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# MODERNIZATION OF THE SYSTEM MAINTENANCE THE MACHINES LINE HOR 6000

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***Abstract***

*Article concerns maintenance strategy for HOR 6000 production line machines, which is realized during their exploitation. The main goal of the article is to point at weak points of HOR 6000 production line and justification of the proposal of going from plan-preventive strategy to technical condition valuation strategy for HOR 6000 production line machines.*

***Key words****: production line HOR6000, weak point, opinion of state, maintenance strategy*

## 1. Introduction

Implementation of the optimum methods in the exploitation process requires setting diagnostic parameters and tests as well as genesis and prognosis methods. The solution of those tasks depends on many factors connected with the degree of complexity of the machines and the quality of the explotation process.

Thus, there is the need for performing the research concerning compilation of the genesis monitoring procedures depending on those factors. In order to move from the traditional operating system based on the plan-preventive maintenance strategy to the machines state maintenance strategy the study of new procedures to be used for the monitoring of the state of the machine process are required. Also the algorithmization is required which will enable the compilation of the new computer program design and its implementations.

## 2. Characteristics of the HOR 6000 line machine operating system

HOR 6000 production lines, which are placed in the Philips Lighting Poland in Pila, which are the subject of this study are able to produce fluorescent lamps TLD 8/8” diameter at the speed from 6900 to 7100 items per hour [1] .

At the beginning of the line there are the two cassette coating machines. They are used to deposite the suspension which changes the invisible into the visible light. The glass tube is

provided automatically by automatic Laser Guided Vehicles in the special, dedicated containers, which are put in the unloading subsystem (Fig.1.).

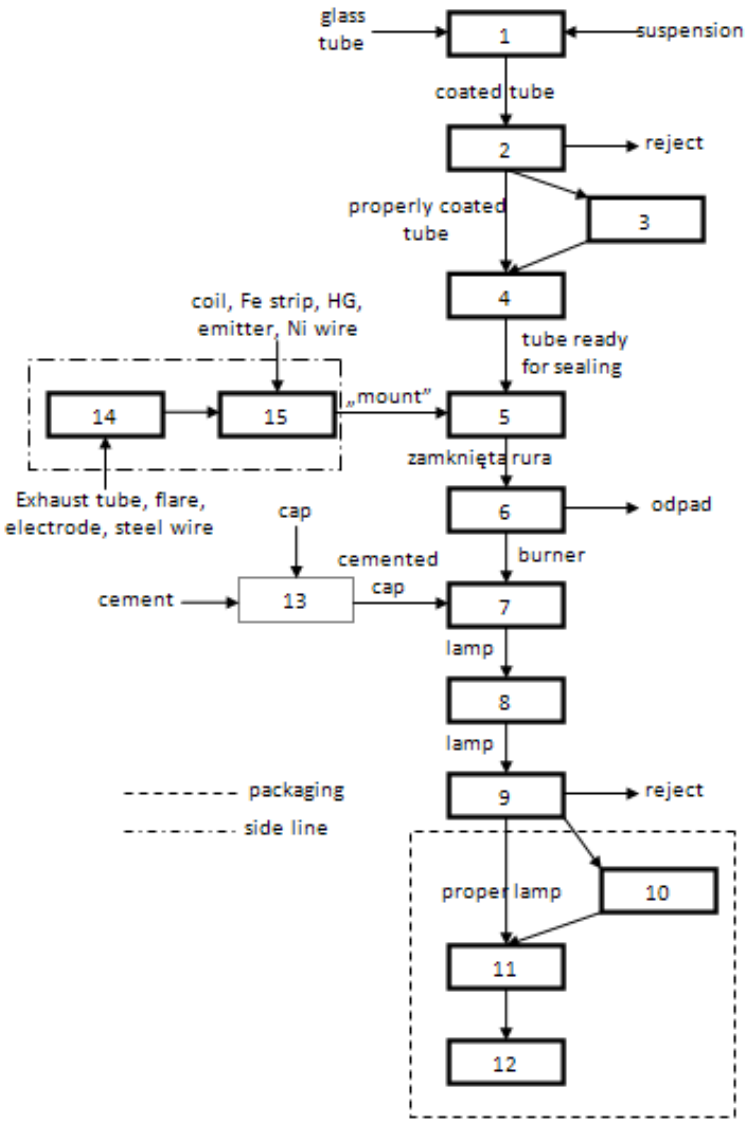


*Fig.1. Functional schema of HOR6000 production line:*
*Main line: 1– coating machines, 2 – visual controls system, 3 – coated tubes robotized buffer, 4 – sintering oven with wiping machine, 5 – sealing machine, 6 – pumping machine, 7 – capping machine, 8 – hardening machine, 9 – flashing machine. Packaging group: 10 – robotized lamps buffer, 11 – single packaging machine, 12 –group packaging machine, 13 – cementing machine. Side line: 14 – steam making machine, 15 – mounting machine.*

Following the coating machines there is the visional control system which checks if the quality of coating is according to technical specification. Then there is the buffer robot which buffers coated tubes e.g. for the time of the change of the produced lamp colour, which happens mainly in coating machines.

The next machines are wiping machines and the sintering oven in which flu-powder is dried so that it sticks to the sides of the tubes. In wiping machine the ends of the tubes are cleaned, what is very important for the sealing process. Sealing operation, which is done on sealing machine, is the process of closing both sides of the tube through connecting them with the mounts. After the connection process the tube is filled with the right gases mix in the pumping machine. The next machine - capping machine - is where the cap is putted thru. After the cement hardening on hardening machine the lamp is complete and theoretically ready for use, but it still needs to be tested in the flashing machine. Ready and tested lamps are packed and sent to customers.

During the production of the final product, which is TLD fluorescent lamp, the only activity required, providing that line if working well, is providing the components. Apart from that, in some machines there are short-lived machine parts which need to be renovated in highly specialized workshop.

Despite HOR6000 production line is atomited (Siemens S7 system) the whole process needs to be monitored by highly-qualified machine operators. There are seven people required for the whole process to work properly.

The line functions thanks to the following electricity, ice water (<5$^{o}$C), demineralized water, earth gas, oxygen, compressed air – *high and low preasure.* The production process is stable and does not demand constant regulating. Some minor corrections on the machines are nevertheless necessary because of the difference in the used components.

The change in the range of the produced lamps concerns the change of the color or the power of the lamp.

The colour change takes place mainly in the coating machines area where liquid flu-powders are changed (suspension) currently produced lamp into the suspension which composition is adequate to colour desired after changeover. Actions connected with the colour changeover also take place on the side line - the change in the amount of mercury and in the product quality control systems through introduction of the parameters proper for the certain colour.

The change of the power in a lamp concerns the changes in the geometric setting in the main line, because different power lamps are of different lenght. Additionally, on the side line coil must be changed and the lamp control systems must be set for the proper power of the lamp.

Maintenance of the HOR 6000 production line is realized through the plan-preventive maintenance strategy. Once a week the line is stopped in order to maintenance during which, according to schedule, the parts and sub-systems of the machines are checked and replaced if needed. Similar checks are realized once a month and throughout a year.

The boosting of the exploitation effectiveness of HOR 6000 production line is possible through implementation of the exploitation strategy based on the state and monitoring of the machine state is indesoensible for that. It is stated base on study of similar exploitation systems.

## 3. Analysis of the HOR 6000 production line systems

HOR 6000 production line has three systems which could be included in the monitoring of the machine state but the information gathered from the system is not complete and post factum [4,5,6]. Two of those systems are focused on the process data, and the third one concerns mainly the parameters of the machine work.

Also two of the accessible systems are fully automated and the third one is operated by the employees on the HOR 6000. Fully automated systems are CIRCLE (Control, Information, Recording, Communication, Labeling, Evaluation) based on the properly programmed PC computers and PLC Siemens S7 controllers with the suitable software, and particular breakdowns diagnosis system based on Siemens S7 controllers with suitable software.

CIRCLE system collects and archives process data which concern a small number of HOR 6000 (Fig.2.) machines units which have a direct impact on the production process.

Based on the CIRCLE system data a Process Engineer is able to estimate the state of some units of the machines which are directly involved in the production, e.g. looking at reject generated by particular machines, or the ready product parameters but he cannot estimate other sub-systems or their influence on the process parameters.

The first reaction for the increase of the reject is the regulation during the working of the machines. However, when there is no positive reaction to the corrections, or it is negative and the waste is rising to the interface value, determined by economic conditions, the machine is stopped, and it usually involves the whole production line to be stopped.

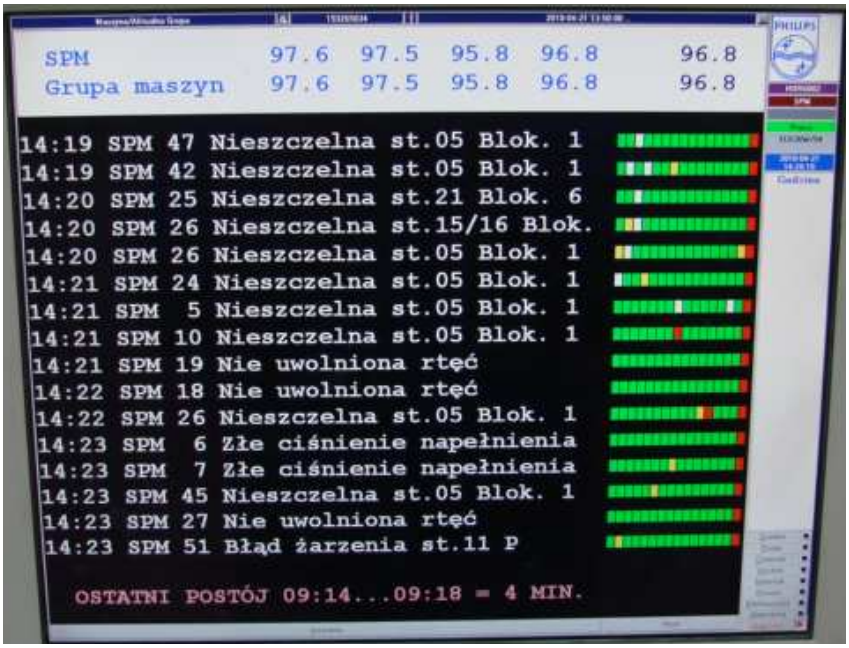


*Fig. 2. CIRCLE screen*


*Fig. 3. Siemens S7 control panel*

In the next step certain units of the machine are surveyed to localize the waste generating cause. It often happens that the replacement of the faulty element does not affect the decrease of the generated reject, which may bring the next stop of the machine and the line and the replacement of another unit of the machine. The type of the waste send the information to the expert about the potentially faulty units but only their check will assure the 100 percent certain diagnosis.

Siemens S7 (Fig.3.) computer system which controls work of the production line is programmed to detect the group of faults which can be identified based on the digital signals from the 1-binar detectors. Additionally, the machine working time is monitored and at the right

moment (predicted by the constructor), by means of the programmed announcements, informs about the necessity of the specified elements check.

Because the signal from the detectors is one-binar it provides the information whether the given unit is usable or not, but only at the moment when the production line is stopped due to a faulty unit.It shortens the time of enabling the machine and the line to work, but does not let estimate the state of the unit(e.g. useful, operatable but not necessary, requires operation, useless).

In the recent time (e.i. since mid-January 2010) HOR 60006 struggles with the waste reaching 18 percent of the production. All regulations and unit replacements based on CIRCLE system and expertise seem not to be effective (the waste at the moment is about 10 per cent). The situation gives a good reason for extending of the machine diagnosing in the state estimation, or even connecting the state estimating system with the process control system (CIRCLE).

State estimation procedure , which would be a part of the line monitoring system, would allow for the quick localization of the problem, and constant estimation of the machine state. That would allow for the fuzzy logic implementation and, together with process parameters monitoring, and for determining whether the worsening machine parameters are mechanic or process source(component, settings)

## 4. Damage analysis on the HOR 6000 production line

The first step of changing into the maintenance strategy based on the machine state, which seams to be much more suitable for production line with such high tech level, is indication of the weak points and determination of their incapacity states [1, 2, 3, 8].

For that aim all the damage in all the machines has been analyzed and it was shown that two thirds aff all damage have the source in the following machines: *mounting machine, pumping machine, sealing machine.* The problem has been described by means of the following indicators [1,7,9,10,11]:

a) the main - probability of the machine damage (Fig.4.)

b) subsidiary - the time of breakdown in minutes over the period of one year (Fig.5.).

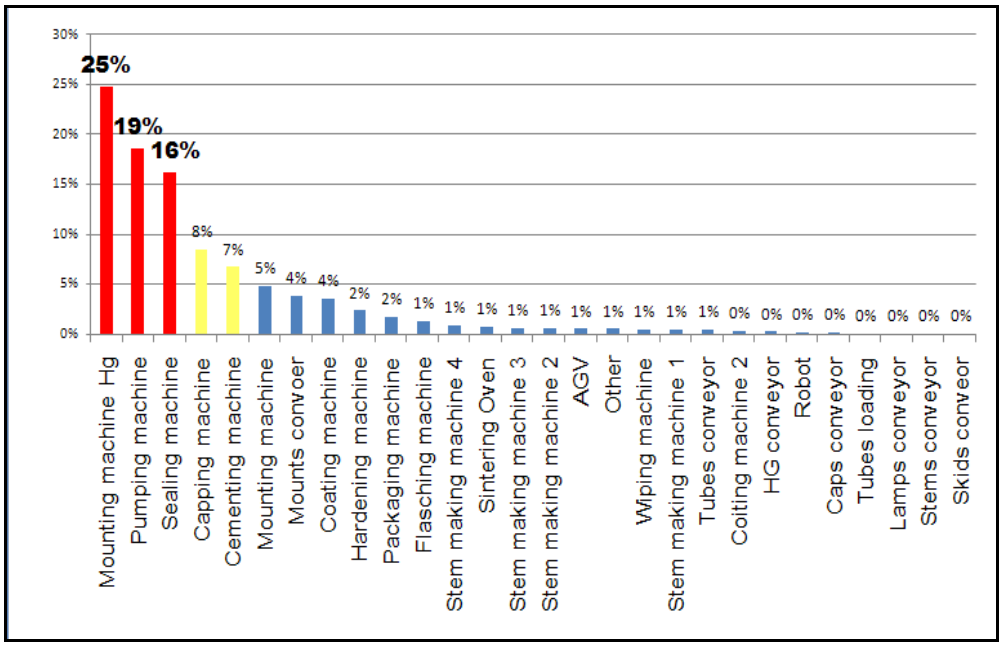


*Fig.4. Probability of machines breakdowns*

The subsidiary indicator has been chosen for the economic reasons. The cost of producing one lamp assumes the certain machine efficiency and each stop of the production causes the efficiency decrease. The results of analysis of the stop times throughout the year has confirmed that damage of the most breakdown prone machines are also the most troublesome.

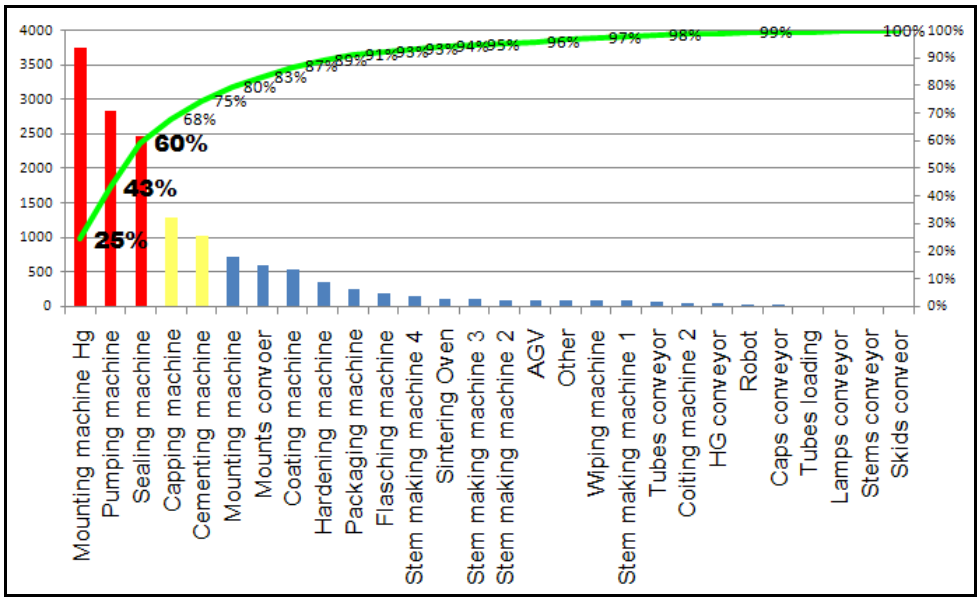


*Fig.5. Time of breakdowns in min*

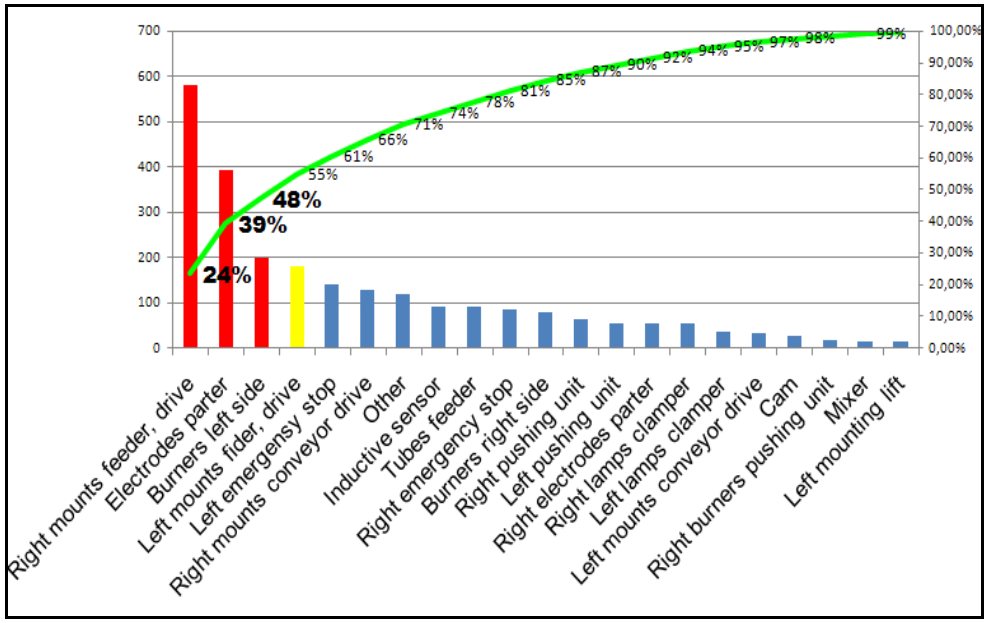


*Fig.6. Breakdown time for sealing machine units*

The very indication of the weak points in the set of several machines is not good enough information for building the monitoring system and that is why analysis of the weak points on a lower level has been done (e.g. the analysis of the faulty mechanisms of the sealing machine has been made). The result of the analysis is indication of the group of the machine unit which cause the biggest trouble (Fig.6) in the context of breakdown burner on the left side of the machine, electrodes parter on the left side as well as mounts feeder with drive.

The probability of the unit breakdown has been defined and also the auxiliary indicator has been introduced in the shape of *breakdown time particular unit of machine*. The values of the auxiliary indicator (Fig.7) for the certain mechanisms confirms the choice of those mechanisms: burners left side, electrodes left side parter and mounts feeder with drive.

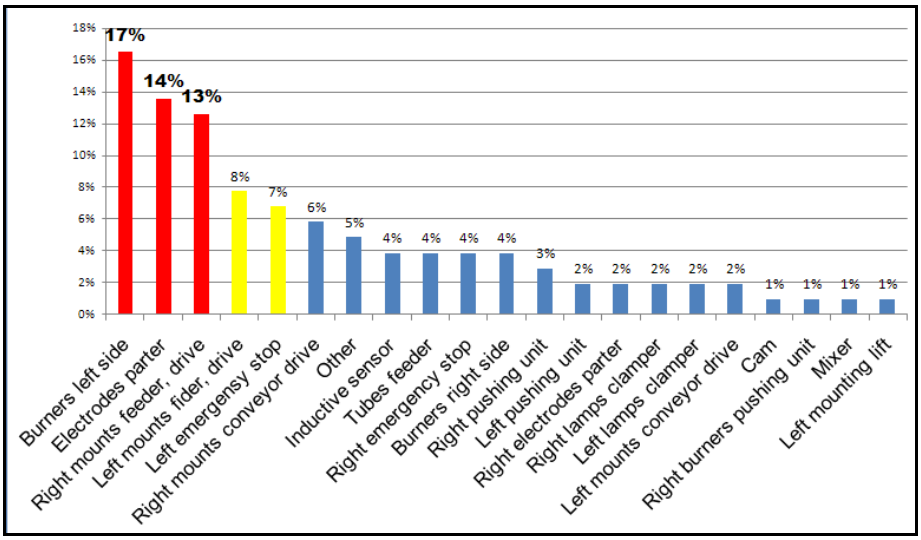


*Fig.7. Breakdowns probability of sealing machines units*

## 5. Conclusions

To sum up, the above study as well as the analysis of the breakdowns, the current operating system is not efficient enough, because the breakdowns done during the current maintenance strategy does not allow for the determination of some damages. This inability leads to the decrease in the trust level necessary for the production planning, which influences the company image. Changing into the new strategy may not only facilitate the controlling processes but will probably allow planning of the stops according to the needs, which may bring benefits such as decreasing the amount of stored items, lowering the time-consuming of the operation system and will lead directly to saving the financial means.

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