

FAILURE FREQUENCY OF CANDIES PACKING LINE BEFORE AND AFTER INTRODUCING SERVICE STRATEGY OF *TOTAL PRODUCTIVE MAINTENANCE* (TPM)

Summary

The candies packing line includes the following devices: candies stacking machine, packing machine, X-Ray controller, machine grouping candies and packing them into boxes (boxformer), box wrapping machine, board machine and pallets wrapping machine. The line works 504 hours a month. During 2003-2007 the line was serviced according to the strategy of after-damage repairs and during 2008-2012 according to the TPM strategy. The introduction of TPM contributed to the decrease of the line failure frequency by 50%, the standstill time by 60% and the increase of productivity by ab. 10%.

Key words: production line, TPM strategy, failure frequency

AWARYJNOŚĆ LINII PAKOWANIA CUKIERKÓW PRZED I PO WPROWADZENIU STRATEGII OBSŁUGIWANIA *TOTAL PRODUCTIVE MAINTENANCE* (TPM)

Streszczenie

Linie pakowania cukierków tworzą następujące urządzenia: układarka cukierków, maszyna pakująca, kontroler X-Ray, maszyna grupująca i pakująca cukierki w tzw. boksy (boxformer), owijarka boksów, kartoniarka i owijarka palet. W ciągu miesiąca linia pracuje 504 godziny. W latach 2003-2007 linia była użytkowana według strategii napraw poawaryjnych, a w latach 2008-2012 według strategii TPM. Wprowadzenie TPM przyczyniło się do spadku liczby awarii linii o 50%, skrócenia czasu postoju o 60% i wzrostu wydajności o ok. 10%.

Słowa kluczowe: linia produkcyjna, strategia TPM, awaryjność

1. Introduction

In order to decrease the object ageing intensity, i.e. to stabilize its fitness to use, as well as its reproducibility, there is a series of actions to be done which are called a service. They are both operating actions of preventive and repair character and the organization one.

Continuity of manufacturing processes achievement depends on many factors, however, in a great measure it depends on reliability of technical objects included in the process lines. The failure of the line or its wrong operation force stopping for repairs that is always cost-generating. That is why it is so important to maintain the line in operating conditions what in a high degree depends on the used service strategy.

The most important and generally used service strategies are as follows:

- 1) strategy of after-damage repairs (NPA),
- 2) strategy of planned and preventive repairs (PZR, acc. to overhaul life),
- 3) strategy of service according to the condition (system of preventive supervision SIZ),
- 4) strategy of Total Productive Maintenance (TPM).

The TPM strategy is the enterprise complex and preventive service of machines and devices performed by the operators and personnel responsible for keeping the machines in motion [1, 2, 3, 6].

TPM assumes the responsibility of all enterprise employees for maintaining the machines in good condition. However, the key problem is to arouse the operators interest and engagement in maintaining the machines fit for use, as they, first of all, have information enabling successful failures avoidance. In the TPM strategy the machine servic-

ing (maintenance, overhauls) is the priority in relation to the manufacturing plan [1]. The comparison between the traditional attitude towards keeping the machines in motion and the TPM strategy is presented in the table 1.

Table 1. The comparison between the traditional attitude towards keeping the machines in motion and the TPM strategy (basing on [1])

Tab. 1. Porównanie tradycyjnego podejścia do utrzymania ruchu ze strategią TPM (na podstawie [1])

Criterion	Traditional service strategies	TPM Strategy
Priority	Manufacturing plan	Preventive service
Organization of service for keeping machines in motion	Separated from production	Integrated with production

In the TPM strategy the basic index is OEE – the overall equipment effectiveness calculated as a product of three indexes: equipment accessibility F, equipment usage I, quality of manufacturing process K.

In order to determine OEE it is necessary that the operators record the indexes influencing its value. They are mainly: failures, shutdowns and standstills, quality departures, productivity changes (so called power losses).

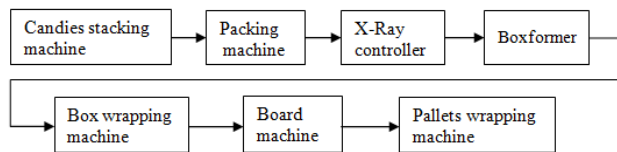
The OEE value (desirable above 60%, acceptable above 80% [2]) allows to evaluate the machine usage effectiveness and, in the effect, the whole process from the point of view of technical equipment.

The TPM strategy is more and more often introduced in the food industry enterprises in order to improve the efficiency of process lines [4, 5].

The purpose of this paper is to determine the influence of the TPM strategy on decreasing the failure frequency and improving the candies packing lines effectiveness.

2. Candies packing line characteristics

The candies packing line scheme is presented in the fig. 1.



Source: Own work / Źródło: opracowanie własne

Fig. 1. Candies packing line scheme

Rys. 1. Schemat linii pakowania cukierków

The most important objects of the line are: the candies stacking machine with a vibratory conveyor, the packing machine of the firm Loesch, the X-Ray controller, the machine grouping and packing candies in so called boxes (boxformer), the box wrapping machine and the board machine.

The task of the stacking machine is to put candies on the vibratory conveyors in the vertical position and to transport and distribute them to the packing machine conveyor.

The packing machine packs candies in packages containing 16 pcs each at speed of 50-204 pcs \cdot min⁻¹.

The task of the X-Ray controller is to check if the packed product is free of foreign matters and if a package contains the suitable amount of candies. This machine using ionizing radiation X-rays the product: spoilage and metal contaminated products are rejected.

The boxformer of the firm Paal groups and packs the products in boxes – 24 pcs a box consisting of four layers with 6 pcs.

The wrapping machine wraps ready boxes in foil.

The board machine arranges groups of 12 pcs of packed boxes and packs them to the boards of appropriate size.

The packing line operates from Sunday (night shift) to Friday (second shift) in the three shift system: a nominal worktime during one month is 504 hours.

3. Tests

The analysis of the operation of the candies packing line was carried out in two five-year periods, i.e. in the years 2003-2007 and 2008-2012.

In the years 2003-2007 the line was serviced according to the strategy of after-damage repairs. It consisted of the following machines: the candies stacking machine, the packing machine of the firm Loesch, the boxformer Pall, the wrapping machine and the board joint gluer. On the packaging line worked 3 people in the 3 shift system for five days a week. The line was operated through delivering the product for packing and the packing materials and packed the candies manually. Unforeseen failures and sometimes the lack of spare parts caused extended standstills influencing negatively the line efficiency.

In the years 2008-2012 the line being after modernization was serviced according to the rules of the TPM strategy. After the modernization the line consists of the following machines: the candies stacking machine, the packing machine of the firm Loesch, the X-Ray controller, the boxformer Pall, the wrapping machine Ima, the scales, the board machine Ima, the pallets wrapping machine.

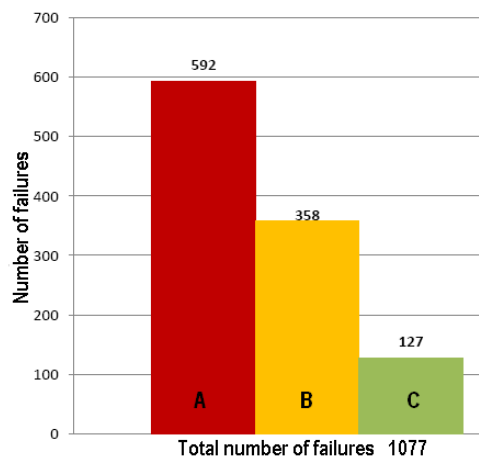
The line operates in the three shift system, five days a week; it is operated by two persons.

The motion keeping service data base “ORACLE” was the main source of information about failures. The failures lasting less than 10 minutes were not taken into consideration in the analysis.

Basing on the data it was established as follows:

- number of failures of the packing line and its individual objects,
- overall stop time of the line and its individual objects,
- the weakest link in the line,
- the most common damage of the weakest link.

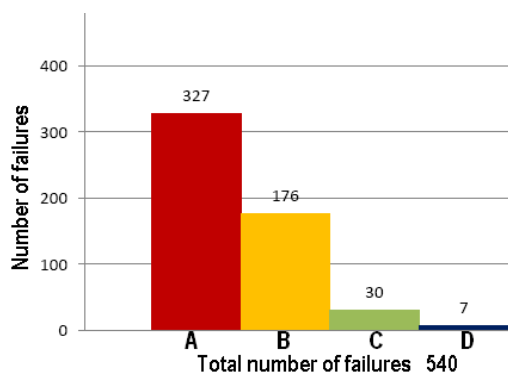
The results of the data analysis concerning candies packing line damages are presented in the following figures. The figures 2 and 3 show the line failure frequency during 2003-2007 (before the introduction of the TPM strategy) and during 2008-2012 (after the introduction of the TPM strategy), respectively.



Source: Own work / Źródło: opracowanie własne

Fig. 2. Failure frequency of the line and its individual objects – during 2003-2007 (before TPM strategy introduction); A – packing machine Loesch, B – boxformer Pall, C – wrapping machine BFB

Rys. 2. Awaryjność linii i poszczególnych jej obiektów – lata 2003-2007 (przed wprowadzeniem strategii TPM); A – maszyna pakująca Loesch, B – boxformer Pall, C – owijarka BFB

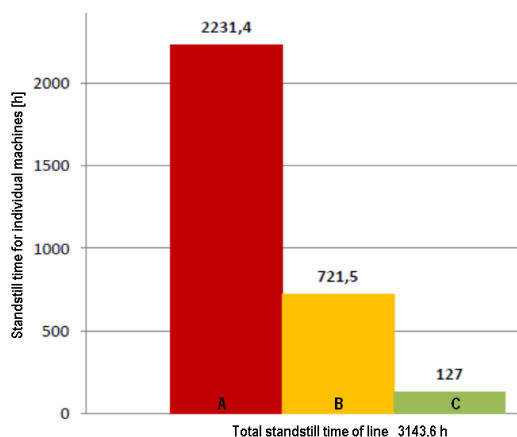


Source: Own work / Źródło: opracowanie własne

Fig. 3. Failure frequency of the line and its individual objects during 2008-2012 (after TPM strategy introduction); D – Board machine BFB, other designations as in the fig. 2

Rys. 3. Awaryjność linii i poszczególnych jej obiektów w latach 2008-2012 (po wprowadzeniu strategii TPM); D – Kartoniarka BFB, pozostałe oznaczenia jak na rys. 2

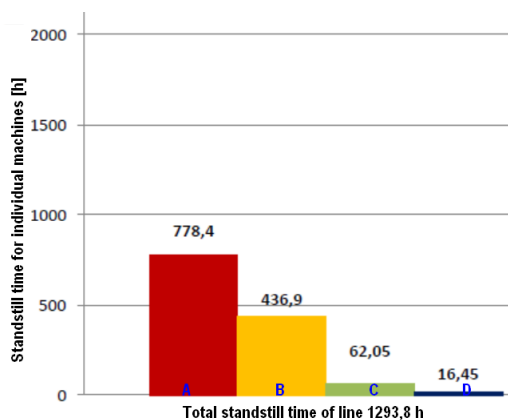
Figures 4 and 5 present the packing line standstill time before and after the introduction of the TPM strategy.



Source: Own work / Źródło: opracowanie własne

Fig. 4. Standstill time of the line and its individual objects during 2003-2007 (before TPM strategy introduction); designations as in the fig. 2

Rys. 4. Czas postoju linii i poszczególnych jej obiektów w latach 2003-2007 (przed wprowadzeniem strategii TPM); oznaczenia jak na rys. 2



Source: Own work / Źródło: opracowanie własne

Fig. 5. Standstill time of the line and its individual objects during 2008-2012 (after TPM strategy introduction); designations as in the fig. 2 and 3

Rys. 5. Czas postoju linii i poszczególnych jej obiektów w latach 2008-2012 (po wprowadzeniu strategii TPM); oznaczenia jak na rys. 2 i 3

The table 2 presents values of the OEE index describing the candies packing line effectiveness. The introduction of the TPM strategy caused that the index increased at the average by 10%.

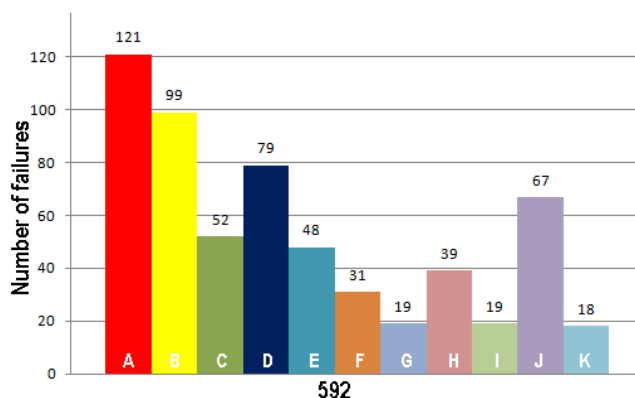
Table 2. Obtained values of OEE index depending on service strategy

Tab. 2. Osiągnięte wartości wskaźnika OEE w zależności od strategii obsługi

Strategy	Values OEE [%] in individual years					Mean value OEE [%]
	2003	2004	2005	2006	2007	
NPA	64.9	68.1	70.7	72.4	74.6	70.1
	75.8	78.0	81.1	82.2	83.6	
TPM	75.8	78.0	81.1	82.2	83.6	80.1
	75.8	78.0	81.1	82.2	83.6	

Source: Own work / Źródło: opracowanie własne

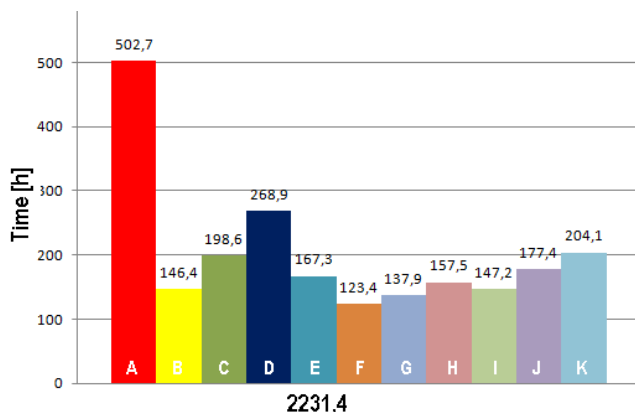
After analysing the data both of years 2003-2007 and 2008-2012 they found out that in both periods the packing machine of the firm Loesch was the weakest link. The number of damages and the standstill time caused by the individual units of the machine are presented in the figures 6-9.



Source: Own work / Źródło: opracowanie własne

Fig. 6. Number of failures of packing machine Loesch and its units during 2003-2007; A – packing head, B – feeding system CTB, C – lower benders, D – chain, grabs – set, E – welding system, F – printing system, G – lubricating system, H – pneumatic system, I – carriers, J – drops no. 1 and no. 2, K – drive

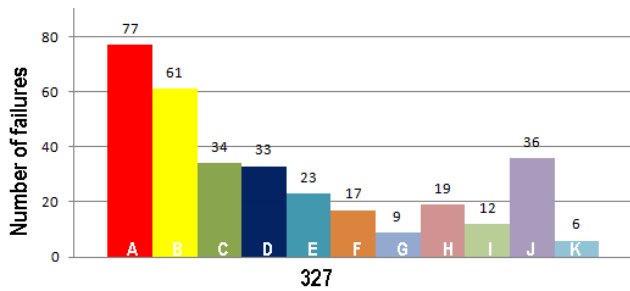
Rys. 6. Liczba awarii maszyny pakującej Loesch i jej zespołów, które wystąpiły w latach 2003-2007: A – głowica pakująca, B – układ podawania CTB, C – zaginacze dolne, D – łańcuch, chwytaki – komplet, E – układ zgrzewania, F – układ drukowania, G – układ smarowania, H – układ pneumatyczny, I – transportery, J – zrzuty nr 1 i nr 2, K – napęd



Source: Own work / Źródło: opracowanie własne

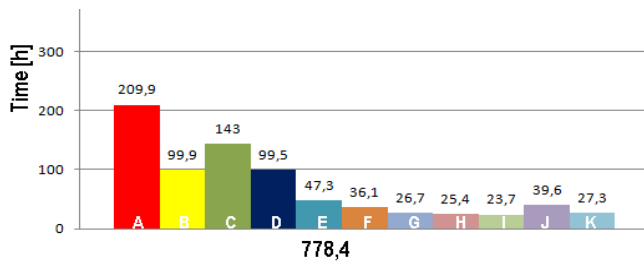
Fig. 7. Standstill time of packing machine Loesch and its units during 2003-2007; designations A-K as in the fig. 6

Rys. 7. Czas postoju maszyny pakującej Loesch i jej zespołów w latach 2003-2007; oznaczenia A-K jak na rys. 6



Source: Own work / Źródło: opracowanie własne

Fig. 8. Number of failures of packing machine Loesch and its units during 2008-2012; designations A-K as in the fig. 6
Rys. 8. Liczba awarii maszyny pakującej Loesch i jej zespołów, które wystąpiły w latach 2008-2012; oznaczenia A-K jak na rys. 6



Source: Own work / Źródło: opracowanie własne

Fig. 8. Standstill time of packing machine Loesch and its units during 2008-2012; designations A-K as in the fig. 6
Rys. 8. Czas postoju maszyny pakującej Loesch i jej zespołów w latach 2008-2012; oznaczenia A-K jak na rys. 6

The introduction of the packing line service according to the TPM strategy required the elaboration of the overhaul schedules for the individual machines included in the line.

Such schedule elaborated, for example, for the packing machine and assuming the inspections of the most failure causing units to be performed every two weeks, contributed

to the decreased number of damages and the machine standstill, respectively by 45% and 65%.

4. Summary

1. The obtained test results allow for stating that the departure from the candies packing line after damage repairs and the introduction of its servicing line according to the TPM strategy caused as follows:

- number of failures decreased by ab. 50%,
- standstill time caused by the failure decreased by ab. 60%,
- achieving the satisfactory level of the OEE line objects overall effectiveness being over 80%.

2. Taking into consideration the long 5-year comparison periods, one can state that the presented results unambiguously confirm the benefits arising from the application of the TPM service strategy.

5. References

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