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SETTLING BASIN MODELING TO REDUCE FLUCTUATION OF SEDIMENT CONCENTRATION ON MHP IRRIGATION CHANNELS

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ABSTRACT

Potential of MHP irrigation channel is suitable for Open Flume Propeller turbine type. The fluctuating process of sediment concentration, making the quality of electrical power deteriorate. This study aims to reduce these influences.

This settling basin modeling is divided into 3 design models from 9 scenarios. The condition of MHP in the rain without modeling, voltage deviation Vd = 17, 6%, Frequency deviation fd = 6, 8% and rotation deviation nd = 6, 8%. fluctuation of sediment concentration C between 2,551 (g/l) and 3,864 (g/l) condition of the MHP abnormal operation. With the modeling of the settling basin design III obtained voltage deviation Vd = 3%, frequency deviation nd = 1% and rotation deviation nd = 1% at the fluctuation of sediment concentration C between 1.160 (g/l) and 1.340 (g/ l) resulted in the condition of the MHP operating normal.

Key words: Microhydro, Irrigation, Sedimentation, Settling Basin.

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1. INTRODUCTION

Potential irrigation channels are scattered throughout Indonesia is very large, so now is being ogled by renewable energy observers. In the irrigation channel, the use of open flume propeller turbine type is very suitable because it only requires a relatively low high fall. This turbine can change the entire potential of hydro power into torsional energy. The condition of the field is reported at the time in the rain of high sedimentation process which is very influence on the quality of electricity at the plant so as to make damage to the household electric appliances..

The amount of sediment passing through the turbine over a period of time needs to be checked and analyzed as to how this relates to the overall production of electricity [André Abgottspon, et al. 2013] [1]. Typically, sediment measurements are performed in high sediment working conditions. This led to a significant time lag between sediment observations during high sediment working conditions and production records at power plants. Manual sampling and laboratory analysis are often very time consuming and, moreover, low frequency manual sampling can miss the incidence of high sediment concentrations.

Small-scale of micro hydro power plants are the most cost-effective hydroelectric power generation technology to consider on a rural electric scale. Is also a major prospect for future hydro-energy developments in Europe, where large-scale hydropower often involves the construction of large dams and exploiting the environment by spreading vast valleys so that in Europe it is unacceptable [Phais O, 2012] [2] That Mikrohydro is an environmentally friendly energy technology available, with little maintenance costs. In Indonesia, microhydro power reserves are quite large potentials that are generally far away from community settlements, this is because elegant altitude levels are only located in the mountains, so with irrigation channeling as a microhydro generator will provide additional reserves of microhydro generators that are significant.

The speed of precipitation and not settling of sedimentation materials in the irrigation canal networks examined by various methods provides that the limits of Kennedy's theory and Method are the best measurement values agreed upon and considered. This method can be used to avoid the sedimentation process on the planned irrigation channel [Karimi Gh. H. And H. Moazed, 2013] [3] The impact of this research is to assess the elevation of surface water and sediment concentrations in water, thus making it possible to create a non-settling velocity condition on the irrigation canal.

In achieving the ideal sedimentation level for a plant. From this research explains the dynamics simulation of a single irrigation channel based on quadratic linear control algorithm developed for intersection channel. Using the concepts of feedback theorem, an expression for the opening of the upstream gate of the irrigation canal The system works either close to a constant or near equilibrium condition. This indicates that the optimum control theory (feedback) still applies to irrigation channels by combining the junction channels. [Omer Faruk Durdu, 2005] [4], In this study impacted the irrigation channel, the type of feedback simulation scheme control system for channel operation Irrigation with a convergent channel junction used to minimize the magnitude and timeframe of a mismatch between supply and demand

The sediment arrangement based on the equation shown is a safe image of the characteristics for a calculation of reservoir sedimentation utilized by Hydroelectric generator. In this study also suggested an ekxtractor for rinsing the sediment, thus [Ranga Raju K.G. And U.C. Kothyari

2004] [5] The results of this study have an impact on improving hydroelectricity development requiring the construction of reservoirs or dams in rivers and canals to carry water to turbines.

According to [Issam Salhi, 2009] [6], the micro-hydro power plant is usually isolated from the network, thereby requiring control to maintain constant frequency, power and voltage for the operation of the microhydro power plant. Every working condition, with the Fuzzy control is generated simulated by storing the water energy supply and will only be used for the time required.

. A study disclosed by BPPT researchers [Ahmad Hasaan, 2007] [7] Electronic Load Control at MHP in principle where with PLN remote network from the location of the PLTMH (isolated power plant), the power that should be given to the network when the consumer load at the location of the MHP reduces its use Is done so that the artificial loads are controlled by the ELC.

2. RESEARCH METHODS

2.1. Research design

PLMTH on irrigation channels has a relatively low (effective) head down (below 5 meters), where the turbine used is a Plopeler Open Flume turbine. In general, this research is to obtain the correlation of the concentration magnitude of the sedimentation concentration C (g / lt) on the maximum and minimum value limits affecting the rotation of turbine-generator n (rpm), frequency f (Hz) and voltage V (Volt). So that a settling basin model is needed which can reduce sedimentation effect on MHP Type of Propeller Open flume turbine to obtain quality of power supply within tolerance limit standard of electrical equipment used by consumer. The design of this research is where the modeling is placed on the front of the water gate (intake) entering the keturbin in the cross-sectional view of the design as shown in Figure. 1 and Figure. 2.

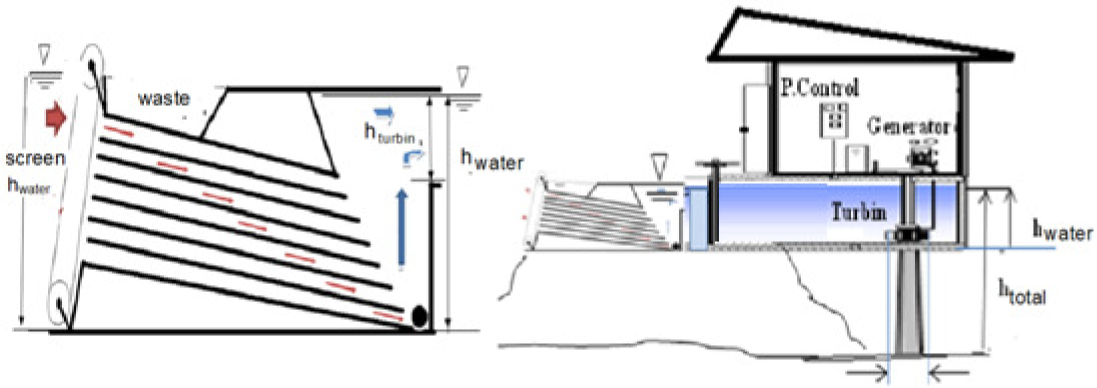


Figure 1 MHP on irrigation channel using turbine type Open flume propeller with modeling of basin settling design I

The aim of this research is to obtain the correlation of the concentration of the sedimentation concentration C (g / lt) on its maximum and minimum value limits, affecting the rotation of turbine-generator n (rpm), frequency f (Hz) and voltage V (Volt). So that a settling basin model is needed which can reduce sedimentation effect on MHP Type turbine Open flume Propeller to get quality power supply that is within tolerance limit standard of electrical equipment used by consumer. Therefore the stages of this research is done in 2 stages of research and research analysis done in 3 models of basin laying design. Initial research phase on the MHP Type turbine Open flume Propeller Tulabolo where the modeling of this research is applied to the installed MHP object. From the three models of basin laying design that are done in 9 scenarios of the state, it is expected to obtain an amount of concentration (C) of sedimentation which is ideal for an object for MHP type turbine Openf lume propeller installed in this.

. From the three models of settling basin design that are done in 9 scenarios of the state, it is expected to obtain an amount of sedimentation concentration (C) which is ideal for an object for MHP Type Propeller Open flume turbine installed in this study.

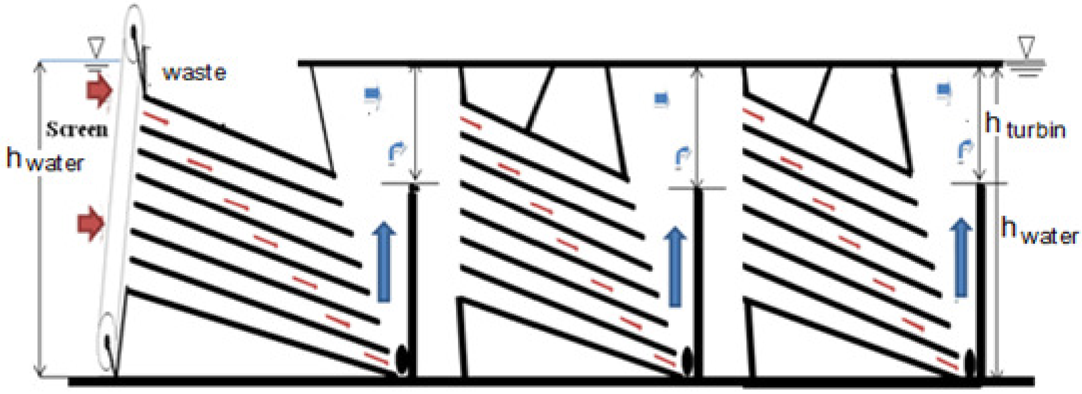


Figure 2 Modeling of Settling Basin Design III

The next stage of research is for all irrigation potentials in the province of Gorontalo by testing the efficiency level of settling sedimentation building (SSB) and the feasibility of sedimentation concentration level deposited from SSB for MHP type of Open flume propeller turbine commonly used in Irrigation MHP, so it is expected from This research obtained the recommendation of safe sedimentation concentration for MHP an open flume propeller type turbin and the feasibility of mounting the MHP at certain location points on irrigation network in Gorontalo province.

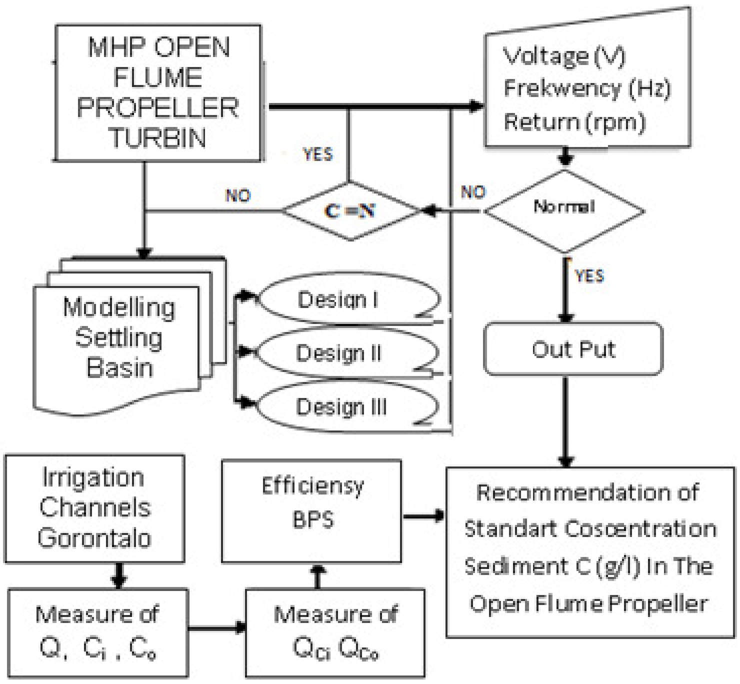


Figure 3 Flow diagram of the research

3. DISCUSSION AND ANALYSIS

3.1. Overview of Research Object of MHP tulabolo

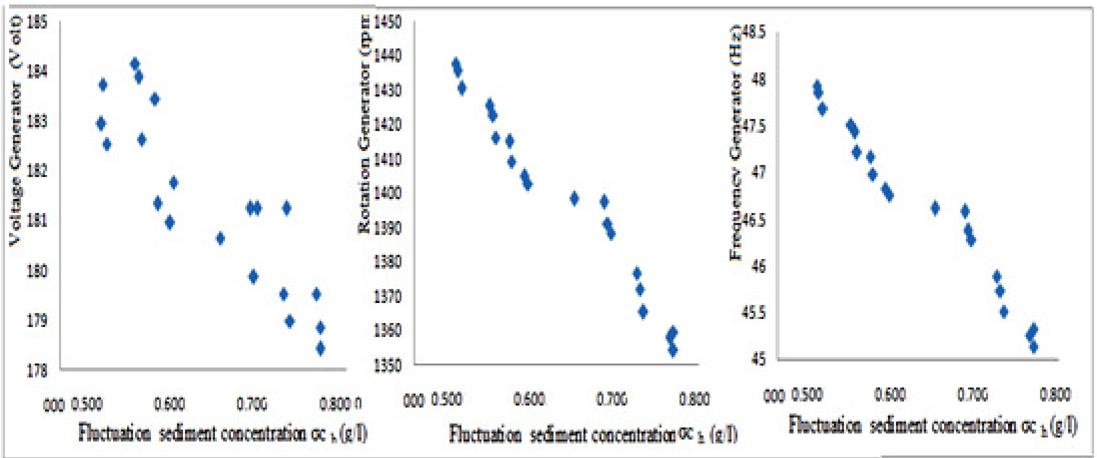
Based of field conditions in this study with the parameter on measurements were obtained: A = 2.48 m^2, V = 0789 m/s, it is obtained: Q = 2.48 m^2 x 0789 m/s = 1.96 m^3/s, with k = 9.8 and higher draft tube h = 1.75 m, from equation 1.2, 3. theoretical power P = k. h. Q = 33.614 [KW] This power is divided into 6 generating units so that each plant produces theoretically power of 5.6 KW, the efficiency of each ie:.η draftube 0.95, η turbine 0.7, η generator 0,95, turbine power is P = 3.92 [kW] So that the power generator the calculation results P = 3.5 [kW] per unit.

Generator MHP on the research capacity of 3 KW per unit. With existing data as follows:

Type	:	ST – 10	Cos φ	: 1.0
Power	:	3 KW	Exitasi Volt	: 80 Volt
Voltage	:	220 Volt	Exitasi current	: 2 Ampere
Current	:	13, 6 A	Frekuency	: 50 Hz
Rotation	:	1500 rpm	Standar	: Q/MDl001- 1998

3.2. Condition of MHP in the rain

During the rainy season from the field observation seen that the turbidity of water caused by soil sediment lifting is very influential on the quality of electric power generated. From table 1 it can be seen that from the mean value of voltage deviation V_d = 17, 6%, deviation of frequency fd = 6,8% and deviation of rotation nd = 6,8% at fluctuation of sediment concentration C = 2.551 -. 3.864 g/l The MHP conditions operate abnormally. Linear regression equation of the voltage V_{hDI} = 189.73 - 0.21 σc $_{hD1}$, frequency f_{hD1} = 47.86 + 0.023 σc $_{hD1}$ and rotation n_{hD1} = 1440.65 - 0.21 σc $_{hD1}$ to obtain the characteristic in figure 4:



Gambar 4. Karakteristik hubungan sd fluktuasi konsentrasi sediment σc dengan V, n dan f saat kondisi hujan tanpa pemodelan desain settling basin.

3.3. Modeling of Settling Basin Design I when it rains

By conducting a settling basin model it is expected to reduce the effect of sediment on MHP so as to obtain the quality of power supply which is within the limits of the feasibility standard at the desired frequency and voltage. Characteristics of Modeling of Design Basin Basin in rain.

Table 1 Parameter fluctuations in sediment concentration σc to Voltage (v), frequency (Hz) and round (rpm) when it rains

No sample	Sediment concentration fluctuations c (g/lt),	Sd C (g/lt), σc_h	Rotation turbine/gen n(rpm) n_h	frequency (Hz) f_h	Voltage Gen V (Volt) V_h
1	3.864	0.7690	1354.2	45.14	178.41
2	2.987	0.5945	1402.8	46.76	181.78
3	3.843	0.7648	1357.8	45.26	179.53
4	3.267	0.6502	1398.3	46.61	180.64
5	2.965	0.5901	1404.9	46.83	180.95
6	3.864	0.7690	1359.6	45.32	178.84
7	3.663	0.7290	1371.9	45.73	181.24
8	3.683	0.7330	1365.3	45.51	178.97
9	2.875	0.5722	1415.1	47.17	183.44
10	2.792	0.5557	1416.3	47.21	182.64
11	2.889	0.5750	1409.4	46.98	181.34
12	2.776	0.5525	1422.9	47.43	183.87
13	3.643	0.7250	1376.7	45.89	179.53
14	2.756	0.5485	1425.3	47.51	184.14
15	3.487	0.6940	1388.4	46.28	181.24
16	2.586	0.5147	1430.4	47.68	182.54
17	3.467	0.6900	1391.1	46.37	179.86
18	2.562	0.5099	1435.5	47.85	183.72
19	3.447	0.6860	1397.4	46.58	181.24
20	2.551	0.5077	1437.6	47.92	182.94

Table 1 Parameter fluctuations in sediment concentration σc to Voltage (v), frequency (Hz) and round (rpm) when it rains on Modelling design I

No sampel	Sediment concentration fluctuations c (g/lt)	sd C (g/lt) $\sigma c_{h D1}$	Rotation turbine /gen n(rpm) $n_{h D1}$	frequency (Hz) $f_{h D1}$	Voltage Gen V (Volt) $V_{h D1}$
1	1.952	0.330	1442.62	48.14	188.62
2	1.909	0.323	1441.67	48.16	192.82
3	1.905	0.322	1442.81	48.12	192.97
4	1.952	0.330	1442.75	48.21	191.53
5	1.956	0.331	1441.82	48.36	191.58
6	1.955	0.331	1442.45	48.25	190.73
7	1.953	0.331	1441.48	48.33	189.89
8	1.964	0.332	1441.27	47.78	190.32
9	2.045	0.346	1440.81	48.27	187.57
10	2.028	0.343	1440.17	47.98	189.78
11	2.009	0.340	1439.95	48.23	190.97
12	2.047	0.347	1440.73	47.89	189.36
13	2.077	0.352	1438.54	47.76	187.58
14	2.072	0.351	1439.16	47.97	189.76
15	2.064	0.349	1440.48	47.72	187.95
16	2.110	0.357	1439.65	47.93	188.29
17	2.188	0.370	1439.42	47.67	188.52
18	2.176	0.368	1438.28	47.95	189.78
19	2.172	0.368	1438.83	47.69	187.97
20	2.289	0.387	1438.73	47.61	187.21

From table 2 it can be seen that from the mean value of voltage deviation Vd = 14%, deviation Frequency fd = 4% and deviation of rotation nd = 4% at sediment concentration fluctuation C = 1.905 - 2.289 g / l, or from the fluctuation of concentration Sediment or standard deviation sediment concentration (σc) 0.322 - 0.387 (g / l). Where the MHP is still operating abnormally. From the measurement deviation voltage corrected 1.2%, frequency deviation and rotation corrected 1.1%. While reduced sediment concentration fluctuations in the range of concentration Sediment 0.646 - 1.575 (g/l). There is a decrease of sediment activity from the application of settling basin model I. In the linear regression equation of model design I on rain condition the equation of voltage $V_{hDI} = 189.73 - 0.21\ \sigma c_{hD1}$, frequency, $f_{hD1} = 47.86 + 0.023\ \sigma c_{hD1}$ and rotation $n_{hD1} = 1440.65 - 0.21\ \sigma c_{hD1}$ so its characteristic in figure 5.

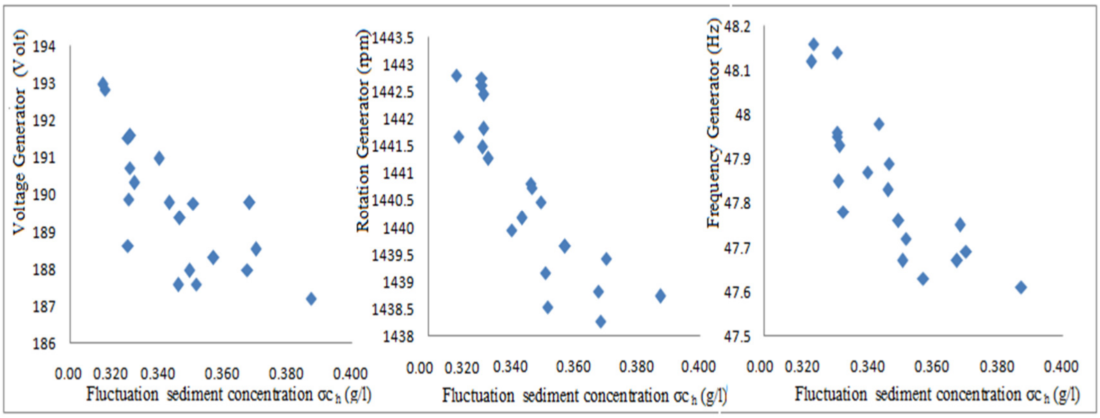


Figure 5 Characteristics of the relationship sd fluctuations in sediment concentration σc with V, n and f when rain conditions in modeling settling basin design I

3.4. Modeling of Settling Basin Design III when it rains

In model design III of rain condition, from table 3 it can be seen that from the mean value of voltage deviation V_d = 3%, deviation Frequency f_d = 1% and deviation of rotation n_d = 1% at fluctuation of sediment concentration C = 1.16 - 1.340 g/l, or with a standard deviation concentration of sediment (σc) 0.322 - 0.387 (g / l). Where the MHP has been operating normally. The linear regression equation of the voltage $V_{hD3} = 189.73 - 0.21\ \sigma c\ hd3$, frequency $f_{hD3} = 47.86 + 0.023\ \sigma c_{hD1}$ and rotation $n_{hD3} = 1440.65 - 0.21\ \sigma c_{hD3}$ characteristics as in figure 6 below.

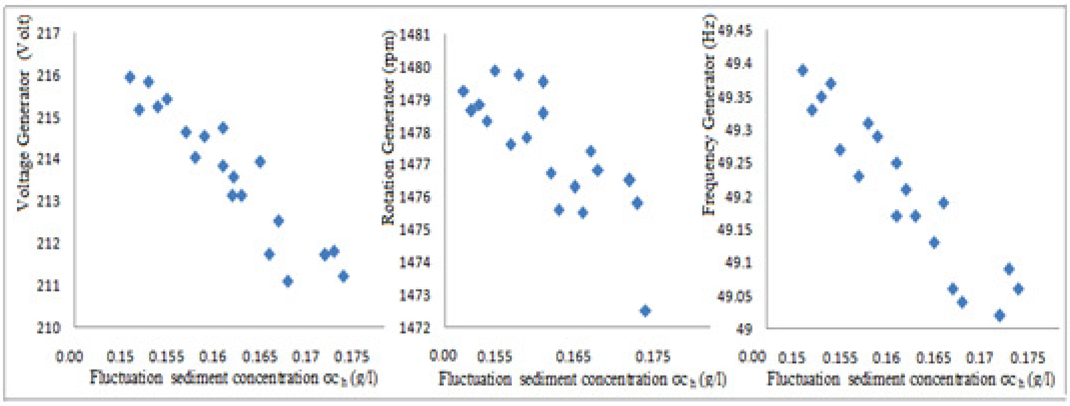


Figure 6. Characteristics of the relationship sd fluctuations in sediment concentration σc with V, n and f when rain conditions in modeling settling basin design III

Table 1 Parameter fluctuations in sediment concentration σc with Voltage (v), frequency (Hz) and round (rpm) when it rains on Modelling design III

No sampel	Sediment concentration fluctuations c (g/lt)	sd C (g/lt) $\sigma c_{h D1}$	Rotation turbine /gen n(rpm) $n_{h D1}$	frequency (Hz) $f_{h D1}$	Voltage Gen V (Volt) $V_{h D1}$
1	1.179	0.153	1478.85	49.35	215.83
2	1.171	0.152	1478.65	49.33	215.17
3	1.160	0.151	1479.25	49.39	215.94
4	1.188	0.154	1478.35	49.37	215.24
5	1.217	0.158	1479.75	49.31	214.04
6	1.209	0.157	1477.62	49.23	214.64
7	1.198	0.155	1479.89	49.27	215.42
8	1.223	0.159	1477.85	49.29	214.54
9	1.250	0.162	1476.75	49.21	213.14
10	1.241	0.161	1479.53	49.17	214.74
11	1.238	0.161	1478.57	49.25	213.84
12	1.259	0.163	1475.63	49.17	213.14
13	1.286	0.167	1477.41	49.06	212.54
14	1.277	0.166	1475.52	49.19	211.75
15	1.268	0.165	1476.31	49.13	213.94
16	1.323	0.172	1476.52	49.02	211.74
17	1.295	0.168	1476.83	49.04	211.11
18	1.323	0.172	1476.52	49.02	211.74
19	1.340	0.174	1472.51	49.06	211.23
20	1.335	0.173	1475.81	49.09	211.82

3.5. Calculation of Efficiency Settling Sediment Building (BPS)

To calculate the efficiency of Settling Sediment Building (BPS) which is a building of irrigation equipment in irrigation network spread along the irrigation networks of Gorontalo province from 5 Observation post. At observation post 01 Bone Bolango Regency the parameters obtained are:

Water height h = 1.19 m,

Cross section area A = 6,798 m2,

Flow velocity v = 0.94 m/s

The concentration of sediment input C_i = 0.776 g/l

Concentration of sediment output C_O = 0.271 g/l,

Thus Q = A x v x h = 3.966 m^3/s:

$Q_{Si} = Q_{Ci}$ = 3.966 x 0.776 = 3.101 kg/s;

$Q_{So} = Q_{CO}$ = 3.966 x 0.271 = 1.083 kg/s

Then the efficiency is EP = (3.101 - 1.083) / 3.101 x 100 = 65.08%

From 10 samples of measurement in the same way, the data obtained for the entire sample of Gorontalo Provincial Irrigation Channel BPS. From the observation of samples from 5 irrigation channel operational observation areas in Gorontalo province the level of BPS efficiency is still low, therefore the modeling of our design of settling basin In this research can optimize the operation of MHP on irrigation channel.

4. CONCLUSIONS

1. From research for MHP type open turbine flume propeller during rain without Modeling settling basin, that voltage deviation V_d = 17.6%, deviation frequency f_d = 6.8%, deviation rotation n_d = 6.8% on sedimentation concentration fluctuation C between 2.551 - . 3.864 g/l That is MHP abnormally operation.
2. Condition of MHP at Modeling of settling basin design I during rain that voltage deviation V_d = 14%, frequency deviation f_d = 4%, rotation deviation n_d = 4% on fluctuation of sedimentation concentration C Become reduced between 1,905 (g / l) and 2,289 (g/l) MHP is still again abnormal.
3. Condition of MHP at Modeling of Settling Basin Design III when rain. that voltage deviation V_d = 3%, frequency deviation f_d = 1% , rotation deviation n_d = 1% on fluctuation of sedimentation concentration C between 1.160 (g/ l) and 1.340 (g/l) MHP operating normally.
4. From the results of research which is the novelty value of this research is the fluctuation of the sedimentation concentration of C in the category for normal operation on the Open Flume Irrigation type turbine irrigation channel is on the sedimentation concentration value C = 1.16 - 1.340 g / l, where the MHP operates Under normal conditions.
5. Calculation result of efficiency of Sediment Settling Building (BPS) scattered along Gorontalo provincial irrigation networks from 5 stations observation of average efficiency is around 64.5%. So the results of this research is still needed.

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