International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 11, November - 2017

Optimazation of Desalination Plant of Distilled Water Production At Pt Pln (Persero), Belawan Electric Generator Sector

Arsamsyah Putra [1], Harmein Nasution[2], and Listiani Nurul Huda[2]
[1]Student of Industrial Engineering Department, University of Sumatera Utara, Indonesia
[2] Departement of Industrial Engineering, University of Sumatera Utara, Indonesia

Abstract **- PT PLN (Persero) (Indonesian government owned corporation which has a monopoly on electricity distribution in Indonesia), Belawan Electric Generator Sector in Northern Part of Sumatera located on Naga Putri Island is a PLTU (Steam Power Generation) amd a PLTGU (Gas/Steam power Generation). The research problem is the sedimentation in the evaporation room of the Desalination Plant which makes the water production not optimum. It requires an improvement design for the sedimentation basin in order to optimize the distilled water production at the Distillation Desalination Plant in PT PLN (Persero), Belawan Electric Generator. The objective of the research is to design the production improvement that enables PT PLN (Persero), Belawan Electric Generator to optimize its distilled water production.** ***Desalination Plant*** **us a tank for sea water desalination; a process that produces fresh water from distilled sea water by maximum 24 hour-evaporation. Action research is employed in this research which is completed by the Bisection optimization method with operational research basis. Optimization parameter for the mud sedimentation debit in the Desalination Plant using Bisection Method resulted in x= 0,929113 as the optimum solution with high conscientiousness. The results of Bisection method on seven iterations showed that the low water production was caused by mud sedimentation and water which were filtered simultaneously, so that it interrupted the desalination process. More mud was sedimented in the evaporation room with less wastewatervolume. The mud sedimentation had impeded desalination plant operation indicated by the clogged material filter, mud blocking water flow so that the mud, garbage and other wastes created clog. The production of distilled water decreased as the mud sedimented. Sedimentation tank was made of concrete in rectangular and circular shape. The rectangular shaped tank is made for water processing installation with big capacity of 100 m length, 15 width and 5 m depth. The circular shaped tank is made for for water processing installation with small capacity of 50 m diameter, and 5 m depth. The circular shaped tank is designed with horizontal water flow heading to radial to the edge of the waterways or vertically. Holistically, the function of sedimentation unit, processing installation of the Desalination Plant is to reduce the workload of filtration unit, to endure the economic age of filtration unit, and to reduce the operational budget of the processing installation.**

Keywords: Sedimentation, Design, Optimization

1. INTRODUCTION

Desalination Plant is a facility for sea water distillation to become destillation water. It operates continuously in 24 hours every day. Desalination is intended to remove salt/salinity from the sea water. It is an effective way to produce clean water from small solids. In the process of desalination, generally only condensate water is taken, while salt concentrate is removed. However, this desalination process can have bad impact on marine life (Ketut, et. al., 2011).

PT. PLN (Persero), Belawan Power Plant Sector, Northern Part of Sumatera, is located on Naga Putri Island. It is a PLTU (Steam Powered Electric Generator) and PLTGU (Steam and Gas Powered Electeric Generator). Steam powered electric generator needs deep wheel by using deep wheel pumps. Constructing PLTGU needs more undistilled water. Since it has not been sufficient, desalination plant has to be constructed. The PLTGU was built in 1996. Water from the sea and rivers is pumped (transferred pumps) and put into the sedimentation basin.

Water from the sea and rivers is pumped (transferred pumps) and put into the *Desalination Plant*. Undistilled mud which is mixed with water flow enters the tubes so that it disturbs the process of heat transfer and will eventually settle in the evaporator of desalination plant before it is pumped out (to thesea or the river) The steam which evaporates in the evaporator will condense or will be condensated in the tubes which takews its position on the upper part with water in the lower part. The result is that the condensed vapor or water is accumulated in the available gutter and flows to the side of the suction pipes to be transferred to Destilation Water Tank and some of it is flowed to the Fire Hydrant through the valve which is arranged manually to the Water Service Tank for daily needs. The other factors which influence the process of sedimentation are overflow rate, vhorizontal (vh), particle Reynold numeral, and the flow characteristic. The flow characteristic is known from Reynolds and Frounder numeral, but these two numerals cannot be fulifilled by both of them so that a reference is needed.

In this research, the use of operational research in the field of production operation needed to be done, related to stabilize the path with various kinds of operation; in other words, by optimizing it (Aminuddin, 2005). The result of literature study showed that an accurate reference for designing rectangular pre-sedimentation vessel is by using Frouder numeral, while an accurate reference for designing circular pre-sedimentation vessel with center feed type is by using Reynolds numeral. Undistilled water provided by nature comes from the land surface water, ground water, and sea water. One of the types of land surface water used by many people in Indonesia is river water since there are a lot of big rivers in Indonesia which can be used as distilled water for drinking. However, fluctuating condition of the rivers had caused distilled water which comes from the rivers sometimes has high suspended solid concentration.

The shape of pre-sedimentation vessels can influence the characteristics of the flow; therefore, their shape should be prioritized in designing pre-sedimentation. Besides its shape, the ratio between the width and the depth also plays an important role in determining the characteristics of the flow because the formula of Reynolds and Froude numeral calculation contains hydrolic R spokes as its function. Hydraulic spokes are related to the area of wet surface A and wet circle P which act as the function of width and depth so that the ratio between the width and the depth will also influence the characteristics of the flow.

Table 1. Data of Distillation Water Normal Production

Tahun	2005	2006	2007	2008	2009	Total Produksi
Produksi Normal	186000	186000	186000	186000	186000	930000

(Source : Data from Operation Dept. of PT PLN Pembangkit Belawan, 2009)

Based on Table 1 and Table 2 above, it was found that the condition of disttillation water production decreased which caused the loss in production, especially the going on electric energy even though clean water production was hampered. The data of distillation water production desribed the decrease in water production within 5 years (in 2010, 2011, 2012, 2013, and 2014 respectively. In the first and second year (2010 and 2011), the production increased to 14.592 tons; from the third year to the fourth year (2012 to 2013), the production decreased to 56.280 tons; from the fourth year to the fith year (2013 to 2014) the production decreased to 22.592 tons.

Desalination Plant is a water distillation machine with the capacity of 15,500 tons/month (30 days), in the neighborhood of 500/day, or producing 20.80 tons/hour. The data of the processing showed that there was no mud sedimentation. Desalination is the process of removing salt/salty from sea water. Here, the writer attempted to cope with the problem of this mud sedimentation by optimizing water production using operational research-based Newton method. The optimization was non-linear if the function of its purpose and obstacles had non-linear form in one or both of them. Linear optimization which did not match with single variable was one of the problems with non-linear optimization. In the beginning, Newton method was

One of the factors which cause Desalination Plant production to decrease is that a large amount of mud in the sedimentation basin is not precipitated properly so that hard mud filtered materials, stopper, and mud filter materials are damaged by high pump pressure. The flow of water becomes obstructed by mud; sometimes garbage like grass or other dirt flow with the water, and the mud in the ervaporator is accumulated. Sedimented mud mixed with water obstructs the process of heat transfer in the side of brine heater so that heating is not in accordance with what has been expected. The result of data processing within five years (from 2010 until 2014) showed significant decrease in the amount of destilation water production which would eventually decrase the company's performance. The decrease in distillation water production was from 20.81 tons/hour (normal) to 13 tons/hour, while the need for the water for Gas and Steam Powered Electric Generator was 15 tons/hour. Devicit in the use ofwater was 7 tons/hour. The distillation water production could be seen clearly in Table 1 annd Table 2 below.

Tabel 2 Data of the Decrease in Distillation Water Production (ton/year)

Tahun	2010	2011	2012	2013	2014	Total Produksi
Produksi	43512	58104	107856	51576	28980	290028

(Source : Data from Operation Dept. of PT PLN Pembangkit Belawan, 2009)

used to find the root of a real function. In its development, Newton method had had a lot of advancement because it could be modified to solve other related problems.Algorithmic modification of Newton method was used to find the hampered non-linear optimal points.

2. RESEARCH METHOD

The research was conducted in the Distillation Water Production Department of Desalination Plant of PT PLN (Persero), Belawan Generator Sector which is one of the Government-owned Desalination Plants located in Naga Putri Island, Belawann, North Sumatera. The data have been gathered from 2014 until today. They were about mud sedimentation concentration with the river rate of flow in 2015.

This was in accordance with the research done by Aminuddin [1] which affirmed the operation research principles which was connected with the process of sea water desalination. Sea water desalination process is process of producing fresh water from sea water by evaporating it (Koester, 2002:17). Asdak [2] pointed out that sea water was heated by a heating devices - steam from a boiler. The hot steam which comes from the boiler was then cooled again so that it turned to fresh water at as certain conductivity value. His concept was again

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 11, November - 2017

reaffirmed Wormleaton [3] who pointed out in lower pressure, water would be boiling and evaporate below 100ºC. According to the research done by Chow [4], multistage flash evaporator shoud be emptied in order to get maximal distillation water. Liebermann [5] points out that operation research is closely related to the implementaion of desalination system.

Liebermann [6] emphasized that an operational research is one of the practical appied sciences that is always needed in the civilization, concerning optimization problem, i.e. which objective is to maximize or minimize something. Optimization of decision making is based on quantitative analysis. Hudson[7] stated that there are many quantitative analysis methods that can be employed, from simple to complex ones. According to Evans [8], water desalination system is required in power plant. In addition to its function as water cooler in a condenser, it can also be used for own needs (Karnaningroem [9]).

Kohler [10] underlined that generator system consists of many components and one of them is the desalination plant. Product of desalination process is usually water with salinated salt less than 500 mg/l, which can be used for domestic, industrial and agricultural needs (Masduki [11], Mulyani, [12]). Distillation is the oldest and most commonly used desalination method {Mulyono [13]). Noel [14], Howard [15], highlighted that an economical desalination of sea water becomes more iimportant because of the higher demand of drinking water due to the decreasing fresh water supply.

The research done by Reynolds [16], concludes that desalination process involves three liquid flows; namely, salty water as the bait (such as sea water), low salinity product, and highly salinated concentrate. Rao [17], supports this research by desalination technique. The most common desalination technique includes membrane (reverse osmosis, RO, electrodialysis, ED) and evaporation (multi-stage flash, MSF; multieffect distillation, MED; mechanical vapor compression, MVC).

Distillation is a method of separation by heating sea water until it produces steam, which is then condensed to produce clean water (Rochana [18], 1977:4). Sea water desalination has operational pressure between 800 and 1000 psi (Gregorio [19]). According to Soewarno [20], the lowest distillation speed was found in the distillatory with a heating tank without baffle which was added by 2ml/2hour charcoal grains. According to the research conducted by Ozaki [21], distillation speed is much influenced by the sun light intensity. Oxtoby [22], states that high intensity of sun will increase the water temperature in the heating container. The research by Tchobanoglous [23], describes that desalination using evaporation method is the transformation of liquid substance into steam at come points below the boiling temperature. Evaporation takes place because there is heat energy that deals with cohesion among the molecules close to the liquid surface.

With an assumption that the sediment concentration is even, its debit is calculated as the results of concentrate multiplied by water debit which is formulated as follows:

$$Qs = 0{,}0864 \times C \times Q$$

In which:

Qs = sediment debit (ton/day)

C = sediment consentration

Q = river debit (m^3/second)

Explorative descriptive method was applied in this research and observation was used to collect the data i.e. carrying out field observation to the data concerning the research object.

Interview method was used by having direct interviews with the company regarding the business scope, organization and management, productional process and so on related to the research object. The objective of the research stages was to prevent fatal mistakes in the research. These stages are mutually related and systematic.

Based on the preliminary observation earlier, it could be determined that the reduction of mud sedimented in the Desalinatedn Plant required optimization of water debit and the kind of water that enters the desalination evaporation room. Therefore, an improvement is needed to iptimize the Distilled water production from the Desalination Plant through mud sedmentation tank design using optimal water debut and kind of water The following Figure 1 is the conceptual framework of this research:

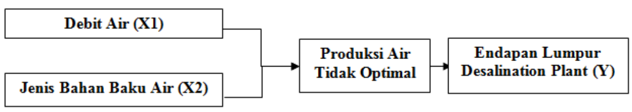


Figure 1. Conceptual Framework

Water debit (X1) is the amount of water during the production process and produces desalinated freshwater as an output. The kind of the water raw material (X2) is the lind of water during the distillation process. The mud sedimentation in the Desalination Plant is the mixture of water and sedimented mud in the pevious period that has hardened and become sedimented stone.

This is an action research. An action research is a research done to obtain practical invention and for the operational decision making (Sinulingga,2011). The objective of the research was to develop new skills or approaches in order to improve the distilled water production at PT PLN (Persero), belawan Electrice Generator.

3. RESEARCH RESULTS AND DISCUSSIONS

The data needed were water volume as the raw material (X1) and kind of water (X2). However, the water volume (X1) is considered constant, does not influence the process. Whereas the kind of the water (X2) is influenced by river debit and concentrentrate or sediment size. Table 3 illustrates the data of the Mud Sedimentation Debit in Desalination Plant of PT. PLN (Persero), Belawan Elecrtic Distribution

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 11, November - 2017

Tab the Mud Sedimentation Debit in Desalination Plant Debit Sedimen Endapan Lumpur Desalination Plant

Hari	Tanggal Pengamatan	Ukuran Sedimen (m)	Debit Sungai (m^3/detik)	Debit Sedimen (ton/hari)
1	01-06-2015	0.000005	0,01	0.000000432
2	22-07-2015	0.000002	69.44	0.011999232
3	23-08-2015	0.000425	275.59	0.010119665
4	04-09-2015	0.0000097	378.70	0.000317381
5	05-10-2015	0.0000071	613.11	0.000376106
6	07-11-2015	0.000005	787.03	0.000339997
7	10-12-2015	0.0000036	1639.66	0.00051

Table 4 Calculation of *Bisection* Method

Iterasi	df/dx	X	Ẍ	X^2	$f(x)^2$
0	0	0	2	1	9.0000
1	0.000000432	0	1	0.3	9.0431
2	0.011999232	0.3	1	0.83	9.2859
3	0.010119665	0.83	1	0.983	9.2315
4	0.000317381	0.83	0.983	0.9113	9.6089
5	0.000376106	0.9113	0.983	0.95383	9.4802
6	0.000339997	0.9113	0.95383	0.929113	9.8362
7	0.00051	0.929113	0.95383	0.9350383	9.8591

From the calculation usinf Biseection Method, it could be concluded that fast infection function f(x) is positive for the small x positive value, but negative for x<0 or x>2. After selecting € = 0.01 and x1 = 1 in the preliminary solution, the results are shown in Table 4. The Bisection Method with seven iteration showed x = 0.929113 as the optimum solution with high conscientiousness.

Sedimentation tank is usually built using circular, square and rectangular reinforced concrete. Based on the previous part, it is explained that the problems encountered is the water production that is not optimum. It is caused by mud sedimentation in the desalination plant. Therefore, improvement is needed to design the sedimentation tank as such so that better water production is resulted. The results of the observation showed that rectangular and circular containers are the right shape for sedimentation container. Previously, the size of the tank used was 42 m long, 4 m wide, and 3 m deep as illustrated below.

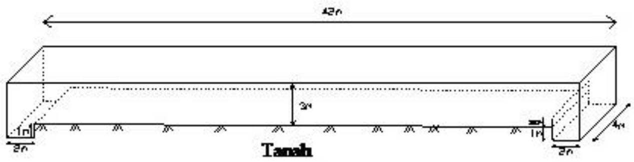
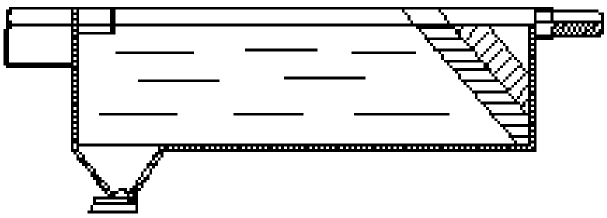


Figure 2. Previous Design of Sedimentation Tank

Rectangular shaped tank is commonly used in desalination plant with large capacity. It is usually 15 m wide, 100 m long, and 5 m deep. In this container, the water flows horizontally from inlet to the outlet, while the particles are sedimented underneath. The long shape pond suits the waterways, so that it can prevent any possibility of short-circuiting.



Gambar 3. Rectangular-shaped Sedimentation Tank Design

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 11, November - 2017

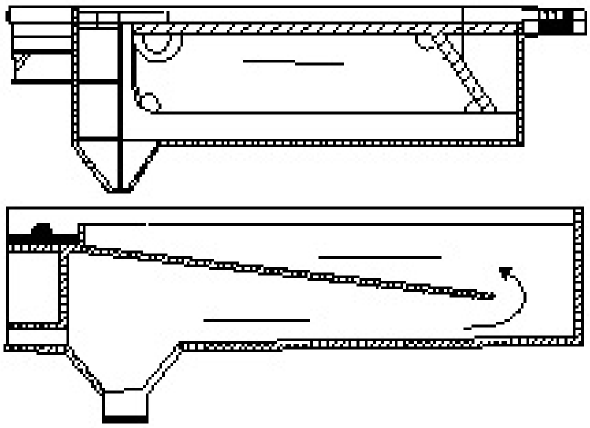


Figure 3. Rectangular-shaped Sedimentation Tank (Advanced)

Circular-shaped tank is commonly used in desalination plant with less capacity. Its diameter is usually 50 meter which is 5 meter deep. The water flows horizontally to radial direction or to the edge of the circle or vertically. With the same capacity, this circular-shaped sedimentation tank possibly has bigger short circuiting than that of in the rectangular-shaped one, especially when reaching the outpouring point that the water flows to only one particular side. This shape is not quite good based on hydraulics because the surface is not even, so that the flow speed is not constant. Therefore, it is difficult to control the flow speed; the bigger dimension of a building is, the more difficult the speed control will be.

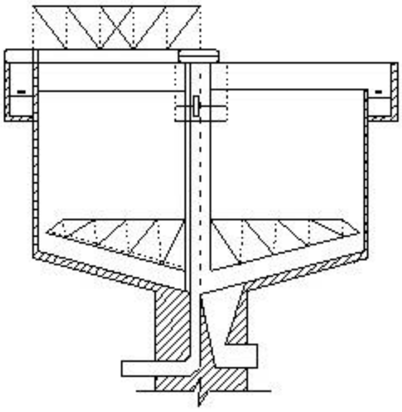


Figure 4. Circular-shaped Sedimentation Tank with Horizontal Flow

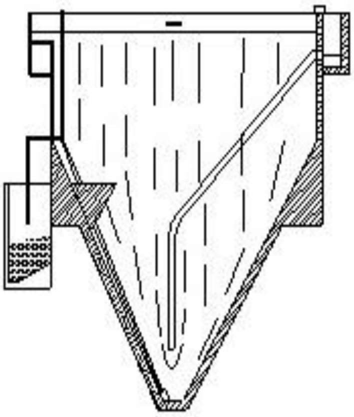


Figure 5. Circular-shaped Sedimentation Tank with Vertical Flow

The wastewaterquantity resulted by the society depends on their water use, while water use usually increase as the technology and social level develop. The reality in the field shows that the wastewaterresulted from humans's activities is thrown away to the water bodies which are the sources of fresh and clean water. If the wastewaterto be thrown away is more than the the nature can receive it, there will be environmental damage. A healthy environment is closely related to the wastewater desalination and management. Therefore, wastewater needs top be treated in wastewater treatment firstly before it is thrown to the waters in order to preserve the quality of the clean water resources in the bodies of water.

The objectives of the plan of this Wastewater Treatment Plant Tujuan are:

1. To understand the stages in planning a wastewater treatment plant, particularly the Sedimentation Unit.
2. To discover the function of Sedimentation Unit in the wastewater treatment plant.
3. To be able to calculate in details for Sedimentation and to design its stages.

In order to calculate the separable BOD and TSS, the following formula can be used: BOD and TSS removal type in primary sedimentation (Greeley,1938) in Metcalf & Eddy, 1991)

Example of the Calculation for Sedimentation Tank 1

The Plans used:

1. Use the rectangular-shaped container
2. Use 4 (four) units
3. Detention water from the laboratory calculation 1.175 hour
4. Settling zone with:

a. Overflow rate (OFR) = 7,5.10-4 m/s
b. Temperature of wastewater = 250C
c. Cinematic viscosity at 250C = 0.8975 x 10-6 m3/second
d. Spesific gravity (Sg) = 2.65
e. Frictional Factor (f) = 0.03
f. For unigranular sand (k) = 0.04

Calculation for the first Sedimentation Tank:

A. Designed Carrier Line:

1. Q peak = 0.487 m3/detik
2. Rectangular Line; b = 2h
3. waterways made of concrete; n = 0,013
4. water velocity; v = 1 m/second

Calculation:

a. Waterways Dimention

$$A = \frac{Q}{v} = \frac{0{,}487}{1} = 0{,}487\ m^2 \rightarrow 2h^2$$

$$h = \left[\frac{0{,}487\ m^2}{2}\right]^{1/2} = 0{,}5\ m$$

b = 1 m

$$R = \frac{b \times h}{b + 2h} = \frac{1 \times 0{,}5}{1 + (2 \times 0{,}5)} = 0{,}25$$

Perhitungan slope saluran

$$S = \left[\frac{v \times n}{R^{2/3}}\right]^2 = \left[\frac{1\ m/detik \times 0{,}013}{(0{,}25)^{2/3}}\right]^2 = 0{,}001$$

b. Pressure Loss along the waterways

Planned ; L waterways = 4 m

Hf = s x L
= 0,001 x 4
= 0,004 m

B. Settling Zone

a. Amount of Q each unit of sedimentation tank:

$$Q\ tiap\ bak = \frac{0{,}487\ m^3/dt}{4} = 0{,}12\ m^3/dt$$

b. Surface area:

$$A_{Surface} = \frac{Q}{OFR} = \frac{0{,}487\ m^3/detik}{7{,}5.10^{-4}\ m/detik} = 160\ m^2$$

c. Tank depth (h)

Time detention (td) obtained from laboratory calculation = 1.175 hour = 4230 seconds

Volume = Q x td
= 0,487 m3/s x 4230 s
= 0,487 m3

Tank depth (h)= Volume :Asurface= 507,7 m^3 : 160m3 = 3,17 m = 3,2 m

d. Tank Dimension

Scale length (P) : width (L) = 4 :1

thus : A = P x L
160 m^2 = 4L2
L = 6,32 m = 6,3 m
P = 4 x L = 4 x 6.3 m
= 25.2 m

Tank dimension : P = 25,2 m h = 3,2 m
L = 6.3 m free board = 0,3 m

e. Horizontal Velocity (Vh)

Vh = P / td
= 2520 cm / 4230 s
= 0,595 cm/s
= 0,6 cm/s

f. Scouring Velocity Control (Vc)

Particle Diameter

$$dp = \frac{(18 \times V_s \times \upsilon)^{1/2}}{(g \times (Sg-1))^{1/2}} = \frac{(18 \times (7{,}5 \times 10^{-2}) \times (8{,}975 \times 10^{-3}))}{(9{,}81 \times (2{,}65-1)\ m)}$$

$$= 2{,}74 \times 10^{-3}\ cm = 0{,}0274\ mm$$

g. Scouring Velocity

$$V_{Sc} = \left[\frac{8 \times k \times (Sg-1) \times g \times dp}{f}\right]^{1/2}$$

$$= \left[\frac{8 \times 0{,}04 \times (2{,}65-1) \times 9{,}80 \times (2{,}74 \times 10^{-3})}{0{,}02}\right]^{1/2}$$

$$= 8{,}42\ cm/detik$$

Because Vsc>VH, scouring will certainly not occur (OK!)

h. Reynolds Control Features

hydraulic radius:

$$R = \frac{L \times H}{L + 2H} = \frac{6{,}3 \times 3{,}2}{6{,}3 + (2 \times 3{,}2)} = 1{,}59\ m$$

$$N_{Re} = \frac{V_H \times R}{\upsilon} = \frac{0{,}06\ cm/dt \times 1{,}59.10^2\ cm}{0{,}8372 x 10^{-2}\ cm^2/dt} = 113{,}95 < 2000\ (ok\ !)$$

i. Froud Control Features:

$$N_F = \frac{V_H^{\ 2}}{g \times R} = \frac{(0{,}6\ cm/dt)^2}{9{,}80\ cm/dt^2 \times 1{,}59.10^{-2}\ cm} = 2{,}3 \times 10^{-6} < 10^{-5}$$

Because Nf< 10-5 will cause short circuiting in the sedimentation tank. In order to overcome thisproblem, an alternative used was by making Perforated Baffle in inlet zone.

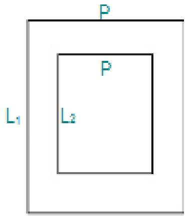
Mud Zone

The data from the laboratory showed the quality of the wastewater in the sedimentation tank:

BOD = 8327,28 kg/day
COD = 19977,07 kg/day
TSS = 9789,90 kg/day

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 11, November - 2017

Removal in Sedimentation tank 1
BOD = 35 %
COD = 35%
TSS = 65%
Thus,
BODe = 35 % x 8327,28 kg/day
= 2914.55 kg / day
CODe = 35% x 19977.07 = 6991.97 kg/day
TSSe = 65% x 8789.90 kg/day = 5713. 43 kg/day
Mud Volume based on the mass of solid TSS
Mud Ingredient = 6% (Sg = 1.05)
Mud Volume = (5713430 gr/day) / (0.06 x 1.05 x 1 g/cm3 x 106 cm^3/m^3)
= 90.689 m^3
Mud Room Dimension :



$P_1 = 6{,}3$ m
$P_2 = 5$ m
$L_1 = 6{,}3$ m
$L_2 = 3$ m

$A_1 = 6{,}3 \times 6{,}3 = 39{,}69\ m^2$
$A_2 = 5 \times 3 = 15\ m^2$

Tinggi ruang lumpur didapat dengan :

$$V = \frac{1}{3} x\, t\, x\, (A_1 + A_2 + \sqrt{A_1 x A_2})$$

$$90{,}689\ m^3 = \frac{1}{3} x\, t\, x\, (39{,}69 + 15 + \sqrt{39{,}69 x 15})$$

$$t = 3{,}44\ m \cong 3{,}4\ m$$

Pengurasan lumpur
Direncanakan : Q = 50 l/s = 0,05 m^3/s
Dilakukan dengan menggunakan valve otomatis Waktu pengurasan 8 jam sekali dalam 1 hari
A = Q / V
= (0,05 m3/s) / (1 m/s) = 0,05 m^2

Diameter pipa penguras : $D = \sqrt{\frac{4 x (0{,}05)}{\pi}} = 0{,}25\ m = 250\ mm$

Waktu pengurasan : $t = \frac{volume}{Q} = \frac{90{,}69\ m^3}{0{,}05\ m^3/dt} = 1813{,}8\ detik = 30{,}23\ menit$

4. CONCLUSION

According to the results of the research and the analysis that has been discussed , it is concluded that :

1. The results of the analysis indicate that the size of mud particles varies. Particles are not necessarily sedimented, only particles with longer sedimentation velocity or bigger ones are sedimented. The particle with lower velocity will be carried by the flow; namely, 0.01 mm.

2.Parameter Optimazation for the mud sedimentation debit in the Desalination Plant using Bisection Method resulted x = 0.929113 sebagai solusi optimal dengan tingkat ketelitian yang tinggi.

3.The results of Bisection Method with seven iteration showed low water production because sedimented mud and water were filtered simultaneously, so that it interferes the distillation process. Mud sedimentation has made the operation of the Desalination Plant not optimum indicated by clogged materials.

4. The sedimentation tank is designed to be built using rectangular-shaped or circular-shaped reinforced concrete. Rectangular shape is used for wastewater treatment plant installation with big capacity which is 100 m long, 15 m wide, and 5 m deep. Circular shape is used for wastewater treatment plant installation with small capacity which diameter is 50 m, and depth is 5 m. This curcular-shaped tank is designed with horizontal way to radial to the edge of the circle or vertical way.

REFERENCE

[1] Aminudin, (2005). Prinsip-Prinsip Riset Operasi, Jakarta, Penerbit Erlangga
[2] Asdak, (2010). Hidrologi dan Pengelolaan Daerah Aliran Sungai, Yogyakarta, UGM Press
[3] Akbari, Ghumman, Wormleaton, (1996). Identification Parameter For Sediment Routing in Rivers, Journal of Engineering, Volume 34
[4] Chow, Maidment, Mays, (1988). Applied Hydrology, Singapore, Mc Graw Hill Book Company
[5] Hillier, Liebermann, (2008). Introduction To Operational ResearchVolume 1, Yogyakarta, Penerbit Andi
[6] Hillier, Liebermann, (2008). Introduction To Operational Reserarch Volume 2, Yogyakarta, Penerbit Andi
[7] Hudson, (1971). Soil Conservation For Earth, London, Batsford Press
[8] Hutabarat dan Evans, (1984). Pengantar Oceanografi, Jakarta, UI Press
[9] Karnaningroem, (1990). Efisiensi Evaporasi Sebagai Metode Penyediaan Air Minum, Surabaya, ITS Press
[10] Linsley, Kohler (1986). Hidrologi Untuk Insinyur, Edisi Ketiga, Jakarta, Penerbit Erlangga
[11] Metcalf & Eddy, (1991). Wastewater Engineering,Mc. Graw Hill. New York.
[12] Masduki, (2008). Perencanaan Alat Desalinasi Dengan Metode Evaporasi, Surabaya, ITS Press
[13] Mulyani, (2006). Sistem Destilasi Air Laut Menggunakan Kolektor Plat Datar Dengan Tipe Kaca Penutup Miring, Padang, Hatta Press
[14] Mulyono, (2001). Aplikasi Metode Model Tangki Untuk Angkutan Sedimen, Semarang, UNDIP Press
[15] Nevers, Noel De, (1995). Air Pollution Control Engineering, New York, Mc Graw Hill Press
[16] Peavy, Howard, Donald Rowe, (1985). Environmental Engineering, England, Mc Graw Hill Publishing Company
[17] Reynolds, Ton Richards, (1996). Unit Operations and Processes in Engineering,Boston, PWS Press
[18] Rao, (1977). Optimization Theory and Application, New Delhi, Wiley Sons Press
[19] Rochana, (1996). Aplikasi Metode Untuk Optimasi Koefisien Model Tangki, Yogyakarta, UGM Press
[20] Sincero, Arcadio dan Gregorio, (1996).Environmental, England, Prentice Hall Publishing Company
[21] Soewarno, (2000). Hidrologi Operasional, Bandung, Citra Press
[22] Sugawara, Watanabe, Ozaki, (1984). Tank Model With Snow Component, Tokyo, National Limited Press
[23] Oxtoby, Gillis dan Norman, (2001). Kimia Modern, Jakarta, Penerbit Erlangga
[24] Tchobanoglous, George, (1991). Wastewater Engineering, Treatment, Disposal and Reuse, New York, Prentice Hall Publishing Company