# TECHNICAL AND ENVIRONMENTAL STUDY OF TAL BARAT'S SETTLING POND PT. BUKIT ASAM (PERSERO) TBK TANJUNG ENIM MINING UNIT SUMATERA SELATAN

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## ABSTRACT

TAL Barat's runoff comes from TAL Barat and MT4's sump. Area of MT4's sump will be done mining extention cause there's coal reserves so it needs sump drying. It've an impact on settling pond. So it needs to conduct technical and environmental study to overcome problems, where data taken, processed, and analysed in location with survey method and laboratory test. Result're the difference characteristics of both sump which will be flowed towards the one settling pond. It'll give technical effects increasing runoff to settling pond that would exceed current capacity and environment effects, there's a change in pH, TSS, Fe and Mn. Plan debit and pump time of TAL Barat's sump're 480 m3/h and 5 h/day and MT4's sump're 972 m3/h and 21 h/day. Plan's runoff to settling pond is 38.514 m3/day. Plan compartment're 7 compartement. Plan of sedimentation time to be 2-3 times higher than actual. Related environment's aspect, water quality test of TAL Barat's inlet(1) and MT4's inlet(2)'re average pH1=4.9133, pH2=3,8333, TSS1=398,3333 mg/L, TSS2=202,6667 mg/l, Fe1=4,6355 mg/l, Fe2=5,0191 mg/l, Mn1=7,8172 mg/l, Mn2=7,9234 mg/l. Outlet're average pH=5,8283, TSS=119 mg/l, Fe=4,6815 mg/l, Mn=7,5966 mg/l. It'll be concluded pH and Mn haven't fulfilled quality standard. Active treatment's performed to increase pH=5,83 to 6 by adding dose of lime 53,08 kg. Passive treatment's performed to reduce metal by plant 6.348 Kiambang,86.017 Akar Wangi,20.933 Eceng Gondok dan 21.504 Lembang.

Keywords: Probabilistic, Fitting-Test, Distribution.

## 1 INTRODUCTION

TAL Barat's settling pond runoff water comes from 2 Sumps, namely West TAL Sump and MT4 Sump. In the MT4 Sump area there are coal reserves so that mining extensions will be carried out in the area which is planned to be carried out in August 2018 so that it is necessary to dry the Sump. Regarding technical aspects, there will be an increase in the total pump discharge and runoff discharge to KPL which will exceed the current capacity so it is necessary to increase the number of KPL compartments. Regarding environmental aspects, large runoff discharges to MPAs will affect water quality.

With this influence, it is necessary to test water quality to comply with environmental quality standards in Kepmen LH No. 113 of 2003 concerning Wastewater Quality Standards for Coal Mining Businesses and / or Activities and South Sumatra Governor Regulation No. 8 of 2012 concerning Coal Mining Liquid Waste Quality Standards [1-2]. There are 4 parameters of environmental quality standards including pH of 6-9, TSS of 300 mg / L, Fe of 7 mg / L and Mn of 4 mg / L. The results of the water quality test will show whether the water quality in KPL has met environmental quality standards to be ready to flow into the river because if it does not meet environmental quality standards, it is necessary to do water management (Water Treatment) [1] [2].

There are five formulations of problems in the technical and environmental study research of KPL TAL Barat including how the initial hue conditions of Sump and KPL, how the actual and planned pump discharge affect KPL, how many and dimensional KPL plans, how the quality of water in KPL Inlet and Outlet zones and how water management should be carried out in KPL. This study aims to analyze the initial of Sump and

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KPL, the effect of actual and planned pump discharge on KPL, the number and dimensions of KPL plan, water quality in KPL Inlet and Outlet zones and water management that should be carried out on KPL

## 2 METHODOLOGY

The research was conducted in the mud settling pond of West TAL PT. Bukit Asam (Persero) Tbk from October 16, 2017 to November 27, 2017. Data collection, processing and analysis are carried out in the field by field survey methods and laboratory tests. The data taken is divided into 2, namely primary and secondary data. Primary data include actual KPL dimension data, actual KPL volume data, actual pump discharge data, water speed data in the pool, laboratory test data of pH, TSS, Fe and Mn parameters in KPL Inlet and Outlet zone water. Secondary data include Catchment Area data, rainfall data, groundwater discharge data and average temperature, pump and pipe specification data, as well as pipe length data and water management data. The primary and secondary data are then processed with a statistical approach using Microsoft Excel and processed with the Minescape 5.7 application. The data that has been processed is then analyzed.

## 3 RESULTS AND DISCUSSIONS

### 3.1 Analysis of the Initial Conditions of Sump and KPL

The initial conditions of the TAL Barat Sump and MT4 Sump were analyzed based on technical aspects and environmental aspects. Technical aspects include analysis of topography, analysis of dimensions and analysis of runoff discharge. Analysis of topography shows that the West TAL Sump area has a slower surface (2-7%) than the MT4 Sump area (7-15%) so that the flow speed will be slower and result in a lot of sedimentation in the West TAL Sump. Conversely, for the MT4 Sump area, the flow speed will be faster and result in less sedimentation on the MT4 Sump. Analysis of the dimensions shows that the dimensions of the West TAL Sump are smaller than the MT4 Sump.

The area and depth of West TAL Sump are 1.51 Ha and 7 m respectively. The area and depth of the MT4 Sump are 20 Ha and 49 m respectively. Analysis of runoff discharge shows that runoff discharge towards West TAL Sump will be smaller than runoff discharge towards MT4 Sump because West TAL Pit has a smaller Catchment Area than MT4 Pit which is 59 Ha and 162 Ha. Environmental aspects include 4 parameters, namely TSS, pH, Fe and Mn. From the results of water quality tests on the West TAL Sump, it was obtained that pH = 5.45 means that the pH is acidic, TSS = 435 mg / L means that the TSS value exceeds the set threshold of 300 mg / L so that the color of the water is cloudy, Fe = 4.8903 mg / L means that it has met the quality standards of 7 mg / L, Mn = 8.2096 mg / L means that it exceeds the threshold set at 4 mg / L From the results of the water quality test on the MT4 Sump, it is obtained pH = 3.64 means pH is acidic, TSS = 189 mg / L means that the TSS value has met the quality standard of 300 mg / L so that the color of the water is not cloudy, Fe = 5.6565 mg / L means it has met the quality standard of 7 mg / L, Mn = 8.9727 mg / L means exceeding the threshold set at Mn = 4 mg / L.

With the different characteristics of the two Sumps which will then be flowed to 1 KPL, it will affect the KPL. The application of this system will have an impact on technical and environmental aspects. From the technical aspect in the form of an increase in the amount of runoff discharge to MPA so that it will exceed the current capacity and from the environmental aspect in the form of large changes in pH, TSS and Fe and Mn metal content.

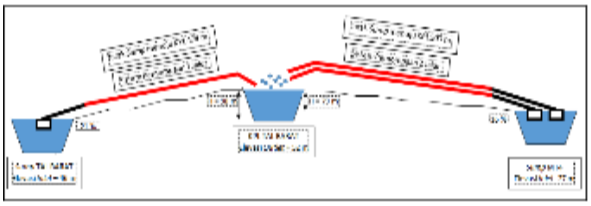

Figure 1 Settling Pond's flow chart

### 3.2 Analysis of Actual Pump Discharge and Plan Against KPL

The actual pumping system of Sump TAL Barat to KPL TAL Barat is a 1 pipeline pumping system. The pump used is the MF 420 E pump with a pumping time of 5 hours / day. The actual pumping system of Sump MT4 to KPL TAL West is a 2 pipeline pumping system. The pump used is the MF 420 EX pump with a pumping time of 10 hours / day. The actual pump discharge is obtained from the Hydrological Operation Planning and Support Task Force of PT. Bukit Asam (Persero), Tbk by using the Water Current Meter OTT type C31 tool. The MF 420 E and MF 420 EX pumps each have an actual discharge of 8 m3/min. The pumping water of Sump TAL Barat and Sump

MT4 will flow using a suction pipe (HDPE) DN 250 mm with a length of 6 m then exit through the DN 315 mm HDPE discharge pipe. The length of the West TAL Sump and MT4 Sump exhaust pipes is 474 m and 500 m respectively. Total Head calculations on TAL West and MT4 were obtained at 103 m and 84 m respectively. After getting the total head, then to find out the planned discharge, plot it in the pump discharge curve. From the pump discharge curve, the planned pump discharge on the West TAL Sump is 864 m3 / hour or 0.24 m3 / second with an engine speed of 1300 rpm and an efficiency of 72%. However, the field application for the West TAL Sump still uses the actual discharge and pump time of 480 m3 / day and 5 hours / day because it sees the condition of the Sump which has a lot of mud. In Sump MT4, a planned pump discharge of 792 m3 / hour or 0.22 m3 / second is obtained with an engine speed of 1200 Rpm and an efficiency of 72%. The planned pump time for Sump MT4 is 21 hours/day according to the maximum pumping hours/day.

KPL TAL Barat is currently able to accommodate 16,500 m3. With the plan of PT. Bukit Asam (Persero), Tbk to continue mining at the Sump MT4 location, there will be a change in discharge and actual pump time to discharge and plan pump time. This resulted in a change in the actual total pump discharge to the total planned pump discharge which was originally 12,000 m3/day to 35,664 m3/day. KPL is currently unable to accommodate the runoff discharge of the planned pump that will enter, so it is necessary to add a KPL compartment.

### 3.3 Analysis of Number and Dimensions of Plan KPL Compartments

The calculation of the total discharge to the KPL is determined by the pump discharge and runoff discharge around the KPL. The estimated amount of sludge that will enter KPL is assumed to be 1% of the total incoming discharge (K3L and Keloling Work Units). From the calculation results, the actual total discharge and estimated amount of sludge entered respectively 14,868.61 m3 and 148.7 m3 and the total discharge of the plan and estimated amount of sludge entered respectively 38,532.61 m3 and 385.33 m3.

The actual condition of KPL TAL Barat has four compartments. However, only two compartments are functioned, namely compartments 1 and 2. Each compartment has a different geometry. To find out the actual geometry, measurements are made directly in the field

| No | Panjang (m) | Lebar (m) | Kedalaman (m) | Luas ($m^2$) | Volume ($m^3$) |
|---|---|---|---|---|---|
| 1. | 50 | 50 | 3 | 2.500 | 7.500 |
| 2. | 60 | 50 | 3 | 3.000 | 9.000 |
| 3. | 63 | 46 | 3 | 2.898 | 8.694 |
| 4. | 60 | 74 | 3 | 4.440 | 13.320 |
| | | Total | | 12.838 | 38.514 |

Figure 2 Dimension of actual settling pond

The land area around KPL TAL Barat is 30,600 m2 or 3.06 Ha can be seen in (Figure 2) marked with a red border. The four existing compartments have an area of 12,838 m2 or 1.2838 Ha. This means that there is still free land for the planned location for the addition of KPL compartments with an area of 1.7762 Ha. In KPL TAL Barat, it is planned to add 3 new compartments as sedimentation sites and 4 old compartments as treatment sites. KPL TAL Barat has a large total discharge because it comes from 3 pumps which results in an estimate of the amount of sludge to be sedimented is also large. Therefore, the dimensions of the compartments on KPL TAL Barat are made large, namely length, width and depth respectively 150 m, 24 m and 5 m. The consideration of planning the dimensions of width and depth is the range of tools to perform dredging using the Long Arm PC 200 Excavator which has a Max Reach Along Ground of 12 meters and a Max Digging Depth of 5 meters.

The increase in the number of KPL compartments includes the addition of compartments that function as sedimentation sites, 3 new compartments are made, namely compartments 1-2-3 and actual compartments 1, 2, 3 and 4 have large enough dimensions, if the 4 compartments are used as sedimentation sites, dredging cannot be done optimally. So that the 4 compartments can only be used as a treatment place into compartment 4-5-6-7. The increase in the number of compartments will affect the capacity of KPL which originally had an actual capacity of 16,500 m3 to a planned capacity of 87,714 m3. This is an anticipation to overcome the discharge that will increase in line with the increase in production.

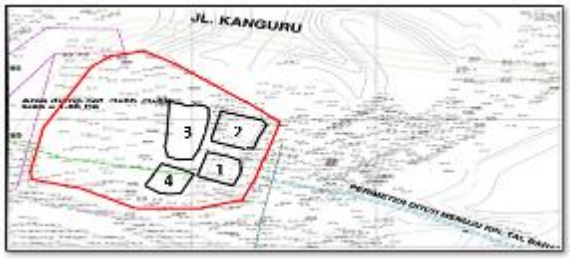


Figure 1 Actual of TAL Barat Settling pond

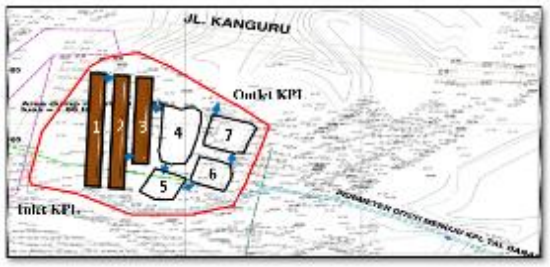


Figure 5 Plan of TAL Barat Settling pond

| No | Panjang (m) | Lebar (m) | Kedalaman (m) | Luas ($m^2$) | Volume ($m^3$) |
|---|---|---|---|---|---|
| 1. | 150 | 24 | 5 | 3.600 | 18.000 |
| 2. | 150 | 24 | 5 | 3.600 | 18.000 |
| 3. | 110 | 24 | 5 | 2.640 | 13.200 |
| 4. | 60 | 74 | 3 | 4.440 | 13.320 |
| 5. | 63 | 46 | 3 | 2.898 | 8.694 |
| 6. | 50 | 50 | 3 | 2.500 | 7.500 |
| 7. | 60 | 50 | 3 | 3.000 | 9.000 |
| | | Total | | 22.678 | 87.714 |

Figure 6 Plan of Settling pond's dimension

KPL TAL Barat actually has 2 compartments that function as sedimentation sites. The condition of both compartments is saturated, characterized by the fullness of mud to the surface. This is due to the fast deposition speed and the volume of the compartment is less large, as a result of which more sludge will settle and fill the compartment in a short time. If this condition continues without routine dredging, the function of KPL is only a place for water to pass without any sedimentation process so that the water that comes out will not be in accordance with environmental quality standards. Therefore, the calculation of sedimentation time until it fills the compartment is very important. KPL TAL West plan has 3 compartments that serve as sedimentation sites. This means that there is an increase in the actual number of compartments which originally amounted to 2 compartments to 3 compartments. The three compartments of the plan have a fairly large volume because the total discharge of the plan to the MPA is large which results in an estimate of the amount of sludge to be sedimented is also large. If the deposition speed is fast and the volume of the compartment is large, the sludge will settle and fill the compartment for a longer time so that the dredging time becomes longer as well.

From the calculation of sedimentation time to fill the compartment both in the actual KPL condition and the KPL plan, it can be concluded that the actual KPL condition with smaller dimensions will fill up faster. Conversely, the condition of KPL plans with larger dimensions will be longer full. This is evidenced by the same amount of solids going to the actual and planned MPAs but the sedimentation time until it fills the compartment has a different duration. The actual LVC takes time in compartments 1 and 2 for 17 days and 872 days (Table 4). On KPL plans take time in compartments 1, 2 and 3 for 43 days, 2,722 days and 132,000 days (Table 5). With the KPL plan, it is more efficient because the dimensions become larger, the full time becomes longer (2-3 times the actual KPL) and the dredging time becomes longer so that it will minimize KPL maintenance costs.

| Kompartemen | tr (menit) | vh (m/detik) | th (menit) | Padatan yang berhasil diendapkan dalam 1 hari ($m^3$/hari) | Waktu pengerukan (hari) |
|---|---|---|---|---|---|
| 1 | 3,3 | 0,005734 | 145,3 | 376,5 | 17 |
| 2 | 7,2 | 0,002752 | 363,5 | 8,6 | 872 |

Figure 7 Actual sedimentation time until it meets the compartment

| Kompartemen | tr (menit) | vh (m/detik) | th (menit) | Padatan yang berhasil diendapkan dalam 1 hari ($m^3$/hari) | Waktu pengerukan (hari) |
|---|---|---|---|---|---|
| 1 | 5,56 | 0,007188 | 348,77 | 348,77 | 43 |
| 2 | 11,9 | 0,00341 | 726,74 | 726,74 | 2.722 |
| 3 | 41,67 | 0,00206 | 889,96 | 0,09 | 132.000 |

Figure 8 Sedimentation Time Plan Until It Meets the Compartment

## 3.4 Water quality analysis

PT. Bukit Asam (Persero), Tbk must meet 4 water quality parameters including pH = 6-9, TSS = 300 mg / L, Fe = 7 mg / L and Mn = 4 mg / L according to Kepmen LH No.113 of 2003 Wastewater Quality Standards for Coal Mining Businesses and / or Activities and South Sumatra Governor Regulation No. 8 of 2012 Coal Mining Liquid Waste Quality Standards. The results of the water quality test will show whether the water quality in KPL has met environmental quality standards to be ready to flow into the river because if it has not met environmental quality standards, water management needs to be carried out.

Runoff water entering the KPL Inlet comes from 2 Sumps, namely West TAL Sump and MT4 Sump. The average water quality test results in the KPL Inlet zone can be seen in (Table 6). From

(Table 6) it is known that the pH at West TAL Inlet and MT4 Inlet respectively 4.9133 and 3.8833 can be said to have an acidic pH or < 6, this happens because runoff water that goes to KPL Inlet has direct contact with Potential Acid Forming (PAF) material around the Sump. The TSS value in the West TAL Inlet exceeds the environmental quality standard of 398.3333 mg / L while the MT4 Inlet has met the environmental quality standard of 202.6667 mg / L. The Fe metal content in the West TAL Inlet and MT4 Inlet respectively 4.6355 mg / L and 5.0191 mg / L can be said to have met environmental quality standards. However, the Mn metal content in West TAL Inlet and MT4 Inlet is quite high or exceeds environmental quality standards of 7.8172 mg / L and 7.9234 mg / L respectively so that Passive Treatment is needed so that the Mn metal content can be reduced.

After passing through the two compartments in KPL, it is expected that the water coming out of KPL has met environmental quality standards. The average water quality test results in the KPL Outlet zone can be seen in (Table 7). From (Table 7) it is known that the pH still does not meet the environmental quality standard of 5.8283 so it is necessary to do Active Treatment by adding a dose of lime so that the pH becomes neutral. In addition, the Mn metal content has not met environmental quality standards, which is 7.5966 mg / L. The cause of Mn metal content has not met quality standards is because there is no compartment in KPL that functions as a treatment site so that the metal is not reduced.

| Parameter | Baku Mutu Lingkungan | Rata Rata Inlet KPL | | Keterangan | |
|---|---|---|---|---|---|
| | | TAL Barat (1) | MT4 (2) | TAL Barat | MT4 |
| pH | 6 – 9 | 4,9133 | 3,8833 | Belum Memenuhi | Belum Memenuhi |
| TSS | 300 mg/L | 398,3333 | 202,6667 | Belum Memenuhi | Memenuhi |
| Fe | 7 mg/L | 4,6355 | 5,0191 | Memenuhi | Memenuhi |
| Mn | 4 mg/L | 7,8172 | 7,9234 | Belum Memenuhi | Belum Memenuhi |

Figure 9 Average KPL Inlet Water Quality Test Results (October-November 2017)

| Parameter | Baku Mutu Lingkungan | Rata-Rata Inlet KPL | Keterangan |
|---|---|---|---|
| pH | 6 – 9 | 5,8283 | Belum Memenuhi |
| TSS | 300 mg/L | 119 | Memenuhi |
| Fe | 7 mg/L | 4,6816 | Memenuhi |
| Mn | 4 mg/L | 7,5966 | Belum Memenuhi |

Figure 10 Average KPL Outlet Water Quality Test Results (October-November 2017)

## 3.5 Water treatment analysis

Water treatment is divided into 2, namely active management (Active Treatment) and passive management (Passive Treatment). Active management serves to change the pH of water in accordance with environmental quality standards by adding doses of lime and NaOH. The addition of NaOH is carried out if in the last compartment the pH value still does not meet environmental quality standards. However, if it meets environmental quality standards, the addition of NaOH is no longer needed. Passive management serves to reduce Fe and Mn metal content by making a Floating Wetland System.

From the test results of water samples in the KPL Outlet zone, a pH of 5.83 was obtained. The amount of pH has not met environmental quality standards, namely pH ranging from 6-9. The effort to change the pH of the water is to increase the dose of lime. An additional dose of chalk is given to the connecting channel between 1 compartment and the other compartment. The calculation results found the need to increase the dose of lime in the current KPL condition of 53.08 kg so that the pH value can be increased from 5.83 to 6.

From the test results of water samples in the KPL Outlet zone, the Mn content was obtained at 7.5966 mg / L. The Mn content has not met the quality standards, namely the maximum limit of Mn of 4 mg / L. Efforts to reduce metal content are by making a Floating Wetland System, which is engineering land plants to grow on water media with a floating / floating system that functions to reduce Fe and Mn. These plants include Kiambang (Salvinia Natans), Fragrant Root (Vetiveria Zizanoide), Hyacinth (Eichhornia Crassipes) and Lembang (Typa Angustifolia). Calculation of plant needs according to current KPL conditions.

The plants used consist of 4 types, namely Kiambang (Salvinia Natans) has a maximum height of 0.08 m, Fragrant Root (Vetiveria Zizanoide) has a height of 1.5 m – 3 m, Hyacinth (Eichhornia Crassipes) has a height of 0.4 m – 0.8 m and Lembang (Typa Angustifolia) has a height of 1.5 m – 3 m. The difference in plant height causes metal absorption to occur from the bottom of the water to the surface of the water so that it is expected that all flat water is reduced to metal elements.

The more plants planted, the better the water quality. Because the nature of passive

management is to reduce heavy metals (Fe and Mn) biologically so as not to adversely affect the environment. Another case with active management that utilizes chemicals (Tohor Lime) so that it must be in accordance with the addition of lime doses. In the KPL plan, it is known that there is an increase in the number of compartments so that initially there are no compartments to carry out Treatment, after technical review, it is planned that there are 4 compartments as Treatment places. So that water quality can be in accordance with established environmental quality standards.

| No | Kenaikan pH | Dosis (gr/Liter) | Debit (m³/hari) | Penambahan Dosis Kapur (Kg) |
|---|---|---|---|---|
| 1. | 3 – 6 | 0,062 | 14.508,61 | 921,85 |
| 2. | 4 – 6 | 0,041 | | 608,61 |
| 3. | 5 – 6 | 0,021 | | 312,24 |
| 4. | 5,83 – 6 | 0,00357 | | 53,08 |

Figure 11 Addition of chalk dose

| No | Tanaman | Mn yang perlu diserap (ppm) | Jumlah Tanaman |
|---|---|---|---|
| 1. | Kiambang | 52.040.135 | 6.348 |
| 2. | Akar Wangi | | 86.017 |
| 3. | Eceng Gondok | | 20.933,3 |
| 4. | Lembang | | 21.504,2 |

Figure 12 The Need for Passive Management

## 4 CONCLUSIONS

1. With the different characteristics of the two Sumps which will then be flowed to 1 KPL, it will affect the KPL. The application of this system will have an impact on technical and environmental aspects. Technical in the form of an increase in the amount of runoff discharge to MPA which will exceed the current and environmental capacity in the form of changes in pH, TSS, Fe and Mn.
2. The discharge and pumping time of the plan are obtained at the West TAL Sump consecutively 480 m3/hour and 5 hours/day and at the MT4 Sump consecutively 792 m3/hour and pumping time 21 hours/day.
3. The total planned discharge and the amount of sludge planned to KPL are 38,532.61 m3/day and 385.3 m3/day. The number of planned compartments is 3 sedimentation compartments and 4 treatment compartments. The plan dredging time becomes 2-3 times the actual dredging time.
4. The amount of pH and Mn has not met the established environmental quality standards.
5. To raise the pH from 5.83 to 6 (neutral), Active Treatment is carried out with the addition of a dose of lime of 53.08 kg. To reduce the Mn content, Passive Treatment was carried out by making a Floating Wetland System obtained the needs of each plant as many as 6,348 Kiambang plants (Salvinia Natans), 86,017 Fragrant Root plants (Vetiveria Zizanoide), 20,933 Hyacinth plants (Eichhornia Crassipes) and 21,504 Lembang plants (Typa Angustifolia).

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