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Method of calculation overall equipment effectiveness in fertilizer factory

I Siregar[1*], M A Muchtar[2], R F Rahmat[2], U Andayani [2], T H Nasution[3] and R M Sari[1]

[1]Department of Industrial Engineering, Universitas Sumatera Utara, Almamater Rd., University of Sumatera Utara, Medan 20155
[2]Department of Information Technology, Universitas Sumatera Utara, Almamater Rd., University of Sumatera Utara, Medan 20155
[3]Department of Electrical Engineering, Universitas Sumatera Utara, Almamater Rd., University of Sumatera Utara, Medan 20155

[*]Email: ikhsan.siregar@usu.ac.id

Abstract. This research was conducted at a fertilizer company in Sumatra, where companies that produce fertilizers in large quantities to meet the needs of consumers. This company cannot be separated from issues related to the performance/effectiveness of the machinery and equipment. It can be seen from the engine that runs every day without a break resulted in not all of the quality of products in accordance with the quality standards set by the company. Therefore, to measure and improve the performance of the machine in the unit Plant Urea-1 as a whole then used method of Overall Equipment Effectiveness (OEE), which is one important element in the Total Productive Maintenance (TPM) to measure the effectiveness of the machine so that it can take measures to maintain that level. In July, August and September OEE values above the standard set at 85%. Meanwhile, in October, November and December have not reached the standard OEE values. The low value of OEE due to lack of time availability of machines for the production shut down due to the occurrence of the engine long enough so that the availability of reduced production time..

1. Introduction

A process on the production floor can be stopped due to a problem in the production machine / equipment, for example the engine stops unexpectedly, the length of setup time, the decline in the engine production speed, the engine produces defective products and damage to the engine. This causes losses to the company because in addition to lowering the efficiency and effectiveness of machinery / equipment and productivity companies also resulted in the cost to be incurred due to such damage.
Preventive maintenance is very important, as was done in previous research, especially for machines that have been used in the past 10 years [1]. Other studies have suggested that using preventive maintenance can reduce maintenance costs [2]. Even in previous research states that by doing preventive mintenance can improve availability and reability [3].
In this study, will be measured the value of OEE, where previous research states that OEE can be useful for the industrial world [4]. Even OEE can also be used for use in software and hardware [5].
The fertilizer plant where this research is conducted is a company that produces fertilizer in large quantities to meet the needs of consumers. The company is inseparable from problems related to the

performance / effectiveness of machinery and equipment. This can be seen from the machine that runs every day without a break resulting in not all product quality in accordance with the quality standards set by the company. Therefore, to measure and improve the performance level of the engine in the Urea-1 Plant unit as a whole system, the Overall Equipment Effectiveness (OEE) method is used which is one of the important elements in the TPM to measure the effectiveness of the machine so that it can take steps to maintain That level.

The problem to be solved in this research is how to increase the value of overall equipment effectiveness (OEE) in Plant Urea-1. While the goal to be achieved from this research is to calculate the value of availability, performance, quality and OEE on Urea-1 Plant Plant as a whole system.

2. Research method

The study was conducted in the Department of Reliability in Urea plant area.

Calculation of OEE

According to Nakajima (1988), OEE calculations are performed with several steps, i.e.:

1. The availability calculation, i.e. the ratio indicating the utilization of the time available for the operation of the machine or equipment. The required data is downtime and loading time, using the following calculation formula:

$$Availability = \frac{Operation\,Time}{Loading\,Time} \times 100\%$$
$$= \frac{Loading\,Time - Total\,Downtime}{Loading\,Time} \times 100\%$$

2. Performance calculation, which is the ratio that indicates the ability of the equipment to produce the goods. The required data are total production, cycle time, and operation time, using the calculation formula is as follows:

$$Performance\,Efficiency = \frac{processed\,amount \times Ideal\,Cycle\,Time}{Operation\,Time} \times 100\%$$

3. Calculation of quality, namely the ratio that shows the ability of the equipment to produce goods in accordance with the standards specified. The required data is the total production and the number of defects, using the calculation formula is as follows:

$$Rate\ of\ Quality\ Product = \frac{Processed\ Amount - Defect\ Amount}{Processed\ Amount} \text{x} 100\%$$

4. Calculation of overall equipment effectiveness (OEE), obtained from the multiplication of the three categories. So that, the formula used for calculation is as follows:

OEE = *Availability* x *Performance x Quality*

3. Result and Analysis

Calculation of OEE Value

The calculation is done on Plant Urea-1 where the Plant is a Plant that produce urea fertilizer and always operate so often experience constraints during the production process. Prior to performing OEE calculations, the calculations were made on its constituent categories, namely availability, performance and quality. The data used are data in 2016 from July to December obtained based on historical data from the Reliability Department.

Table 1. Availability Ratio Calculation from July 2016 until December 2016

Month	Loading Time (Hours)	Downtime (Hours)	Operation Time (Hours)	Availability Ratio (%)
July 2016	661,10	22,75	638,35	96,56
August 2016	645,50	9	636,5	98,61
September 2016	715,90	13,25	702,65	98,15
October 2016	626,20	20,7	605,5	96,69

November 2016	720	-	720	100
December 2016	594,17	22,25	571,92	96,26

Table 2. Calculation of Performance Efficiency from July 2016 until December 2016

Month	Processed Amount (Ton)	Ideal Cycle Time (Hours/Ton)	Operation Time (Hours)	Performance Efficiency (%)
July 2016	69.359,24	0,8151	638,35	88,56
August 2016	80.766,00	0,6844	636,5	86,84
September 2016	88.490,10	0,7905	702,65	99,55
October 2016	96.180,60	0,5290	605,5	84,03
November 2016	71.988,86	0,6995	720	69,93
December 2016	64.768,94	0,7072	571,92	80,10

Table 3. OEE Calculation Result from July 2016 until December 2016

Bulan	*Availability Ratio* (%)	*Performance Efficiency* (%)	*Rate of Quality Product* (%)	OEE (%)
July 2016	96,56	88,56	100,00	85,52
August 2016	98,61	86,84	100,00	85,63
September 2016	98,15	99,55	100,00	97,71
October 2016	96,69	84,03	100,00	81,25
November 2016	100	69,93	100,00	69,93
December 2016	96,26	80,10	100,00	77,10

Table 1 shows the recapitulation of the calculation results for the availability category of Urea-1 Plant. The data in Table 1 shows the achievement of availability ratio on machines in Urea-1 Plant unit in July 2016 until December 2016 is above the predetermined standard of 90%. This indicates the availability of machines for production has been used effectively.

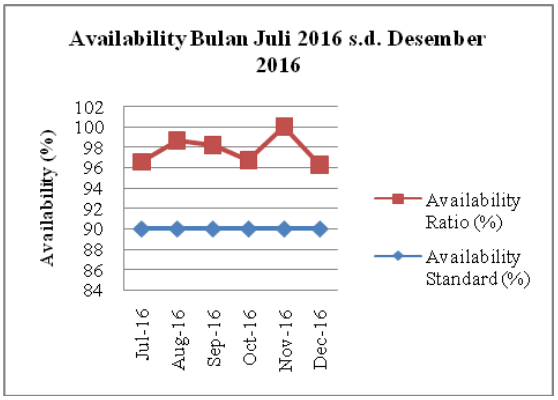

Figure 1. Availability Ratio Achievement from July 2016 until December 2016

Table 2 shows the recapitulation of performance performance calculation results. The data in Table 2 shows only in September that has reached an average of 95%, whereas in July, August, October, November and December

have not reached the standard. This shows that the performance of the engine in the Urea-1 Plant unit has not been effective.

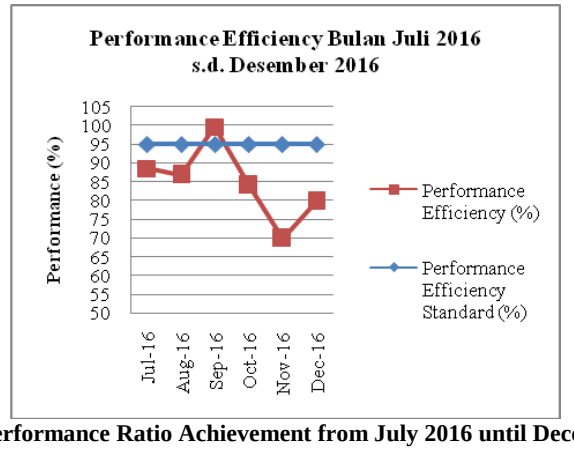

Figure 2. Performance Ratio Achievement from July 2016 until December 2016

Rate of Quality machine in Urea-1 Plant unit during July 2016 until December 2016 has reached the standard set that is 99%. This is because there are no defective urea fertilizer production (waste amount).

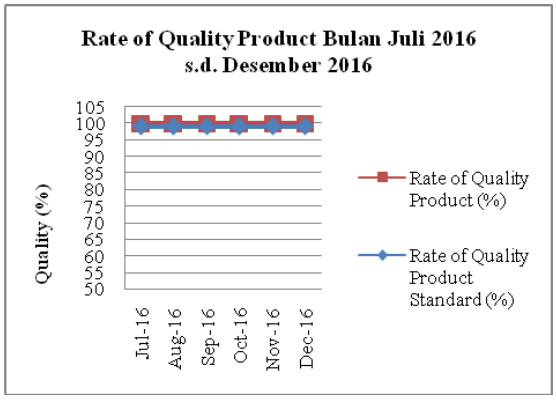

Figure 3. Quality Ratio Achievement from July 2016 until December 2016

Table 3 shows the recapitulation of OEE values and shows that in July, August and September the OEE score is above the prescribed standard of 85%. While in October, November and December the value of OEE has not reached the standard. The low value of OEE is due to the low Performance Efficiency value

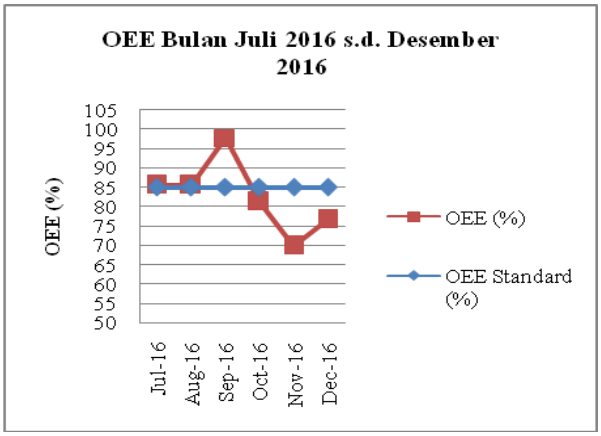

Figure 4. OEE Achievement from July 2016 until December 2016

The low value of OEE is due to the lack of machine availability time for the production due to the shut down on the machine long enough so that the availability of production time is reduced.

The company has indeed set preventive maintenance but only based on the economic life of the constituent components of the machine so that the engine maintenance is not regular and the machine damaged fluently. The proposed increase in the effectiveness of the machine in the Urea-1 Plant Unit can be done by increasing Preventive Maintenance. Efforts made Preventive Maintenance is to inspect the machine periodically and perform timely maintenance and use of quality materials so that the components of the engine in the Plant Urea-1 unit is not easily damaged. This can prevent breakdowns and delays on machines in the Urea-1 Plant unit, thus increasing the engine's effectiveness.

4. Conclusion and Discussion

The conclusions that can be obtained from the analysis and evaluation stage are as follows:

1. The value of OEE obtained during July, August and September 2016 has reached the expected standard, indicating that the machine is being used effectively.
2. Proposed in improving the effectiveness of the machine on the Urea-1 Plant Unit can be done with the increase of Preventive Maintenance that is to inspect the machine periodically and perform timely maintenance.

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