Efficiency Analysis of Sterilizer Machine Using Overall Equipment Effectiveness (OEE) Method at PT. Gersindo Minang Plantation, Pasaman Barat

Maryam[a*], Selvi Novia Wahyuni[a], Yunizurwan[a]

[a]*Politeknik ATI Padang, Jl Bungo Pasang Tabing, Padang, 25171, Indonesia*

Abstract

PT. Gersindo Minang Plantation is a company in the field of processing of palm oil to Crude Palm Oil (CPO). The boiling section uses three sterilizer machines. Machine number three has many disruptions during operation so that causing decreased level of productivity. Therefore, special attention should be paid to the maintenance of the sterilizer machine so that the production process is effective and efficient. Total Productive Maintenance (TPM) is a management principle to improve productivity and production efficiency by using machinery effectively. The first step in improving production efficiency is by measuring the effectiveness of the sterilizer machine. The purpose of this study is knowing the value of Overall Equipment Effectiveness (OEE) on sterilizer machine number 3 and knowing the factors causing it. The value of OEE in the period of January - December 2016 was 57.08%. The value is low and has not reached the standards required by Japan Institute of Plant Maintenance (JIPM) is more than 85%. Factors that affect the low value of OEE are speed loss factors which include idling, minor stoppages and reduced speed. Companies need to conduct training to operators and technicians in order to improve the ability to overcome the problems on the sterilizer machine so that companies can apply autonomous maintenance.

Keywords: OEE, Sterilizer, Efficiency

1. Introduction

The company requires a system that can prevent the machine from damage and if the machine has been damaged can be immediately known cause of damage. Total Productive Maintenance (TPM) can be a solution for companies to optimize machine work and maximize machine maintenance in order to minimize maintenance cost. Total Productive Maintenance (TPM) is a machine maintenance system that involves all factory operators. The operator is not only in charge of running the machine, but also in charge of maintaining the machine before and after its use.

Maintenance is an activity to maintain or maintain plant facilities and equipment by making necessary repairs or adjustments and replacements in order to have a satisfactory operational condition of production in accordance with what is planned. Maintenance plays an important role in the production activities of a company concerning the smoothness or congestion of production, so that the product can be produced and received by consumers in time without delay and keep no work resources idle due to damage to the machine during the production process so that can minimize the cost of losing production or if it is possible the cost can be eliminated [1].

Engine efficiency is a measure of the engine's ability to perform an operation or inspection process. The greater the value of efficiency, meaning more processes can be done by the machine in question. And Efficiency is a measure that shows how resources should be used in the production process to produce output and is also a characteristic process of measuring the actual performance of a resource relative to a defined standard [2].

The principle of efficiency is to avoid all forms of waste. Engine efficiency is the ratio between actual exit and effective capacity. Effective capacity is the maximum output that a machine can produce in real conditions which, among other things, are affected by production scheduling, engine maintenance, defects, and lack of raw materials [3].

The low productivity of machines / equipment that cause losses to the company is often caused by the use of ineffective and efficient machinery / equipment there are six factors called six big losses. In today's era of free competition, the measurement of a production system that only refers to the quantity of output alone can be misleading as it does not take into account the main characteristics of the process: capacity, efficiency and effectiveness. Using the machine / equipment efficiently means to maximize the function of the performance of machine / equipment of production with appropriate and efficient. To increase the productivity of the machine / equipment used it is necessary to analyze the productivity and efficiency of machinery / equipment in six big losses. The six big losses are as follows [4] :

a. Loss due to equipment damage (Equipment / Breakdown).
b. Disadvantages due to installation and adjustment (Set-up and adjustment)
c. Losses due to operate without expense or stop for a moment (Idling and Minor stoppages)
d. Loss due to reduced speed (Reduced speed).
e. Loss due to defective products or due to the work of processed products (Process defect).
f. Losses at the beginning of production time to reach a stable production time (Reduced yieled losses).

* Corresponding author phone : +62751 7055053; fax: +62751 41152
Email : Maryam.atip@gmail.com

Overall equipment effectiveness (OEE) is a product of six big losses in machinery and equipment. The six factors in the six big losses can be grouped into three main components in OEE to be used in machine / equipment performance measurement: donwtime losses, speed losses and defect losses. For more details OEE calculations can be seen in Figure 1 [5].

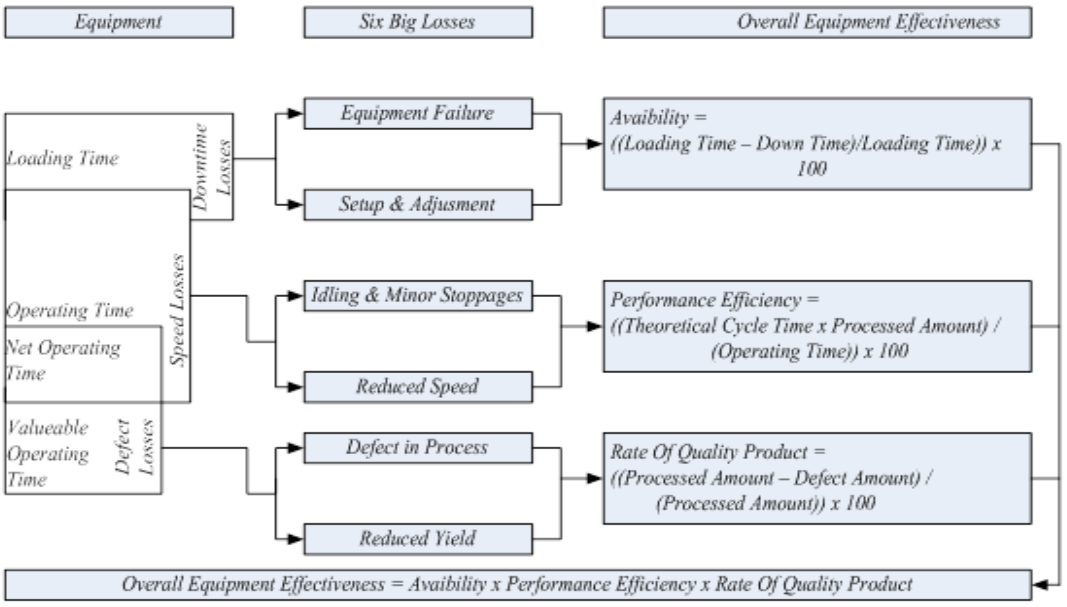

Fig. 1 Chart of OEE Calculation

The standards set in the JIPM (Japan Institute of Plant Maintenance for Performance Ratio) OEE ideal conditions are as follows [5] :

a. Availibity > 90 %
b. Performance Efficiency > 95 %
c. Quality Product > 99 %

So the ideal OEE is: 0.90 x 0.95 x 0.99 = 85%. For the benchmark standard world class recommended JIPM is OEE = 85%. The Japan Institute of Plant Maintenance (JIPM) has set the standard benchmarks that have been widely practiced worldwide:

a. OEE = 100%, production is considered perfect: only produce products without defects, work in fast performance, and no downtime.
b. OEE = 85%, production is considered world class. For many companies, this score is a suitable score to be a long-term goal.
c. OEE = 60%, production is considered fair, but shows there is great room for improvement.
d. OEE = 40%, production is considered to have a low score, but in most cases can be easily improved through direct measurement (e.g by tracking downtime reasons and handling the sources of downtime one by one).

PT. Gersindo Minang Plantation (GMP) is a branch of one of the largest group of CPO companies in Asia, namely Wilmar Group. In order to maintain the quality and superiority of its products PT. Gersindo Minang Plantation must perform maintenance and more monitoring on the smoothness of its production process. One more care that must be done in PT. GMP is the treatment of sterilizer machine number 3. PT. Gersindo Minang Plantation has three sterilizer machines that operate in sterilizer but the number three machine is often damaged because of older age when compared with other Sterilizer engines. This sterilizer machine is one machine that has a major influence in the CPO production process, in case of problems in this machine then the processing at the next station will be disrupted and even can stop operating.

Machine maintenance can be done through job loss analysis by Overall Equipment Effectiveness (OEE) method. The OEE method is performed on the sterilizer machine to determine the efficiency level of the machine. Method Overall Equipment Effectiveness is an open way in terms of providing information to deal with problems of a work system. Overall Equipment Effectiveness (OEE) helps maximize the company's assets on availability in generating performance with the best quality product.The objectives of the research are:

1. Obtain an OEE value from the number three Sterilizer machine at PT. GMP in order to know the level of machine efficiency.
2. Knowing the cause factors that affect the value of Overall Equipment Effectiveness (OEE) on Sterilizer machine number 3.

2. Method

This research was conducted at boiling station at PT. Gersindo Minang Plantation located in Tanjung Pangkal, Kenagarian Simpang Empat Pasaman Barat, West Sumatera. Data was collected :

a. Downtime
b. Planned downtime for the sterilizer machine
c. Data for setup
d. Time sterilizer production data
e. Number of Output
f. Rejected Products

Data processing is done by using the Overall Equipment Effectiveness method steps are carried out as follows [4]:

a. Availability

$$\text{Availability} = \frac{\text{OperasionTime}}{\text{LoadingTime}} \times 100\% \quad (1)$$

Operation Time = Loading Time – Downtime (2)
Loading Time = Total Available Time – Planed Downtime (3)

b. Peformance efficiency

$$\text{Performance effieciency} = \frac{\text{Processed amount} \times \text{Actual cycle time}}{\text{Operating time}} \quad (4)$$

c. Rate of Quality Product

$$\text{Rate of Quality Product} = \frac{\text{Processed Amount} \times \text{Defect Amount}}{\text{Processed Amount}} \times 100\% \quad (5)$$

d. *Overall Equipment Effectiveness* (OEE)
OEE (%) = Availability (%) x Performance (%)x Quality Rate (%) x 100% (6)

e. Analysis of Factors Affecting the Value of OEE

3. Results and Discussion

Downtime is the time that should be used to make the production process but due to the damage or disturbance in the machine cause the machine can not carry out the production process as it should. Downtime is an activity that can be seen clearly, because the damage / engine stopped suddenly and resulted in the absence of output produced by the machine does not produce. Data of downtime, planned downtime and setup can be seen in Table 1.

Table 1. Data of downtime, planned downtime and setup

Month	*Downtime (hours)*	*Planned Downtime* (hours)	*Setup* (hours)
January	7,34	20	5,25
February	6,24	16	5,55
March	7,15	16	6,04
April	6,23	16	5,45
May	12,54	20	6,35
June	7,21	16	5,25
July	8,27	20	6,05
Augustus	2,25	16	5,02
September	6,00	16	6,05
October	3,34	20	5,03
November	3,37	16	6,45
December	5,50	16	7,05

Source : PT. Gersindo Minang Plantation, 2016

Data downtime is not stable, because the amount of breakdown time and steam instability in sterilizer machine number 3 is not the same in every month, but depends on the type of damage that is in the sterilizer machine itself. The highest downtime was in May, due to the unavailability of the spare parts required in the event of damage, requiring the workshop to purchase the required spare parts to the place that provides them outside the factory environment causing the cessation of sufficient production process activities long.

Planned downtime is the time already scheduled in the production plan. Scheduled maintenance is done by the company to keep the machine is not damaged during the production process last. Maintenance is done regularly and on schedule

made by maintenace department. Setup time is the production time to produce the first good product until the last well finished product is executed. The time required to carry out engine setup starts from the engine stop time until the process for subsequent production activities.

Production data of Sterilizer machine at boiling fresh fruit bunch at PT. Gersindo Minang Plantation (GMP) in the period January - December 2016 can be seen in Table 2.

Table 2. Production data of Sterilizer machine (January – December 2016)

Month	Total Available Time (hours)	Total Product Procesed (Ton)	Total Reject Product (Ton)	Total Good Product (Ton)
January	744	7.128,23	0,00	7.128,23
February	696	7.282,44	0,00	7.282,44
March	744	7.654,14	0,00	7.654,14
April	720	8.416,20	0,00	8.416,20
May	744	8.437,30	0,00	8.437,30
June	720	6.910,34	0,00	6.910,34
July	744	9.388,53	0,00	9.388,53
Augustus	744	8.691,20	0,00	8.691,20
September	720	7.376,43	0,00	7.376,43
October	744	7.815,33	0,00	7.815,33
November	720	9.487,77	0,00	9.487,77
December	744	9.349,65	0,00	9.349,65

Source : PT. Gersindo Minang Plantation, 2016

A. Avaibility

Loading time is the time available per day or per month minus the planned engine downtime. Data downtime can be seen in Table 3.

Table 3. Loading Time of Sterilizier (January-December 2016)

Month	Total Available Time (hours)	Planned Down Time (hours)	Loading Time (hours)
January	744	20	724
February	696	16	680
March	744	16	728
April	720	16	704
May	744	20	724
June	720	16	704
July	744	20	724
Augustus	744	16	728
September	720	16	704
October	744	20	724
November	720	16	704
December	744	16	728

Downtime is the time that should be used to perform the production process, but because of a disturbance in the machine (equipment failures) then resulted in the machine can not carry out the production process as appropriate. Data downtime can be seen in Table 4. Operation Time is the total effective processing time. In this case the operation time is the result of the reduction of Loading time with Downtime machine. The value of Operation Time can be seen in Table 5. The availability value can be seen in Table 6.

Table 4. Downtime of Sterilizier (January-December 2016)

Month	Break Down time (hours)	Setup (hous)	Downtime (hours)
January	7,34	5,25	12,59
February	6,24	5,55	11,79
March	7,15	6,04	13,19
April	6,23	5,45	11,68
May	12,54	6,35	18,89
June	7,21	5,25	12,46
July	8,27	6,05	14,32
Augustus	2,25	5,02	7,27
September	6,00	6,05	12,05
October	3,34	5,03	8,37
November	3,37	6,45	9,82
December	5,50	7,05	12,55

Table 5. Operation time of Sterilizier (January-December 2016)

Month	*Loading time* (hours)	*Downtime* (hours)	*Operation time* (hours)
January	724	12,59	711,41
February	680	11,79	668,21
March	728	13,19	714,81
April	704	11,68	692,32
May	724	18,89	705,11
June	704	12,46	691,54
July	724	14,32	709,68
Augustus	728	7,27	720,73
September	704	12,05	691,95
October	724	8,37	715,63
November	704	9,82	694,18
December	728	12,55	715,45

Table 6. Availability of Sterilizier (January-December 2016)

Month	*Operation time (hours)*	*Loading Time* (hours)	*Availability* (%)
January	711,41	724	98,26 %
February	668,21	680	98,27 %
March	714,81	728	98,19 %
April	692,32	704	98,34 %
May	705,11	724	97,39 %
June	691,54	704	98,23 %
July	709,68	724	98,02 %
Augustus	720,73	728	99,00 %
September	691,95	704	98,29 %
October	715,63	724	98,84 %
November	694,18	704	98,61 %
December	715,45	728	98,28 %

Value Availability indicates the extent to which the sterilizer machine can function properly [6]. It can be concluded that the Availability level for the Sterilizier machine from January to December 2016 is ideal, since the Availability value on the Sterilizer machine is over 90% (Japan Institute of Maintenance for Performance Ratio). This proves that the sterilizer machine can still function properly.

B. Performance Efficiency

Performance efficiency is the number of products generated multiplied by the ideal cycle time to the time available to perform the production process. The performance efficiency value can be seen in Table 7. Ideal cycle time is the cycle of process time that is expected to be achieved in the optimal state or not experiencing barriers. Ideal cycle time on a Sterilizier machine is a processing time cycle that a machine can achieve in a production process in its optimal state or this machine has no barriers in production. The optimal time sterilizier machine in producing the product is 8 hours. With the provision in a single process for 1.5 hours sterilizier engine can produce semi-finished CPO products. Ideal cycle time machine sterilizier = 1.5 hours/30 ton = 0.05 hours/ton.

Table 7. Performance Efficiency of Sterilizer machine (January – December 2016)

Month	*Total Product Procesed* (Ton)	*Ideal Cycle Time* (Ton/hours)	*Operation time* (hours)	*Performance Effiecicency* (%)
January	7.128,23	0,05	711,41	50,10 %
February	7.282,44	0,05	668,21	54,49 %
March	7.654,14	0,05	714,81	53,54 %
April	8.416,20	0,05	692,32	60,78 %
May	8.437,30	0,05	705,11	59,83 %
June	6.910,34	0,05	691,54	49,96 %
July	9.388,53	0,05	709,68	66,15 %
Augustus	8.691,20	0,05	720,73	60,29 %
September	7.376,43	0,05	691,95	53,30 %
October	7.815,33	0,05	715,63	54,60 %
November	9.487,77	0,05	694,18	68,34 %
December	9.349,65	0,05	715,45	65,34 %

Performance Efficiency is the ratio of actual production to expected levels [6]. Based on the table above Performance efficiency calculation results can be concluded that the level of Performance efficiency for Sterilizier machine number three

in the period January 2016 - December 2016 is not ideal, because the value of Performance Efficiency on Sterilizier machines are all below 95% (Japan Institute of Plant Maintanance For Performance Ratio) Performance Efficiency value of sterilizer machine obtained is between 50.10% to 68.34%, this means the actual production rate of sterilizer machine is not as expected.

The low value of Performance Efficiency on Sterilizier engine is caused by two main causal factors based on six big losses analysis ie idling and minor stoppage losses and reduced speed loss, downtime on the machine Sterilizer number three high that affect the value of the operation time and consequently the final value of the low Performance Efficiency is below 95% (Japan Institute of Plant Maintenance for Performance Ratio). This is what affects the low value of OEE on sterilizer machine number 3.

C. Rate of Quality Product

Rate of Quality Product is a good product ratio with product quality specifications that have been determined against the number of products processed. Value of quality product can be seen in Table 8.

Table 8. Rate of Quality Product (January-December 2016)

Month	Total *Product Procesed* (Ton)	Total *Reject Product* (Ton)	*Rate Of Quality Product* (%)
January	7.128,23	0,00	100,00
February	7.282,44	0,00	100,00
March	7.654,14	0,00	100,00
April	8.416,20	0,00	100,00
May	8.437,30	0,00	100,00
June	6.910,34	0,00	100,00
July	9.388,53	0,00	100,00
Augustus	8.691,20	0,00	100,00
September	7.376,43	0,00	100,00
October	7.815,33	0,00	100,00
November	9.487,77	0,00	100,00
December	9.349,65	0,00	100,00

Based on the Rate of Quality Product table can be concluded that the Rate of Quality Product for Sterilizier machine in the period January 2016 - December of 2016 is very ideal. This is because the value of the Rate of Quality Product on Sterilizier machines are all above the 99% average (Japan Institute of Plant Maintenance for Performance Ratio). Percentage Rate of Quality Product is perfect that is 100%, this is because the number of defects for CPO products in PT. GMP can not be detected due to lack of quality checking tools.

D. Overall Equipment Effectiveness (OEE)

The Overall Equipment Effectiveness (OEE) values can be seen in Table 9. During the period of January to December 2016, the value of Overall Equipment Effectiveness (OEE) ranged from 49.08% to 67.38% with an average of 57.08%, so it can be said that the effectiveness and efficiency of the machine has not met the global standard where the value of OEE ≥85% (Japan Institute of Plant Maintenance for Performance Ratio). Therefore it is necessary to make some improvements for the effectiveness of the Sterilizer machine is getting better.

Table 9. Overal Equipment Effectiveness (OEE) values (January – December 2016)

Month	*Availability* (%)	*Performance Effieciency* (%)	*Rate of Quality Product* (%)	OEE (%)
January	98,26	50,10	100,00	49,23
February	98,27	54,49	100,00	53,55
March	98,19	53,54	100,00	52,57
April	98,34	60,78	100,00	59,77
May	97,39	59,83	100,00	58,27
June	98,23	49,96	100,00	49,08
July	98,02	66,15	100,00	64,84
Augustus	99,00	60,29	100,00	59,69
September	98,29	53,30	100,00	52,39
October	98,84	54,60	100,00	53,97
November	98,61	68,34	100,00	67,38
December	98,28	65,34	100,00	64,21

The low value of OEE on Sterilizer number three engine is caused by low performance eficiency value. This is influenced by the loss of production speed. That is the loss caused by idling and minor stoppages and loss due to reduced

speed. This is because the machine often occurs sudden damage at the time of production process resulting in high downtime value resulting in low operation time value so that affect the low value Performace Effieciency.

Another factor that affects idling and minor stoppages is that the lorries can not run into the Sterilizer engine without the loader help that will push it, while the loader is still in the sorting station to push the fresh fruit bunches into the loading ramp. PT. Gersindo Minang Plantation has only one unit loader so it requires that the Sterilizer machine pause for a moment. Therefore the sterilizer machine will wait until the loader arrives and push the lorry into the sterilizer machine.

In addition to the two factors above the steam that goes into the Sterilizer also greatly affects the speed losses because the steam pressure is not sufficient to boil, requiring the operator to close the inlet valve. This causes the engine to stop operating until the steam state is restored. This problem often occurs when the boiling process takes place, requiring the operator to close the steam entrance valve and wait until the steam is recovered to continue the boiling process. Furthermore, the factors that affect the speed losses are losses due to decreased speed (Reduced Speed), this is a loss that occurs due to decreased engine speed, so that the machine can not operate with the maximum. One of the factors that cause the engine to experience a decrease in speed is the age and wear and tear of a machine

4. Conclusion

The average value of OEE Sterilizer machine number 3 is 57.08%. It is at a low level and has not reached the standard set by JIPM (> 85%) so the machine can not yet be said to work effectively and efficiently.A brief summary should be given for the principal conclusions of the work. The factors that affect the value of OEE on the number three sterilizer machine are the speed loss factors (Idle and minor stoppages) and Reduced Speed.

References

[1] Assauri, Sofyan. 2008. Manajemen Produksi dan Operasi. Edisi Revisi 2008, Jakarta: Fakultas Ekonomi Universitas Indonesia.

[2] Soekartawi. 2001. Agribisnis teori dan aplikasinya Jakarta : Rajawali Pers Universitas Brawijaya

[3] Fachrurrozi. 2002. Studi Manajemen Pemeliharaan Mesin-mesin Produksi di Industri Pengolahan Kayu PT. Inhutani Administratur Industri Bekasi, Jawa Barat. Bogor. Skripsi Institut Pertanian Bogor. Bogor

[4] Wireman, T. 2002. Total Productive Maintenance, Tutorialspoint, Second Edition.

[5] Nakajima, Seiichi. 1988. Introduction to Total Productive Maintenance. Cambridge, MA, Productivity Press.

[6] Davis, Roy K., 1996. Making TPM a Part of Factory Life, Work Management, Vol 49, Part, pp.16-7