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CALCULATION OF MASS BALANCE OF CRUDE OIL TANK (COT) AT PT. XAZ

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ABSTRACT

Palm oil is a triglyceride, which is a glycerol compound with fatty acids that can be obtained from the mesocarp of oil palm fruit. CPO is produced from a long process, starting from a weighbridge to palm oil pressed, which is purified at the Purification (Clarification) station. Crude Oil Tank accommodates crude oil filtered from the vibrating screen which functions to reduce NOS (Non Oil Solid) and increase heat. The presence of impurities and high water content in the oil will affect the total composition and output rate of CPO production, so that it is not in accordance with the design of the mass balance. Mass balance calculations are used to obtain the mass of input and output from the palm oil production process. This Percentage of oil entering CST from Crude Oil Tank processing with crude oil feed amounting to 1,770,048 kg/week with an oil percentage of 43,9603614458%, water percentage 19,8631807229% and Sand 36,176457831%. The bottom flow rate from Crude oil tank to Solution Tank is 10.536 kg/Hour with a percentage of 1,70% oil, 26,39% of Water percentage and 71,91% of Sand of 576 Kg/Hour.

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1. INTRODUCTION

Crude Palm Oil (CPO) or crude palm oil is one of the mainstay agricultural commodities in Indonesia. CPO produced from palm oil processing goes through a long process, starting from the weighbridge, sorting the fruit, the process of boiling the fruit, the threshing process, the pressing process, the refining process and the kernel processing process. To achieve efficient results in CPO processing, it is necessary to design a mass balance process[1]. The mass balance in the palm oil production process is a quantitative calculation of all incoming, outgoing and wasted materials or by-products. The oil refining station plays an important role in the CPO production process, because in this process a lot of oil losses occur if it is not operated and cared for properly (Sand trap tanks, oil vibrating screens, crude oil tanks, continuous clarifier tanks, vacuum dryers)[2]. The Crude Oil Tank has the main function of collecting oil from the vibrating sieve before it is pumped to the voorscheider or oil settling tank, which is placed right under the vibrating sieve, so that the oil from the vibrating sieve is immediately accommodated[3]. Crude Oil Tank is the initial stage in the refining process which will then be pumped to the continious settling tank for further purification process. The presence of adhering impurities and high water content in the oil will affect the quality of the CPO that will be produced and also affect the amount of output composition and the output flow rate of CPO production[4].

2. RESEARCH METHOD

2.1 Palm oil

Oil palm is the largest vegetable oil producing plant among other vegetable oil producing plants (soybean, olive, coconut and sunflower). Broadly speaking, oil palm fruit consists of fruit flesh which can be processed into CPO (Crude Palm Oil) and the core (kernel) which can be processed into PKO (Palm Kernel Oil)[5].

2.2. Palm oil

Palm oil is a triglyceride, which is a compound of glycerol with fatty acids. Palm oil belongs to the oleic-linoleic acid oil group. Palm oil comes from the extraction of the mesocarp of the palm fruit (Yustina & Rahayu, 2014), which is continued in the refining and fractionation stages[6].

2.3. Palm Oil Quality Standards

The quality of palm oil can be determined by assessing its physical properties. In this case the quality requirements are measured based on international quality standard specifications which include levels of Free Fatty Acids, Water, impurities, ferrous metals, copper metals, peroxides, and the size of bleaching. As for the quality of palm oil. According to the CPO quality standard (SNI 01-2901-2006), the required quality standard is for Free Fatty Acid (ALB) to have a maximum threshold value of 5%, a maximum impurities content of 0.5%, and a maximum moisture content of 0.5%. Based on these requirements, generally Indonesian CPO meets the criteria to be exported[7].

Table. 1 Quality of CPO Oil PT. XAZ

No.	Normal Oil Quality Parameter	(%)
1	Free Fatty Acid	3.00
2	Moisture Content	0,150
3	Dirt Content	0,020

2.4. The Process of Processing Fresh Fruit Bunches into CPO (Crude Palm Oil)

The processing of palm oil into CPO and palm kernel goes through a long process. The process of processing palm oil into CPO consists of several main stations, namely:

1. Fruit Receiving Station
2. Boiling Station (Sterilizer)
3. Thresher Station
4. Enumeration and Pressing Station (Digester and Pressing Station)

5. Oil Purification Station (Clarification station)
6. Seed Station (Kernel station)[8]

2.5. Crude Oil Tanks (COT)

Crude oil tank or RO tub is a crude oil storage tank filtered from a vibrating screen which functions to reduce NOS (Non Oil Solid) and increase heat.

Heating is done using direct steam injection until it reaches a temperature of 90-950C. This tool, which is also known as RO Bak, consists of several parts including an inlet channel which functions as a channel to enter oil, an oil gutter which functions as an inlet oil, tank bodies that function as walls in crude oil tanks, This Crude Oil Tank consists of 3 partitions which function to separate oil from dirt, and an oil pump which functions to pump oil to the CST (Continuous Settling Tank). This tank is equipped with a faucet to remove sludge or sand that has settled at the bottom of the tank. The working principle of the COT is that with an overflow system, crude oil after going through the vibrating screen enters the tank, inside the tank there is a partition so that oil will overflow through the bulkhead and will then be pumped to CST[9].

The difference with the Vibrating Screen is that in the vibrating screen the separation is carried out by vibrating sieve through a mesh of a certain size. While the working principle of separation in the Continious Settling Tank is to utilize the force of gravity so that a layer of oil, water and sludge is formed. Because of the Crude Oil tank oil, tank bodies that function as walls in crude oil tanks, This Crude Oil Tank consists of 3 partitions which function to separate oil from dirt, and an oil pump which functions to pump oil to the CST (Continuous Settling Tank). This tank is equipped with a faucet to remove sludge or sand that has settled at the bottom of the tank[10].

The working principle of the COT is that with an overflow system, crude oil after going through the vibrating screen enters the tank, inside the tank there is a partition so that oil will overflow through the bulkhead and will then be pumped to CST. The difference with the Vibrating Screen is that in the vibrating screen the separation is carried out by vibrating sieve through a mesh of a certain size. While the working principle of separation in the Continious Settling Tank is to utilize the force of gravity so that a layer of oil, water and sludge is formed. Because of the Crude Oil tank The main function of the oil tank is to collect oil from the vibrating sieve before it is pumped to the voorscheider or oil settling tank, which is placed right under the vibrating sieve, so that the oil from the vibrating sieve is immediately accommodated. Oil separation is more perfect if the oil heat is maintained at 90°C, therefore in the COT a heating coil pipe is installed. Heating is done with closed steam and open steam. The use of direct steam (open pipe) on the oil will cause several things:

a. Emulsion Formation, direct application of steam to the oil (the end of the pipe is in the tank) can cause the formation of an oil emulsion which is very difficult to separate in the next separator.
b. Increase in Viscosity of Liquids. Giving steam directly can cause shocks which cause fine particles to float again in the oil liquid, and increase the viscosity of the liquid so that the separation of oil and non-oil fractions is increasingly difficult.
c. Mist Removing, The use of direct open steam will emit steam in the form of fog so that it can affect the operator's peace of mind, and the effect is felt on the processing unit which is next to the tool[11].

Heating with an open pipe is often done to speed up the heating of the oil, because the temperature of the oil that comes out accelerates the heating of the oil, because the temperature of the oil that comes out of the oil gutter very low, which may be due to the introduction of low-temperature dilution water in the screw press. To maintain the retention time of the liquid in the COT, it is necessary to regularly remove sludge and water from the bottom layer of the tank by pumping it into a solution tank, and if it is discharged into the ditch, oil loss occurs because the oil attached to the mud is still high. Providing heat to the Crude Oil Tank (COT) aims to reduce the water content in CPO and to facilitate the separation of oil from sludge or other impurities. An increase in water content can damage the quality of CPO because water can cause a hydrolysis reaction in CPO which will also increase the free fatty acid content in CPO. Therefore, each tool at the clarification station is given hot steam which aims to reduce the water content[12].

2.6. Oil Losses

Oil losses are losses of palm oil during the production process. High levels of oil losses affect the efficiency of processing production, especially in the design efficiency of the mass balance which will cause losses. The large number of oil losses in the palm oil processing process results in production results that have been targeted through the design of the mass balance not suitable, this is due to equipment that does not have optimal design capability and capacity.

3. RESULTS AND DISCUSSIONS

3.1 Place and time of research

Research conducted at PT. XAZ, especially at the Clarification station located in Batang Terap village, Tebing Tinggi, Kec. Perbaungan, North Sumatra. Field work practice at PT. XAZ begins on 28 June 2021 and ends on 31 July 2021.

3.2 Data collection

Data collection was carried out secondary by taking data from the log sheet at the clarification station at PT. XAZ. In the implementation of practical work, materials and methods related to the main issues are as follows:

Material

1. Equipment Used
   a. Tools used in the Field
      1) Crude Oil Tanks
      2) Dipper
      3) Sample Bottle
   b. The tools used in the laboratory, namely:
      1) Foss NIRS DA1650
      2) Large Cup Sample Test
      3) Cover the Sample Test Cup
      4) Materials Used
         a) Crude Oil
         b) Steam
         c) Sludge Drain

Working Method

The methods used in conducting research, such as:

a. Study Literature

Literature Study is a literature study which includes a literature review section as a reference theoretical basis and formulas used from various sources of scientific work, such as Journals, Final Work, and Books related to this Final Work.

b. Field Observations

In conducting direct field observations, the following methods were carried out:

1) The author together with the field supervisor to study the process of processing Fresh Fruit Bunches into Crude Palm Oil.

2) Observing the problem object, namely the CPO refining process at the Clarification station, especially the Crude Oil Tank
3) Processing the data to be taken in accordance with the subject matter
4) Conduct discussions with relevant supervisors regarding how to obtain data
5) The data is obtained by direct reading on the device

c. Methods in the laboratory

Percentage of water, oil and sand content using Foss NIRS DA1650

1. Samples are taken and put into a 250 ml sample bottle
2. The Foss NIRS tool cover is opened
3. The sample is put into the large sample test cup, and covered with a sample test cup cover on the top so that no light enters
4. The Foss NIRS tool is closed
5. Selected in the selection panel in the "Centrifuge (vibro)" section
6. Wait for 10 minutes until the results appear on the monitor screen of the Foss NIRS tool
7. Record the results of the Foss NIRS tool analysis as data for the percentage of water, oil and sand content
8. Equal treatment for all samples

Provide a statement that what is expected, as stated in the "Introduction" chapter can ultimately result in "Results and Discussion" chapter, so there is compatibility. Moreover, it can also be added the prospect of the development of research results and application prospects of further studies into the next (based on result and discussion).
The formula used in data analysis is as follows:

1. Total Mass Balance (Input = Output)

$F_1 = F_2 + F_3$

2. Component mass balance

Component 1 = $F_1 . W_{11} = F_2 . W_{21} + F_3 . W_{31}$
Component 2 = $F_1 . W_{12} = F_2 . W_{22} + F_3 . W_{32}$
Component 3 = $F_1 . W_{13} = F_2 . W_{23} + F_3 . W_{33}$

Information:
F_1 = CPO Flow Rate from Vibrating screen
W_{11} = Weight of oil at F_1
W_{12} = Weight of water at F_1
W_{13} = Weight of Sand on F_1
F_2 = Flow Rate of COT output to CST
W_{21} = Weight of Oil at F_2
W_{22} = Weight of Water at F_2
W_{23} = Weight of Sand at F_2
F_3 = Bottom Flow Rate
W_{31} = Weight of Oil at F_3
W_{32} = Weight of Water at F_3
W_{33} = Weight of Sand at F_3

4.1. Observation data

The data obtained at PT. XAZ are data on 5 July, 12 July and 19 July. The data obtained are as follows:

Table 2. Observation Data Process Conditions and Mass Rate in the COT Unit

No.	**Speed In *Crude Oil* (Kg/Hour)**	**Speed Out**

		Crude oil (Kg/Hour)
1.	10.536	9.960
2.	10.536	9.960
3.	10.536	9.960

No.	Temperature		
	Crude Oil (°C)	*Crude Oil to CST*(°C)	*Drain* (°C)
1.	90	90	90
2.	90	90	90
3.	90	90	90

Table 3. Data on Oil Content, Moisture Content and Sand Content

No.	Output		
	Crude Oil (%)		
	oil	Water	*Sand*
1.	41,65	20,22	38,13
2.	41,65	20,22	38,13
3.	41,66	20,22	38,12

No.	Output		
	Drain (%)		
	oil	Water	*Sand*
1.	1,70	26,39	71,91
2.	1,70	26,40	71,90
3.	1,70	26,40	71,90

(Source: PT. XAZ, 2021)

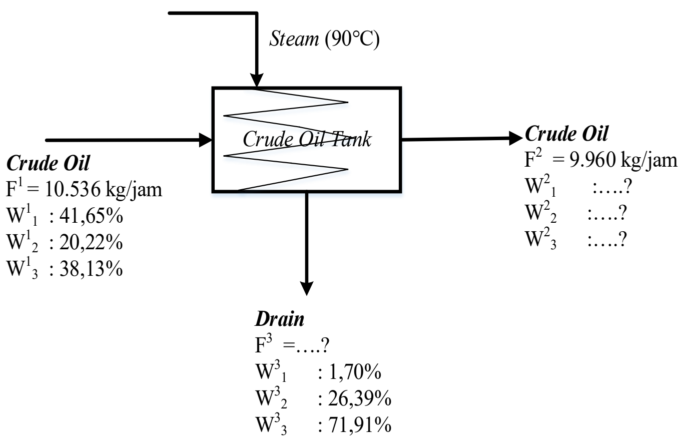

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Figure 1. Schematic of Mass Balance Flowchart in Crude Oil Tank

4.2. Mass Balance Calculation

1. Total Mass Balance (*Input* = *Output)*

$F^1 = F^2 + F^3$

$10.536 \text{ kg/Jam} = 9.960 \text{ kg/Jam} + F^3$

$F^3 = 576 \text{ kg/Jam}$

2. Component Mass Balance

a. Oil Mass Balance

$F^1 . W^1_1 = F^2 . W^2_1 + F^3 . W^3_1$

$10.536 . (41,65\%) = 9.960 . (W^2_1) + 576 . (1,70\%)$

$4388,244 = 9.960 . (W^2_1) + 9,792$

$4388,244 - 9,792 = 9.960 . (W^2_1)$

$\frac{4378,452}{9.960} = W^2_1$

$W^2_1 = 0,43960361446 .(100\%)$

$W^2_1 = 43,9603614458 \%$

2.1. Neraca Massa Air

$F^1 . W^1_2 = F^2 . W^2_2 + F^3 . W^3_2$

$10.536 . (20,22\%) = 9.960 . (W^2_2) + 576 . (26,39\%)$

$2130,3792 = 9.960.W^2_2) + 152,0064$

$2130, 3792 - 152,0064 = 9.960 . (W^2_2)$

$\frac{1978,3728}{9.960} = W^2_2$

$W^2_2 = 0,1986318072 .(100\%)$

$W^2_2 = 19,86193180723 \%$

2.2. Neraca Massa *Sand*

$F^1 . W^1_3 = F^2 . W^2_3 + F^3 . W^3_3$

$10.536 . (38,13\%) = 9.960. (W^2_3) + 576 . (71,91\%)$

$4017,3768 = 9.960. (W^2_3) + 414,2016$

$4017, 3768 - 414,2016 = 9.960 . (W^2_3)$

$\frac{3603,1752}{9.960} = W^2_3$

$W^2_3 = 0,3617645783 .(100\%)$

$W^2_3 = 36,176457831 \%$

4.3. Balance of incoming and outgoing masses

The following is the mass balance in and out of the Crude Oil Tank unit for the first data

Table 4. Balance of Mass In and Mass Out

Composition	**Incoming Mass (Kg/Jam)**	**Exit Mass (Kg/hour)**	
	Crude Oil	***Crude Oil***	***Drain***
Oil	4388,244	4378,452	9,792
Water	2130,3792	1978,3728	152,0064

Sand	4017,3768	3603,1752	414,2016
Subtotal	10.536	9.960	576
Total	Input = 10.536	Output = 10.536	

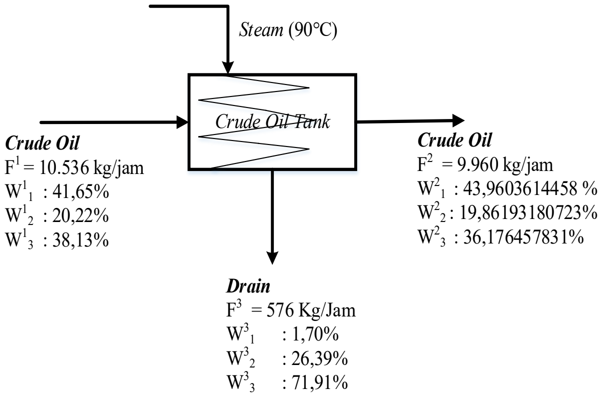

Figure 2. Balance of mass in and out

Crude palm oil produced from the pressing process still contains impurities so it must be purified through a clarification station. The filter results from the vibrating screen will be put into the Crude Oil Tank which functions to reduce the Sand content. The working principle of the COT is that with an overflow system, crude oil after going through the vibrating screen enters the tank, inside the tank there is a partition so that oil will overflow past the 3 partitions and then will be pumped to CST. With a size of 12 M3, the oil retention time is relatively short (30-45 minutes) so that it functions more to precipitate large particles such as sand (particles measuring 0.0074 mm-5 mm). Meanwhile, separating fine particles (<1 mm) was less successful. Oil separation is more perfect if the oil heat is maintained at 90°C, therefore in the COT a heating coil pipe is installed. Heating is done with closed steam. Then, the oil from the COT is sent to the settling tank (continuous settling tank/clarifier tank).
The percentage of oil that enters CST from the Crude Oil Tank processing on July 5, based on the amount of crude oil feed that enters is 10,536 kg/hour with an oil percentage of 43.9603614458%, a percentage of water as much as 19.863180723% and sand 36.176457831% . To maintain the quality of the retention time of the liquid in the COT, it is necessary to regularly remove sludge and water from the bottom layer of the tank by pumping it into a solution tank. The bottom flow rate from the Crude oil tank to the Solution Tank from the Crude Oil Tank processing on July 5, based on the amount of crude oil feed that enters is 10,536 kg/hour with an oil percentage of 1.70%, a percentage of water of 26.39% and sand. 71.91% is 576 Kg/Hour.

4. CONCLUSION

From the results of the discussion of data analysis that has been carried out, the following conclusions can be obtained:
1. Total water content from COT (Crude Oil Tank) to CST is 19.8631807229%, oil content is 43.9603614458%, and sand is 36.176457831%
2. The bottom flow rate of the Crude Oil Tank is 576 Kg/Hour

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