the inappropriateness of the quality of drinking water consumed by humans but also the high cost that must be spent to get water with poor quality.

Surya Sembada provides clean drinking water using water treatment plants. Actually, it has water treatment plants (WTP) in Ngagel, Karangpilang and outside the city with a total installed capacity of 10,830 liters / second. The capacity of each installation for water treatment plant Ngagel are as follows: (PDAM, 2016)

1. Installation Ngagel I is 1,800 liters / second
2. Installation Ngagel II is 1,000 liters / second
3. Installation Ngagel III of 1,750 liters / second

The optimization of the treatment in the drinking water treatment plant Ngagel is an issue of particular concern. With reference to the Minister of Health RI 492 of 2010, regarding drinking water quality standards, until the month of July 2016, Surya Sembada was able to serve up 95.12% and is planned to reach 100% by 2018.

In order to provide better drinking water services in Surabaya, there should be an evaluation of the technical performance of water treatment in the WTP Ngagel which has the second large capacity of water treatment plant in Surabaya. Based on the results of the performance evaluation conducted on WTP Ngagel, alternatives to improve the performance of water treatment at the WTP Ngagel can be determined, therefor these alternatives will improve the performance of Surya Sembada PDAM Surabaya City in the future.

1.2 Research Problems

The problems of this research are:

1. How is the performance of WTP Ngagel in terms of efficiencies?
2. How is the performance of WTP Ngagel in terms of water stability?
3. How can PDAM Surabaya improve the performance of WTP Ngagel?

1.3 Objectives

The purpose of this research is to:

1. Know the performance of WTP Ngagel in terms of efficiencies.
2. Know the performance of WTP Ngagel in terms of water stability.
3. Obtain alternatives to improve the performance of WTP Ngagel

1.4 Scope

The scope of this study, include:

1. Identify the existing conditions of each WTP in Ngagel.
2. Evaluation was done by comparing the quality of production water to the quality of raw water, referring to Indonesian standard (Permenkes Number 492 Year 2010), then calculate the efficiencies.
3. Evaluation was also done by calculating the saturation index for Ngagel I, II and III.

1.5 Benefits

Benefits that can be obtained from this research include:

1. Providing input for PDAM Surya Sembada Surabaya about the improvement of the performance of water treatment plant Ngagel related to technical operational aspect.
2. Provide information for further related research

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CHAPTER 2
LITERATURE REVIEW

2.1 Description of PDAM Surabaya

The producer of drinking water is managed by the Drinking Water Company (*Perusahaan Daerah Air Minum*) or PDAM Surabaya (Surya Sembada). The company uses Surabaya River (Kali Surabaya) as the raw material to distribute the clean drinking water to Surabaya citizens, which are approximately more than 3 million population. In more detail, 6 drinking water treatment plants have been used in plenty numbers of years to convert the river water into the drinking water. The 6 drinking water treatment plants are located in two sites, which are 3 units at Karangpilang and 3 other units at Ngagel. (Razif & Persada, 2016)

Figure 2. 1 Potential Raw Water for PDAM Surabaya (Rispam, 2014)

2.2 Description of WTP Ngagel

Ngagel is a village in the sub district of wonokromo in Surabaya which belongs to East java. WTP Ngagel is a complex consisting of three units: WTP Ngagel I, II and III. For WTP Ngagel layout, can be seen in the figure 2.2.

I

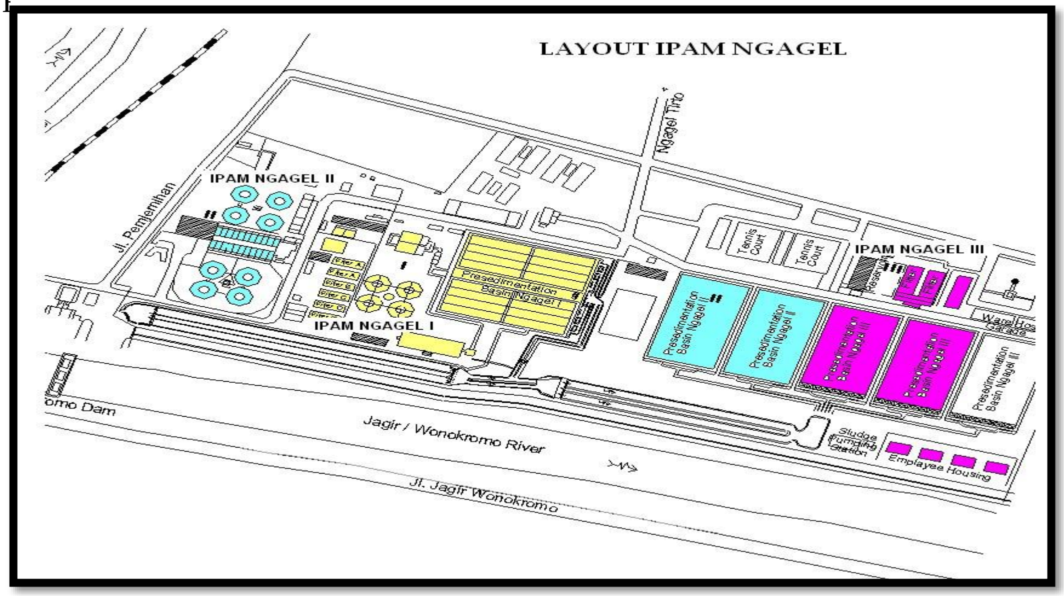

Figure 2. 2 Layout WTP Ngagel (Rispam, 2014)

2.2.1 Raw Water of WTP Ngagel

The raw water that is treated in each installation Ngagel is obtained from Kali Surabaya (River) whose quality can vary each year because it is caused by several factors (PDAM, 2016). Many problems of contamination related to this source, due to anthropogenic and industrial discharges as nitrogen, phosphorus, heavy metals and suspended solids (Razif & Persada, 2016). Status of water quality in Surabaya River by method STORET 49.44% is heavily polluted for second class designation. While the status of water quality in Surabaya River by 100% pollution Index method is contaminated medium for designation second grade (Septine et al., 2003)

Figure 2. 3 Kali Surabaya (Rispam, 2014)

2.2.1.1 WTP Ngagel 1

Drinking Water Treatment Plant Ngagel I, is the first water treatment plant operated in Surabaya in 1922 with a capacity of 60 L / s. The raw water which is taken from Kali Surabaya via gravity flow system at Jagir Dam and going through the canal toward the troughs pre-sedimentation. The raw water is pumped from the tanks to the aerator pre-sedimentation of three levels. Rapid stirring chemicals and coagulant takes place in the inlet pipe to the aerator and clarifier. Of the aerator, water flowed by gravity into the flocculator / clarifier which has a separate compartment settler tube. The water from the settlers are transferred to the filter. Then to the reservoir for a given disinfectant (PDAM, 2016). Diagram of WTP Ngagel I can be seen in Figure 2.4:

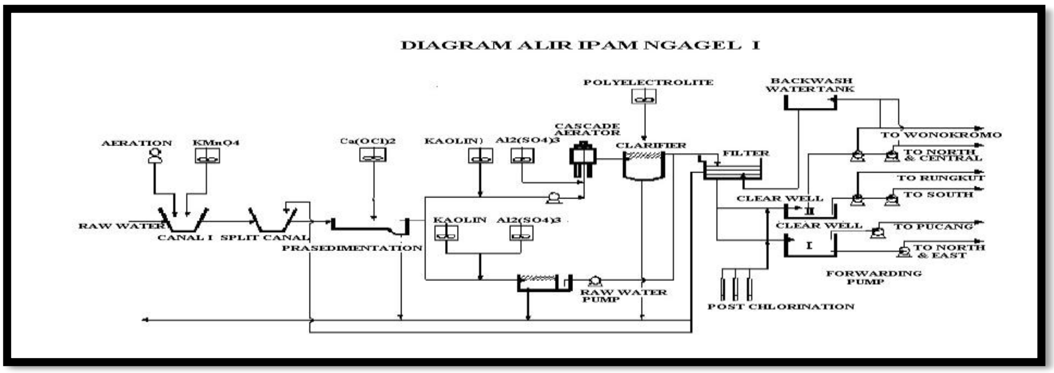

Figure 2.4 Diagram of Water Treatment Plant Ngagel I (Rispam, 2014)

2.2.1.2 WTP Ngagel 2

WTP Ngagel II was built in 1959 by Degremont French FA. This Installation was originally built without any treatment unit pre-sedimentation. Pre-sedimentation unit was built and incorporated in a single unit of WTP Ngagel II in 1982 concurrent development of WTP Ngagel III. WTP Ngagel II discharge capacity installed up to 1000 L / sec. WTP Ngagel II has a target to produce drinking water to the water quality of production is less than 1 NTU where concentration is still below standard Permenkes 492 / Menkes / PER / IV / 2010 (5 NTU) (PDAM, 2016). Diagram of WTP Ngagel II can be seen in Figure 2.5:

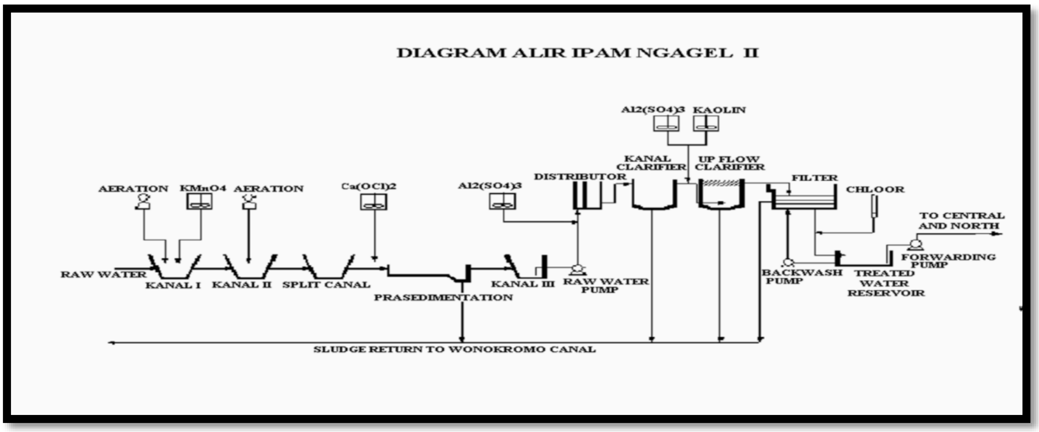

Figure 2. 5: Diagram of Water Treatment Plant Ngagel II (Rispam, 2014)

2.2.1.3 WTP Ngagel 3

Water treatment plants (WTP) Ngagel III Surabaya is one effort to clean water with good quality, making it suitable for consumption and meets the health requirements. Drinking water treatment plant Ngagel III was built with a large capacity, namely 1750L / sec. Treatment systems used in WTP Ngagel III are conventional. But in the treatment of the raw water, WTP Ngagel pre-sedimentation III does not use the building, which serves to precipitate discrete particles (PDAM, 2016). Diagram of WTP Ngagel III

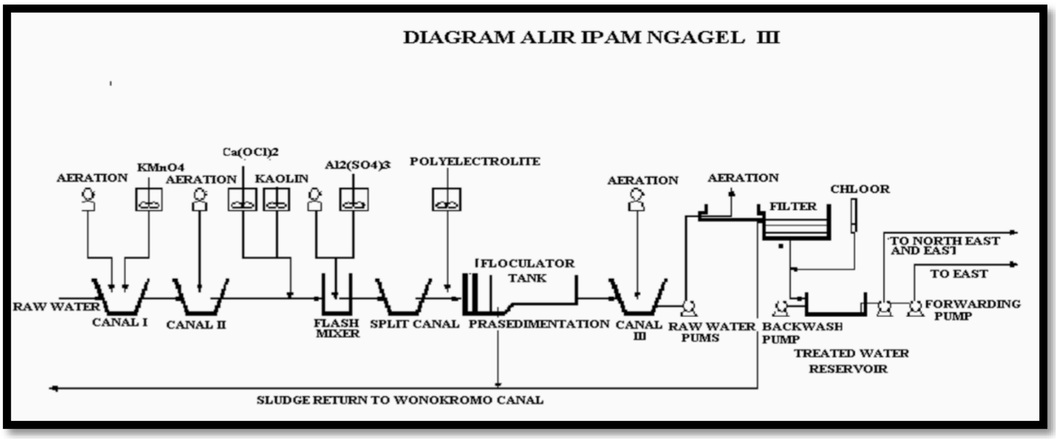

Figure 2.6: Diagram of Water Treatment Plant Ngagel III (Rispam, 2014)

can be seen in Figure 2.6:

2.2.2 Units of Water Treatment Plant Ngagel

A. Intake

Intake is a water collector. Example: River intake, lakes intake reservoirs, and ground water intake. The types of intake can be: the intake tower, shore intake, intake crib, intake pipe or conduit, infiltration gallery, shallow wells and deep wells (PDAM, 2016).

B. Aerator

Using aerator help us to incorporate oxygen into the raw water to be treated at the same time to eliminate the CO2 gas as well as lower levels of odors from the raw water (PDAM, 2016). The basic aim of using aerator is to improve the aeration which is used to remove gazes dissolved in surface waters or to add oxygen to water to convert surface substances into an oxide (Arifiani & Hadiwidodo, 2007), it is done by physical and chemical characteristics of water that will be treated for the domestic, commercial, and industrial purposes.

C. Pre-sedimentation

Pre-sedimentation is part of building a functioning water treatment to precipitate discrete particles, the particles can settle freely on an individual basis without the need for interaction between them. Precipitation occurs due to the interaction styles around the particles, the drag force and impelling force (PDAM, 2016). The mass of particles causes the drag force and are offset by the impelling force, so that the particle sedimentation velocity is constant.

D. Fast Stirring (Coagulation)

Rapid stirring in water treatment is to produce turbulence water so as to disperse chemical or coagulant to be dissolved in the raw water. In general, rapid stirring is carried out on a gradient stirring speeds ranging from 100 - 1000 per second for 5 minutes to 60 seconds. In the process of rapid stirring, a coagulant is mixed with raw water for a few minutes until evenly distributed. After this mixing, there will be destabilization of colloidal exist in the raw water. Colloids are already lost cargo or destabilized experiencing attract each other so that tends to form larger clumps (PDAM, 2016).

E. Clearator

Building clearator, the WTP process instance can be called with a reactor that serves as a second sedimentation basin once contained in flocculation process. Back of the precipitant to precipitate flocculent particles formed by the addition of coagulant in the coagulation process and flocculation (PDAM, 2016). The form of clearator buildings in general can be:

1. Rectangle (rectangular): The raw water flows horizontally from the inlet to the outlet. Flocculent formed particles are expected to settle by gravity to the settling zone.
2. Circle (circular): The raw water inlet enters through horizontally through circle heading to the outlets around the circle. Flocculent formed particles settle by gravity to the bottom. The mechanism of the process of sedimentation in general that: The formation of flock in the center circle and affixing diffuser include polyethylene.

F. Filtration

In water treatment processes used to filter water filtration results of coagulation, flocculation, and sedimentation so that the resulting water with high quality. Besides reducing the solids filtration can also reduce the bacterial content, eliminates color, taste, odor, iron and manganese (PDAM, 2016). Based on the used filter media can be classified into three, namely, single media (one type of media), dual media (two types of media) and multimedia (more than two types of media).

G. Disinfection

Drinking water disinfection aims kill bacteria air. Disinfectant pathogens in the water can be done in various ways, namely: heating, irradiation with UV light, metal ions, among others, with copper and silver, acids or bases, chemical compounds, and chlorination. With chlorination disinfection process begins with the preparation of chlorine solution with a certain concentration and the determination of appropriate dose chlorine (PDAM, 2016).

H. Reservoir

Reservoir is used on distribution system to evaluate the level of the flow, regulate the pressure, and to emergency states. Type a lot water supply pumps used are: type rotary (centrifugal pumps, turbine pumps or pump diffuser includes turbine to pump wells and pumps in the wells submersible to), positive kind of step pumps (piston pumps, hand pumps, a special pump or pump cascade includes vortex pump, bubble pump air or water lift pump, jet pump, and the pump blades) (PDAM, 2016).

2.3 Drinking Water Quality Standard

Indonesian water quality Permenkes number 492 of 2010 are the regulations made by the ministry of health of the republic Indonesia, in 19 April 2010 (Permenkes, 2010). It describes the conditions of quality of water measured or tested according to certain specific parameters. Water quality standards are threshold limits or levels of living creatures, substances, energy or components that exist or should exist or pollutant elements that are tolerable in the water.

In this research, we will try to measure the necessary parameters of a good quality of water and compare it to the standard parameters mentioned in the new regulations of Indonesia.

2.4 Parameters of Drinking Water Quality and Their Impacts

2.4.1 Temperature:

It affects the solubility of chemicals and biological activity. The maximum temperature of drinking water should be 25 degrees C (Blokker and Quirijns, 2013). Temperature is an important parameter to consider when assessing water quality. In addition to its own effects, temperature influences several other parameters and can change the physical and chemical properties of water.

2.4.2 pH

The presence of acidic or alkaline substances in water is indicated by pH values on a scale of 0-14. Water with high pH causes bitterness, creates a crust on the pipe, and decreases chlorine effectiveness. Water with low pH causes corrosion or dissolves metals (Masduqi and Assomadi, 2016). pH is most important in determining the corrosive nature of water. Lower the pH value higher is the corrosive nature of water (Sawant et al, 2012).

2.4.3 Turbidity

Turbidity is the amount of cloudiness in the water. This can vary from a river full of mud and silt where it would be impossible to see through the water (high turbidity), to a spring water which appears to be completely clear (low turbidity). Turbidity is caused by suspended materials such as clay, silt, and fine organic and inorganic particles, planktons, and microscopic organisms. The labor is not health-conscious, but with aesthetic reasons, the water consumed must contain low turbidity (Masduqi and Assomadi, 2016).

Drinking water should have a turbidity of *5* NTU/JTU or less. Turbidity of more than *5* NTU/JTU would be noticed by users and may cause rejection of the supply. Where water is chlorinated, turbidity should be less than 5 NTU/JTU and preferably less than 1 NTU/JTU for chlorination to be effective (PDAM, 2016).

2.4.4 Alkalinity

Alkalinity refers to the capability of water to neutralize acid. Alkalinity is an electrometric measurement which is performed using a titrant and a pH electrode. It is composed primarily of carbonate (CO_3^{2-}) and bicarbonate (HCO_3^-), alkalinity acts as a stabilizer for pH. Alkalinity, pH and hardness affect the toxicity of many substances in the water. It is determined by simple dilution of HCl titration in presence of phenolphthalein and methyl orange indicators. Alkalinity in boiler water essentially results from the presence of hydroxyl and carbonate ions. Hydroxyl alkalinity (causticity) in boiler water is necessary to protect the boiler against corrosion (Sawant et al, 2012).

2.4.5 Organic Substances

Organic substances formed by carbon compounds, in which the carbon atoms are covalently bonded to other atoms such as hydrogen, oxygen, phosphorus and others. High levels of organic matter in the water caused by the influx of organic matter in the water, as well as by industrial pollution. Natural organic matter (NOM) originating from natural sources that are present in all water bodies are caused by break down of vegetation that finds its way in water bodies. (Ashery et al. 2010).

High levels of organic matter in the water can cause turbidity, odor and color of the water, as well as reducing the levels of dissolved oxygen in the water.

2.4.6 Calcium

Calcium is an alkaline earth metal which is extremely common in nature and especially in calcareous rocks, in the form of carbonates. These salts are found in almost all natural waters. Their water content, which can range from 1 to 150 mg / l, is directly related to the geological nature of the lands traversed. It is the dominant cationic element of surface waters. Calcium is the main component of water hardness.

2.4.7 Ammonia

Ammonia is defined as ionized forms (ammonium ion NH 4) and non-ionized (NH 3) forms of ammoniacal nitrogen. The presence of ammonia nitrogen in water, like that of nitrates, comes from the decomposition of vegetable and animal waste. In its ionized form, nitrogen ammonia is low in toxicity, but a high concentration in water may indicate fecal pollution or industrial discharges.

2.4.8 Total Dissolved Solids (TDS)

Water containing TDS concentrations below 1000 mg/liter is usually acceptable to consumers, although acceptability may vary according to circumstances. However, the presence of high levels of TDS in water may be objectionable to consumers owing to the resulting taste and to excessive scaling in water pipes, heaters, boilers, and household appliances. Water with extremely low concentrations of TDS may also be unacceptable to consumers because of its flat, insipid taste; it is also often corrosive to water-supply systems (World Health Organization, 2003).

2.5 Water stability Indices

Stability of water is the tendency of water to either dissolve or deposit minerals varying with its chemical makeup. Water that tends to dissolve minerals is considered corrosive and the one that tends to deposit mineral is considered scaling. Corrosive water can dissolve minerals like calcium and magnesium, also can dissolve harmful metals such as lead and copper from plumbing utilities. Where scaling waters deposit a film of minerals on pipe walls and may prevents corrosion of metallic surfaces. The occurrence of scale deposition and corrosion which can cause secondary pollution of water quality are shown because of the chemical instability of water quality, increase energy consumption of water transportation and decrease service life of pipe networks. The most common methods used for calculating the stability of water are Langelier saturation index (LSI) and Ryznar stability index (RSI). In order to evaluate the chemical stability of any type of water, many parameters are detected, such as Temperature, Alkalinity in mg/l as CaCO3, pH, Total dissolved Solids (TDS), and concentration of Calcium (Ca) (Alsaqqar et al, 2014).

$$\text{LSI} = \text{pH}\alpha - \text{pHs} \qquad (1)$$

pH*a*: the measured water pH.

pH*s*: the pH at which water with a given calcium content and alkalinity is in equilibrium with calcium carbonate.

The equation expresses the relationship of: pH, calcium, total alkalinity, dissolved solids, and temperature as they are related to the solubility of calcium carbonate in waters with pH of 6.5 to 9.5. This is known as the pH*s*:

$$\text{pH}s = (9.3 + A + B) - (C + D) \qquad (2)$$

$$A = \frac{[\text{Log}_{10}(\text{TDS}) - 1]}{10} \qquad (3)$$

$$B = -13.12 \times \text{Log}_{10}(^{\circ}\text{C} + 273) + 34.55 \qquad (4)$$

$$C = \text{Log}_{10}(\text{Ca}^{+2} \text{ as CaCO}_3) - 0.4 \qquad (5)$$

$$D = \text{Log}_{10}[\text{Alkalinityas CaCO}_3] \qquad (6)$$

In these equations, TDS is the total dissolved solids, expressed in $mg \cdot L^{-1}$; Ca^{2+} is the concentration of Ca(II) ions expressed as $CaCO_3$, in $mg \cdot L^{-1}$; and Alk is the total alkalinity given in the equivalent $CaCO_3$, and expressed in $mg \cdot L^{-1}$ (Vasconcelos et al. 2015).

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CHAPTER 3
RESEARCH METHODOLOGY

3.1 Description of PDAM Surabaya

In conducting this research, the first step is to determine the idea of research to be done, so that problems can be identified and formulated in accordance with the purpose and scope specified. Once that was done the study of literature, with the aim of theory and research in accordance with scientific principles. Based on the objectives to be achieved and the scope is specified, this study was conducted using the method applied research and survey. The research will be carried out by applying the existing theory, the research methods to be performed. From the theory used and the data collected, the evaluation and discussion of the problem can be done by using descriptive method that is by way of describing the performance conditions related Ngagel WTP operational techniques. Having obtained the results and discussion related to the existing problems and objectives, conclusions and recommendations can be presented as an alternative to improve performance WTP Ngagel as one installation for PDAM Surabaya.

3.2 Research Framework

Framework for research or study flowchart is a diagram that explains the outline lines of inquiry, which is structured as a reference so that the stages of the research process becomes focused, and easy to observe. Framework of this research can be seen in Figure 3.1:

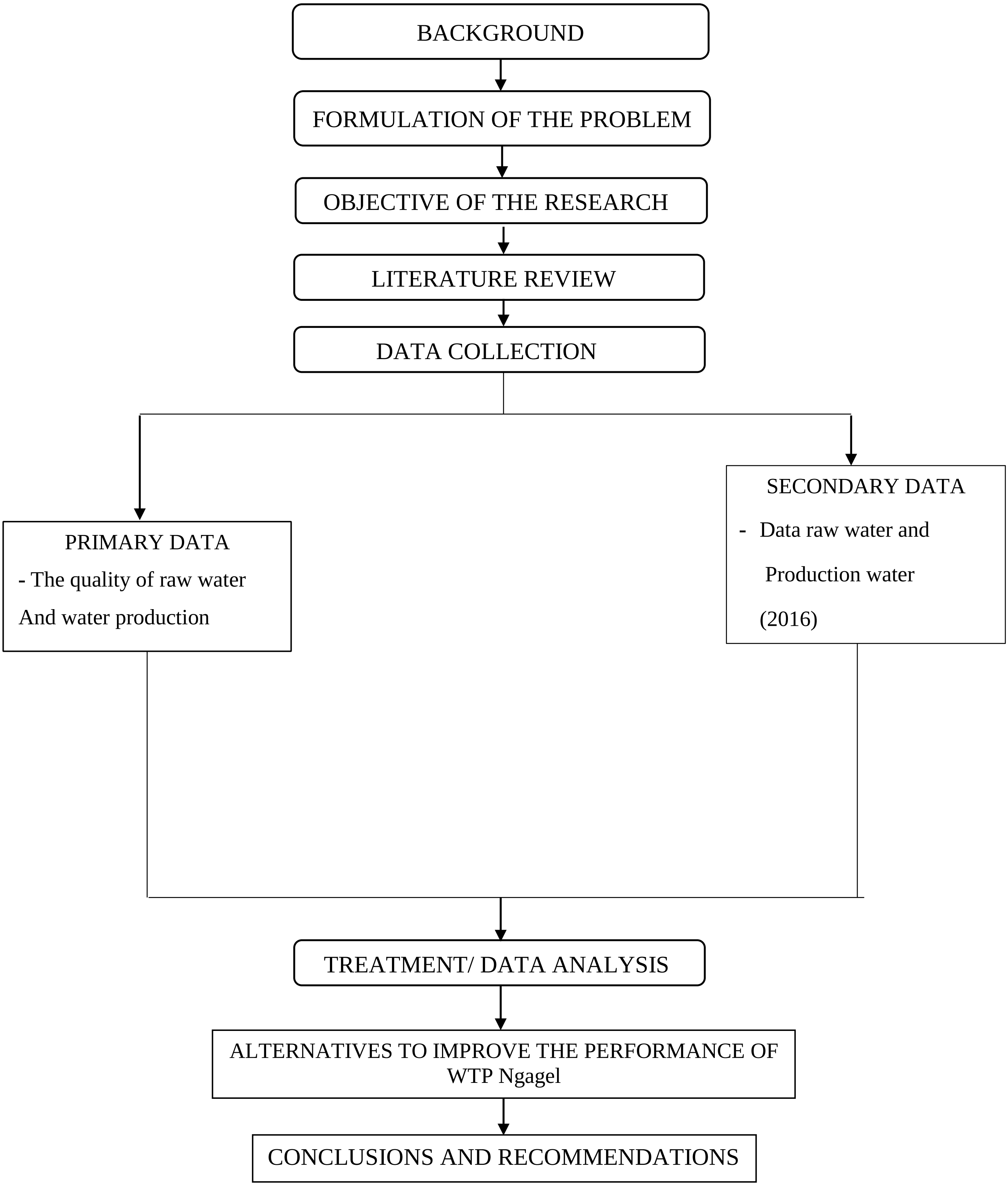

Figure 3. 1: Research methodology

3.3 Stages of Research

3.3.1 Establish Idea and Problem Formulation

Based on existing research ideas, we can see the problem you want to address. The problem itself is defined as a deviation between the rules and implementation, as well as between theory and practice (Sugiyono, 2010). Of the existing problems, then the identification of the problem and the scope used in the study can be determined, so the problem formulation can be prepared and the solution to the problems that have to be found through the analysis of data collected.

3.3.2 Review of Literature (Literature)

After the formulation of the problem, collecting the literature related to the theme of the research, covering theory, legislation, concepts of previous related studies. The aim is to support research in theory, underlying the specified scope, as well as a reference to develop procedures to conduct research in evaluating the performance of WTP Ngagel related to technical and operational aspects.

3.3.3 Data Collection

A. Type of Data

Based on the source, the data used in the study were divided into two, namely primary and secondary data.

1. Primary Data

   Primary data is data obtained directly by researchers from the source data retrieval. In this study, the primary data collection is done as a verification of the results of the analysis using secondary data.

2. Secondary Data

   Secondary data is data obtained indirectly by researchers, where data are derived from various sources. Secondary data is required in this study is the monthly for 2016.

The data include the following:

a. Technical data of buildings and supporting facilities WTP Ngagel I, II and III
b. Raw water discharge data and production capacity WTP Ngagel I, II and III
c. Data quality raw water and water production WTP Ngagel I, II and III
d. Data related to the general conditions of the research area (geographic, demographic and climate
e. Regulations and legislation applicable, related to the research theme.

B. Data Collection Techniques

In this study will be used multiple data collection techniques, as follows:

a. Observation

   This technique is done by direct observation of the object under study, which in this study that the facilities and infrastructure available in WTP Ngagel, raw water quality, water quality production, as well as other matters deemed necessary.

b. Documentation

   This technique is done by collecting literature from various sources related to the research theme.

C. Sampling Techniques

The process of sampling for raw water and production water started from 18/05/2017 until 20/05/2017 (During three days). For each day we took four samples:

- 1 sample of raw water.
- 3 samples for different production water of Water Treatment Plants Ngagel (I, II, III).The total of samples was 12 samples.

3.4 Treatment and Data Analysis

3.4.1 Analyses of Removal Efficiency

Water Removal efficiency is the percentage of pollutant reduction from raw water to production water. The use of a variety of treatment processes by water suppliers to remove contaminants from raw water (Angreni, 2009). The Removal efficiency is calculated by comparing the concentration of pollutants in raw water and in the production water with the concentration of pollutants in the raw water. Mathematically, the efficiency calculation formula can be written as follow:

$$Eff = \frac{C\ raw\ water - C\ prod\ water}{C\ raw\ water}$$

- *Eff (%)*
- *C raw water (mg/L)*
- *C production water (mg/L)*

3.4.2 Analyses of water stability

A. Langelier Saturation Index:

Langelier Saturation Index (LSI) is an equilibrium model derived from the theoretical concept of saturation and provides an indicator of the degree of saturation of water with respect to calcium carbonate (Alsaqqar et al, 2014).

$$LSI = pHa - pHs \quad (1)$$

Where pH*a* is the actual pH of the water, and pHs is the pH of saturation. Water at equilibrium neither dissolves, nor precipitates calcium carbonate, so it is then characterized by its saturation pH called pHs (Vasconcelos et al, 2015). The equation expresses the relationship of: pH, calcium, total alkalinity, dissolved solids, and temperature as they are related to the solubility of calcium carbonate in waters with pH of 6.5 to 9.5. This is known as the pH*s*:

$$pHs = (9.3 + A + B) - (C + D) \quad (2)$$

$$A = \frac{[\mathrm{Log}_{10}(\mathrm{TDS}) - 1]}{10} \quad (3)$$

$$B = -13.12 \times \mathrm{Log}_{10}(^{\circ}\mathrm{C} + 273) + 34.55 \quad (4)$$

$$C = \mathrm{Log}_{10}(\mathrm{Ca}^{+2} \text{ as } \mathrm{CaCO}_3) - 0.4 \quad (5)$$

$$D = \mathrm{Log}_{10}[\text{Alkalinityas } \mathrm{CaCO}_3] \quad (6)$$

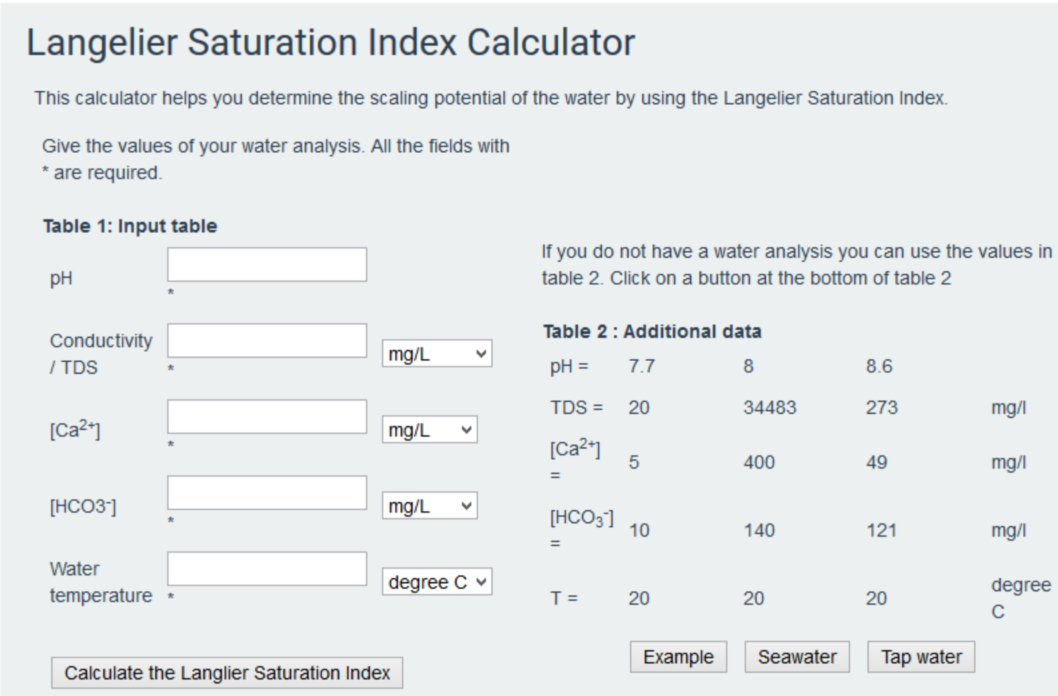

Figure 3.2: Langelier Saturation Index Calculator (Alsaqqar et al, 2014)

B. Ryznar Stability Index:

The Ryznar index is an empirical method for predicting scaling tendencies of water based on study of operating results with water at various saturation indices. The Stability Index developed by John Ryzner in 1944 used the Langelier Index (LSI) as a component in a new formula to improve the accuracy in predicting the scaling or corrosion tendencies of water (Alsaqqar et al, 2014).

The Ryznar index (RSI) takes the form:

$$(\mathrm{RSI}) = 2(\mathrm{pH}s) - \mathrm{pH} = \mathrm{pH}s - \mathrm{LSI} \tag{7}$$

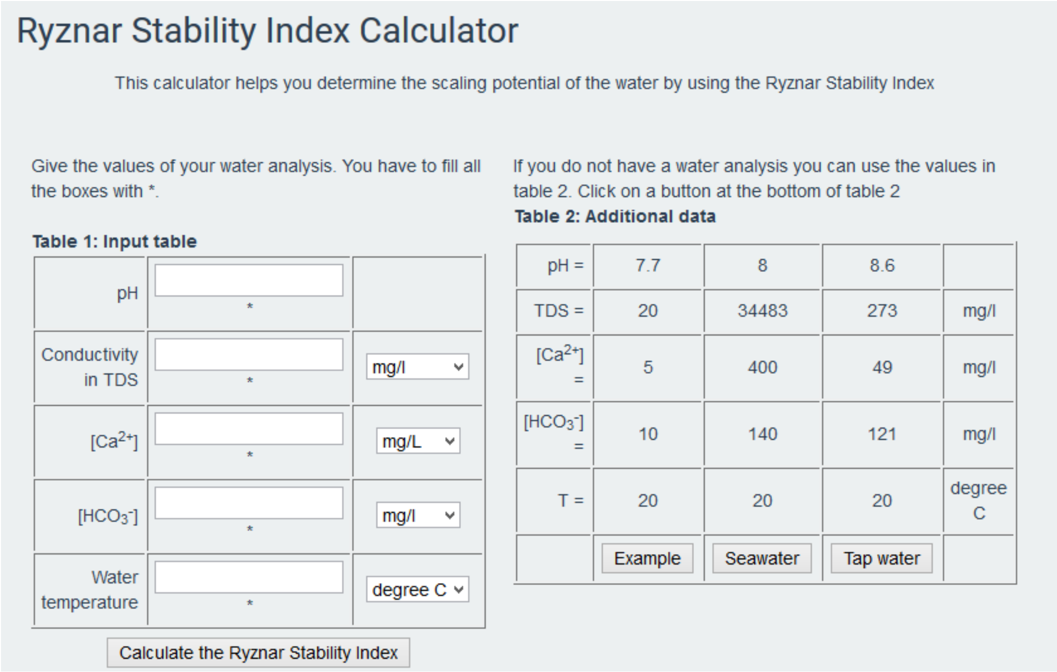

Figure 3.3 Ryznar Saturation Index Calculator (Alsaqqar et al, 2014)

Index value	Water condition
$LSI > 0$	Water is supersaturated with respect to calcium carbonate ($CaCO_3$) and scale forming and $CaCO_3$ precipitation may occur.
$LSI = 0$	Water is considered to be neutral. Neither scale-forming nor scale removing. Saturated, $CaCO_3$ is in equilibrium. Borderline scale potential.
$LSI < 0$	Water is under saturated with respect to calcium carbonate. Under saturated water has a tendency to remove existing calcium carbonate protective coatings in pipelines and equipment. No potential to scale, the water will dissolve $CaCO_3$.
$RSI \leq 6$	Supersaturated, tend to precipitate $CaCO_3$. The scale tendency increase as the index decrease.
$6 < RSI < 7$	Saturated, $CaCO_3$ is in equilibrium. The calcium carbonate formation probably does not lead to a protective corrosion inhibitor film.
$LSI \geq 7$	Under saturated, tend to dissolved $CaCO_3$. Mild steel corrosion becomes an increasing problem.

Figure 3.4 Summary of water stability indexes (Alsaqqar et al. 2014)

Negative values of the LSI indicate corrosive water while positive results indicate non-corrosive water. Another common index is the Ryzner Stability Index or RSI. A RSI greater than about 6.5 indicates water that is probably corrosive with higher values being increasingly corrosive (Swistock, 2017).

CHAPTER 4
RESULTS AND DISCUSSION

In this part of research, tables and graphics show the results of analyses done. For each graphic, will be defined an interpretation down to explain it.

4.1 Turbidity

Figure 4.1 shows that the raw water in Ngagel I has a high Turbidity in February (182.26 NTU) and March (182.09 NTU). During the rainy season when mud and silt are washed into rivers and streams, high turbidity can quickly block filters and stop them from working effectively. High turbidity will also fill tanks and pipes with mud and silt, and can damage valves and taps. The process of electro-aggregation could reduce the turbidity in a short period of time.

The use of aluminum electrode will be a better choice, as compared to stainless steel or iron electrodes due to its role as scarified electrodes releasing of aluminum ions as coagulant (Po-Ching Lee et al, 2007).This Turbidity start to decrease by April to reach a minimum of (41.84 NTU) in August then increase again to reach a maximum of (185.3 NTU) by December.Drinking water should have a turbidity of 5NTU/JTU or less. It is also seen that the Turbidity of raw water in Ngagel I still not stable and is not conform toPermenkes 492/2010. Effective removal ofturbidity and soluble natural organic matter from water could be achieved by micro-floc formation process (coagulation) and macro-floc development (flocculation) (Ashery et al, 2010). However, Figure.1 shows that turbidity of production water is totally conform to Permenkes 492/2010 during all the months of the year 2016.

Table 4.1: Comparison of Turbidity concentration (NTU) in Ngagel I

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
R. water	121.83	182.26	182.09	156.48	89.39	75.32	51.745	41.84	44.645	132.72	100.65	185.3
P. water	1.37	1.2	1.13	1.26	1.33	1.54	1.12	0.9	0.93	0.87	1.08	1.18
Per 492/2010	5	5	5	5	5	5	5	5	5	5	5	5

Source: Results of analyses of secondary data 2016

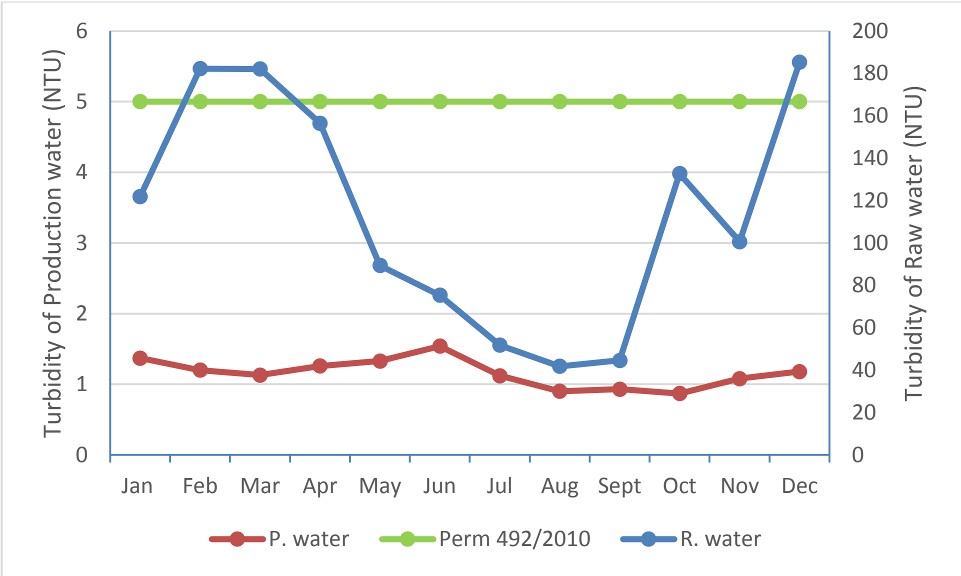

Figure 4.1: Comparison of Turbidity concentration (NTU) in Ngagel I

Table 4.2: Comparison of Turbidity concentration (NTU) in Ngagel II

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
R. water	121.83	182.26	182.09	156.48	89.39	75.32	51.745	41.84	44.645	132.72	100.65	185.3
P. water	0.88	0.86	0.74	0.72	0.79	0.8	0.75	0.78	0.9	0.76	0.89	0.77
Per 492/2010	5	5	5	5	5	5	5	5	5	5	5	5

Source: Results of analyses of secondary data 2016

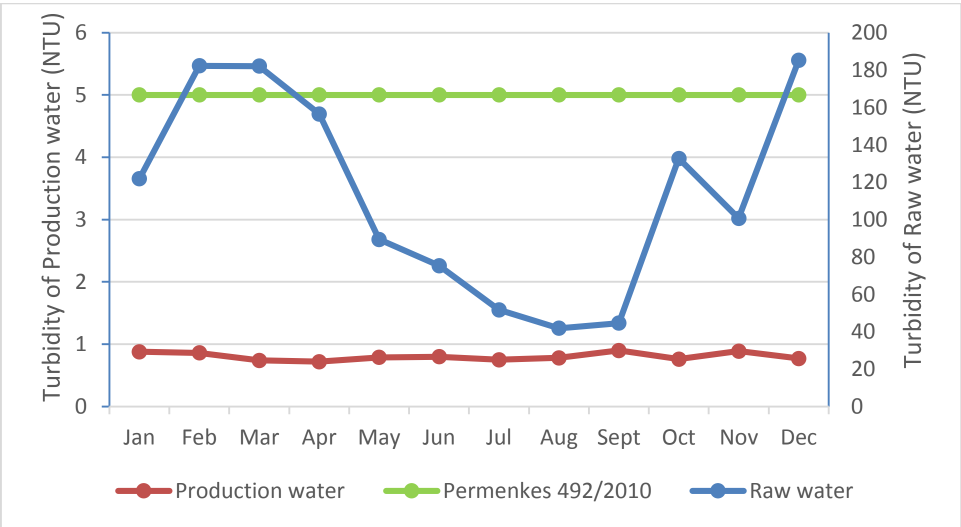

Figure 4.2: Comparison of Turbidity concentration (NTU) in Ngagel II

From Figure 4.2, it is seen the same conditions as in figure.1 where the raw water in Ngagel II still has high Turbidity which is not stable during the months of the year 2016. Moringa oleifera, Cicer arietinum, and Dolichos lablab can be used as locally available natural coagulants to reduce the turbidity of raw water(Fakhruddin & Hossain, 2011). Although, the Turbidity of production water seems to be conform to the Indonesian standard 492/2010.

Table 4.3: Comparison of Turbidity concentration (NTU) in Ngagel III

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
R. water	121.83	182.26	182.09	156.48	89.39	75.32	51.745	41.84	44.645	132.72	100.65	185.3
P. water	0.55	0.48	0.53	0.66	0.83	0.68	0.7	0.75	0.79	0.65	0.64	0.59
Per 492/2010	5	5	5	5	5	5	5	5	5	5	5	5

Source: Results of analyses of secondary data 2016

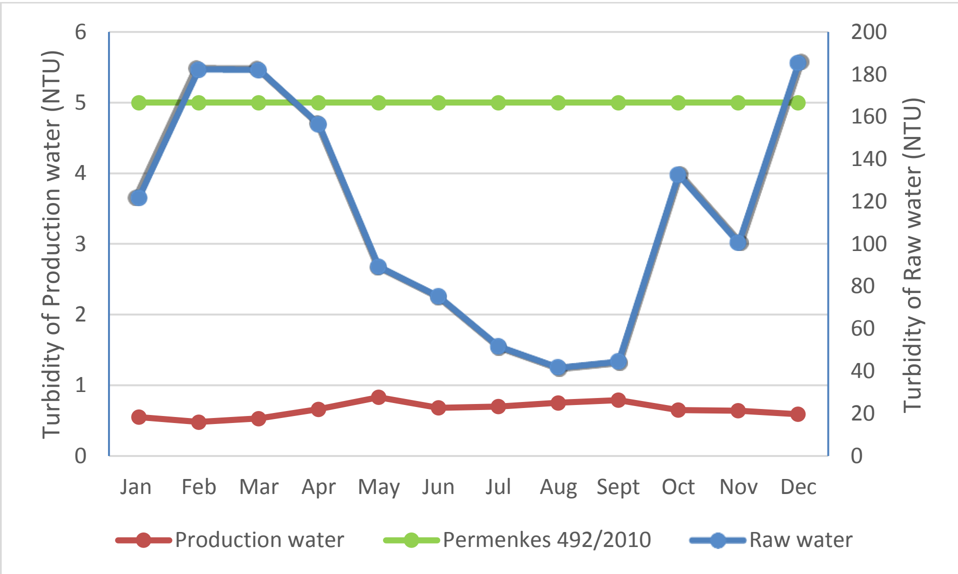

Figure 4.3: Comparison of Turbidity concentration (NTU) in Ngagel III

From Figure 4.3 it is seen the same condition as the previous figures, where the Turbidity of raw water still high with a maximum of (185.3 NTU) and a minimum of (41.84 NTU). The availability of raw drinking water resources in Surabaya which is supplied from kali Surabaya is influenced by the economy activities along the stream of this river(Sumantri, 2016).However, the Turbidity of production water in Ngagel III is almost conform to the Indonesian standard 492/2010.

It can be concluded from the three figures below, that Ngagel I, Ngagel II and Ngagel III have a good efficiencies to decrease the Turbidity in the raw water.

Table 4.4 Comparison of Turbidity removal efficiencies (%) between Ngagel I, Ngagel II and Ngagel III

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Eff (Ngagel I)	98.87	99.34	99.38	99.19	98.50	97.95	97.83	97.85	97.92	99.34	98.93	99.36
Eff (Ngagel II)	99.28	99.53	99.59	99.54	99.12	98.94	98.55	98.13	97.98	99.43	99.11	99.58
Eff (Ngagel III)	99.55	99.74	99.71	99.58	99.07	99.10	98.65	98.21	98.23	99.51	99.36	99.68

Source: Results of analyses of secondary data 2016

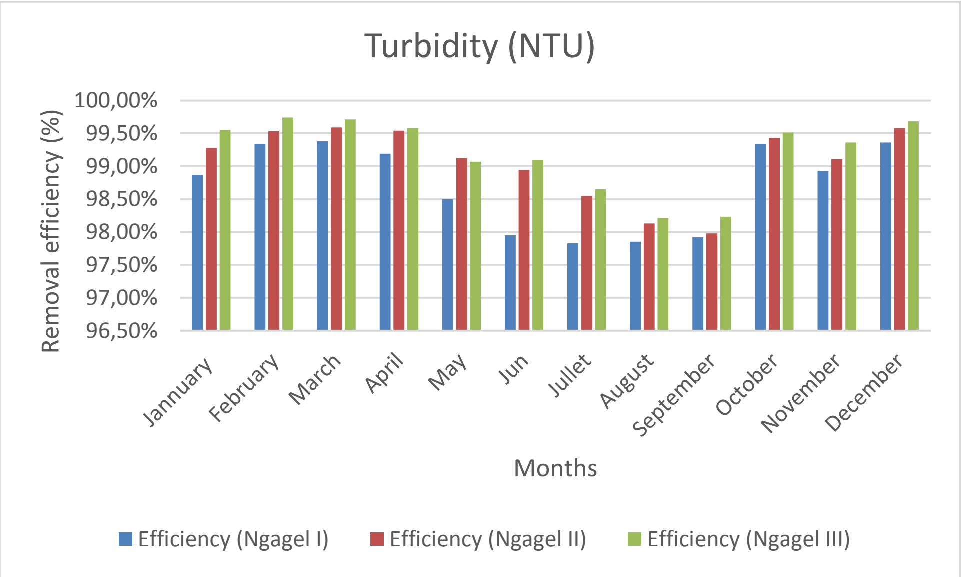

Figure 4.4: Comparison of Turbidity removal efficiencies (%) between Ngagel I, Ngagel II and Ngagel III

From Figure 4.4, it is seen that during almost all of the months in the year 2016, the total turbidity removal efficiencies of Ngagel III were leading over

Ngagel II and Ngagel I. Only in the month of May, that the turbidity removal efficiency of Ngagel III (99.07%) was 'defeated' by Ngagel II (99.12%) with only a slight value.From the same figure, it is also seen that during all of the months in the year 2016, the total turbidity removal efficiencies of Ngagel II were also leading over Ngagel I.

4.2 Organic Substances

From Figure 4.5 it is seen that the concentration of organic substances in Ngagel I is high in raw water, with a minimum of (10.605 mg/L) and a maximum of (22.72mg/L) in October. So, it is not conform to the Indonesian standard 492/2010. However, Ngagel I has a good performance to decrease the concentration of organic substances in production water to a minimum of (4.21 mg/L) in August and a maximum of (7.75 mg/L) in Jannuary.

Table 4.5: Comparison of Organic Substances concentration (mg/L) in Ngagel I

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
R. water	16.458	16.87	13.183	16.168	15.693	15.453	13.14	10.605	12.528	22.71	14.76	16.65
P. water	7.75	6.08	5.49	5.3	7.11	5.79	4.81	4.21	4.41	5.84	6.24	6.5
Per 492/2010	10	10	10	10	10	10	10	10	10	10	10	10

Source: Results of analyses of secondary data 2016

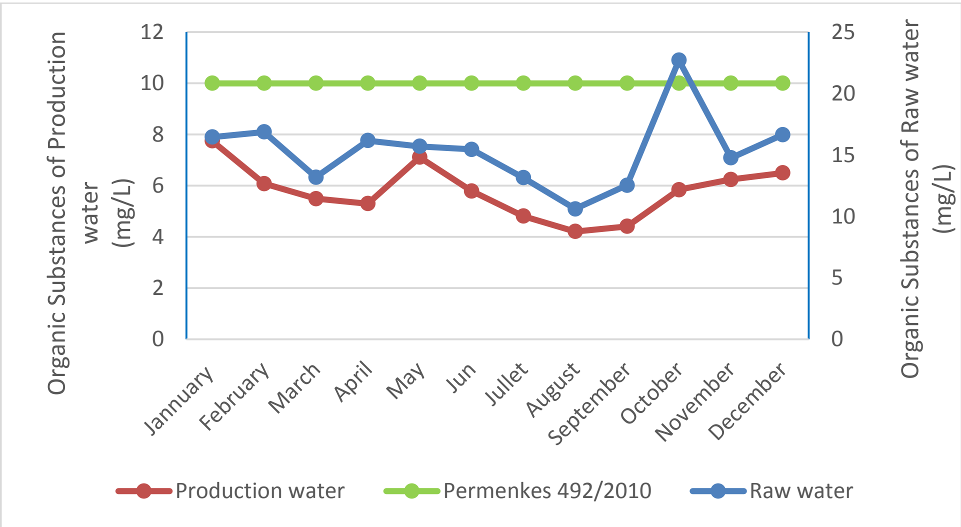

Figure 4.5: Comparison of Organic Substances concentration (mg/L) in Ngagel I

Table 4.6: Comparison of Organic Substances concentration (mg/L) in Ngagel II

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
R. water	16.458	16.87	13.183	16.168	15.693	15.453	13.14	10.605	12.528	22.71	14.76	16.65
P. water	7.72	5.98	5.56	5.77	6.84	6.06	4.85	4.05	4.3	6.01	6.82	6.58
Per 492/2010	10	10	10	10	10	10	10	10	10	10	10	10

Source: Results of analyses of secondary data 2016

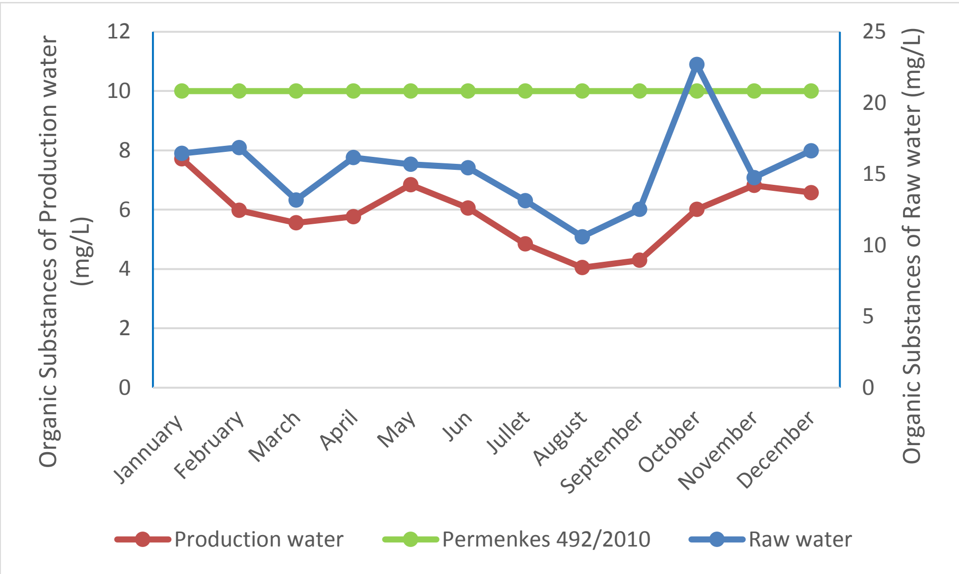

Figure 4.6: Comparison of Organic Substances concentration (mg/L) in Ngagel II.

From Figure 4.6, it is seen that Ngagel II has approximately the same performance to remove organic substances as Ngagel I. It is also seen that the concentration of organic substances reaches a minimum of (10.605 mg/L) in August which is very near from the Indonesian standard. However, the concentration of organic substances reaches a maximum of (22.71 mg/L) in October.

It can be concluded here also, that Ngagel II has a good performance to remove Organic substances from raw water.Also, the concentration of Organic substances in production water can be considered as conform to Indonesian standard. Because, it reaches a maximum of (7.72 mg/L) in jannuary and a minimum of (4.05 mg/L) in August.

Table 4.7: Comparison of Organic Substances concentration (mg/L) in Ngagel III

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
R. water	16.458	16.87	13.183	16.168	15.693	15.453	13.14	10.605	12.528	22.71	14.76	16.65
P. water	6.37	4.92	4.19	4.58	6.54	5.41	4.62	3.82	3.98	5.54	5.68	5.69
Per 492/2010	10	10	10	10	10	10	10	10	10	10	10	10

Source: Results of analyses of secondary data 2016

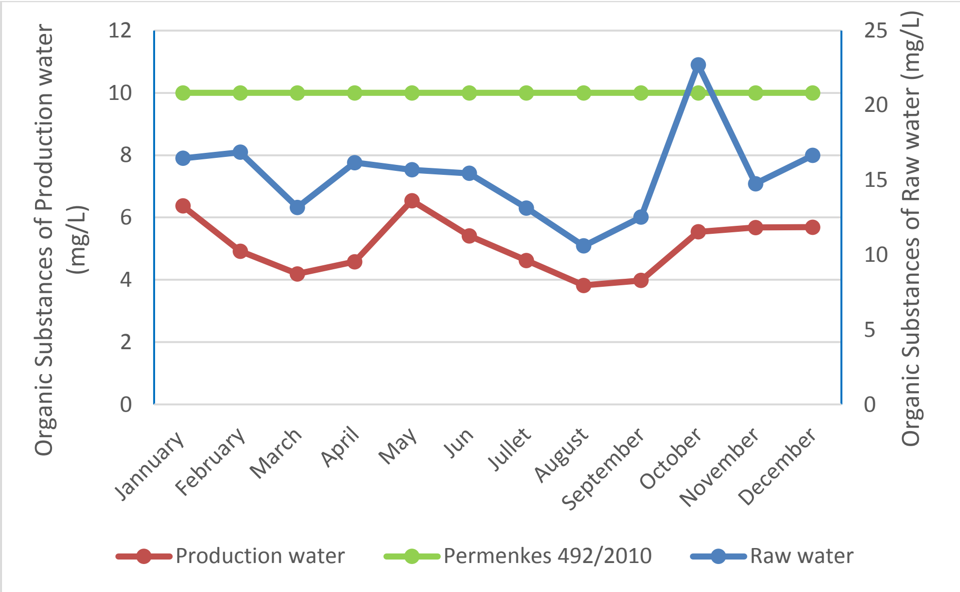

Figure 4.7: Comparison of Organic Substances concentration (mg/L) in Ngagel III

From Figure 4.7, as the previous ones, it can be seen that Ngagel III has approximately the same performance to remove the Organic substance from raw water. It is seen that the concentration of organic substances is higher than the standard with a maximum of (22.71 mg/L) in October and a minimum of (10.605 mg/L) in August. However, the concentration of organic substances in production water is lower than the standard with a maximum of (6.54 mg/L) in May and a minimum of (3.82 mg/L) in August.

Table 4.8: Comparison of Organic Substances removal efficiencies (%) between Ngagel I, Ngagel II and Ngagel III

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Eff (Ngagel I)	52.90	63.96	58.35	67.22	54.68	62.53	63.39	60.30	64.80	74.28	57.72	60.48
Eff (Ngagel II)	53.09	64.55	57.82	64.31	56.40	60.78	63.09	61.80	65.68	73.53	53.79	60.48
Eff (Ngagel III)	61.29	70.83	68.22	71.67	58.32	64.99	64.84	63.98	68.23	75.60	61.52	65.82

Source: Results of analyses of secondary data 2016

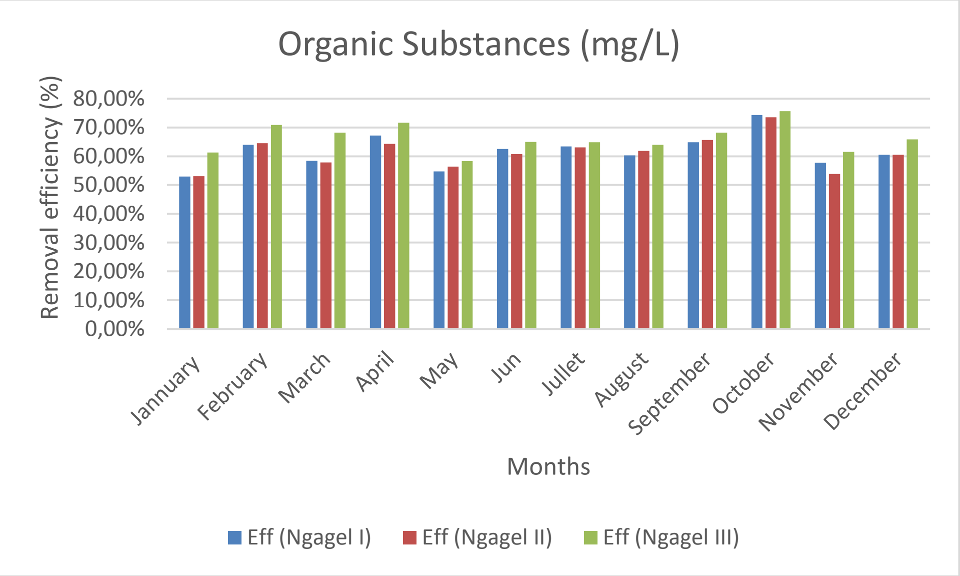

Figure 4.8: Comparison of Organic Substances removal efficiencies (%) between Ngagel I, Ngagel II and Ngagel III

From Figure 4.8, it can be concluded that during all of the months in the year 2016, the total organic substances removal efficiencies of Ngagel III were leading over Ngagel II and I. From the same figure it is also seen that, in terms of organic substances removal efficiency, Ngagel II were only leading over Ngagel I in the months of January, February, May, August, and September. While the rest of the months i.e. March, April, June, July, October and November, Ngagel I were leading over Ngagel II. In the month of December, both plants (Ngagel II and I) have similar organic substances removal efficiencies (60.48%).

4.3 Ammonia

For Figure 4.9, it is seen that the concentration of Ammonia in raw water depends the month of the year. It is less than (1 mg/L) between (February, March, April, May, Jun, and August), however, in (Jannuary, Jully, September, November and December), the concentration of Ammonia in raw water, become higher than (1mg/L), and it over the Indonesian standard in October with (1.87 mg/L). For, production water, the concentration of Ammonia is between (0.056 mg/L) in June and (0.19 mg/L) in Jannuary. It is considered as conform to the Indonesian standard 492/2010.

Table 4.9: Comparison of Ammonia concentration (mg/L) in Ngagel I

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
R. water	1.29	0.4	0.28	0.22	0.28	0.32	1.556	0.85	1.45	1.87	1.49	1.3
P. water	0.19	0.07	0.09	0.09	0.06	0.056	0.134	0.06	0.096	0.18	0.14	0.08
Per 492/2010	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5

Source: Results of analyses of secondary data 2016

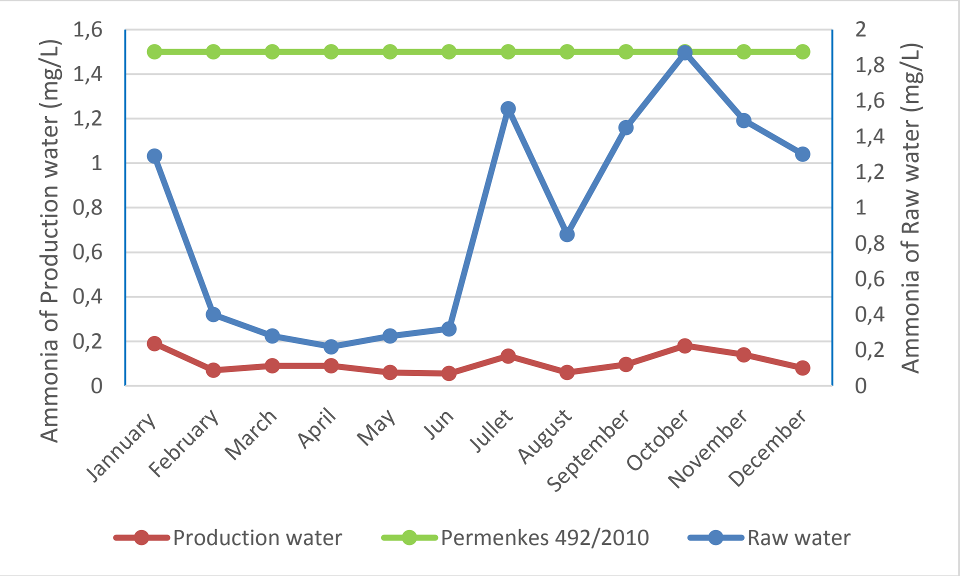

Figure 4.9: Comparison of Ammonia concentration (mg/L) in Ngagel I

Table 4.10: Comparison of Ammonia concentration (mg/L) in Ngagel II

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
R. water	1.29	0.4	0.28	0.22	0.28	0.32	1.556	0.85	1.45	1.87	1.49	1.3
P. water	0.07	0.08	0.12	0.11	0.06	0.042	0.077	0.02	0.217	0.2	0.15	0.05
Per 492/2010	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5

Source: Results of analyses of secondary data 2016

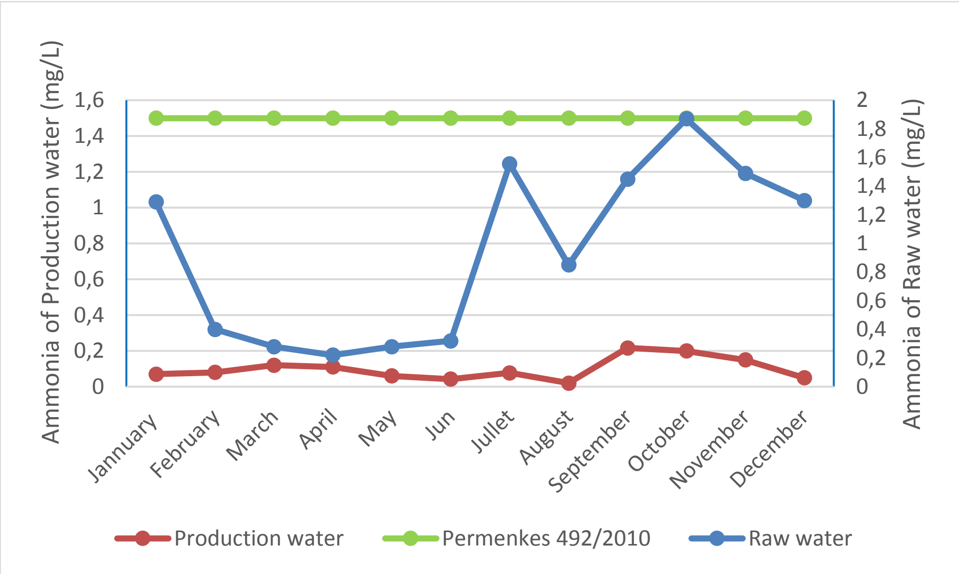

Figure 4.10: Comparison of Ammonia (mg/L) in Ngagel II

From Figure 4.10, it is seen that the raw water in Ngagel II has a conform concentration of Ammonia which vary between (0.22mg/L) in February (< 1.5 mg/L), and (1.556 mg/L) in jullet (<1.5 mg/L). It just over the standard in month of October with (1.87 mg/L) which is (> 1.5 mg/L).

Table 4.11: Comparison of Ammonia concentration (mg/L) in Ngagel III

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
R. water	1.29	0.4	0.28	0.22	0.28	0.32	1.556	0.85	1.45	1.87	1.49	1.3
P. water	0.051	0.043	0.077	0.161	0.042	0.031	0.101	0	0.119	0.19	0.11	0.02
Per 492/2010	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5

Source: Results of analyses of secondary data 2016

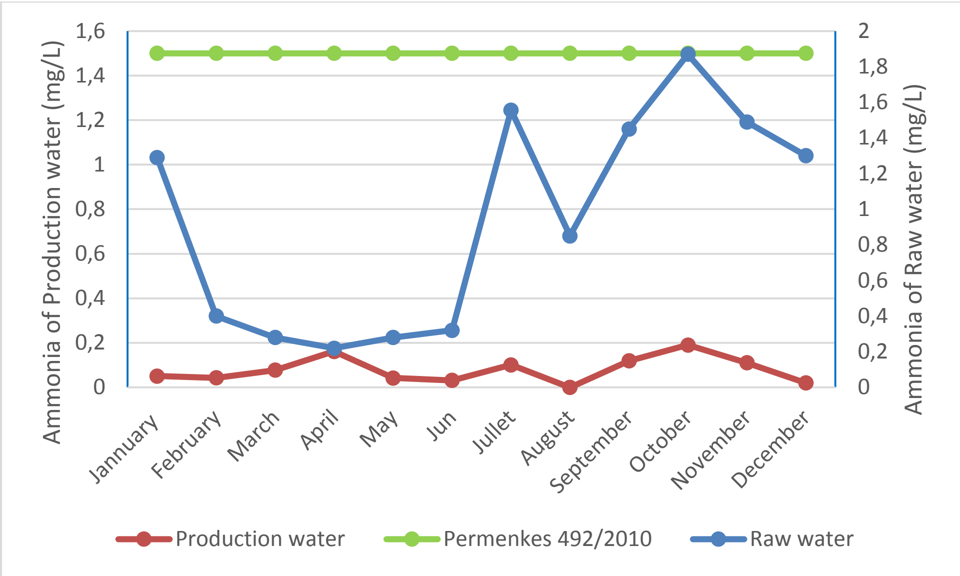

Figure 4.7: Comparison of Organic Substances concentration (mg/L) in Ngagel III

From Figure 4.11, it can be seen that the concentration of Ammonia in raw water is still less than the Indonesian standards during the months of the year, between (0.22 mg/L) in April and (1.556 mg/L) in jullet. It is also seen as in previous figures that the concentration of Ammonia in raw water just over the Indonesian standards in October with (1.87 mg/L). For production water, the concentration of Ammonia is still conform to the Indonesian Standard, it varies between (0 mg/L) in August and (0.19 mg/L) in October.

Table 4.12 : Comparison of Ammonia efficiencies between Ngagel I, Ngagel II and Ngagel III

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Eff (Ngagel I)	85.27	82.50	67.86	59.09	78.57	82.50	91.39	92.94	93.38	90.37	90.60	93.85
Eff (Ngagel II)	94.57	80.00	57.14	50.00	78.57	86.88	95.05	97.65	85.03	89.30	89.93	96.15
Eff (Ngagel III)	96.05	89.25	72.50	26.82	85.00	90.31	93.51	100.00	91.79	89.84	92.62	98.46

Source: Results of analyses of secondary data 2016

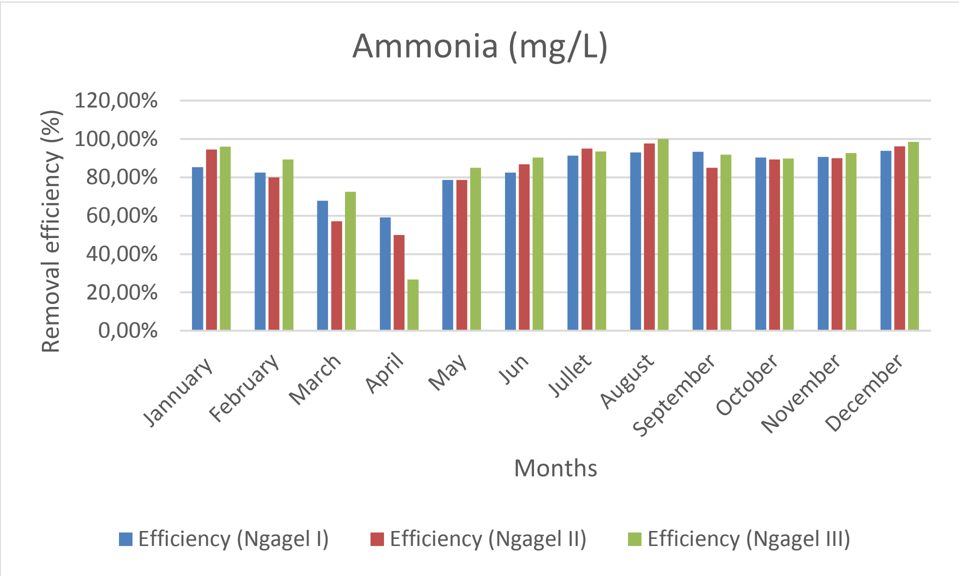

Figure 4.12: Comparison of Ammonia removal efficiencies between Ngagel I, Ngagel II and Ngagel III

From Figure 4.12 it is seen that during almost all of the months in the year 2016, the ammonia removal efficiencies of Ngagel III were leading over Ngagel II and Ngagel I. Only in the month of April, July, September and October, the ammonia removal efficiencies of Ngagel III were ‘defeated’ by Ngagel II and Ngagel I.From the same figure, it is also seen that, in the months of April, September, and October the ammonia removal efficiencies of Ngagel I were leading over Ngagel III and Ngagel II. Only in the month of July, the ammonia removal efficiencies of Ngagel II leading over Ngagel I and Ngagel III.

4.4 Analyses of primary data 2017

4.4.1 Analyses of removal efficiency

In this part of research, samples of raw water and production water were taken from WTP Ngagel during 3 days. The reason was to compare the concentration of different parameters between raw water and production water first then calculate the efficiency. Also, these results will help confirm the secondary data.

A. Turbidity

From Figure 4.13, it is seen that raw water in Ngagel I has a high turbidity which vary between (23.8 NTU) and (33.4 NTU). From the same Figure it is seen that the turbidity of production water is totally conform to the Indonesian standards 492/2010. It varies between (1.07 NTU) and (1.47 NTU) still (< 5 NTU).

Table 4.13: Comparison of Turbidity concentration (NTU) Ngagel I

	18/05/2017	19/05/2017	20/05/2017
Raw Water	23.8	27.2	33.4
Production Water	1.07	1.3	1.47
Permenkes 492/2010	5	5	5

Source: Result of analyses of primary data 2017

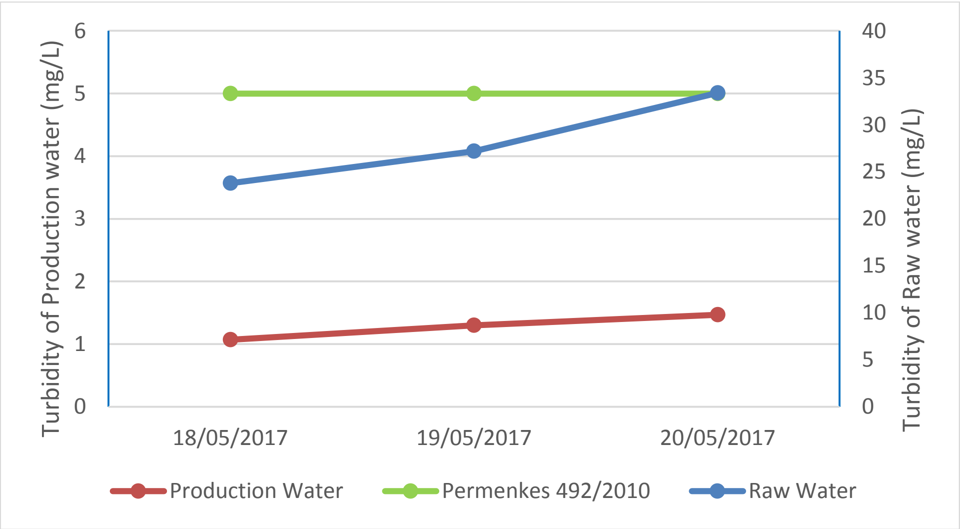

Figure 4.13: Comparison of Turbidity concentration (NTU) in Ngagel I

From Figure 4.14, also it is seen that Ngagel II is able to decrease the Turbidity in raw water. It was between (23.8 NTU) and (33.4 NTU) and become between (1.11 NTU) and (0.63 NTU) which is conform to the Indonesian standards 492/2010.

Table 4.14: Comparison of Turbidity concentration (NTU) in Ngagel II

	18/05/2017	19/05/2017	20/05/2017
Raw Water	23.8	27.2	33.4
Production Water	1.11	0.76	0.63
Permenkes 492/2010	5	5	5

Source: Result of analyses of primary data 2017

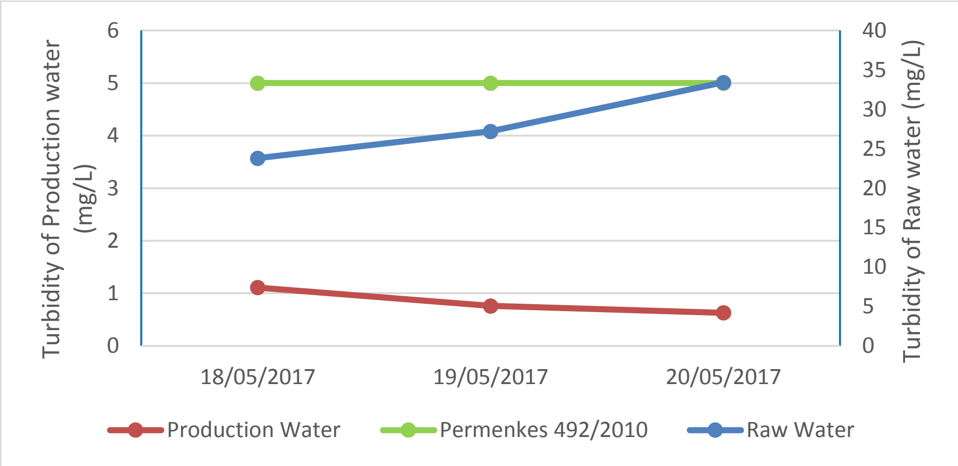

Figure 4.14: Comparison of Turbidity concentration (NTU) in Ngagel II

From this Figure 4.15, it is seen also that Ngagel III is able to decrease the Turbidity in raw water which become (0.96 NTU) instead of (23.8 NTU) and (2.78 NTU) instead of (33.4 NTU). It can be concluded from this Figure that the Turbidity in of production water in Ngagel III is also conform to the Indonesian standards 492/2010.

Table 4.15: Comparison of Turbidity concentration (NTU) 0 in Ngagel III

	18/05/2017	19/05/2017	20/05/2017
Raw Water	23.8	27.2	33.4
Production Water	0.96	1.51	2.78
Permenkes 492/2010	5	5	5

Source: Result of analyses of primary data 2017

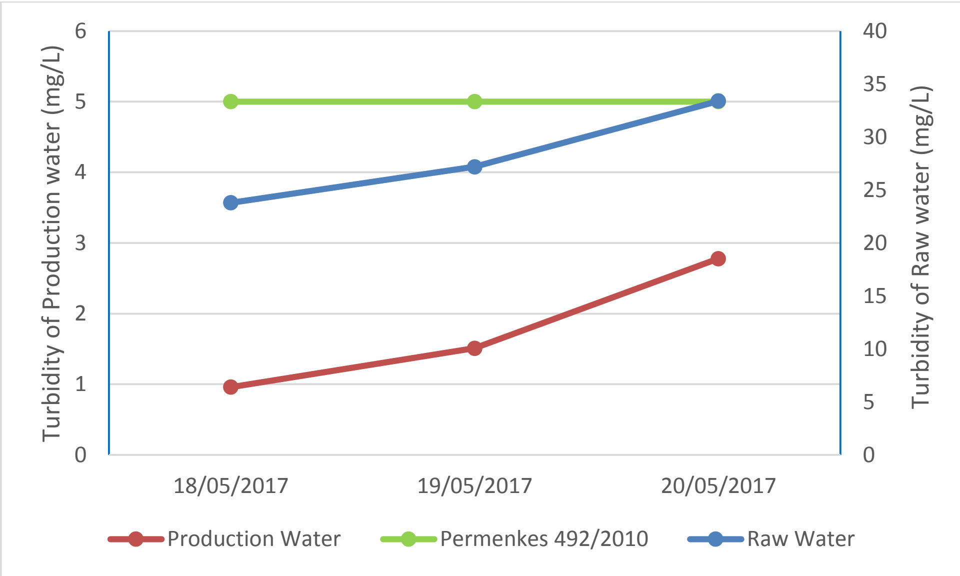

Figure 4.15: Comparison of Turbidity concentration (NTU) in Ngagel III

From Figure 4.16, it is seen that the Removal efficiency of Turbidity in Ngagel II dominate Ngagel I and Ngagel III during 19/04/2017 and 20/04/2017. However in the day of 18/04/2017, Ngagel II has the lowest removal efficiency compare it to Ngagel I and Ngagel III.

Table 4.16: Comparison of Turbidity removal efficiencies (%) between Ngagel I, Ngagel II and Ngagel III

	18/05/2017	19/05/2017	20/05/2017
Efficiency (Ngagel I)	95.50%	95.22%	95.60%
Efficiency (Ngagel II)	95.34%	97.20%	98.11%
Efficiency (Ngagel III)	95.97%	94.45%	91.68%

Source: Results of analyses of Primary data 2017

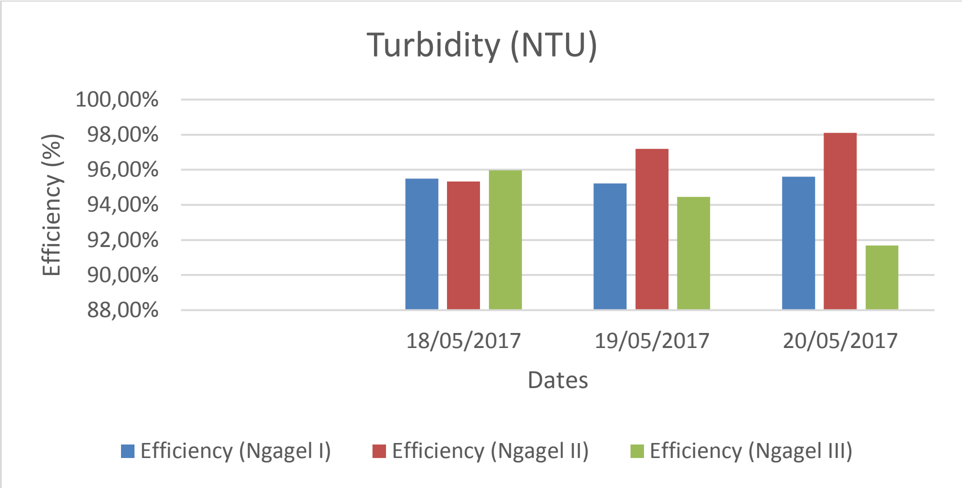

Figure 4.16: Comparison of Turbidity removal efficiencies (%) between Ngagel I, Ngagel II and Ngagel III

B. Organic substances

From Figure 4.17, it is seen that in the first day, the raw water of Ngagel I had a higher concentration of Organic substances than the standards (10.82 mg/L),then after treatment, Ngagel I treatment plant could decrease this concentration in production water to become conform with the standard (5.03 mg/L). The same condition in the second day, where the concentration of organic substances in raw water was (10.21 mg/L) little higher than the Indonesian standards (10 mg/L). After treatment, Ngagel I could decrease this concentration to become less than the standards (conform) with (3.5 mg/L). For the last day, it is seen that Ngagel I still able to decrease the concentration of organic substances from (8.38 mg/L) in raw water (conform to Indonesian standards (10mg/L)) to (3.81 mg/L) in production water which is conform to Indonesian standards 492/2010).

Table 4.17: Comparison of Organic substances concentration (mg/L) in Ngagel I

	18/05/2017	19/05/2017	20/05/2017
Raw Water	10.82	10.21	8.38
Production Water	5.03	3.5	3.81
Permenkes 492/2010	10	10	10

Source: Result of analyses of primary data 2017

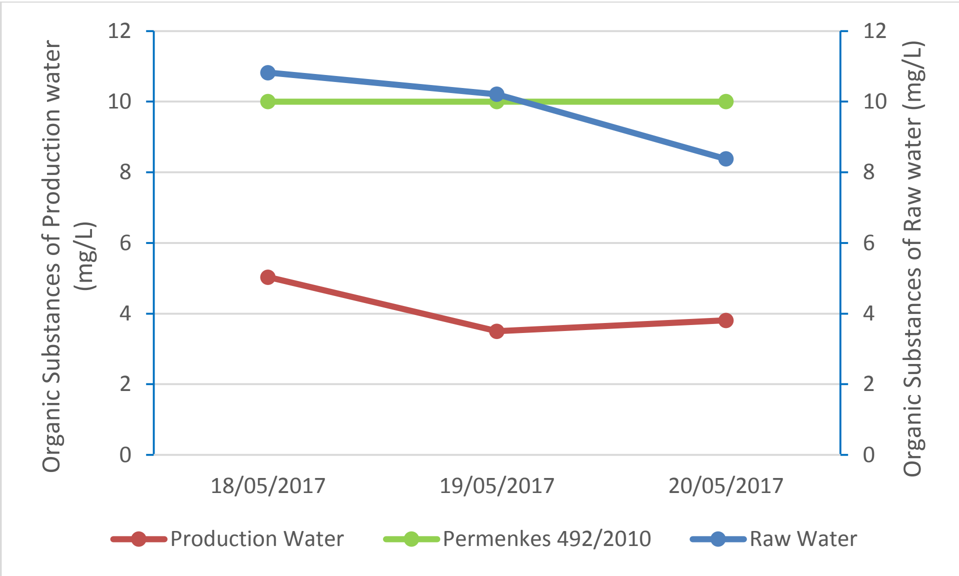

Figure 4.17: Comparison of Organic substances concentration (mg/L) in Ngagel I

From Figure 4.18, it is seen that raw water of Ngagel II start by having a non-conform concentration of organic substances (54.7 mg/L) then after treatment, Ngagel II could decrease this concentration to become (5.03 mg/L) which is conform to Indonesian standards. On the second day, the concentration of organic substances in raw water, was near by Indonesian standards (10.21 mg/L). Then decrease to (5.03 mg/L) in production water. During the last day, the concentration of organic substances in raw water was (8.38 mg/L): conform to Indonesian standards 492/2010. Then, Ngagel II could decrease it to become (3.5 mg/L) which is conform.

Table 4.18: Comparison of Organic substances concentration (mg/L) in Ngagel II

	18/05/2017	19/05/2017	20/05/2017
Raw Water	10.82	10.21	8.38
Production Water	5.03	5.03	3.5
Permenkes 492/2010	10	10	10

Source: Result of analyses of primary data 2017

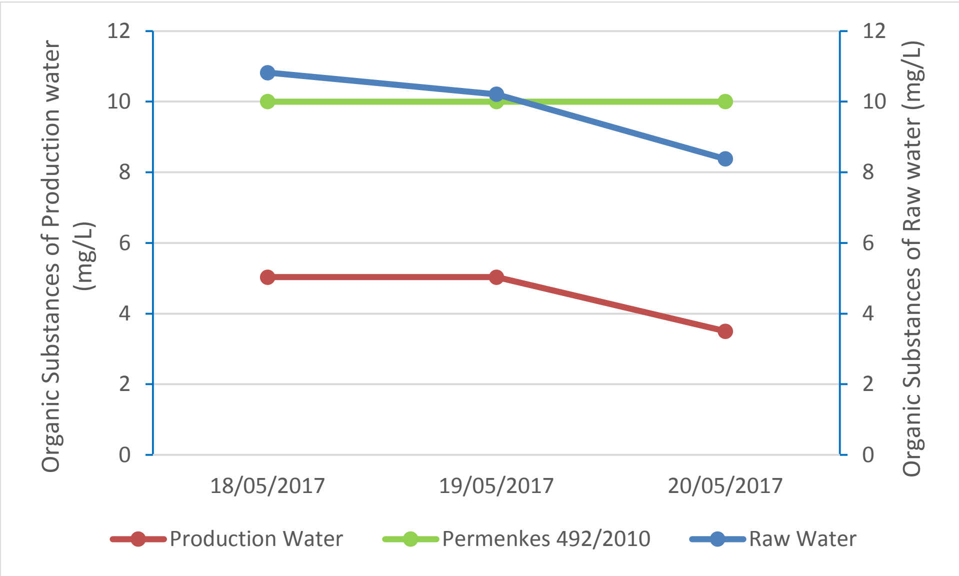

Figure 4.18: Comparison of Organic substances concentration (mg/L) in Ngagel II

Table 4.19: Comparison of Organic substances concentration (mg/L) in Ngagel III

	18/05/2017	19/05/2017	20/05/2017
Raw Water	10.82	10.21	8.38
Production Water	4.72	3.81	4.72
Permenkes 492/2010	10	10	10

Source: Result of analyses of primary data 2017

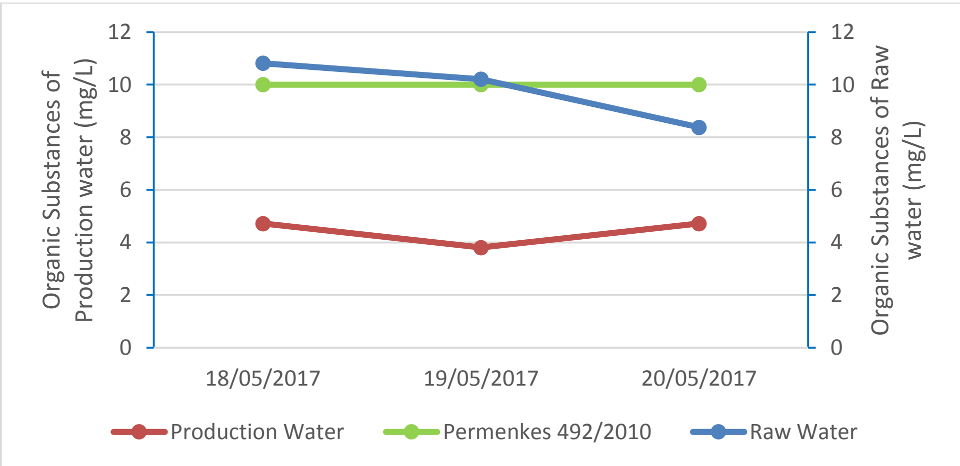

Figure 4.19: Comparison of Organic substances concentration (mg/L) in Ngagel III

From Figure 4.19, same as the previous situation, it is seen that Ngagel III could decrease the concentration of organic substances in raw water during the three days, to become conform in production water. It can be conclude, that Ngagel III, has a good efficiency to remove organic substances.

From this Figure 4.20, it can be seen that Ngagel II (90.8%) and Ngagel III (91.37%) have approximately the same removal efficiency for organic substances during the first day. However, Ngagel I has the lowest removal efficiency (53.51%). During the second day, Ngagel I (65.72 %) is leading compare it to Ngagel III (62.68 %) and Ngagel II (50.73 %) which has the lowest percent for removal efficiency. It is also seen that during the last day, Ngagel II was leading with (58.23%), after Ngagel I (54.53%) and last position for Ngagel III (43.67 %).

Table 4.20: Comparison of Organic substances removal efficiencies (%) between Ngagel I, Ngagel II and Ngagel III

	18/05/2017	19/05/2017	20/05/2017
Efficiency (Ngagel I)	53.51%	65.72%	54.53%
Efficiency (Ngagel II)	53.51%	50.73%	58.23%
Efficiency (Ngagel III)	56.38%	62.68%	43.67%

Source: Results of analyses of Primary data 2017

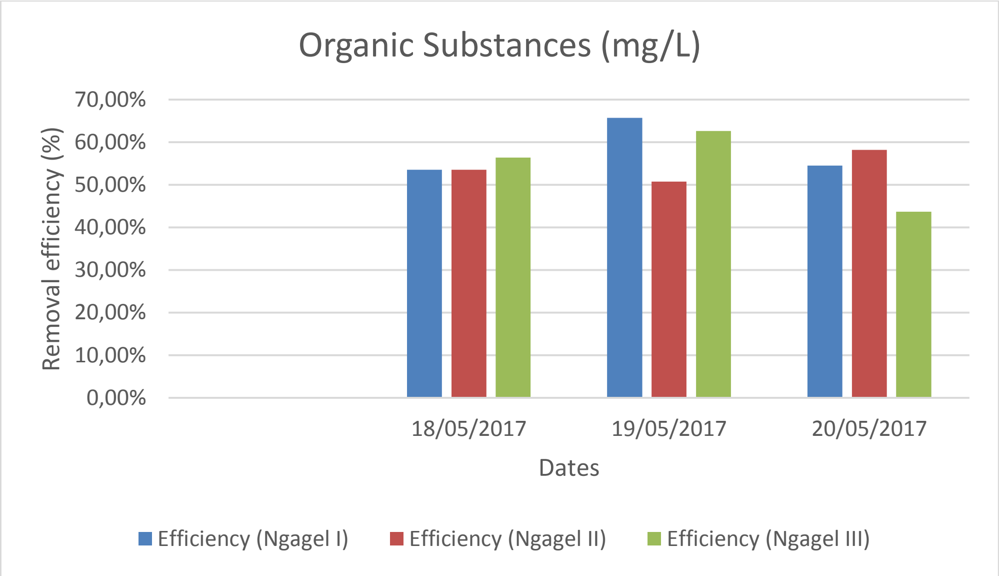

Figure 4.20: Comparison of Organic substances removal efficiencies (%) between Ngagel I, Ngagel II and Ngagel III

C. Ammonia

From this Figure 4.21, it is seen that whatever is the concentration of Ammonia in raw water, Ngagel I is able to remove this concentration in production water. It can be conclude also that Ngagel I has a good removal efficiency during the three days.

Table 4.21: Comparison of Ammonia concentration (mg/L) in Ngagel I

	18/05/2017	19/05/2017	20/05/2017
Raw Water	1.155	1.555	0.459
Production Water	0.333	0.205	0.281
Permenkes 492/2010	1.5	1.5	1.5

Source: Result of analyses of primary data 2017

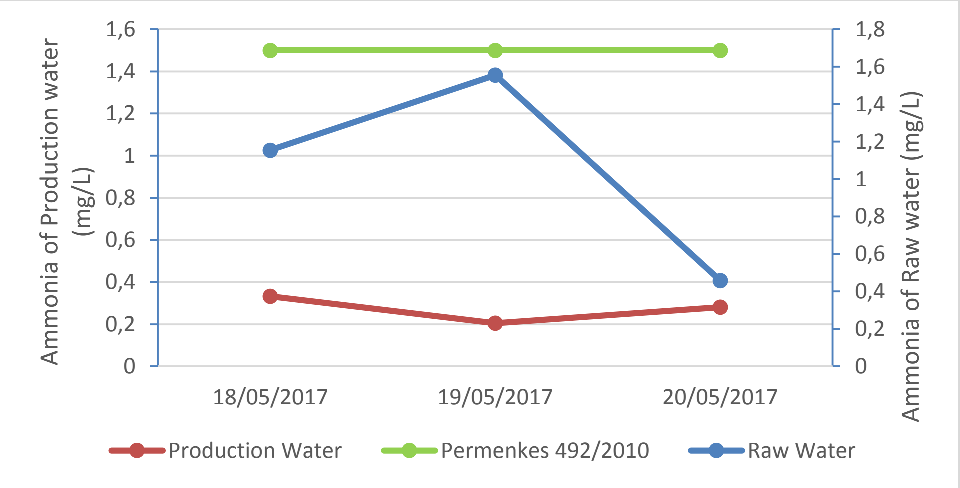

Figure 4.21: Comparison of Ammonia concentration (mg/L) in Ngagel I

From Figure 4.22, it can be seen as the previous Figure that Ngagel II has also a good performance to remove the concentration of Ammonia in production water which become conform to Indonesian standards (492/2010). This concentration decrease from (1.155 mg/L) in raw water to (0.207 mg/L) in production water during the first day. During the second day, the concentration of Ammonia in raw water was (1.555 mg/L) and it becomes (0.113 mg/L) in production water. For the last day, the concentration of Ammonia decrease from (0.459 mg/L) in raw water to (0.17 mg/L) in production water.

Table 4.22: Comparison of Ammonia concentration (mg/L) in Ngagel II

	18/05/2017	19/05/2017	20/05/2017
Raw Water	1.155	1.555	0.459
Production Water	0.207	0.113	0.17
Permenkes 492/2010	1.5	1.5	1.5

Source: Result of analyses of primary data 2017

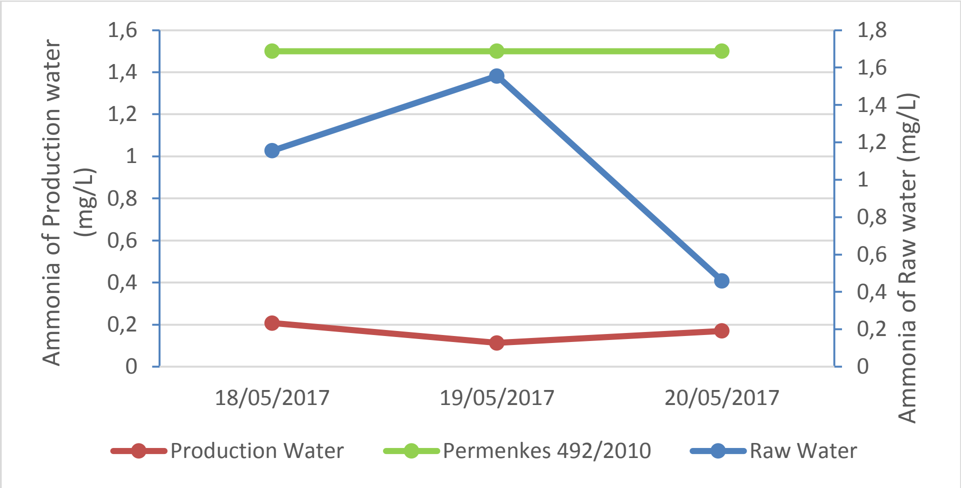

Figure 4.22: Comparison of Ammonia concentration (mg/L) in Ngagel II

From Figure 4.23, it is seen that the concentration of Ammonia in raw water is (1.155 mg/L) in raw water and becomes (0.236 mg/L) in production water during the first day. During the second day, the concentration of Ammonia in raw water decrease from (1.555 mg/L) to (0.161 mg/L) in production water. For the last day, the concentration of Ammonia in raw water is (0.459 mg/L) and becomes (0.311 mg/L) in production water. It can be conclude, that Ngagel III has a good efficiency to remove Ammonia from raw water.

Table 4.23: Comparison of Ammonia concentration (mg/L) in Ngagel III

	18/05/2017	19/05/2017	20/05/2017
Raw Water	1.155	1.555	0.459
Production Water	0.236	0.161	0.311
Permenkes 492/2010	1.5	1.5	1.5

Source: Result of analyses of primary data 2017

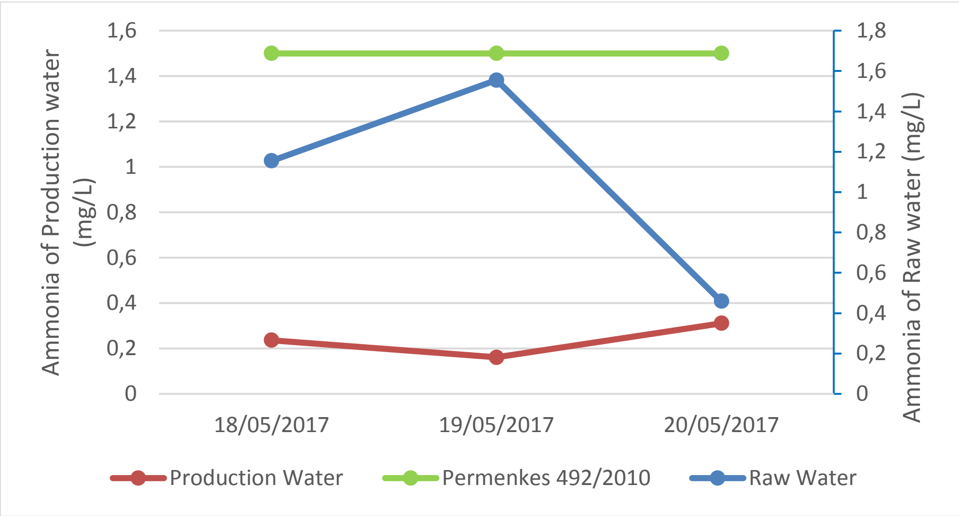

Figure 4.23: Comparison of Ammonia concentration (mg/L) in Ngagel III

From Figure 4.23, it is seen that the concentration of Ammonia in raw water is (1.155 mg/L) in raw water and becomes (0.236 mg/L) in production water during the first day. During the second day, the concentration of Ammonia in raw water decrease from (1.555 mg/L) to (0.161 mg/L) in production water. For the last day, the concentration of Ammonia in raw water is (0.459 mg/L) and becomes (0.311 mg/L) in production water. It can be conclude, that Ngagel III has a good efficiency to remove Ammonia from raw water.

From Figure 4.24, it is seen that during the three days of evaluations, Ngagel II keep leading Ngagel I and Ngagel III for removal efficiency of Ammonia in raw water. Then, Ngagel III was leading Ngagel I during the two first days. In the last day (20/04/2017), Ngagel I has a higher removal efficiency (38.78 %) than Ngagel III (32.24%).

In the previous first part of research, comparison between the efficiencies of different installation of Ngagel (I, II and III) for three parameters (Ammonia, Turbidity and Organic substances) could show the difference of performances in water treatment plants Ngagel. Although, there is small difference of efficiencies between the 3 installations, however WTP Ngagel showed a good performance to remove the three parameters mentioned before. For the second part of research evaluation and comparison of water stability was done, and the results are explained using tables, formulas and figures.

Table 4.24: Comparison of Ammonia removal efficiencies (%) between Ngagel I, Ngagel II and Ngagel III

	18/05/2017	19/05/2017	20/05/2017
Efficiency (Ngagel I)	71.17%	86.82%	38.78%
Efficiency (Ngagel II)	82.08%	92.73%	62.96%
Efficiency (Ngagel III)	79.57%	89.65%	32.24%

Source: Results of analyses of Primary data 2017

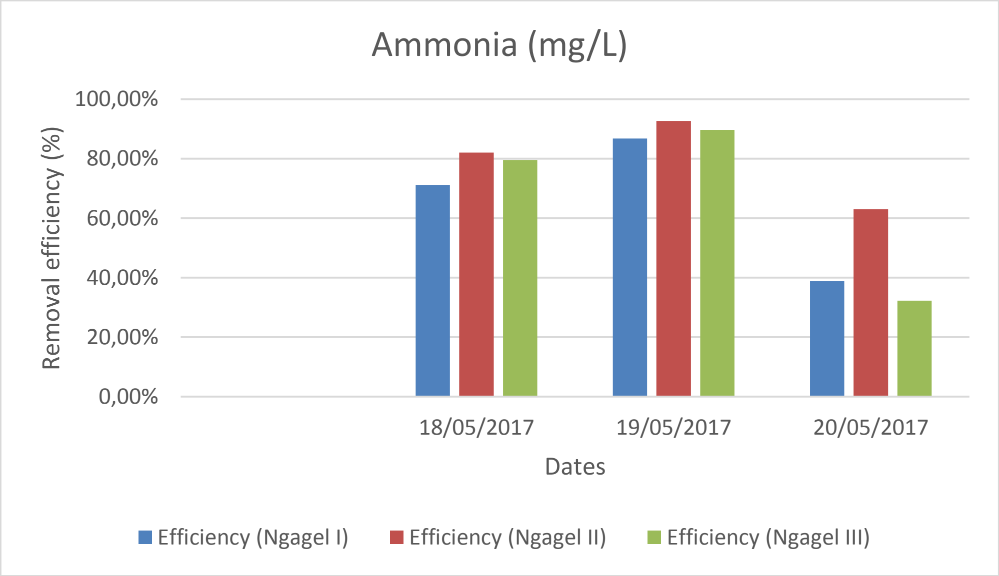

Figure 4.24: Comparison of Ammonia removal efficiencies between Ngagel I, Ngagel II and Ngagel III

4.4.2 Analyses of Water Stability Index

4.4.2.1 Langelier Saturation Index (LSI)

In this part of research, calculation of LSI were done using 5(five) parameters: pH, Temperature, Alkalinity, Calcium Hardness and TDS during 3 days. Then, average of variables were calculated also to get one variable for each parameter (pH, Temperature, Alkalinity and Calcium Hardness).

Table 4.25: Analyses of production water stability for Ngagel I

	Days			Average
	18/05/2017	**19/05/2017**	**20/05/017**	**During 3 days**
pH	7.26	7.18	7.22	7.22
Temperature	26.3	27.5	27.2	27
Alkalinity	142.49	167.89	174.67	161.68
Calcium Hardness	106.7	100.11	120.28	109.03
TDS	220	230	232	227.33

Source: Results of analyses of primary data 2017

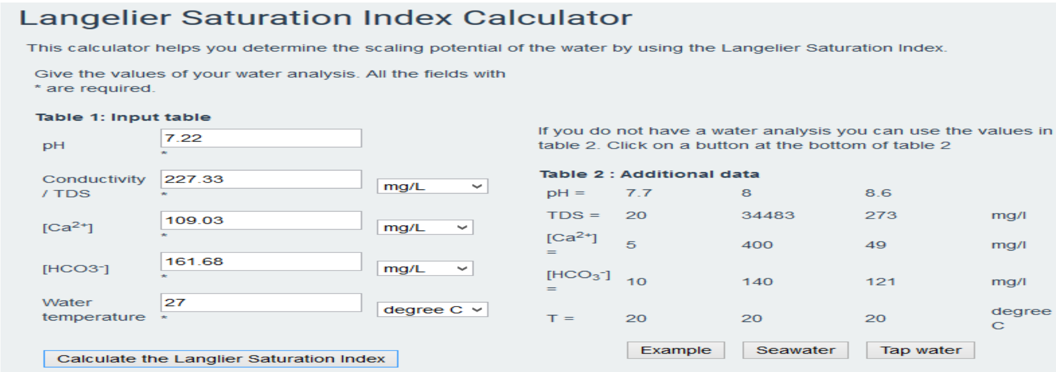

Figure 4.25: Calculation of saturation index (LSI) for Ngagel I

Table 4.26: Analyses of production water stability for Ngagel II

	Days			Average
	18/05/2017	**19/05/2017**	**20/05/017**	**During 3 days**
pH	6.93	6.93	7.01	6.96
Temperature	28.3	27.5	27.4	27.73
Alkalinity	162.74	162.74	174.67	166.72
Calcium Hardness	106.7	116.63	124.16	115.83
TDS	232	230	246	236

Source: Results of analyses of primary data 2017

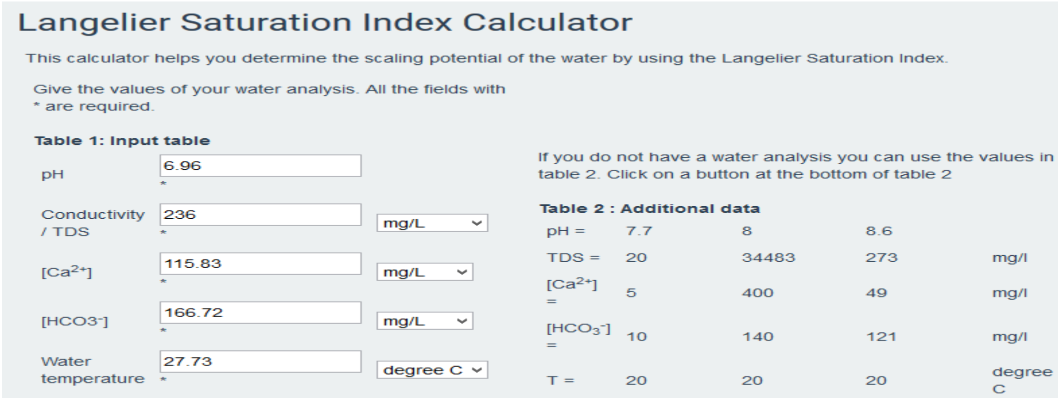

Figure 4.26: calculation of saturation index (LSI) for Ngagel II

Table 4.27: Analyses of production water stability for Ngagel III

	Days			Average
	18/05/2017	**19/05/2017**	**20/05/017**	**During 3 days**
pH	7.31	7.13	7.19	7.21
Temperature	26.1	27.1	27.5	26.9
Alkalinity	152.58	162.81	174.67	163.35
Calcium Hardness	112.69	118.75	124.16	118.53
TDS	224	232	232	229.33

Source: Results of analyses of primary data 2017

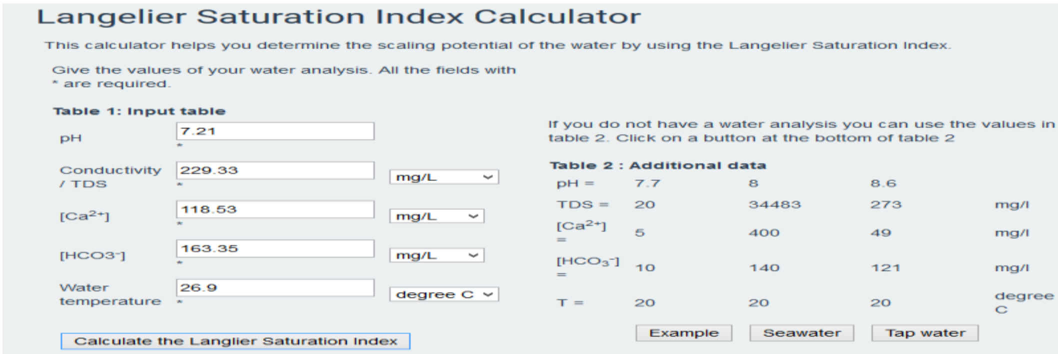

Figure 4.27: calculation of saturation index (LSI) for Ngagel III

Table 4.28: Results of calculation of LSI

	pHs	LSI
Ngagel I	7.3	-0.061
Ngagel II	7.2	-0.27
Ngagel III	7.2	-0.033

Source: Results of calculation of LSI

From table 4.28, and based on Langelier (1936), it is seen that the production water in Ngagel I, has an LSI of -0.061, Ngagel II has an LSI of -0.27 and Ngagel III has an LSI of -0.033. Depending on Langelier (1936), Water of WTP Ngagel I, II and III is undersaturated with respect to calcium carbonate. Undersaturated water has a tendency to remove existing calcium carbonate protective coatings in pipelines and equipment. Based on improved Langelier by Carrier (1965), production water of Ngagel I, II and III is slightly corrosive but non-scale forming.

4.4.2.2 Ryznar Saturation Index (RSI)

RSI also was calculated using the average of 5 parameters: pH, Temperature, Alkalinity, Calcium Hardness and TDS during 3 days of sampling. Below, are the results of calculation related to RSI using the Ryznar Stability Index Calculator, then the interpretation to analyze these results.

Table 4.29: Analyses of production water stability for Ngagel I

	Days			**Average**
	18/05/2017	**19/05/2017**	**20/05/017**	**During 3 days**
pH	7.26	7.18	7.22	7.22
Temperature	26.3	27.5	27.2	27
Alkalinity	142.49	167.89	174.67	161.68
Calcium Hardness	106.7	100.11	120.28	109.03
TDS	220	230	232	227.33

Source: Results of analyses of primary data 2017

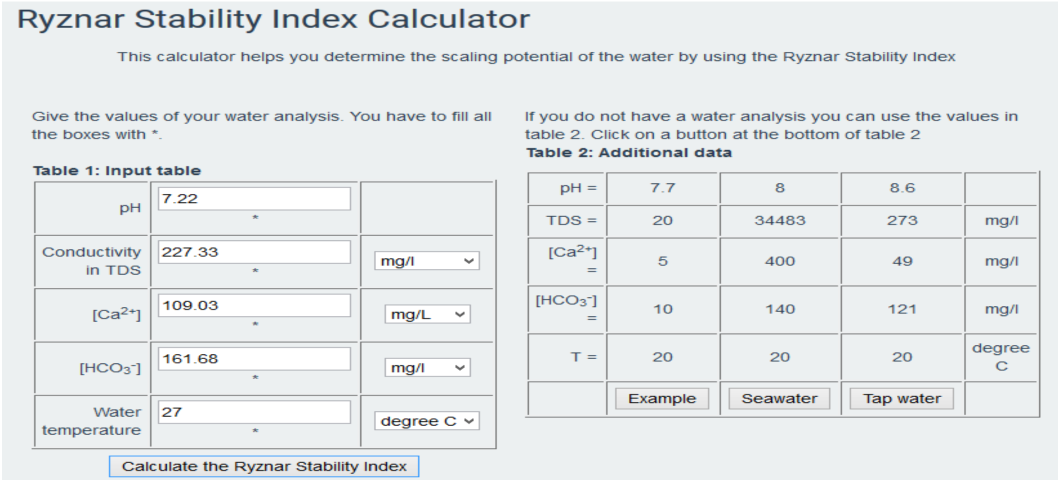

Figure 4.29: Calculation of saturation index (RSI) for Ngagel I

Table 4.30: Analyses of production water stability for Ngagel II

	Days			Average
	18/05/2017	**19/05/2017**	**20/05/017**	**During 3 days**
pH	6.93	6.93	7.01	6.96
Temperature	28.3	27.5	27.4	27.73
Alkalinity	162.74	162.74	174.67	166.72
Calcium Hardness	106.7	116.63	124.16	115.83
TDS	232	230	246	236

Source: Results of analyses of primary data 2017

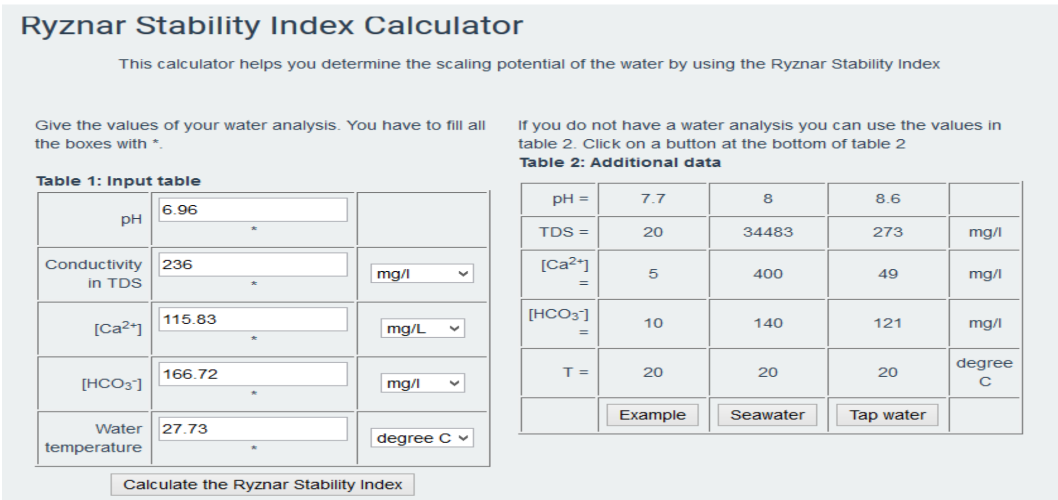

Figure 4.30: Calculation of saturation index (RSI) for Ngagel II

Table 4.31: Analyses of production water stability for Ngagel III

	Days			Average
	18/05/2017	**19/05/2017**	**20/05/017**	**During 3 days**
pH	7.31	7.13	7.19	7.21
Temperature	26.1	27.1	27.5	26.9
Alkalinity	152.58	162.81	174.67	163.35
Calcium Hardness	112.69	118.75	124.16	118.53
TDS	224	232	232	229.33

Source: Results of analyses of primary data 2017

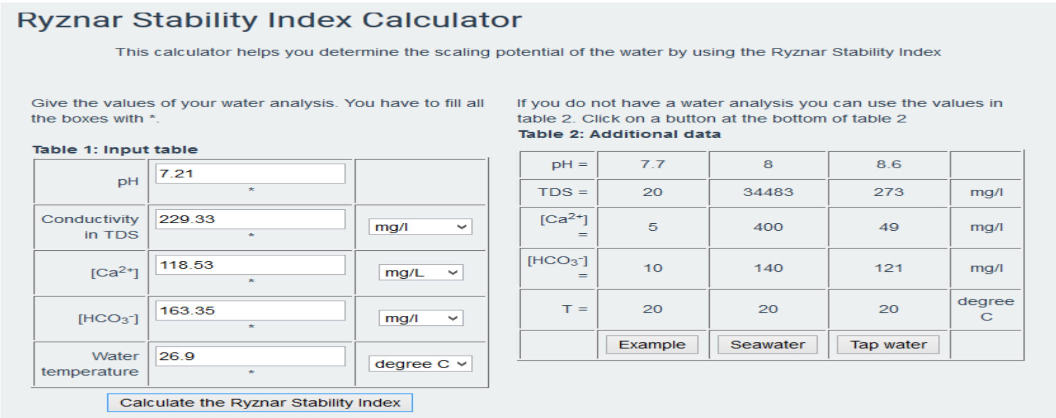

Figure 4.31: Calculation of saturation index (RSI) for Ngagel III

Table 4.28: Results of calculation of LSI

	pHs	**RSI**
Ngagel I	7.3	7.3
Ngagel II	7.3	7.3
Ngagel III	7.2	7.3

Source: Results of calculation of LSI

From table 4.32, the results of calculation of RSI index using Ryznar (1942) for (Ngagel I, Ngagel II and Ngagel III), shows that the water is aggressive.The water can become aggressive after treatment and disinfection with chlorine. The only way to produce a water that is stable (neither scale forming or corrosive) is to adjust the pH between 6.5 and 8.5 (Gebbie et al. 2000). Based on improved Ryznar index by carrier (1965), there is significant corrosion.

CHAPTER 5
CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

Based on the results found in this research, the following conclusions can be noted:

1. From the analyses of the efficiencies related to Ngagel I, II and III, we conclude that PDAM Ngagel has mostly a good efficiency to remove Turbidity, Organic substances and Ammonia from the production water.
2. The calculated stability indices RSI and LSI indicated that the treated water from the plants was corrosive.
3. Adding the caustic soda (or sodium hydroxide) NaOH is a good solution to increase the LSI (LSI=0), which will decrease the degree of corrosion on it.

5.2. Recommendations

Suggestions that can be given based on the results of research conducted are as follows:

1. Langelier Saturation index (LSI) and Ryznar index (RSI) are very important indexes to provide a better quality of water.
2. Using Neutralizing filter can help to decrease the corrosion, then improve the quality of water.
3. Control of water quality in the distribution system seeks to preserve the basic characteristics of water during its conveyance from the point of production and treatment to the consumers tap. The finished water from the treatment plants should be completely stable in its compositional and physical attributes. Several methods could be applied in the treatment plants to produce stable water like pH adjustment (by adding NaOH) or adding corrosion inhibitors.
4. The pretreatment process treats the corrosivity of the water by changing the Saturation Index through an increase or decrease in the pH, hardness, and/or alkalinity.

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APPENDIXES

Appendix 1

Table 1: Monthly parameters for raw water

No	Parameter	Satuan	PP 82/2001	*Bulan*												RATA-RATA
				Januari	Febuari	Maret	April	Mei	Juni	Juli	Agustus	September	Oktober	Nopember	Desember	
1	Suhu	C	Suhu air norma	27.05	26.93	27.20	26.94	27.27	26.79	27.100	27.06	27.514	27.40	27.45	27.25	27.16
2	Kekeruhan	NTU	-	121.83	182.26	182.09	156.48	89.39	75.32	51.745	41.84	44.645	132.72	100.65	185.30	113.69
3	Warna	Pt-Co	-	52.81	51.88	41.82	31.74	54.03	35.43	20.839	23.82	39.421	52.17	64.52	38.09	42.21
4	SS	ppm	50	-	-	-	-	-	-	-	-	-	0.00	-	-	0.00
5	pH		6-8.5	7.41	7.41	7.52	7.56	7.56	7.49	7.597	7.69	7.638	7.57	7.53	7.60	7.55
6	Alkalinitas	ppm CaCO3	-	156.97	147.26	160.00	167.28	179.15	179.09	169.229	178.91	175.265	162.98	167.92	168.54	167.72
7	CO2 Bebas	ppm CO2	-	12.22	11.62	10.18	9.67	9.35	11.62	8.486	7.27	8.565	9.12	10.48	8.54	9.76
8	DO	ppm O2	>4 (min 4)	2.78	2.86	3.26	3.31	2.68	3.28	3.658	3.58	3.010	3.10	3.02	3.11	3.14
9	Nitrit	ppm NO2	0.06	0.14	0.06	0.03	0.07	0.17	0.12	0.090	0.09	0.092	0.08	0.08	0.13	0.10
10	Amonia	ppm NH3-N	-	1.29	0.40	0.28	0.22	0.28	0.32	1.556	0.85	1.450	1.87	1.49	1.30	0.94
11	Tembaga	ppm Cu	0.02	-	-	-	0.32	0.65	0.53	0.666	0.31	0.532	0.00	1.94	0.53	0.61
12	Phospat	ppm PO4	0.2	0.15	0.17	0.11	0.13	0.22	0.23	0.145	0.19	0.252	0.23	0.21	0.17	0.19
13	Sulfida	ppm H2S	0.002	0.29	0.34	0.21	0.20	0.33	0.21	0.151	0.13	0.221	0.39	0.34	0.28	0.26
14	Besi	ppm Fe	-	-	-	-	0.13	0.28	0.17	0.210	0.11	0.138	0.00	0.12	0.27	0.16
15	Krom Heks.	ppm Cr	0.05	0.01	0.01	0.01	0.04	0.06	0.049	0.047	0.03	0.061	0.15	0.06	0.03	0.05
16	Mangan	ppm Mn	-	-	-	-	-	-	-	-	-	-	0.00	-	-	0.00
17	Seng	ppm Zn	0.05	-	-	-	-	-	-	-	-	-	0.00	-	-	0.00
18	Timbal	ppm Pb	0.03	-	-	-	-	-	-	-	-	-	0.00	-	-	0.00
19	COD	ppm O2	25	14.20	15.35	13.35	13.56	14.58	13.45	12.267	14.84	17.143	18.82	15.78	15.80	14.93
20	Detergen	ppm MBAS	0.02	86.30	73.56	72.43	85.04	70.04	73.69	56.257	49.87	48.680	79.11	60.46	61.72	68.10

Source: Secondary data of PDAM 2016

Table 2: Monthly parameters for raw water

No	Parameter	Satuan	PP 82/2001	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Rata-rata
1	DHL	uS/cm	-	520	436.00	466	510.5	547	416	430.000	447	464	472	430	433.00	464.3
2	Kesadahan	mg/L $CaCO_3$	-	203.84	178.24	170.06	198.64	204.48	203.87	221.333	216.83	177.08	146.84	155.05	168.86	187.1
3	Nitrat	mg/L NO_3-N	10	1.263	0.70	0.3909	0.4103	0.9771	1.1017	0.784	1.1034	0.6709	1.0202	1.0496	0.83	0.9
4	Silikat	mg/L SiO_2	-	15.91	15.75	17.095	33.701	33.255	22.456	38.419	41.429	24	29.904	25.759	21.18	26.6
5	Zat Organik **)	mg/L $KMnO_4$	-	16.458	16.87	13.183	16.168	15.693	15.453	13.140	10.605	12.528	22.71	14.76	16.65	15.4
6	BOD	mg/L O_2	2	12	12.00	12.5	12	11.5	11.25	9.667	11.75	11.75	12	12.5	11.25	11.7
7	Kalsium	mg/L $CaCO_3$	-	136.53	146.26	138.03	146.15	136.3	146.26	151.670	149.87	122.33	95.748	114.77	117.08	133.4
8	Magnesium	mg/L Mg	-	16.358	7.77	7.7825	12.758	16.57	14	16.930	16.27	13.303	12.418	9.7875	12.58	13.0
9	Klorida **)	mg/L Cl	600	32.20	24.29	21.513	26.41	30.793	28.9	24.423	26.068	26.533	27.65	23.698	24.74	26.4
10	Sulfat	mg/L SO_4	400	-	42.61	28.645	63.777	62.1	50.67	67.163	45.695	54.818	95.625	72.9	75.66	60.0
11	Fluorida **)	mg/L F	0.5	0.666	0.35	0.6088	0.219	ttd	ttd	0.102	0.4328	0.461	1.567	0.262	0.34	0.5
12	Arsen	mg/L As	0.05	-	-	-	-	-	-	-	-	-	-	-	-	#DIV/0!
13	Kadmium	mg/L Cd	0.01	-	-	-	-	-	-	-	0.0003	0.00	0.00	0.00	0.00	0.0
14	Phenol	mg/L	1	0.278	0.25	0.4048	0.1905	0.3053	0.3355	0.224	0.3693	0.2678	0.2268	0.6035	0.23	0.3
15	Total Coli **)	jml/100 ml	1×10^3	72500	########	221250	131500	313250	163250	########	295750	191000	351500	557500	#######	267917
16	Fecal Coli **)	jml/100 ml	1×10^2	24025	92333.33	32500	42000	45500	36250	########	33250	36333	23225	25000	55500.00	41604

Source: Secondary data of PDAM 2016

Table 3: Monthly parameters of production water for Ngagel I

No	Parameter	Satuan	Permenkes RI	*Bulan*												RATA-RATA
				Januari	Pebruari	Maret	April	Mei	Juni	Juli	Agustus	September	Oktober	Nopember	Desember	
1	Suhu	C	suhu udara+-3C	27.17	27.05	27.22	26.30	26.46	27.03	27.18	26.80	26.52	27.25	27.11	27.18	26.94
2	Kekeruhan	NTU	5	1.37	1.20	1.13	1.26	1.33	1.54	1.12	0.90	0.93	0.87	1.08	1.18	1.16
3	DHL	µmhos/cm	-	538.80	486.10	487.62	514.29	541.40	428.64	414.00	446.64	446.76	480.00	451.18	436.20	472.64
4	pH		6.5 - 8.5	7.30	7.30	7.30	7.33	7.33	7.27	7.38	7.37	7.27	7.16	7.19	7.22	7.28
5	Alkalinitas	ppm CaCO3	-	120.88	115.80	131.03	132.46	137.06	145.58	143.35	158.47	144.25	130.71	135.64	140.35	136.30
6	CO2 Bebas	ppm CO2	-	12.12	11.61	13.38	12.89	13.09	15.65	11.10	13.73	15.51	19.59	17.66	17.47	14.48
7	Zat organik	ppm KMnO4	10	7.75	6.08	5.49	5.30	7.11	5.79	4.81	4.21	4.41	5.84	6.24	6.50	5.79
8	Sulfida	ppm H2S	0.05	0.12	0.07	0.07	0.06	-	-	-	-	#DIV/0!	#REF!	#REF!	#REF!	#DIV/0!
9	Total Coli	org/100 ml	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	Fecal Coli	org/100 ml	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	Khlor Bebas	ppm Cl2	-	0.92	1.04	0.98	0.97	0.94	0.87	0.96	1.08	0.99	0.91	0.79	0.84	0.94
12	Detergen	ppm MBAS	0.05	0.04	0.04	0.03	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.04	0.04	0.04

Source: Secondary data of PDAM 2016

Table 4: Monthly parameters of production water for Ngagel I

No	Parameter	Satuan	permenkes 492	Bulan												Rata-rata
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1	TDS **)	mg/L	1000	259.50	238.00	238.40	260.50	278.00	223	220.000	224.50	228.000	234.00	219.00	214.50	236.4
2	Warna	TCU	15	9.75	5.80	6.20	6.00	7.00	6.250	4.667	2.50	3.500	4.50	4.75	4.25	5.4
3	DO **)	ppm 0_2	-	6.02	5.89	6.02	6.46	6.04	6.580	6.480	6.21	6.693	6.78	6.35	6.71	6.353
4	Amonia	ppm NH_3	1,5	0.19	0.07	0.09	0.09	0.06	0.056	0.134	0.06	0.096	0.18	0.14	0.08	0.1046
5	Nitrit **)	ppm NO_2	3	ttd	ttd	ttd	ttd	0.01	0.009	ttd	0.01	0.011	0.00	< 0.0079	< 0.0079	0.0073
6	Nitrat	ppm NO_3	50	4.85	4.04	3.59	3.39	5.86	5.361	4.263	5.88	3.735	3.68	3.22	3.35	4.2684
7	Fosfat	ppm PO_4	-	0.15	0.15	0.26	0.07	0.21	0.131	0.032	0.34	0.403	0.24	0.12	0.09	0.1827
8	Silikat	ppm SiO_2	-	10.40	10.86	16.24	24.79	33.89	19.356	38.857	40.64	25.641	27.72	20.93	20.51	24.152
9	Kalsium **)	ppm $CaCO_3$	-	131.24	132.58	134.22	141.48	132.41	142.643	151.640	161.60	123.218	110.75	113.87	118.29	132.8277
10	Magnesium **)	ppm Mg	-	142.00	9.51	6.10	12.16	14.58	13.850	16.217	14.75	14.313	11.20	13.77	11.04	23.2906
11	Klorida **)	ppm Cl	250	31.93	24.59	22.73	27.50	33.84	27.523	26.847	28.61	26.240	28.21	26.57	27.05	27.635
12	Sulfat **)	ppm SO_4	250	-	49.66	36.15	77.23	69.83	72.825	70.400	49.93	66.475	108.15	87.85	95.75	71.2948
13	Fluorida **)	ppm F	1.5	0.65	0.32	0.36	0.13	ttd	0.280	ttd	0.44	0.192	1.84	0.68	0.37	0.5270
14	Arsen	ppm As	0.05	-	-	-	-	-	-	-	-	0.000	0.00	-	-	0.00
15	Besi **)	ppm Fe	0.3	-	-	-	ttd	ttd	0.109	0.059	0.05	0.209	0.00	0.06	< 0.0551	0.08
16	Aluminium	ppm Al	0.2	0.39	-	-	-	-	-	-	0.48	0.296	0.20	0.19	0.12	0.28
17	Krom **)	ppm Cr	0.05	ttd	ttd	ttd	0.01	-	0.009	0.016	0.01	0.026	0.01	0.01	< 0.0009	0.01
18	Kadmium	ppm Cd	0.003	ttd	-	-	-	-	-	-	0.00	< 0.000328	< 0.000322	<0.000329	<0.000301	0.000
19	Mangan	ppm Mn	0.1	ttd	-	-	-	-	-	-	0.01	< 0.013449	<0.012623	<0.013762	<0.03502	0.01
20	Seng	ppm Zn	3	0.02	-	-	-	-	-	-	0.00	< 0.000423	0.04	0.00	0.09	0.03
21	Tembaga	ppm Cu	2	ttd	-	-	0.15	0.18	0.183	0.124	0.11	< 0.114	0.00	0.15	< 0.114	0.13
22	Timbal	ppm Pb	0.05	0.01	-	-	-	0.00	-	-	0.00	0.000	0.00	<0.00479	<0.005200	0.003

Source: Secondary data 2016

Table 5: Monthly parameters of production water for Ngagel II

No	Parameter	Satuan	Permenkes RI	*Bulan*												RATA-RATA
				Januari	Pebruari	Maret	April	Mei	Juni	Juli	Agustus	September	Oktober	Nopember	Desember	
1	Suhu	C	suhu udara+-3C	27.10	27.11	27.06	26.03	26.42	26.80	27.05	26.58	27.40	27.38	26.85	27.22	26.91
2	Kekeruhan	NTU	5	0.88	0.86	0.74	0.72	0.79	0.80	0.75	0.78	0.90	0.76	0.89	0.77	0.80
3	DHL	µmhos/cm	-	548.20	480.50	487.43	525.24	545.00	430.23	413.50	449.18	453.81	481.14	448.73	439.50	475.20
4	pH		6.5 - 8.5	7.30	7.30	7.26	7.24	7.27	7.14	7.14	7.19	7.19	6.98	6.97	6.97	7.16
5	Alkalinitas	ppm CaCO3	-	132.34	121.98	131.51	142.49	148.08	153.32	148.36	153.10	144.14	140.03	143.64	139.76	141.56
6	CO2 Bebas	ppm CO2	-	13.26	12.23	13.81	15.32	15.55	22.79	19.73	19.23	18.55	32.07	31.55	34.17	20.69
7	Zat organik	ppm KMnO4	10	7.72	5.98	5.56	5.77	6.84	6.06	4.85	4.05	4.30	6.01	6.82	6.58	5.88
8	Sulfida	ppm H2S	0.05	0.08	0.07	0.07	0.08	-	-	-	-	#DIV/0!	#REF!	#REF!	#REF!	#DIV/0!
9	Total Coli	org/100 ml	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	Fecal Coli	org/100 ml	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	Khlor Bebas	ppm Cl2	-	0.81	0.95	0.91	0.78	0.91	1.09	1.11	0.87	0.77	0.85	0.74	0.74	0.88
12	Detergen	ppm MBAS	0.05	0.04	0.03	0.09	0.04	0.03	0.04	0.03	0.03	0.03	0.02	0.03	0.04	0.04

Source: Secondary data PDAM 2016

Table 6: Monthly parameters of production water for Ngagel II

No	Parameter	Satuan	permenkes 492	Bulan												Rata-rata
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1	TDS **)	mg/L	1000	265.75	232.20	242.00	260.00	281.50	223.500	221.333	228.00	237.000	233.50	219.00	216.50	238.357
2	Warna	TCU	15	7.25	5.40	4.60	7.50	6.75	5.000	5.000	4.25	4.250	4.50	5.00	4.00	5.292
3	DO **)	ppm 0_2	-	5.79	5.95	6.28	6.68	5.97	6.530	6.347	5.95	6.163	6.23	6.11	5.99	6.165
4	Amonia	ppm NH_3	1,5	0.07	0.08	0.12	0.11	0.06	0.042	0.077	0.02	0.217	0.20	0.15	0.05	0.100
5	Nitrit **)	ppm NO_2	3	ttd	ttd	ttd	ttd	0.01	ttd	ttd	0.01	0.000	0.00	< 0.0079	< 0.0079	0.005
6	Nitrat	ppm NO_3	50	5.17	3.05	2.20	2.19	4.24	6.629	3.634	5.98	3.354	3.99	4.39	4.48	4.110
7	Fosfat	ppm PO_4	-	0.13	0.32	0.07	0.08	0.14	0.155	0.094	0.45	0.368	0.33	0.18	0.06	0.199
8	Silikat	ppm SiO_2	-	9.30	11.56	16.17	26.38	34.60	16.814	31.584	41.26	26.763	29.48	19.81	16.83	23.380
9	Kalsium **)	ppm $CaCO_3$	-	136.07	136.75	120.73	141.39	140.01	139.940	146.777	151.65	114.110	102.04	106.49	104.14	128.340
10	Magnesium **)	ppm Mg	-	16.33	11.36	11.46	12.74	14.71	13.078	15.237	19.02	15.273	13.44	15.25	16.75	14.553
11	Klorida **)	ppm Cl	250	32.02	25.44	21.58	25.80	31.48	28.095	27.673	28.00	25.755	28.27	26.14	26.20	27.204
12	Sulfat **)	ppm SO_4	250	-	50.46	30.79	73.47	64.58	65.600	69.300	54.38	68.425	93.25	79.23	95.00	67.679
13	Fluorida **)	ppm F	1.5	1.60	0.30	0.46	0.38	ttd	0.448	ttd	0.32	0.662	1.15	1.41	0.91	0.763
14	Arsen	ppm As	0.05	-	-	-	-	-	-	-	0.00	0.000	0.00	-	-	0.000
15	Besi **)	ppm Fe	0.3	-	-	-	0.15	ttd	0.064	0.173	0.04	0.084	0.00	< 0.0551	< 0.0551	0.087
16	Aluminium	ppm Al	0.2	0.17	-	-	-	-	-	-	0.31	0.275	0.19	0.19	0.09	0.205
17	Krom **)	ppm Cr	0.05	ttd	ttd	ttd	0.02	-	0.008	0.013	0.01	0.021	0.01	0.01	< 0.0009	0.012
18	Kadmium	ppm Cd	0.003	0.00	-	-	-	-	-	-	0.00	0.000	0.00	<0.000329	<0.000301	0.000
19	Mangan	ppm Mn	0.1	ttd	-	-	-	-	-	-	0.08	0.000	0.00	<0.013762	<0.03502	0.025
20	Seng	ppm Zn	3	0.01	-	-	-	-	-	-	0.01	< 0.000423	0.01	0.03	0.00	0.011
21	Tembaga	ppm Cu	2	ttd	-	-	0.15	0.15	0.183	0.124	0.11	< 0.114	< 0.114	< 0.114	< 0.114	0.144
22	Timbal	ppm Pb	0.05	0.01	-	-	-	-	-	-	0.00	0.000	0.00	< 0.004799	<0.005200	0.003

Source: Secondary data of PDAM 2016

Table 7: Monthly parameters of production water for Ngagel III

No	Parameter	Satuan	Permenkes RI	*Bulan*												RATA-RATA
				Januari	Pebruari	Maret	April	Mei	Juni	Juli	Agustus	September	Oktober	Nopember	Desember	
1	Suhu	C	suhu udara+-3C	27.19	27.11	27.16	26.61	26.92	26.92	27.24	26.91	27.40	27.20	27.23	27.31	27.10
2	Kekeruhan	NTU	5	0.55	0.48	0.53	0.66	0.83	0.68	0.70	0.75	0.79	0.65	0.64	0.59	0.65
3	DHL	µmhos/cm	-	540.60	485.68	481.33	513.14	530.40	421.09	411.50	447.64	446.38	475.24	448.91	439.80	470.14
4	pH		6.5 - 8.5	7.30	7.29	7.26	7.22	7.29	7.16	7.21	7.30	7.24	7.05	6.98	6.99	7.19
5	Alkalinitas	ppm CaCO3	-	128.70	121.01	129.11	139.14	151.13	149.25	144.12	153.45	145.89	134.98	137.91	139.63	139.53
6	CO2 Bebas	ppm CO2	-	13.03	12.36	14.08	15.73	15.49	21.05	17.21	15.22	17.58	27.15	28.32	29.74	18.91
7	Zat organik	ppm KMnO4	10	6.37	4.92	4.19	4.58	6.54	5.41	4.62	3.82	3.98	5.54	5.68	5.69	5.11
8	Sulfida	ppm H2S	0.05	0.07	0.05	0.05	0.06	-	-	-	-	#DIV/0!	#REF!	#REF!	#REF!	#DIV/0!
9	Total Coli	org/100 ml	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	Fecal Coli	org/100 ml	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	Khlor Bebas	ppm Cl2	-	0.90	0.91	0.96	0.85	0.80	0.91	0.94	0.89	0.74	0.78	0.77	0.75	0.85
12	Detergen	ppm MBAS	0.05	0.04	0.04	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.02	0.04	0.04	0.03

Source: Secondary data of PDAM 2016

Table 8: Monthly data of production water for Ngagel III

No	Parameter	Satuan	permenkes 492	Bulan												Rata-rata
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1	TDS **)	mg/L	1000	259.500	238.000	237.600	258.250	275.500	217.500	217.333	220	230.500	229.00	218.50	213.00	234.557
2	Warna	TCU	15	6.750	3.600	4.000	4.750	5.750	4.250	4.333	3.00	4.000	5.50	3.50	4.00	4.453
3	DO **)	ppm O_2	-	3.718	4.366	5.030	5.725	4.053	4.680	4.583	3.98	5.018	4.57	5.26	4.52	4.624
4	Amonia	ppm NH_3	1,5	0.051	0.043	0.077	0.161	0.042	0.031	0.101	0.00	0.119	0.19	0.11	0.02	0.078
5	Nitrit **)	ppm NO_2	3	ttd	ttd	ttd	ttd	ttd	ttd	ttd	0.01	0.000	0.00	< 0.0079	< 0.0079	0.003
6	Nitrat	ppm NO_3	50	4.735	2.386	1.078	3.019	5.586	6.703	4.361	6.28	4.332	5.02	4.37	5.56	4.453
7	Fosfat	ppm PO_4	-	0.118	0.164	0.123	0.043	0.169	0.075	0.099	0.28	0.390	0.06	0.68	0.17	0.198
8	Silikat	ppm SiO_2	-	9.898	11.880	17.625	36.791	35.232	18.346	38.386	40.85	28.909	23.28	19.03	18.85	24.924
9	Kalsium **)	ppm $CaCO_3$	-	128.725	128.990	125.486	149.790	135.635	135.063	139.847	155.49	109.970	116.64	111.50	115.07	129.350
10	Magnesium **)	ppm Mg	-	18.720	12.926	9.498	9.333	16.448	14.480	15.603	18.54	16.488	8.28	12.74	13.04	13.841
11	Klorida **)	ppm Cl	250	31.558	25.250	22.992	27.113	32.555	29.495	27.283	26.62	26.098	28.31	25.53	26.03	27.403
12	Sulfat **)	ppm SO_4	250	-	54.000	41.100	80.700	64.175	62.220	65.200	50.18	60.125	92.98	77.75	95.33	67.613
13	Fluorida **)	ppm F	1.5	0.743	0.346	0.487	0.267	ttd	0.750	0.096	0.57	0.925	1.47	0.37	0.19	0.564
14	Arsen	ppm As	0.05	-	-	-	-	-	-	-	0.00	0.000	0.00	-	-	0.000
15	Besi **)	ppm Fe	0.3	-	-	-	ttd	ttd	0.049	ttd	0.06	0.084	0.00	< 0.0551	0.25	0.087
16	Aluminium	ppm Al	0.2	0.117	-	-	-	-	-	-	0.31	0.182	0.13	0.12	0.11	0.160
17	Krom **)	ppm Cr	0.05	ttd	ttd	ttd	0.010	-	0.004	0.008	0.01	0.016	0.01	0.00	< 0.0009	0.008
18	Kadmium	ppm Cd	0.003	ttd	-	-	-	-	-	-	0.00	0.000	0.00	< 0.000317	<0.000301	0.000
19	Mangan	ppm Mn	0.1	ttd	-	-	-	-	-	-	0.03	0.000	0.00	< 0.013762	<0.03502	0.009
20	Seng	ppm Zn	3	0.018	-	-	-	-	-	-	0.02	< 0.000423	0.00	0.00	< 0.000489	0.010
21	Tembaga	ppm Cu	2	ttd	-	-	0.097	0.071	0.097	0.150	0.11	< 0.114	0.00	< 0.114	< 0.114	0.088
22	Timbal	ppm Pb	0.05	ttd	-	-	-	-	-	-	0.00	< 0.004395	<0.004497	< 0.004825	<0.005200	0.005

Source: Secondary data of PDAM 2016

BIOGRAFY

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Industrial Waste Water Treatment

Operations and Water Treatment Processes

System Analysis and Optimization

Improvement of Paint Industrial processes

Thesis:

AN OVERVIEW OF NGAGEL WATER TREATMENT PLANTS OPERATIONS IN TERMS OF WATER QUALITY EFFICIENCY AND WATER STABILITY

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Bio Note:

Mehdi Lassoued is a Master's student at Institut Teknologi Sepuluh Nopember, Surabaya, Indonesia, studying Envionmental Engineering. Mehdi, over his time has conducted research on improving the formulas of paints in Astral paint industry in Tunisia, by making new ecologic paint. Then, learned about the process to make and analyse different parameters of paint poducts. Mehdi, has conducted new research in his master research program, related to ***'An overview of Ngagel water treatment plants operations in terms of water quality efficiency and water stability'***. In 2012, Mehdi received Bachelor of Environmental Physics and Chemistry, from Higher Institut of Sciences and Technologies of Environment in Tunisia. His undergraduate departmental dissertation was on 'Evaluation and Diminution of Volatil Organic Coumpounds in Astral paint- Tunisia by manufacturing a new ecologic paint'.

Mehdi Lassoued has gained experience and can provide planning and technical support on issues related to manufacturing and controlling the quality of paint products. Also, learnt to manage and control the quality of drinking water in water treatment plants, then suggest solutions to improve it.