Analysis of Quality Control of Avtur Fuel in The Storage Tank at PT. XYZ on The Value of Electrical Conductivity During Covid-19

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Abstract. In the process of receiving Avtur/Jet A-1 by PT. XYZ, the product received often does not meet the specification standard on the Electrical Conductivity. To overcome, doping Stadis 450 was carried out which could increase the Conductivity Unit. In the doping process, there are inefficiencies in the use of the Stadis 450. The result obtained indicates that all the final CUs are not following the CU target with an average difference of 41.67 pS/m. Also, the current pandemic conditions have resulted in the stockpiling of Avtur/Jet A-1 in the stockpile tank for a longer time. So that PT. XYZ increases the CU target in the doping process so the CU value can be appropriate when used. Determination of CU targets in trial and error without standard considerations will lead to waste in the use of Stadis 450 and increase the potential for discrepancies that occur in the doping process. To minimize, a reduction in CU Avtur/Jet A-1 is calculated as one of the suggestions in considering the CU target to be achieved. The result of the observed decline based on hoarding data showed that there was an average decline of 6.4646 pS/m per day.

Keywords: Quality Control, Avtur/Jet A-1, Electrical Conductivity, Stadis 450

1 Introduction

PT. XYZ is one of the companies included in the downstream business sector within the aviation fuel business scope. PT. XYZ has the role and responsibility to receive, store and distribute Avtur/Jet A-1 received from Tankers to Airports. To carry out activities related to its role, PT. XYZ has several supporting facilities such as a Storage Tank (Receiving and Distribution) with a total capacity that reaches 111,000 KL, Micro Filter which serves to prevent Avtur/Jet A-1 contamination with contaminants, Water Filter Separator which serves to separate Avtur/Jet A-1 from water, and so other supporting facilities.

During the Covid-19 pandemic, the amount of fuel needed for flights at Airports decreased. It is due to government regulations to impose flight restrictions to prevent the spread of the virus. The decrease in the amount of fuel needed at the Airport has an impact on the business processes at PT. XYZ. The decrease requires the fuel to be in the storage tank to be longer. The storage duration of Avtur/Jet A-1 corresponds to the change in quality related to the characteristics of the fuel. One of the changes in quality that occurs is due to a decrease in the value of Electrical Conductivity, which is the ability of a substance to conduct electric current. This ability plays a role in circulating electron charges on a material surface

to prevent static electricity that has the potential to cause a fire.

To minimize risk, PT. XYZ adds additives in the form of Static Dissipator (Stadis) 450, pure organic compounds, and serves to increase the value of the Electrical Conductivity (Conductivity Unit) to reduce the risk of fire. However, during the pandemic, the average monthly usage of Stadis 450 was increased from 1.709 ccs to 5.428 ccs. An increase in the volume of use from Stadis 450 also impacts handling costs. For this reason, the process of adding Stadis 450 needs to be optimized to minimize waste and other losses.

In determining the proposed improvement to obtain optimal volume, it is necessary to gradually identify the causes and impacts associated with the Avtur/Jet A-1 characteristics, and in the process of adding Stadis 450, this can be done with a Six Sigma approach. In this research, the Six Sigma approach is carried out using the DMAIC method, which is a method consisting of the stages of Define, Measure, Analyze, Improve, and Control. The final goal to be achieved in this research is to determine the optimal volume of Stadis 450 which can be added to Avtur/Jet A-1 to increase the value of Electrical Conductivity.

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2 Research Methods

2.1 Preparation

This research was conducted because based on the observations made it was found that there was a decrease in demand for Avtur/Jet A-1 fuel at PT. XYZ during a pandemic which then has an impact on changing fuel characteristics. Based on the information obtained, one of the contributing factors is a decrease in the value of Electrical Conductivity. So that the addition of Stadis 450 was carried out to increase this value. This addition needs to be done optimally so that there is no waste and loss. Therefore, the main problem examined in this research is to determine the optimal volume in the addition of Stadis 450 to Avtur/Jet A-1 fuel which has decreased the value of Electrical Conductivity.

2.2 Data Collection

The data used in this study are divided into 2 types of data:

1. Primary Data is data obtained from PT. XYZ directly either through observation or interviews with related parties. The primary data in this research are data on the value of the day of coverage, defective products/products that do not meet specifications, Doping Stadis 450, Conductivity Unit (CU), Density, and so on.
2. Secondary Data is data or information obtained indirectly. In this research, data were obtained from the results of previous research which could be sourced from PT. XYZ itself, books, journals, websites, and other valid sources.

2.3 Data Processing

The data that has been collected is then processed so that it can be analyzed and conclusions can be drawn. In data processing, the stages carried out include analysis of the business process flow at PT. XYZ is conducted to obtain information and identify how the business process takes place. In addition, data processing is also carried out by following the stages of DMAIC analysis on Six Sigma to facilitate analysis and concluding, as well as using supporting methods to make improvements in all aspects of the company.

2.4 Final Stage

This stage consists of drawing conclusions based on the results of processing and analysis that have been carried out in the previous stage. In addition, this stage also contains constructive suggestions for both companies and researchers, so that it is hoped that improvements and development can be carried out in further research.

3 Result and Discussion

3.1 Process Bussiness Flow

Fig. 1. Process Business Flow.

In the scope of the aviation fuel business, PT. XYZ is included in the downstream business which includes the management, marketing, and trading, as well as the distribution of the fuel itself. In the downstream business process, crude oil that has been purchased is then processed into several products at the Refinery Unit (RU). The products produced include *light* (premium, pertamax, and pertalite), *medium distillate* (kerosene, aviation fuel, and diesel), *heavy* (fuel oil, asphalt, and residue), *petrochemicals*, and LPG. The processed product is then distributed using a specific distribution system so that it can be utilized by various types of consumers according to the target fuel use.

PT. XYZ's role is to receive, store and distribute Avtur/Jet A-1 received from RU through tankers and pipeline distribution systems to meet fuel needs at the Airport. PT. XYZ is also responsible for ensuring the quality of Avtur/Jet A-1 remains within standard limits so that the products delivered are of the best quality

3.2 Define

3.2.1 SIPOC Diagram

The elements below (Table 2) show the relationship between Suppliers, Inputs, Processes, Outputs, and Customers in a business process at PT. XYZ.

In the process of distributing Avtur/Jet A-1 to PT. XYZ, received products often have substandard product quality based on the cause of certain defects. So in this case the researchers suspect that RU as a supplier plays a role in causing quality that does not meet the standards of this product. The following is a SIPOC diagram showing the activities at PT. XYZ.

Table 1. SIPOC Diagram.

Supplier	Input	Process	Output	Customer
- Refinery Unit IV - Refinery Unit II	Avtur/Jet A-1	Store and maintain the quality of avtur: - Increase the value of Conductivity Unit - Ensure the Density is within standard limits - Ensure the Temperature is under the Flash Point - Ensure that Avtur/Jet A-1 is not contaminated with contaminants - Separate Avtur/Jet A-1 from water	Avtur/Jet A-1 that according to standard specifications	- Airport - Aircraft maintenance company

3.2.2 Control To Quality (CTQ)

A product is categorized as a defective product or has decreased in quality if the specifications shown from the inspection results do not comply with the standard criteria. The inspection was carried out at the receiving tank, where the Avtur/Jet A-1 had passed the quality control process. In this study, 5 types of disability criteria were found which are shown in the following table:

Table 2. Control To Quality.

No.	Type of Defect	Effect of Product Defect
1	Low the value of Conductivity Unit	Reduce the Electrical Conductivity of Avtur/Jet A-1, thereby increasing the potential of static electricity occurring
2	Density beyond the standard limit	Potential contamination
3	Temperature above the Flash Point	Potential fire
4	Contaminated with contaminants	Damage storage tanks and fuel tanks in aircraft, eliminating separation ability, and reducing the surface tension between water and Avtur/Jet A-1.
5	Contains water	The water in Avtur/Jet A-1 will freeze at a certain temperature and voltage so that it will clog the filter pipes and the combustion pipes on the aircraft.

Based on the information submitted by the Receiving Storage and Distribution division as well as the data recapitulation that has been done, it can be seen that most of the disability criteria are still under control. This is because of the existing facilities at PT. XYZ can work well. Though, defects may still be found for defective products caused by a low Conductivity Unit (CU) value. However, only Avtur/Jet A-1 in the receiving tank had sub-standard CU values, with the CU values for tanks 104, 107, 108, and 109 being 59.13, 51.17, 41.40, and 53.23, respectively. Because of PT. XYZ becomes the supply point for similar companies, so the minimum CU value set is 80 pS/m.

3.2.3 Avtur/Jet A-1 stockpile relationship with increased doping volume.

Hoarding activities can affect the quality of Avtur / Jet A-1, this quality change can be caused either due to the nature of Avtur/Jet A-1 itself or due to environmental factors. One of the efforts to maintain the quality of Avtur/Jet A-1 is by doping Stadis 450. Doping Stadis 450 is an activity to add Static Dissipator (Stadis) 450 to Avtur/Jet A-1 to increase the value of the Conductivity Unit (CU). According to information from the Receiving Storage and Delivery division of PT. XYZ, Doping Stadis 450 additions increased during the pandemic. This happened in line with the increase in the specified target CU value. Under normal conditions, the target CU value is 80 pS/m. Meanwhile, currently, the CU target could reach 200 pS/m. The increase in the CU target was carried out by considering the decline in sales and hoarding that had occurred.

3.3 Measure

3.3.1 Avtur/Jet A-1 volume stockpile and usage of Stadis 450

The recapitulation of the volume of use of Stadis 450 was carried out based on recording data in the form of injection activity worksheets (doping). This sheet provides various information regarding Avtur/Jet A-1

volume in the storage tank, the Stadis 450 pure volumes used for doping, Conductivity Unit (CU), the Stadis 450 concentrations in Avtur/Jet A-1, and so on. The volume usage of this Doping Stadis 450 is then recapitulated to get the total and average usage per month. So that the following data is obtained:

Table 3. Avtur/Jet A-1 volume stockpile and usage of Stadis 450.

No.	Month	Volume	
		Product (L)	Stadis (cc)
1	March	257,115,818	20,900
2	April	132,460,139	14,200
3	May	54,189,099	6,000
4	June	110,134,793	34,000
5	July	110,423,584	36,000
6	August	137,855,675	41,500
7	September	181,239,601	45,431
8	October	233,386,475	48,822
9	November	225,245,441	67,682
10	December	290,601,503	70,880
Total		1,732,652,128	385,415
Average		173,265,213	38,542

3.3.2 Data Normality Test

The data normality test is carried out to determine the distribution of data in a certain population so that it can be seen whether the data used is normally distributed or not.

Fig. 2. Data Normality Test of Total Product (volume).

Fig. 3. Data Normality Test of Total Defect (volume).

Based on the graph above, it can be concluded that the P-Value generated for the data on the number of products and the number of defects is > 0.100 . Where the $P\text{-Value} > \alpha$ or $0.100 > 0.05$, so the data is normally distributed.

3.3.3 P Control Chart

Fig. 4. P Control Chart.

Based on the calculation results and control chart above, it can be seen that all data is outside the control limit. The control boundary distance from the mean value is very small, for example, the distance between UCL and CL is only 0.000000010608, while the LCL value with CL is much smaller. The out-of-control data from the control limit is due to the business processes that occur at PT. XYZ, Avtur/Jet A-1 received from the Refinery Unit (RU) had a CU value that was below the CU acceptance standard (80 pS/m). So it can be said that part of Avtur/Jet A-1 was received by PT. XYZ from RU experienced a decrease in quality due to a decrease in the value of CU.

3.3.4 Defect Per Opportunity and Defect Per Million Opportunities

Based on the CTQ, the failure criteria used to perform DPO calculations are based on the Conductivity Unit (CU). The calculations to get the DPMO value and the sigma value are as follows:

1. Defect Per Opportunity (DPO)

$$DPO = \frac{93,306,993}{257,115,818 \times 1} = 0.3629 \quad (1)$$

2. Defect Per Million Opportunities (DPMO)

$$DPO = \frac{93,306,993}{257,115,818 \times 1} \times 1,000,000 \quad (2)$$

$$= 362,899$$

3. DPMO Conversion to Sigma Value

$$Sigma\ Value = NORMINV[1,000,000 \quad (3)$$

$$- \frac{362,899}{1,000,000}] + 1.5$$

$$= 1.8507$$

Table 4. Recapitulation of DPO, DPMO, and Sigma Value.

No.	Month	Number of Product (L)	Number of Defect (L)	DPO	DPMO	Sigma Value
1	March	257,115,818	93,306,993	0.3629	362,899	1.8507
2	April	132,460,139	45,832,055	0.3460	346,007	1.8961
3	May	54,189,099	21,656,996	0.3997	399,656	1.7542
4	June	110,134,793	43,933,956	0.3989	398,911	1.7562
5	July	110,423,584	44,997,189	0.4075	407,497	1.7340
6	Aug	137,855,675	57,055,798	0.4139	413,881	1.7176
7	Sept	181,239,601	70,723,662	0.3902	390,222	1.7787
8	Oct	233,386,475	86,228,566	0.3695	369,467	1.8333
9	Nov	225,245,441	84,934,035	0.3771	377,074	1.8132
10	Dec	290,601,503	104,459,944	0.3595	359,462	1.8599
Total		1,732,652,128	653,129,194	0.3770	3,825,076	17.9939
Average		173,265,213	65,312,919	0.3770	382,508	1.7994

Based on the results of the recapitulation table above, it shows that the average DPO and DPMO produced are 0.3770 and 382.508 respectively and are at a sigma value of 1.7994 or 1.8.

3.4 Analyze

3.4.1 Doping Static Dissipator (Stadis) 450.

Based on Control To Quality (CTQ) at the define stage and the results of the DPMO calculation at the measurement stage, efforts were made to overcome the

Avtur/Jet A-1 defect caused by low CU values. Efforts to add additives in the form of Doping Stadis 450 continue to be made to increase the ability of Avtur/Jet A-1 to conduct electric current.

The total Avtur/Jet A-1 that underwent Doping Stadis 450 was 653,129,194 L with an average per month of 65,312,919 L. To increase the CU of Avtur/Jet A-1, a Stadis 450 of 385,415 cc is needed or the equivalent of 350,727.65 grams with a monthly average requirement of 38,542 cc or the equivalent of 35,073.22 grams. The recapitulation of Doping Stadis 450 is shown in the following table :

Table 5. Recapitulation of Doping Stadis 450 (a).

Month	Volume			CU (pS/m)			Concentration (mg/L)
	Product (L)	Product Doping (L)	Stadis (cc)	Current	Target	Final	
March	257,115,818	93,306,993	20,900	47	99	90	0.2273
April	132,460,139	45,832,055	14,200	57	123	103	0.3014
May	54,189,099	21,656,996	6,000	48	110	79	0.2835
June	110,134,793	43,933,956	34,000	39	206	154	0.8118
July	110,423,584	44,997,189	36,000	39	203	220	0.8038
Aug	137,855,675	57,055,798	41,500	46	196	218	0.7246
Sept	181,239,601	70,723,662	45,431	46	188	275	0.6349
Oct	233,386,475	86,228,566	48,822	57	185	147	0.5704

Table 6. Recapitulation of Doping Stadis 450 (b).

Month	Volume			CU (pS/m)			Concentration (mg/L)
	Product (L)	Product Doping (L)	Stadis (cc)	Current	Target	Final	
Nov	225,245,441	84,934,035	67,682	41	198	200	0.7116
Dec	290,601,503	104,459,944	70,880	53	186	162	0.6316
Total	1,732,652,128	653,129,194	385,415	473	1,694	1,648	5.7008
Average	173,265,213	65,312,919	38,542	47	169	165	0.5701

3.4.2 Correlation Test

This test is carried out to determine whether there is an increase in storage time whether this can affect the addition of Doping Stadis 450. The following are the calculation results obtained from the correlation test:

Fig. 5. Correlation Test Graph.

The resulting P-Value is 0.035. $P\text{-Value} < \alpha$ or $0.035 < 0.05$, so that there is a significant relationship between the stockpiling of Avtur/Jet A-1 and the Doping Stadis 450 process. For the Coefficient Correlation value, it is 0.668. Where it is positive, it means that the relationship between hoarding and doping statistics shows the same direction. If viewed from the point of view of the strength of the correlation, the resulting value is in the limit of $0.6 \leq |r| \leq 0.8$ which means that both of them have a strong relationship.

3.4.3 Fishbone Diagram

In the Doping Stadis 450 process, process inefficiencies were found, which was indicated by a mismatch between the CU target value and the resulting final value. The mismatch that occurs can become waste (waste) using Stadis 450 so that the resulting CU value is not optimal.

Fig. 6. Fishbone Diagram of Doping Stadis 450.

The diagram above shows the cause and effect that occurs in the Doping Stadis 450 process in several factors. From these causes, some can be minimized if PT. XYZ replaces the machine that was previously an automatic machine currently planned by PT. XYZ. However, some of the causes, such as targeting that still uses estimates and material properties that can decrease periodically, still require other solutions so that plans to minimize process inefficiencies can run well.

3.5 Improve

3.5.1 Decrease of Conductivity Unit (CU)

The determination of the reduction in the value of CU was carried out based on the consideration of the absence of transfer activity from the receiving tank and the transfer of Avtur/Jet A-1 to the airport (the tank must be idle). The process of calculating this reduction is carried out by using the CU value in the sales tank, this is done so that the resulting CU value can last during the stockpiling period that occurs in the sales tank. Determination of CU reduction, obtained from the difference in CU value from routine examinations. Based on the calculations that have been made, the average reduction in the value of CU in the sales tank based on the CU condition data in the stockpile is 6.4646 pS/m. The results of these calculations can then be used by Receipt and Storage officers to determine the CU target before committing Doping Stadis 450.

3.5.2 Doping Stadis 450 Stage

Based on the causes of process inefficiency in the Fishbone Diagram, the determination of CU targets is

still carried out based on estimates without standard references. Therefore, in determining the CU target, a proposal is made by considering the average amount of CU reduction. So that the Doping Stadis 450 stages can be carried out as follows:

1. Calculation of the combined CU value

$$CU X = \frac{(CU A \times Vol A) + (CU B \times Vol B)}{Vol A \times Vol B} \quad (4)$$

Combined CU is the CU obtained when Avtur/Jet A-1 in the sales tank (tank A) is mixed with Avtur/Jet A-1 in receiving tank (tank B) without adding Stadis 450. If the resulting value meets the standard, then Avtur/Jet A-1 does not need to go through the injection process (Doping Stadis 450). However, if the resulting CU value is still below the standard, then Doping Stadis 450 is required.

2. Determination of the average CU

Based on the results of calculations that have been done, the average reduction in CU value in the stockpiling process is 6.4646 pS/m. This value is then multiplied by the estimated hoarding that occurs, for example, if it is estimated that there will be hoarding for 1 week, 2 weeks, and 3 weeks, then the average reduction in CU value is 45.2522 pS/m, 90.5044 pS/m, and 135.757 pS/m.

3. Determination of the CU targets

Based on the average reduction in CU value that has been obtained, the determination of the target CU value can be obtained by summing the CU target under normal conditions (80 pS/m) with the average reduction based on estimated stockpiling. Thus, the expected CU targets for the 1 week, 2 weeks, and 3 weeks stockpile estimates are 126 pS/m, 171 pS/m, and 216 pS/m, respectively.

4. Determination of Stadis Mix concentration

$$Concent. = \frac{CU Target - Combined CU}{200} \quad (5)$$

Stadis Mix is a solution or a mixture of pure 450 Stadis with Avtur/Jet A-1. This mixing process is

carried out by dissolving 50 grams of pure 450 Stadis into 1L Avtur/Jet A1 to produce 1L Stadis Mix. The denominator (200) is obtained from the terms of the relationship Stadis 450 in Avtur/Jet A-1. Where giving Doping Stadis 450 with a concentration of 1 mg/L will increase the CU value by 200 pS/m.

5. Determination of the Avtur/Jet A-1 transfer volume

$$Volume tf = Receive tank volume - Ampafabel volume \quad (6)$$

Avtur/Jet A-1 in the receiving tank is not completely transferred or transferred to the sales tank. The transfer volume takes into account the volume of Avtur/Jet A-1 in the sales tank and the ampafabel volume, which is the amount of Avtur/Jet A-1 that cannot be moved to avoid emptying the tank.

6. Determination of the pure Stadis 450

$$Volume Stadis 450 = Consentration \times Volume tf \quad (7)$$

After knowing the total volume of pure Stadis 450, then the Doping Stadis 450 can then be carried out with an injection system during the transfer process from the receiving tank to the sales tank using an injection machine.

3.5.3 The inefficiency of the CU target with the final CU value at Doping Stadis 450

The inefficiency of this value can be wasteful in using the Stadis 450, causing the process to be inefficient and the Doping Stadis 450 is not optimal. For this, calculations are carried out to determine the mismatch that has occurred. The calculation is done by calculating the difference between the target CU and the resulting final CU value. In addition, the calculation of the pure Stadis 450 requirement is also carried out, if the target determination uses the current CU final value, with the assumption that there is no difference between the CU target and the final achieved value as follows:

Table 7. Recapitulation of Inefficiency of Doping Stadis 450.

Stadis 450	CU (pS/m)			Concentration (mg/L)	Inefficiency CU (pS/m)		Concentration of Inefficiency (mg/L)	Vol. Stadis of Inefficiency (cc)
	Current	Target	Final		Less	More		
Total								
385,415	3,401	12,065	11,743	40	-1,642	1,311	42	395,560
Average								
5,428.38	47.90	169.27	165.27	0.57	-41.05	42.29	0.59	5,571
Average of Inefficiency CU							41.67	

The results obtained indicate that the average difference between the target CU value and the final CU value, whether it does not reach the target or exceeds the target, is 41.67 pS/m. Meanwhile, if the doping process is carried out following the final CU value, the average Stadis 450 concentration in Avtur/Jet A-1 becomes 0.59 mg/L from the previous 0.57 mg/L. The increase in this concentration is in line with the increasing demand for Stadis 450.

3.6 Cost Requirement for Doping Stadis 450

Based on information according to the Receiving and Storage officer, the need for a stationary 450 under normal conditions in 1 month is estimated to be 1 pail (22 kg or the equivalent of 24.176 cc). Increasing the use of Stadis 450 today has the impact of increasing costs incurred. The cost incurred for 1 pail Stadis 450 is Rp. 32,230,000. So, based on the results of the non-conformity calculations that have been carried out, the following results are obtained:

Table 8. Cost Requirement for Doping Stadis 450.

The total cost of Stadis				
Month	Target	Final	Less	More
March	27,862,835	26,187,907	-4,777,338	3,102,410
April	18,930,730	13,695,915	-5,234,815	0
May	7,998,900	4,547,786	-3,451,114	0
June	45,327,100	33,379,946	-12,721,404	774,250
July	47,993,400	54,316,242	-1,171,665	7,494,507
August	55,325,725	65,526,018	-1,620,667	11,820,960
September	60,566,338	107,281,201	0	46,714,864
October	65,087,049	50,503,186	-22,145,547	7,561,684
November	90,230,258	94,992,061	-10,042,755	14,804,558
December	94,493,672	76,910,639	-21,181,180	3,598,147
Total	513,816,007	527,340,901	-82,346,487	95,871,381
Average	51,381,601	52,734,090	-9,149,610	11,983,923

The table above shows that the current total cost of using Stadis 450 is Rp. 513,816,007. Meanwhile, the "Final" column shows if PT. XYZ performs strategic doping with the target CU value following the current final CU value, and the CU results are assumed to be fulfilled. Then the total cost incurred is Rp. 527,340,901. The total loss suffered by the company due to failure to reach the target value of CU was Rp. 82,346,487. While the total profit that the company gets due to these conditions is Rp. 95,871,381. So if only seen from the addition of Stadis 450 as a whole, then PT. XYZ benefits from the cost of using the Stadis 450. This is due to differences in profit and loss at PT. XYZ generates a profit of Rp. 13,524,894. However, even though PT. XYZ benefits from a cost perspective, this mismatch results in unpredictable uncertainty. So that this process does not always generate profits or have a good impact.

4 Conclusion

Based on the measurements and calculations as well as the discussion carried out, it can be concluded as follows:

1. The resulting DPO and DPMO were 0.377 and 382.508, respectively, and were at the 1.7994 or 1.8 sigma level. A large number of defective products (below quality standards) are largely due to a decrease in the Conductivity Unit (CU). So that the effort made is to do Doping Stadis 450.
2. The inefficiency of the Doping Stadis 450 process will result in suboptimal use of the Stadis 450. For this reason, the measurement of the decrease in the average CU value on the Avtur/Jet A-1 in the sales tank was carried out, the result was 6.4646 pS/m per day. This can then be a consideration in determining the target CU value to minimize waste and approach the optimal use of the Stadis 450 volume.

The inefficiency can be indicated by the presence of a final CU that exceeds the target CU value or does not even reach the target, with an average of 41.67 pS/m. When viewed from a cost perspective, PT. XYZ benefits from the mismatch of the doping process of Rp. 13,524,894. However, this advantage comes from an uncertain and unpredictable process. So that in certain conditions, losses are also possible.

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