

The machines maintenance conditions assessment in the plastic industry

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Abstract The purpose, methodology, main findings, the originality of the subject area (research), way of using. The main research analysis purpose is a presentation, an assessment and an interpretation of the research findings on the machines maintenance conditions in the plastic industry. The research analysis was carried out with applying Technology ABC method and TPM coefficients calculations connected with Techno pak machine components maintenance. The research was carried out in the chosen manufacturing enterprise of the plastic industry. Research findings interpretation results have been introduced in the analyzed enterprise in the form of the manufacturing processes improvement.

Key words – manufacturing, plastic industry, machine maintenance, TPM coefficients, Technology ABC method

1. Introduction

The manufacturing process in the plastic industry is related to constant assessment of the machines maintenance conditions. Results of this assessment influence on the final product quality since the quality is determined by the production processes evaluation and its improvement with regard to identified technical problems.

The research examinations presented in the paper have been carried out in the chosen manufacturing enterprise of the plastic industry dealing with cleaning products manufacturing. Research period includes data obtained within 8 weeks. Products are made of polyurethane foam containing the abrasive non-woven fabric or polyurethane foam massage that has a density of 21/23 kg / m³ in 5 different colours is used in the ana-

lyzed manufacturing process. The produced foam is certified. The nonwoven fabric abrasive has a basis weight of 550 g/m².

Individual operations marked with numbers are as follows (in parentheses there are identified operations' duration):

1. The unloading of ordered raw material from a lorry.
2. The qualitative and quantitative control of raw materials taken to the warehouse.
3. Transport of raw materials by a forklift to place of materials' storage.
4. Storage of materials.
5. Preparation of stored materials for the production on the basis of the supplied production order.
6. Transport of materials from the warehouse to the production hall by a forklift truck.
7. The inspection of delivered raw materials by the foreman.
8. Transport of materials to the first stage of the horizontal cutting machining by a forklift truck.

9. The operation of the horizontal materials (polyurethane foam blocks) cutting with the panel dimension control and record of the measurement result. 10. Transport of the cutting raw material on pallets to the next production stage. 11. The bonding operation of cut material cut with non-woven abrasive material, hooking of the glued pallets with simultaneously administered glue weight control and record of control results. 12. Transport of a glued material to the glued pallet storage. 13. The storage of glued materials at the production place to ensure adequate conditions for the binding glue process. 14. The operation of glued pallets unfastening. 15. Transport of materials for vertical cutting station. 16. The vertical cutting operation of the material and the dimensions control of the cut material and record of the control results. 17. Transport of the cut material to the packing station. 18. The packing operation with visual control based on the product model. 19. Transport of the finished product to the place of temporary storage, which is a place of constant control. 20. The sampling control carried out by quality controller. 21. Transport of the finished product to the warehouse. 22. Preparation of the pallet with the finished product for a storage. 23. Transport of the finished product to the storage. 24. The storage of the finished product.

2. Methodology of research

The research analysis was conducted with applying the machines maintenance conditions assessment based on Technology ABC method (BORKOWSKI S., SELEJDAK J., SALAMON SZ. 2006). The Technology ABC methodology allows specifying the modernity level of individual components parts in the chosen machine. Presented research methodology is based on the principle related to the fact, that each group of machine's components are divided into several groups marked with the letter A (affect on the main manufacturing results). There are also some machine's components that are marked with the letter C (have a small contribution to the manufacturing results and the machines maintenance conditions). The other parts of groups are marked with the letter B (BORKOWSKI S. 2004).

Application of ABC analysis allows identifying of significant technological capabilities of enterprises'

machines responsible for the final quality performed by the manufacturing processes (BORKOWSKI S. 2012). Technology ABC analysis is applied with using Parker scale (5 grading scale).

Research findings on chosen machine's modernity level have been analyzed in the context of machines' maintenance conditions by applying calculations on the Overall Effectiveness Efficiency of the Machine (OEE) that is a key measure of Total Production Maintenance. The Overall Effectiveness Efficiency of the Machine is a measure of the machine efficiency that is calculated based on its performance (BORKOWSKI, S., JEZIORSKI, L., RYCHTER, A. 2004).

3. Results and discussions

Table 1 presents an assessment of the individual machine components modernity level carried out with using the ABC method for the machine of Techno pak FP 05 type, that was produced in 1994.

Table 1. Assessment of the machine parts modernity level for Techno pak

Subassembly	No	Parts/Components of the machine	The modernity level
A	A1	Control system	2
	A2	Console	1
	A3	Gear (changing a length of the package)	3
	A4	Drive motors	3
	A5	Sprockets	3
B	B1	Main propulsion system	3
	B2	Drive train feed	3
	B3	Pneumatic system of heaters shutdown	3
	B4	Electric heating system	3
	B5	The drive system of sealing rollers	3
	B6	The team of guide rollers	4
	B7	Team rolls of tape leading to the repeller	4
	B8	Feeder chain to sponges running	4
	B9	Chains	4
C	C1	The machine construction	4
	C2	Covers of the moving parts	5
	C3	Platen	4
	C4	Control valves	3

Source: own study based on internal materials of the enterprise.

Parts located in different components (Table 1), can be qualified in accordance to Parker scale:

- A in 60% is identified on 3 level and two others (20%) - on 2 and 1 level,
- B in 55,5% is identified on 3 level and 45% - on 4 level,
- C in 50% is identified on 4 level and 25% - on 5 and 3 levels.

As a result of research analysis based on Technology ABC method, that 18 parts in the analyzed machine is characterized as follows:

- 1 is on the level 1 in Parker scale,
- 1 is on the level 2 in a Parker scale,
- 9 is on the level 3 in Parker scale,
- 6 is on the level 4 in Parker scale,
- 1 is on the level 5 in Parker scale.

On the basis of the analysis, it can be stated, that modernity level of the analyzed machine parts is identified between 1 and 5 level in Parker scale with the majority of those parts identified in the range: 3 ÷ 4 level.

The research findings on the machines modernity level in the analyzed enterprise dealing with plastic products manufacturing shown that analyzed ma-

chines' components are modern, what can be directly reflected to high product quality level. It has been also confirmed as the result of analysis that concerned non-conformities identified in the packaging. It was stated, that within two months the analyzed machine packed 44417 pieces and there were identified 3566.7 pieces of nonconformities, what is 0.81% of nonconformities at all.

Analysis of the machines' maintenance conditions based on TPM coefficients assessment have been presented with applying of OEE analysis. The calculation of OEE coefficients for chosen machines maintenance conditions assessment are presented in Table 2.

Figure 1 presents analyzed coefficients that are following: the quality coefficient, the overall machines efficiency coefficient and the use coefficient.

As it results from the analysis of data presented in Table 2 and Figure 1, the value of OEE coefficient is highly variable (34.87% ÷ 81.16%). These values have a large range. It can be concluded, that obtained research findings are caused by unplanned machines breakdown and stops. In majority of obtained research results, OEE coefficient is assessed as a high nominal-ly (in the range: 74.31% ÷ 81.16%).

Table 2. Techno pak efficiency analysis for 8 weeks

Research period	Shift work fund [min]	The planned stoppage of machines [min]	The work time [min]	Unscheduled machine stoppage [min]	Netto maintenance time [min]	The availability coefficient [%]	The number of processed products [szt]	The projected time of one product processing [min/pc]	The Real time of the product processing [min/szt]	The velocity coefficient of the action [%]	The utilization coefficient [%]	The number of incompatibilities [pc]	The quality coefficient [%]	The overall efficiency of the device [%]
1	4320	885	3435	845	2590	75,40	36592	0,033	0,071	46,62	46,62	295,7	99,19	34,87
2	4800	2315	2485	330	2155	86,72	66154	0,033	0,035	94,29	101,30	613	99,07	81,16
3	4800	3400	1400	250	1150	82,14	32284	0,033	0,036	92,64	92,64	400	98,76	75,16
4	4800	2740	2060	415	1645	79,85	47434	0,033	0,035	95,16	95,16	494,7	98,96	75,19
5	3840	120	3720	435	3285	88,31	77944	0,033	0,042	78,30	78,30	256,6	99,67	68,92
6	4800	2310	2490	215	2275	91,37	56337	0,033	0,040	81,72	81,72	270	99,52	74,31
7	4800	1880	2920	310	2610	89,38	68132	0,033	0,038	86,14	86,14	849,2	98,75	76,04
8	4800	1540	3260	280	2980	91,41	59108	0,033	0,050	65,45	65,45	387,5	99,34	59,44

Source: own study based on internal materials of the enterprise

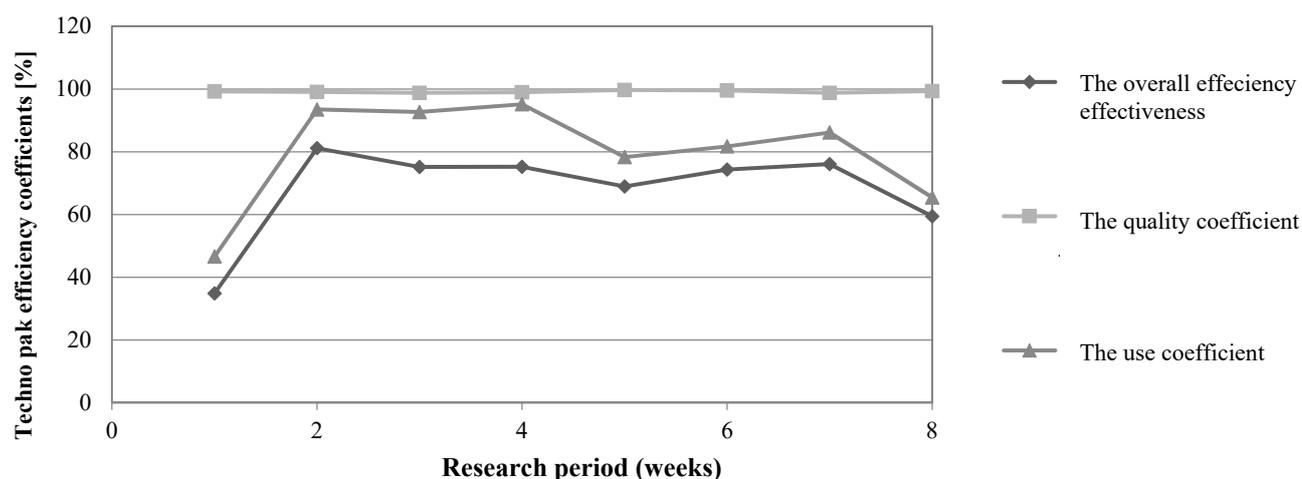


Fig. 1. Comparison of Techno pak efficiency coefficients in the research period 8 weeks.

Source: own study based on internal materials of the enterprise.

Research findings presented in Figure 1 shown, that the quality coefficient is characterized by high level and it is stable. The other coefficients are in the range: 40% ÷ 98%.

4. Summary and conclusions

Presented research paper presents research examinations results that concerns machines' maintenance conditions assessment based on TPM coefficients analysis. The overall efficiency (OEE) for packaging machine Techno pak fluctuated within two months (8 weeks) in the range 34.87% ÷ 81.6%. In most cases the OEE coefficients amounted high values (74.31% ÷ 91.16%).

An evaluation of the modernity machine components' level of the packaging machine was conducted in accordance to technology ABC method with applying Parker scale. On the basis of the obtained research findings, it can be stated, that the machine's components are evaluated between 1 and 5 level of Parker scale with the majority of parts identified on level 3 and 4. As it results from above research results, most of the component parts are assessed as modern components and it is reflected to product quality level. It has been also confirmed in the results of the nonconformities analysis results for the packaging process, because within two months analyzed machine packed

44417 pieces and in that period there were identified 3,566.7 of nonconformities (0.81%).

5. Additional information

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