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PREDICTIVE MAINTENANCE IMPLEMENTATION OF AUTOCLAVE REACTOR AGITATOR

Oktafianus Toding[1]*, Dayal Gustopo Setiadjit[2], Fuad Achmadi[3]

[1]Maintenance and Reliability Department, Sorini Agro Asia Corporindo, Pasuruan, Indonesia
[2,3]Industrial Engineering, National Institute of Technology (ITN) Malang, Indonesia

*** Corresponding Email:** oktafianus_toding@yahoo.com

ABSTRACT: Machines are an important factor in the industrial world to produce a product in a company. PT. XYZ is a company engaged in the food industry for sweeteners processed from tapioca flour and corn flour where, through research observations, data is obtained that there are problems that are often faced such as damage to the Agitator Autoclave machine, unavailability of spare parts (spare parts) needed when there is a breakdown and a breakdown schedule for maintenance workers who have to work overtime. The purpose of this study is to determine the current condition of machine maintenance to reduce damage or failures, the level of machine effectiveness and provide alternative solutions to increase machine effectiveness. The research method used is quantitative using the Overall Equipment Effectiveness (OEE) method, Six Big Losses, Failure Modes and Effects Analysis. The results of the study resulted in an Overall Equipment Effectiveness (OEE) value of 75.07%. The low OEE value on the Agitator Autoclave machine is due to the low performance factor because the engine speed does not match its ideal speed and also the low idle and minor losses in the losses factor caused by frequent breakdowns. Suggestions and suggestions that can be recommended are to periodically evaluate machines and replace old machines.

Keywords: Overall Equipment Effectiveness (OEE), Predictive Maintenance, Six Big Losses.

1. Introduce

Machinery in an industry must be properly maintained in order to operate optimally and produce high quality products and according to production plans[1]. Maintenance is carried out by making repairs[2], replacing components needed so that activities in the production process run as planned. In addition, if the machine is interrupted or damaged, it will result in a disturbance in the production process, and may even result in the halt of part or all of the company's production process[3]. The next consequence is the number of defective products, decreased production, increased repair costs, workers experience stress and the potential to lose customers[4]. The problems that often occur in the production process at PT. XYZ, namely damage to the Agitator Autoclave machine[5], unavailability of spare parts needed when there is a breakdown and a disruption to the break schedule for maintenance workers who have to work overtime[6]. In order to overcome the various problems that occur, that is the background of this research and as a basis for solving existing problems in order to reduce machine damage or failures, to know the level of machine effectiveness, and to be able to provide recommendations and solutions in increasing machine effectiveness[3].

2. Research Methods

This study uses quantitative methods to collect the required data such as running time, downtime, production process sequence, production capacity, balancing, production improvement data and maintenance schedules[7]. After obtaining the data then it is processed by calculating Availability, Performance Rate, Quality Rate, Overall Equipment Effectiveness, Six Big Losses including Equipment Failure Losses, Setup Adjustment Losses, Idling and Minor Stoppages Losses, Reduced Speed Losses, Rework Losses and Scrap Losses and Failure Modes and Effects Analysis[8]. After the OEE and Six Big Losses calculations are obtained, the next step is to make a Fishbone Diagram and finally provide a suggestion for improvements to increase the effectiveness of the machine[9].

3. Results and Discussion

3.1. Result

The data used for calculations are obtained from daily reports on the Agitator Autoclave Reactor Machine for the period of 1 October - 31 October 2020 as presented in Table 1 [10].

Table 1 Operating Data of the Octob Autoclave Reactor Agitator Machine

Date	*Running Time* (menit)	*Planned Downtime* (menit)	*Loading Time* (menit)	*Set Up &Adj* (menit)	*Failure and Repair* (menit)	*Operating Time* (menit)
1 Oct	1440	100	1340	30	30	1280
2 Oct	1440	100	1340	25	15	1300
3 Oct	1440	100	1340	43	30	1267
4 Oct	1440	100	1340	30	100	1210
5 Oct	1440	100	1340	10	0	1330
6 Oct	1440	100	1340	15	40	1325
7 Oct	1440	100	1340	20	30	1290
8 Oct	1440	100	1340	20	35	1285
9 Oct	1440	100	1340	10	15	1315
10 Oct	1440	100	1340	30	235	1075
11 Oct	1440	100	1340	60	600	680
12 Oct	1440	100	1340	45	825	470
13 Oct	1440	100	1340	30	295	1015
14 Oct	1440	100	1340	25	115	1200
15 Oct	1440	100	1340	15	40	1285
16 Oct	1440	100	1340	10	35	1295
17 Oct	1440	100	1340	20	35	1285
18 Oct	1440	100	1340	10	15	1315
19 Oct	1440	100	1340	5	0	1335
20 Oct	1440	100	1340	5	0	1335
21 Oct	1440	100	1340	10	10	1320
22 Oct	1440	100	1340	10	20	1310
23 Oct	1440	100	1340	10	5	1325
24 Oct	1440	100	1340	20	238	1082
25 Oct	1440	100	1340	30	260	1050
26 Oct	1440	100	1340	15	70	1255
27 Oct	1440	100	1340	15	40	1285
28 Oct	1440	100	1340	5	0	1335
29 Oct	1440	100	1340	5	10	1325
30 Oct	0	0	0	0	0	0
31 Oct	1440	100	1340	10	35	1295
Total	**43200**	**3000**	**40200**	**1083**	**3178**	**36474**

The collection and processing of operating data are used to measure Overall Equipment Effectiveness (OEE) as presented in Table 3.

Table 2 Recapitulation Results Average Value Availability Rate, Performance Efficiency, Quality of Product and OEE

Availability Rate (%)	Standar	*Performance Efficiency* (%)	Standar	*Quality of Product* (%)	Standar	OEE (%)	Standar
90.72	90	80.91	95	99.73	90	75.07	85

After the OEE calculation is obtained, the next step is to calculate Six Big Losses to identify losses such as losses due to equipment damage, preparation and adjustment losses, product damage losses and hidden losses such as reduced speed and idle and minor stoppage losses, as shown in Table 2.

3.2. Discussion

3.2.1 Analysis of the measurement of the OEE value Availability Analysis

Availability shows a measure of the extent to which a machine can function properly or it can also be said to be the probability of a system operating according to its function at a certain time under predetermined operating conditions[11]. The resulting average availability value is 90.72%. This means that the quality of the machine is good, so it needs to be maintained.

Table 3 Value Recapitulation (OEE) Results for the October 2020 Period

Date	*Availability Rate* (%)	*Performance Efficiency* (%)	*Quality of Product* (%)	OEE *Availabilty* (%)
1 Oct	95.52	87.38	99.77	83.27
2 Oct	97.01	81.71	100	79.26
3 Oct	94.55	90.27	100	85.35
4 Oct	90.29	95.75	100	86.45
5 Oct	99.25	88.22	100	87.55
6 Oct	98.88	84.29	100	83.34
7 Oct	96.26	88.90	100	85.57
8 Oct	95.89	83.11	100	79.69
9 Oct	98.13	84.73	100	83.14
10 Oct	80.22	57.94	99.76	46.36
11 Oct	50.74	39.58	97.78	19.63
12 Oct	35.07	40.56	96.27	13.69
13 Oct	75.74	66.04	99.41	49.72
14 Oct	89.55	89.32	99.93	79.93
15 Oct	95.89	93.39	100	89.55
16 Oct	96.64	87.12	100	84.19
17 Oct	95.89	90.08	100	86.37
18 Oct	98.13	84.34	100	82.76
19 Oct	99.62	87.15	100	86.81
20 Oct	99.62	86.44	100	86.11
21 Oct	98.50	76.78	100	75.62
22 Oct	97.76	88.80	100	86.81
23 Oct	98.88	76.71	100	75.85
24 Oct	80.74	66.88	99.82	53.90
25 Oct	78.35	65.92	99.69	51.48
26 Oct	93.65	93.68	100	87.73
27 Oct	95.89	87.99	100	84.37
28 Oct	99.62	89.05	100	88.71
29 Oct	98.88	87.26	100	86.28
30 Oct	0	0	0	0
31 Oct	96.64	88.07	99.69	84.84

Table 4 Results of Six Big Losses Value Recapitulation

Date	*Equipment Failure Loss* (%)	*Setup and Adjustment Loss* (%)	*Idling and Minor Stoppages* (%)	*Reduced Speed Loss* (%)	*Rework Loss* (%)	*Scrap Loss* (%)
1 Oct	2.23	2.23	7.46	16.52	0.18	0
2 Oct	1.19	1.86	7.46	20.71	0	0
3 Oct	2.23	3,20	7.46	14.63	0	0
4 Oct	7.46	2.23	7.46	14.63	0	0
5 Oct	0	0.74	7.46	12.42	0	0
6 Oct	2.98	1.11	7.46	16.64	0	0
7 Oct	2.23	1.49	7.46	14.40	0	0
8 Oct	2.61	1.49	7.46	20.29	0	0
9 Oct	1.11	0.74	7.46	16.83	0	0
10 Oct	17.83	2.23	7.46	53.50	0.11	0
11 Oct	44.77	4.47	7.46	79.90	0.44	0
12 Oct	61.56	3.35	7.46	85.76	0.52	0
13 Oct	22.01	2.23	7.46	49.97	0.29	0
14 Oct	8.58	1.86	7.46	20.00	0.05	0
15 Oct	2.98	1.11	7.46	10.43	0	0
16 Oct	2.61	0.74	7.46	15.79	0	0
17 Oct	2.61	1.49	7.46	13.60	0	0
18 Oct	1.11	0.74	7.46	17.21	0	0
19 Oct	0	0.37	7.46	13.16	0	0
20 Oct	0	0.37	7.46	13.87	0	0
21 Oct	0.74	0.74	7.46	24.35	0	0
22 Oct	1.49	0.74	7.46	13.17	0	0
23 Oct	0.3	0.74	7.46	24.14	0	0
24 Oct	17.76	1.49	7.46	45.98	0.09	0
25 Oct	19.40	2.23	7.46	48.33	0.15	0
26 Oct	5.22	1.11	7.46	12.25	0	0
27 Oct	2.98	1.11	7.46	15.61	0	0
28 Oct	0	0.37	7.46	11.27	0	0
29 Oct	0.74	0.37	7.46	13.71	0	0
30 Oct	0	0	0	0	0	0
31 Oct	2.61	0.74	7.46	14.87	0.25	0
	7.90	2.69	22.38	2.38	2.15	0

Performance Efficiency Analysis

Performance efficiency is the level of the machine's ability to produce output. The resulting average performance value is 80.91%.

The low value of performance efficiency is influenced by speed losses, namely the actual speed of the engine is not in accordance with the ideal speed so that it affects the number of orders that the machine must bear and is often below the engine standard itself[12].

Quality Rate Analysis

Quality rate is an indicator that shows the success rate of the machine in producing good quality products. The resulting average quality rate is 99.73%, which means that the quality of the machine is good enough.

Overall Equipment Effectiveness (OEE) Analysis.

Overall Equipment Effectiveness (OEE) is a measuring tool to determine the effectiveness of a machine in performing its function for a single product. The resulting average OEE value is 75.07%. One of the causes of the low OEE value is the low performance rate value because the quality of the machine does not meet the standards.

3.2.2 Analysis of Six Big Losses

Failure Losess Equipment Analysis

Analysis of equipment failure losess is an unscheduled equipment repair. The value of equipment failure losess is around 7.90%. The value of the equipment failure losess indicates that the amount of time wasted due to damage to production equipment or machinery.

Analysis of Setup and Adjustment Losess

Analysis of setup and adjustment losess an average of 2.69% is the time absorbed for installation, adjustment and adjustment of machine parameters to get the desired specifications. The large value of setup and adjustment causes losses, starting from the stopping of the engine, until the machine can operate until it reaches the specified specifications and is allowed to start production by the quality control.

Reduced Speed Losess Analysis

Analysis of reduced speed losess is a loss that occurs due to the equipment being operated below the speed standard. The value of these losses absorbs an average loading time of 2.38%. The possible cause for this loss is the operator's lack of understanding in machine setup.

Idle and Minor Stoppage Losess Analysis

The analysis of idle and minor stoppage losess is the average value of idle and minor stoppage of 22.38%. This shows the highest losses of all losses. This loss occurs due to frequent machine breakdowns and the absence of an operator.

Rework Losess Analysis

Rework losses analysis is wasted equipment time to produce inappropriate (bad) products[13]. The average value of rework losses is 2.15%.

3.2.3 Fishbone Diagarm

After knowing the cause of low score of Overall Equipment Effectiveness is idle and minor losses; equipment failures losses, then to find root cause using a fishbone diagram. Factors analyzed in fishbone diagram is a man power, machines; methods and materials. Here is a picture of the fishbone diagram.

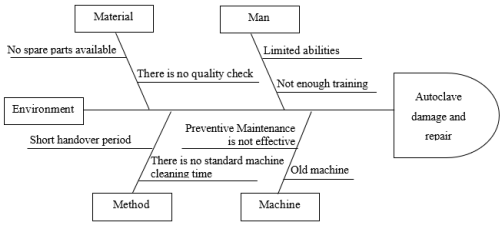

Figure 1 Fishbone Diagram

4. Conclusion

1. From the calculation of Overall Equipment Effectiveness (OEE), it is obtained 75.07% with a 90.72% availability rate, 80.91% performance efficiency and a Quality Ratio value of 99.73%. This value is still far below the world standard, namely 85%. The low OEE value is due to the low performance variable value due to speed losses, namely the actual engine speed is not in accordance with the ideal speed.
2. From the calculation of Six Big Losses, the results of Idle and minor losses are 22.38%, equipment failures losses with a value of 7.90%, setup and adjustment losses of 2.69%, reduced speed losses with a value of 2.38% and rework losses of 2.15%. The cause of idle and minor losses as the biggest loss factors is due to frequent machine breakdowns or the absence of an operator.
3. Suggestions that can be given to companies are to carry out periodic evaluations to prevent frequent engine breakdowns, replacement of old machines, providing training to employees and carrying out engine repairs according to the standard method of the machine.

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