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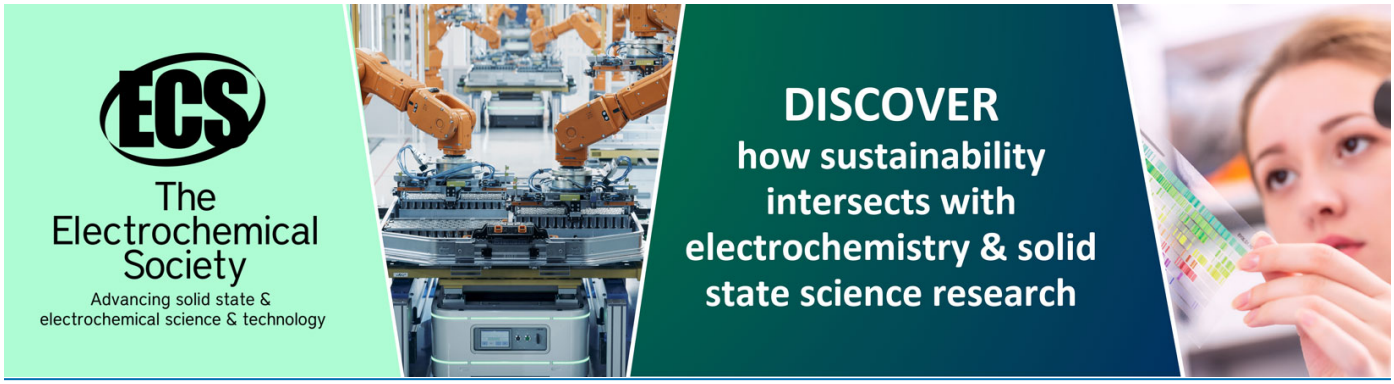

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Analysis of Increasing Quality of Surfactant Powder at Oversize Parameter Using PDCA and FMEA in PT BCCI

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Abstract. Quality of product is the important thing for PT BCCI in order to compete with other chemical industry of surfactant. In the production process of surfactant powder the particle size of the product is bigger than screener with mesh size 30 will produce oversize reaching 30% from every batch of products, indicates there is an issue that to be fixed immediately. This research was to find out the root of problem and action to improve the quality product and increase the output. PDCA and FMEA method were used to resolve these problems. The results are priority problem that needs to be improved based on the highest RPN value is the machine on the product evaporation system is the less working Vacuum maximum and the product temperature is less high. The product temperature need increase to 60ºC which was previously 58ºC and pressure on Vacuum <50 mbar. After improvement was applied the results obtained where the value of Cpk increased from 0.163 in the previous study to 3.609 and Oversize decreased from 30% to 20% in each batch process, this is in accordance with the target to be issued with the Oversize percentage below 30% in each process.
Keywords: PDCA, FMEA, surfactant

1. Introduction

PT BCCI is PT BASF Care Chemicals Indonesia located at Jalan Raya Jakarta Bogor KM 31.2 Cimanggis Depok and hereinafter referred to as PT BCCI in the writing of this Final Project.

Based on the previous research and analysis on the process of making powder surfactant in the Dryer Grinder system at PT BCCI, it was found Cpk 0.163, from the process capability calculation, it can be seen that the process capability has not met the requirements where the capability value can be said to be good if the Cpk value 1. there is a problem in the process of making surfactant powder caused by equipment that is not optimal, one of the production process equipment is vacuum and temperature, vacuum is very influential on the process of making powder surfactants (Grinder dryers), where vacuum or vacuum is needed to make or taking water content in raw material with initial water content of 4% to 0.9% in powder surfactant products. Product temperature is also much needed for evaporation in the manufacture of this powder surfactant, with the temperature expected to evaporate the water content of the raw material easily taken by vacuum system, with the process expected to reduce the product oversize. However, the temperature is also very sensitive due to the characteristics of surfactant products that are easy to.

From June 2017 there still a lot of oversize around 30% per batch. Powder surfactants with oversized parameters that do not meet the specifications (particle size) will be reworked again to achieve results that meet specifications, but require longer processing time and the company must pay

for the rework process. Therefore, it is necessary to systematically investigate the causes of size mismatches in powder surfactant products so that improvements can be made to quality and production results by reducing oversize 20% of each batch.

2. Methods

Data Processing and Analysis are carried out with a phase of the PDCA cycle that relates to problems that occur during the testing process. In addition, the results of the summary of the estimated values before and after the improvement are also displayed. All stages of the PDCA cycle are the Plan Phase, Do Stage, Check Phase and Action Stage was applied in full, with the following explanation[1]:

1. Plan Phase:
   a. Create a fishbone diagram[2] to find out the root causes of oversized mismatches based on brainstorming data.
   b. Perform Failure Mode and Effect Analysis (FMEA)[3][4] to determine the factors that most influence the defect to parameterize, choose the priority of improvement based on the highest RPN (Risk Priority Number) value and provide a repair proposal.
2. Do Phase : Implementing corrective actions.
3. Check Phase:
   a. Conduct monitoring to ensure that the proposals made provide an effect of improvement leading to the expected targets and processes.
   b. Make additional improvement proposals for other problems that may arise, if needed. Comparing implementation actions after repairs and before repairs.
4. Action Stage: Standardize the process in the form of the SOP (Standard Operating Procedure) so that the proposed improvements can be carried out effectively and efficiently.

At the conclusion stage, a conclusion is drawn which contains a summary of the results of data processing and analysis based on the research objectives by providing suggestions that can build or improve the company's performance based on the analysis that has been made.

3. Result and Discussion

3.1. Plan Phase

3.1.1. Data Collection. The data that were collected is size of surfactant powder which oversize as a product out of specification. Table 1 shows the amount of oversized product in February 2018.

3.1.2. Cause of Identification Brainstorming Results. To find out the factors that influence the occurrence of Oversize Powder surfactant as a product out of specification, Cause and Effect Analysis are done by brainstorming through questionnaires to respondents that are directly related to the process.

3.2. Do Phase

3.2.1. Cause and Effect Analysis. From the results of the analysis with the previous brainstorming method, it can be identified that there are four categories that cause excessive oversize products in PT BCCI, as shown in Table 1.

Table 1. Oversize Data in february 2018

Day	Batch Number				
	1	2	3	4	5
1	350	354	352	354	352
2	355	354	350	352	352
3	354	354	352	354	352
4	355	350	352	350	352

Table 1. Oversize Data in february 2018 (cont.)

Day	Batch Number				
	1	2	3	4	5
5	350	352	350	354	352
6	354	350	352	350	354
7	352	354	350	354	352
8	350	354	350	354	352
9	350	354	352	354	352
10	355	354	350	352	352
11	354	354	352	354	352
12	355	350	352	350	352
13	350	352	350	354	352
14	354	350	352	350	354
15	352	354	350	354	352
16	350	354	350	354	352
17	352	350	354	352	354
18	352	355	354	350	352

Table 2. Excessive identification of oversize causes factors.

No	Category	Causes Factors
1	Human	Didn't check the water content of raw material which used for process
2	Machine	- Machine operated fully 24 hour - Not optimal in vacuum process - Temperature of product evaporation not maksimal
3	Material	Water content of raw material was out of specification
4	Method	- There was no schedule of cleaning of filter grinder - The method of evaporation product not optimal

The results in Table 2 are then drawn into fishbone diagrams as shown in Figure 1.

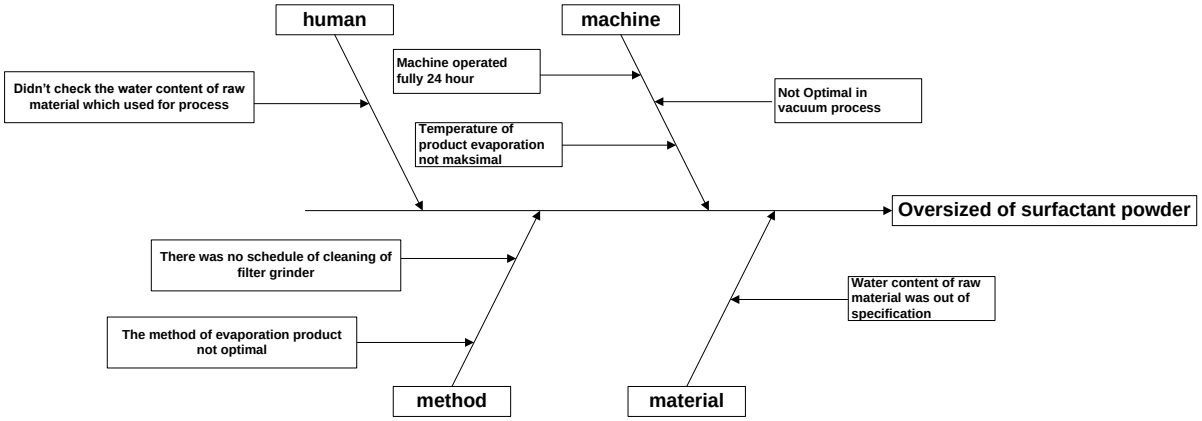

Figure 1. Fishbone diagram

*3.2.2. Failure Mode Effect and Analysis.*From the results of Cause and Effect Analysis FMEA is conducted to determine the priority of the proposed improvements as well as the application for the proposed improvements that will be made. To do FMEA, previously, brainstorming was conducted with several employees at PT BCCI (Production Leader Group and Quality Assurance Staff) to

determine the value of Severity, Occurrence, and Detection. The values of each characteristic can be seen in tables 3, 4, and 5.

Table 3. Severity table (S).

Severity level	Criteria	Rating
Very high	Failure can made much of oversize product	10
High	Failure can made oversize product not uniform, in product size	7
Moderate	Failure can influence yield of product output	5
Low	Failure can made oversize product but still in specification	3
In Control	Failure not affected in product quality	1

Table 4. Occurence table (O).

Occurence level	Criteria	Possibility of failure	Rating
Very high	Failure is almost inevitable	2500 kg per 8000kg	10
High	Failure continues to recur	2000 kg per 8000 kg	7
Moderate	Failure occurs occasionally	1500 kg per 8000 kg	5
Low	Failure relatively few	1000 kg per 8000kg	3
In Control	Failure is not possible	500 kg per 8000 kg	1

Table 5. Detection Table (D).

Occurence level	Criteria	Rating
Very high	The possibility of problems is very high, prevention methods are not effective, the cause is still repeated	10
High	The possibility of problems is high, prevention methods not fully effective, the cause is still repeated	7
Moderate	The possibility of problems is moderate, prevention methods sometimes allow problem occur	5
Low	The possibility of problems is low	3
In Control	The possibility of problems is effective, not allow problem occur	1

Table 6. FMEA.

Category	Failure Mode	Failure Effects	Failure causes	Failure control	S	O	D	RPN
Human	Product was rough	Size of particle size out of specification	Didn't check the water content of raw material which used for process	Chose raw material with low water content	5	7	5	175

Table 6. FMEA (cont.)

Category	Failure Mode	Failure Effects	Failure causes	Failure control	S	O	D	RPN
Machine	The formation of powder is not perfect	Powder product was rough	Vacuum is not maximal, vacuum filter is dirty, product evaporation temperature is less high	Increase product temperature, making schedul cleaning filter grinder	10	7	5	350
Material	Much of oversize	Lumpy and rough product	Water content of Raw material was high	Large size particles are Oversize much	7	5	5	175
Method	Particle size of product was rough	Product evaporation is less than optimal Vacuum> 50 mbar	Product temperature is not high High vacuum presure	Increase the product temperature and maximize the vacuum grinder	7	7	7	343

From the results of the RPN (Risk Priority Number) assessment on the FMEA, the causal factor with the highest RPN from the equipment machine category is less than the maximum temperature and vacuum. Therefore, improvements will be focused on these factors.

The implementation was carried out in February 2018. From the CPK results showed that the increase in output of surfactant powder products was very significant up to 100 kg per batch, the product oversized was 10%, ie before repair Average 480 kg/batch to 350 kg/batch, according to the expected target.

3.3. Phase (check) implementation of repair

3.3.1. Normality Test. Normality tests were carried out on the data presented in table 1 of the data from the analysis of oversized data on 06.07.08 in February 2018 with a total of 90 data. The stages of testing the normality of the data using the Kolmogorov-Smirnov[4] method manually are as follows:
Calculation :
Is Known:
$X_i = 352{,}16$
i = 1,64
n = 90
Calculation $\bar{\bar{x}}$
$\bar{\bar{x}} = \frac{\sum \bar{x}}{n}$ = 352,16
Calculation $\bar{R}$
$\bar{R} = \frac{\sum R}{n}$ = 3,83
Calculate the X control chart boundary line

A_2 = 0,577 (Constant Table)
UCL = $\bar{\bar{x}} + A_2.\bar{R}$
= 352,16 + (0,577 x 3,83)
= 354,37
CL = $\bar{\bar{x}}$
= 352,16
LCL = $\bar{\bar{x}} - A_2.\bar{R}$
= 352,16 - (0,577 x 3,83)
= 349,94

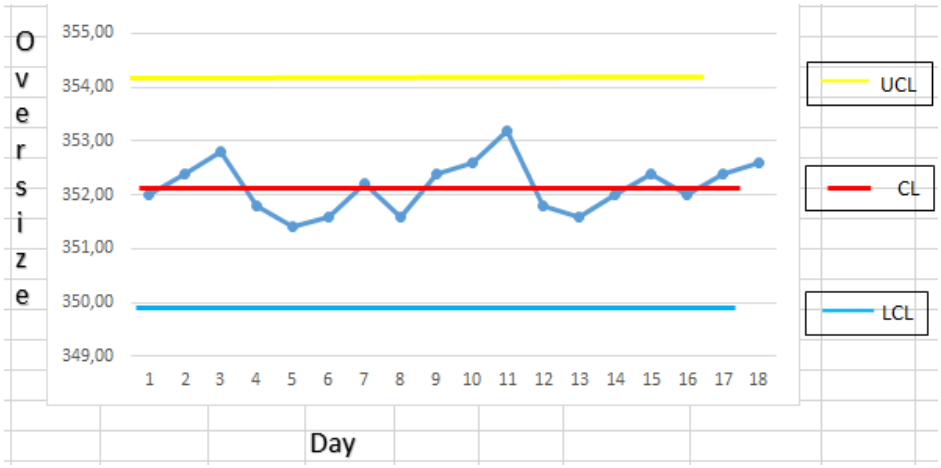

Figure 2. Control map X.

Calculates the R control map boundary
D_4 = 2,114 (Constant Table)
D_3 = 0
UCL = $D_4 x \bar{R}$
= 2,114 x 3,83
= 8,10
CL = $\bar{R}$
= 3,83
LCL = $D_3 x \bar{R}$
= 0 x 3,83
= 0,00

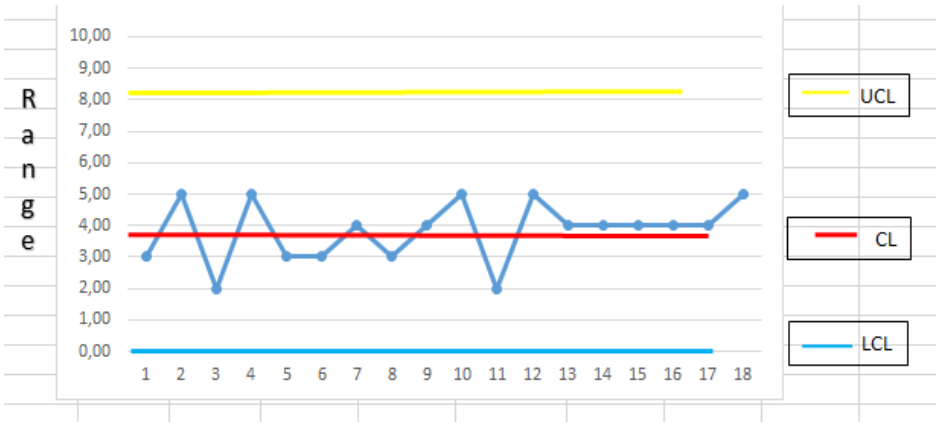

Figure 3. Control map R.

3.3.2. Process Capability. The specifications set by the company for the upper specification limits (USL) and lower specification limits (LSL) are 4.3 and 0, thus the process capability ratio (Cp) and process capability index (Cpk) can be calculated as follows:

$S = \frac{R}{d_2}$ (the value of d2 is taken from the table of constants on the control map where for the sample size 5 the value is 2,326)

$= \frac{3.83}{2.326}$

= 1,648

CP $= \frac{\text{USL}-\text{LSL}}{6\text{S}}$

$= \frac{370-0}{6\,(1{,}648)}$

= 0

CPU $= \frac{\text{USL}-\text{X}}{3\text{S}}$

$= \frac{370-352{,}16}{3(1{,}648)}$

= 3,609

CPL $= \frac{\text{X}-\text{LSL}}{3\text{S}}$

$= \frac{352{,}16-0}{3(1{,}648)}$

= 71,227

Cpk = Min (CPL; CPU) = 3,609

3.4. Stage (action) doing combating work procedures

At this stage standardization of work procedures are carried out from the causes that have been corrected, namely:

1. Creating a new Work Instruction by increasing the product temperature from 58ºC to 60ºC for maximum product evaporation.
2. Make a Schedule Cleaning filter grinder to get the maximum vacuum pressure.

4. Conclusion

Some conclusions can be drawn as follows:

The root cause of the problem of excessive oversize based on the highest RPN value in FMEA (Failure Mode Effect Analysis) is in the machine or tool category that is the maximum evaporation temperature and the vacuum is not working optimally.

The proposed improvements that have been implemented for oversize problems are raising the product temperature to 60ºC in the process and making the cleaning filter grinder scheduling to get the maximum pressure <50 mbar.

From the calculation of process capability, after the improvement has fulfilled the requirements, the capability value said to be good or fulfilling the requirements is the Cpk ≥1. Therefore the CPK results after implementation are 3.609.

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