Waste Treatment Design at Sugar Factory

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Abstract

Waste is a by-product resulting from a process. Waste if disposed of freely without prior processing can harm the surrounding environment. Proper waste management makes waste more friendly to the environment. There are even several categories of waste that can be reused. A sugar factory is a company that processes sugar cane into crystal sugar that can be used for cooking. At the sugar factory, there are problems that occur, namely the absence of waste processing that is produced as a by-product of the production process. Therefore, in this research, the design of by-products of the sugar production process is carried out. after the waste treatment design was made in the sugar factory, parameters such as pH, BOD, COD, TSS, Oil and Fat, Sulfide, which was previously harmful to the environment, has met quality standards after processing.

***Keywords**: Waste Treatment Design, Sugar Waste, Waste Parameters, Quality Standards, Environmentally Friendly.*

A. INTRODUCTION

The total population in Indonesia continues to increase (Sari and Rofiuddin, 2022). The increasing population in Indonesia automatically increases the demand for some products (Sarkodie et al., 2019). Sugar is no exception, which is also experiencing an increase in demand (Mouloudj et al., 2020). Sugar is an important commodity in Indonesia (Sulaiman et al., 2019; Hadi et al., 2019; Widyasari et al., 2022). Because sugar is a product that is consumed by almost everyone. Everyone needs sugar. Starting from food (Snetselaar et al., 2021) to drinks (Pomeranz and Harris, 2020) must contain sugar. Especially now that there is a widespread sale of food and drinks with high sugar content such as cakes (Bayram and Ozturkcan, 2022), puddings (Djaoud et al., 2020), coffee (Iriondo-DeHond et al., 2020), chocolate (Faccinetto-Beltrán et al., 2021), juices and the like (Sundborn et al., 2019). With the increasing number of sales of products that require sugar, the demand for sugar will automatically increase (Roberto et al., 2021). Increasing demand for sugar forces sugar companies to increase their sugar production (Sanghera and Jamwal, 2020).

In recent years, with the increasing amount of production all the time, it has had a very large impact on the environment. Increased production also automatically increases the amount of waste as a by-product generated (Ruiz et al., 2019). Waste from this production process is very dangerous to the environment if it is directly disposed of without going through a processing process (Rao and Rathod, 2019). Without prior processing, the resulting waste can cause damage to the biota where the waste is disposed of (Fu et al., 2020).

Due to the problems that occur, this research will design a wastewater treatment plant at one of the sugar companies located in East Java. The reference used in this study is Governor Regulation Number 52 of 2014 concerning wastewater quality standards for industry and/or other business activities in East Java.

According to East Java Governor Regulation No. 52 of 2014 industrial liquid waste may be disposed of freely after it has the following characteristics and quality standards. However, this value still does not meet these regulations. These characteristics include:

1. BOD (Biological oxygen demand)
   Biological oxygen demand (BOD) is the amount of oxygen required to decompose organic matter by aerobic bacteria through biological processes (biological oxidatioan) in aerobic decomposition. The BOD number describes the amount of oxygen needed by bacteria to decompose (oxidize) almost all dissolved and partially suspended organic compounds in water (Omer, 2019). The BOD content of sugar waste is 1500 mg/l, while the quality standard that regulates the amount of BOD content that is allowed to be discharged into the environment is 60 mg/l.
2. COD (Chemical oxygen demand)
   COD or chemical oxygen demand is the amount of oxygen needed to codify organic matter. The COD number is a measure of the water pollutant load by organic substances which can naturally be oxidized through microbiological processes and results in reduced oxygen conditions in the water (Liu et al., 2019). The COD content of sugar waste is 2000 mg/l, while the quality standard that regulates the amount of COD content that is allowed to be discharged into the environment is 100 mg/l.
3. TSS (total suspended solids)
   TSS in wastewater contains sand, clay and organic matter. If TSS is discharged into water bodies it will increase turbidity in the water and if it is at the bottom of the waters it will interfere with the breeding process of aquatic animals. The permissible TSS is 50 mg/l. Meanwhile, the TSS currently produced is 300 mg/l.
4. Oil and fat
   The oil and fat content of waste water from the sugar industry is 15 mg/l, while based on quality standards the amount of oil and fat that is allowed to be discharged into the environment is 5 mg/l.
5. Sulfide (H_2S)
   The H_2S content of wastewater from the sugar industry is currently 3 mg/l, while based on quality standards the amount of H_2S allowed to be discharged into the environment is 0.5 mg/l. Hydrogen sulfide (H_2S), is a colorless, toxic, flammable gas and smells like rotten eggs. This gas can arise from biological activity when bacteria decompose organic matter in a state without oxygen (anaerobic activity), such as in swamps and sewage. This gas also appears in gas arising from volcanic activity and natural gas.

6. pH (Degrees of Acidity)
   Is a term to express the intensity of the acidic or basic state of a solution. The quality standard regulates the amount of pH content that is allowed to be discharged into the environment, which is 6 to 9. The pH content of sugar industry waste is currently still 3 mg/l.

B. METHOD

Figure 1 below is the flowchart used in this research:

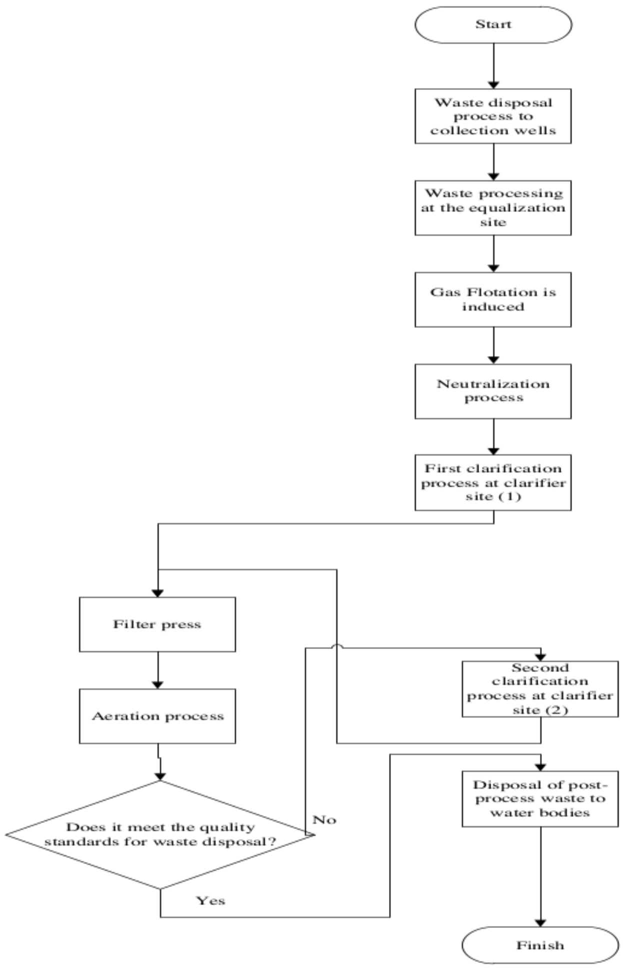

Figure 1. Flowchart

The following are the steps followed in waste treatment (Metcalf, 2014):

1. Waste disposal process
   The waste disposal site is a balancing unit, so that the debit and quality of the waste entering the installation is constant. Pumps are needed to drain the waste from this first site to the next treatment unit.

2. Primary treatment

   This primary treatment can reduce BOD between 25-30% and also TSS between 50-60%.

   a. Waste processing at equalization site
   b. It is useful for settling coarse grains and is a balancing unit, so that the discharge and quality of wastewater entering the treatment plant are in a balanced state and do not fluctuate.
   c. Flotation
   d. It is used to separate suspended particles, such as oil, grease and other floating materials contained in wastewater with a flotation mechanism. Flotation cells can be rectangular or cylindrical in shape. The sizes of flotation Cells should be:
      1). 2 gal/min/ft2 without Coagulant
      2). 4 gal/min/ft2 with Coagulant
      3). Flotation Cell Area: 15 ft2 – 250 ft2 or with a capacity of 2000 BWPD – 3500 BWPD
   e. Neutralization

      Industrial wastewater can be acidic or alkaline. This process aims to change the pH of wastewater to 6.5 – 8.5 so that the biological treatment unit can be optimal.
   f. Clarification process

      Used to separate suspended and dissolved solids from liquids using a gravity system with the condition that the horizontal velocity of the particles cannot be greater than the settling velocity. The skimmer in 1st clarifier site is used to overflow floating fats and oils.

3. Secondary treatment

   Secondary treatment will separate the colloidal and dissolved organic components using biological processes. This biological treatment process is carried out aerobically or anaerobically with a reduction efficiency of BOD between 75 - 90% and 90% TSS. One way of secondary processing is the aeration process. Before going through the aeration process, the waste is put into the filter press. The main function of this filter press is to separate the two different phases by means of a filtration process using wind pressure and filter cloth. The water or liquid to be separated from the slurry phase is pumped into the filter press to pass through the membrane. Dirt or sludge will be left on the cloth, while the clean or desired liquid will be filtered and exit through the capillary tube connected to the filter cloth.

4. Tertiary Treatment

   If in the first and second processing, a lot of certain substances are still dangerous for the general public, this tertiary processing is done. Tertiary processing is carried out at 2nd clarifier site.

C. RESULT AND DISCUSSION

The following is the result obtained from the calculation sewage treatment plant specifications:

1. Collector's Well

   The collecting well is rectangular in shape with specifications:

   a. Length = 4 m
   b. Width = 2 m
   c. Freeboards = 0,5 m
   d. Height = 3,5 m
   e. Inlet pipe = 0,2 m
   f. Outlet pipe = 0,2 m
   g. Pump with characteristic: Hf pump = 4,2 m, centrifugal pump type, obtained performance curve brand grundfos NK 100 – 200, 50 Hz, n = 970 min-1 ISO 2548 Class C, D suction pipe = 0,177 m, D discharge pipe = 0.177 m, Pump power (P) = 0.44 kW.

2. Equalization Tub

   The Equalization tub is rectangular in shape with specifications:

   a. Length = 6 m
   b. Width = 3 m
   c. Freeboards = 0,5 m
   d. Height = 4,5 m
   e. Inlet pipe = 0,2 m
   f. Outlet pipe = 0,2 m
   h. Pump with characteristic: Hf pump = 4,2 m, centrifugal pump type, obtained performance curve brand grundfos NK 100 – 200, 50 Hz, n = 970 min-1 ISO 2548 Class C, D suction pipe = 0,177 m, D discharge pipe = 0.177 m, Pump power (P) = 0.44 kW.

3. Induced Gas Flotation

   Using one unit of induced gas flotation model H-20D with specifications:

   a. Length = 6,7 m
   b. Width = 2,7 m
   c. Height = 2,1 m

4. Neutralization site with spesifications below:

   Adding site:

   a. Diameter = 0,3 m

b. H = 0,45 m
c. Freeboard = 0,5 m

Flat blades:

a. Diameter = 0,15 m
b. Width = 0,075 m

With H is the difference in water level in the sewer and on the site

a. Neutralization site:
   1). Diameter = 0,8 m
   2). Width = 1,2 m
   Flat blades:
   1). Diameter = 0,4 m
   2). Width = 0,08 m
b. Inlet pipe = 0,2 m
c. Outlet pipe = 0,2 m

5. First clarification site

   This site is in circular site and using one clarifier tank with specification:
   a. Settling zone with diameter 7,3 m, inlet wall diameter 1,1 m, and depth 4 m.
   b. Inlet zone with inlet pipe 2m, and perforated wall with diameter 0,1 m and there is 14 holes.
   c. Outlet zone with 30 V notes, depth 0,018 m, and 0,036 m long.
   d. Sludge zone with top surface diameter 7,3 m, bottom surface diameter 2 m, depth 1,84 m, outlet pipe 0,2 m, and sludge pipe 0,2 m.
6. Aeration

   Using surface aerator and 2 aeration tank with rectangular shape and the dimensions: 3m in depth, 0,3 m freeboard, 15,4 m wide, and 30,8 m length, and the capacity of survace aerator is 0,83 m3/s, total 4 aerators and 2 for spare, with inlet 1 m in hight, 27,1 length, and outlet zone with 0,43 width, and 0,73 depth, with 0,2 m inlet pipe, 0,2 m outlet pipe, Length of outlet pipe from Aeration building to Clarifier is 10 m, with 0,07 resirculation's pipe.
7. Second clarification site

   This site is in circular site and using one clarifier tank with specification:
   a. Settling zone with diameter 8,7 m, height 0,4 m, inlet wall diameter 1,3 m, and freeboard 0,5 m.
   b. Inlet zone with inlet pipe diameter 0,2 m
   c. Outlet zone with top survace diameter 0,2 m.
   d. Sludge zone with top surface diameter 8,7 m, bottom surface diameter 2 m, drain pipe lentg 0,08.
   e. Thickening zone with 1,54 in depth, depth in the middle of the tub is 0,4 m, with 1,125 in slant.
   f. Outlet zone with distance between v notches is 0,5 m, there is 55 v notes, with H 0,037 m. Total overflow length is 4,07 m with H 0,14, 0,28 B, and 0,16 outlet pipe

8. Filter press. One unit filter press is used with capacity of 4,445 m^3. 7,5 kW in power, maximum 125 plates that run automatically.

   The post-process waste produced has specifications as shown in Table 1 below:

Table 1. Post Process Waste Specifications

No.	Parameter	Quality Standards (mg/L)	Efluent
1	pH	6-9	6
2	BOD	60	60
3	COD	100	100
4	TSS	50	21
5	Oil and Fat	15	1,5
7	Sulfide	0.5	0,45

Based on Table 1, obtained that referring to the applicable quality standards, it can be seen that the post-process waste produced meets the safe criteria to be disposed of into the environment.

D. CONCLUSION

The conclusions drawn from this research include that the sugar industry waste processing building uses processing buildings, namely: Reservoir Tank, Equalization Tub, Induced Gas Flotation, Neutralization, Sedimentation Tub 1, Aeration, Sedimentation Tub 2. From the building flow chart that is made, the waste obtained after going through the processing have met the quality standards so that they are safe when disposed of into the environment.

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