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Pilot Plant of Water Treatment Unit for Flood Water becomes Clean Water with Pneumatic Flash Mix

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Abstract

Water is primary needs for human beings in any condition such as in disaster condition. More specifically in floods where water condition is abundant but cannot be consumed because it does not comply the existing quality standards. This pilot plant is based on the condition where the location of flood is quite difficult to be accessed and the energy resources are limited. In principle, this water treatment unit in the future is only intended to treat flood water. The process that occurs in this reactor was the coagulation and flocculation process which were done by batch system. Flash mix process using a pneumatic system and slow mix process using pedals were applied in this reactor. All process was done without involving the electrical energy, this was due to limited access to disaster conditions. At this stage, this pilot plant was proved to be effective for decreasing TDS and turbidity in flood water. The turbidity parameter showed the quality of raw water was 14.5 NTU and the treated water turbidity value was 6.51 NTU. Thus, the percentage of removal for turbidity parameter was 55,1%. The decline of turbidity affects the decrease of TDS value. The value of TDS in raw water was 135 mg / l while in the treated water was 1.27 mg / l. As a result, the percentage of TDS removal was 99.06%.

Keywords: *Disaster;Floods; Water*

1. Introduction

Water is the main resource needed in life. None of the living things in the world can survive without water. This water requirement is undeniably still needed in certain conditions, namely natural disasters [2]. There are current issues related to climate change that cause unpredictable changes in rainfall and increased development in Indonesia which causes a decrease in the environmental carrying capacity of hydrometeorological disasters such as putingbelievers, landslides, and flooding is a disaster that dominates. Based on national disaster management data (BNPB) in 2015, hydrometeorological disasters dominated up to 95% of the total disasters in 2015 totaling 1,681 incidents. Of the total 492 incidents that have been flooded, this indicates that floods reached 29% of the total national disasters that occurred in 2015. [4].

Provision of clean water needs in flood conditions becomes a problem that needs to be addressed. The provision of clean water in flood conditions is generally carried out using tank cars that have limitations in their use. Currently flood water treatment using membranes has begun to be developed but the use of membranes requires relatively greater energy, the cost of procurement is more expensive and goprasian which requires special expertise [1].

2. Theoretical background

This section discusses the basics used in this study

2.1. Water Conditions during Floods

Flooding, which is one of the hydrometeorological disasters, is a condition in which environmental conditions do not have sufficient carrying capacity due to the high rate of development and poor governance planning. Floods which are generally a flow of water above the surface of the soil cause suspended solids as the main principal of significant pollutants. [7]. In terms of quality, research has been carried out using a test pond filled with raw water and compared between conditions before rain and conditions after rain. In terms of the TDS parammeter, there has been a doubling of increase. So for other chemical parameters such as calcium, magnesium, and nitrate, the increase has doubled [5].

2.2. Drinking Water Quality

Drinking water quality refers to RI Minister of Health Regulation No. 492 / MENKES / PER / IV / 2010 in article 3 number 1 states that drinking water that is safe for health must meet physical, microbiological, chemical and radioactive requirements contained in mandatory parameters and additional parameters [6]. In this study the tests carried out on the final product are the physical and chemical mandatory parameters listed in Table 1. For additional parameters to be used in accordance with the conditions of the regional environmental quality. If there are parameters that exceed the water produced is not including drinking water and must go through the processing process.

Table 1: Mandatory Drinking Water Quality Parameters

No	Parameter	Unit	Max Level
	Parameters that relate directly to health		
	Microbiological parameters		
	1) E. Coli	Amount per 100 ml sample	0
	2) Total Coliform Bacteria	Amount per 100 ml sample	0
	b. An-organic		
1	1) Arsenic	mg/L	0,01
	2) Fluoride	mg/L	1,5
	3) Total Chromium	mg/L	0,05
	4) Cadmium	mg/L	0,003
	5) Nitrite, (as NO_2-)	mg/L	3
	6) Nitrate, (as NO_3-)	mg/L	50
	7) Cyanide	mg/L	0,07
	8) Selenium	mg/L	0,01
	Parameters that are not directly related to health		
	Physical parameters		
	1) Odor		-
	2) Color	TCU	15
	3) Total Dissolved Solids (TDS)	mg/L	500
	4) Turbidity	NTU	5
	5) Taste		-
	6) Temperature	°C	± 30
	b. Chemical Parameters		
2	1) Alumunium	mg/L	0,2
	2) Iron	mg/L	0,3
	Adequacy	mg/L	500
	4) Chloride	mg/L	250
	5) Manganese	mg/L	0,4
	6) pH	mg/L	6,5-8,5
	7) Zinc	mg/L	3
	8) Sulfate	mg/L	250
	9) Copper	mg/L	2
	10) Ammonia	mg/L	1,5

2.3. Flash Mix

Flash mixing in water treatment is to produce water turbulence. In general, fast stirring is stirring carried out on large speed gradients (300 to 1000 seconds-1) for 5 to 60 seconds or GTd (Camp Numbers) ranging from 300 to 1700. Specifically the G and TD values depend on the purpose or target of fast stirring [8].

2.4. Pneumatic stirring

Pneumatic stirring is stirring that uses bubble-shaped air (gas) as a stirring force. The bubble is put into the water and will cause movement in the water. Injection of pressurized air in water with a large bubble will cause turbulence in the water. The air flow used for fast stirring must have a large enough pressure to be able to suppress and move the water. The greater the air pressure, the greater the speed of air bubbles produced and the greater turbulence obtained [8]. At pneumatic stirring, the power generated is a function of the air flow injected which can be written as follows:

P=3904.Ga.Log[(h+10,4)/10,4]

With : P = Power, (N.M/s)

Ga = air discharge, m3/ minute

H = diffuser depth

3. Research Methods

The materials that will be used in this research are alum as coagulant and river water as raw material for replacing flood water. The tools used are reactors (150-liter drums), Manual Wind Pumps, modified wind pumps, measuring cups, stopwatches, 5-liter Jerigen thermometers, pH indicator paper, spectrophotometers.

3.1. Tool performance

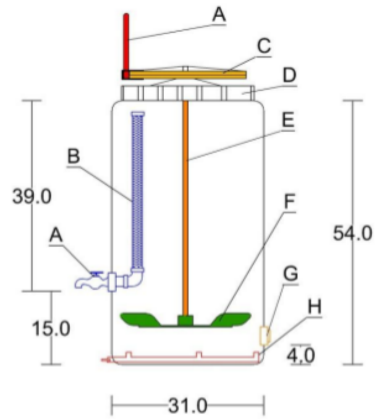

Fig. 1 : Reactor

The reactor used as a prototype for flood water treatment uses pesticide used PET plastic material that has been through a cleaning process. In Figure 4.2 it can be seen that the height of the reactor is 54 cm with a width of 3.10 cm, this size is very easy to carry out tool mobilization and storage. The letter A in the reactor shows that the water treatment tap which previously flowed through the porous pipe is shown in point B. The use of porous pipes at point B is intended so that the water does not flow directly to the faucet hole so that it can increase the flow velocity and disturb the floc formed in the coagulation process of flocculation. The function of this porous pipe is also a simple screening place using dakron cloth media. In addition to inhibiting the drainage in the pipe, the dacron function is also a simple filtering process when there are flocks carried in the water flow that experience the sedimentation stage.

Components that play a role in the stirring process are air pipes (H points) and slow mixing fans (point F). Fast stirring with the aim of stirring the coagulant to be evenly done pneumatically or by using air bubbles. Turbulence of air bubbles formed is expected to be able to assist the stirring process. Furthermore, slow stirring is carried out which is assisted using a mixing fan with 10 fan leaves (point F). fan rotation is affected by the force pivoting on the C wheel at the top of the reactor. C wheel rotation is assisted by lever () which is then channeled to iron E. So that iron E is the energy transfer medium used.

Of course the whole process cannot be 100% processed. Processed water faucets located 15 cm high from the bottom of the reacor besides functioning to avoid collision of the fan, this distance of 15 cm is also the space provided for the sludge produced. Sedimentation / residual water is discharged through drain holes (point G).

In general, it can be concluded that the process that occurs in this reactor is fast stirring, slow stirring, sedimentation and rapid screening carried out in batch process. Where Batch process is a process that takes place alternately and sequentially in the same container, so the calculation of processing debit uses its own approach.

Fig. 2: Reactor operation

4. Results and Discussion

Analysis of detention time is intended to determine how much time is needed for the sedimentation process. In the batch processing system the water stays in one container and undergoes various processes in turn, the detention time is the time needed to process the water from the beginning to the end of the process. In the initial stage process that has been described in next section, there is a process of entering water, alum weighing, pneumatic stirring and slow stirring. These processes are carried out for 10 minutes with the details listed in Table 2

Table 2: Time for each process

NO	Process	Time Required (minutes)
1	Insert water through a rough filter	5
2	Consider and put alum	3
3	Pneumatic stirring	1
4	Slow mix	2
Total		11

In Table 2 it can be seen that the time needed to enter water into the reactor through the filter is done for 5 minutes. The process of entering using a 1 liter folume measuring cup. the use of a measuring cup is intended at the same time to calculate the total volume of the reactor. From the filling process for 5 minutes the reactor is fully charged with a volume of 57 liters.

The results of the sampling were then placed in a 330 ml plastic container as can be seen in Figure 3. Visually it can be seen that the longer the settling time is given the lower the turbidity level produced (more clearly). Test results can be seen in Table 4.

Fig. 3: Results of the turbidity level testing were carried out using a spectrophometer with an NTU unit indicator

The results of the turbidity level testing were performed using a spectrophotometer with an NTU unit indicator. The results of the turbidity level testing were carried out using a spec-trophometer with an NTU unit indicator. Test results can be seen in Table 3.

In Table 3, the results of the analysis when graphed can be seen in Figure 4. In Figure 4 it can be clearly seen the length of time the sedimentation influences the existing NTU value. After being known the precipitation with the best NTU value is in sample number 7, which is precipitation for 35 minutes. So that the total detention time in this reactor can be seen in Table 4.

Table 3: Level of turbidity of treatment with different sedimentation times

Sample No.	Sedimentation time (minutes)	Turbidity (NTU)
1	5	19,2
2	10	13,8
3	15	12,8
4	20	12,1
5	25	9,03
6	30	9,01
7	35	8,85

In Table 3, the results of the analysis when graphed can be seen in Figure 4. In Figure 4 it can be clearly seen the length of time the sedimentation influences the existing NTU value. After being known the precipitation with the best NTU value is in sample number 7, which is precipitation for 35 minutes. So that the total detention time in this reactor can be seen in Table 4, the results of the analysis when graphed can be seen in Figure 4. In Figure 4 it can clearly be seen the length of time the sedimentation influences the existing NTU value. After being known the precipitation with the best NTU value is in sample number 7, which is precipitation for 35 minutes. So that the total detention time in this reactor can be seen in Table 4.

Table 4: Total operational time

NO	Process	Time Required (minutes)
1	Insert water through a rough filter	5
2	Consider and include alum	3
3	Pneumatic stirring	1
4	Slow stirring	2
5	sedimentation	35
	Total	46

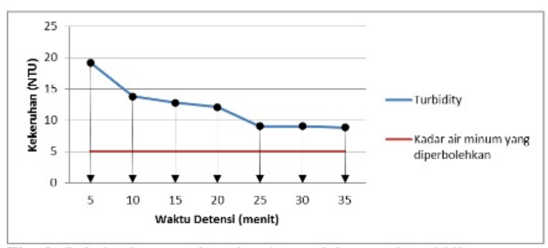

Fig. 4 : Relation between detention time and decrease in turbidity

4.1 Detention time and turbidity

The final sample that was used as a reference for the prototype performance was the result of 46 minutes detention time. After enough water is taken, then the water that can be used is calculated and the water that cannot be used (disposed of as sludge). Of the total 57 liters, the contents of the reactor 81.5% can be used as much as 46.7 liters. Whereas 18.5% which is as much as 10.5 liters is water that cannot be used and as a residue. So that the overall reactor discharge can be interpreted as 1.01 liters / minute.

4.2 Treatment results

The results of processing on this prototype as a whole have not been able to fulfill the requirements as drinking water. But the results of this study can provide some recommendations for further research that is better as the improvement of physical processing results can be seen in Figure 5.

Fig. 5: Comparison of Processed and Raw Water

The results of processing according to laboratory testing can be seen in Table 5. In Table 5 the tests carried out are physical and chemical aspects. For physical aspects, odor, taste, temperature, TDS, and DHL parameters have met. But for turbidity parameters (Tur-bidity) it still does not meet.

Table 5: Final Processing Results

Parameter	Unit	Method	Max Level	Raw Water	treated water
		Physics			
Smell		Organo-leptic	none	none	none
Taste		Organo-leptic	none	none	none
Tempera-ture	^{0}C		+- 30	29,2	29,2
TDS	mg/l	Elec-trodaly-sis	500	135	1,27
Turbidity	NTU	Pho-tometry	5	14,5	6,51
Electrical Conductivi-ty	μmhos/cm	Elec-trodaly-sis		271	84
		Chemical			
Iron	mg/l	Pho-tometry	0,3	0,21	0,39
Chloride	mg/l	Ti-trimetric	250	10	30
Nitrite as NO2	mg/l	Pho-tometry	3	0,07	0,07
Cupri (Cu)	mg/l	Pho-tometry	2	0,2	0,16
Manganese	mg/l	Pho-tometry	0,4	0,09	0,18
pH		Pho-tometry	6,5-8,5	7,6	6,5

In this turbidity parameter, raw water has a turbidity value of 14.5 NTU and the treated water had a turbidity value of 6.51 NTU. So that it can be seen that the percentage of removal for turbidity parameters is 55.1%. The decline in turbidity affects the decline in the TDS value. TDS value in raw water is 135 mg / l while in processed products is 1.27 mg / l. so the percentage of TDS removal reached 99.06%. As for the chemical aspect, the iron parameters entered at the limit do not meet the quality standard.

5. Conclusion

Optimal detention time was carried out for 46 minutes with details, inserting 5 minutes water, 3 minutes alum weighing, 1 minute pneumatic stirring, 2 minutes slow stirring, and 35 minutes precipitation. The coagulant dose used in this process is 360 g, but the coagulant dose will change depending on the level of turbidity of the raw water. Removal process occurs in the parameters of turbidity and TDS with a turbidity percentage of 55.1% and TDS removal percentage of 99.06%.

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