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MANAGEMENT OF THE MAINTENANCE: THE ECONOMY MAY BE RESULT OF SIMPLE CONTROLS

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Abstract. *Periodic and prior maintenance reviews of machinery and equipment (mobile or fixed) are control measures that ensure a smooth operation and minimize the risk of breakage of the same, while providing an identification and respect the need for repairs in order to avoid such as terrible corrective maintenance. However, a management that aims to bring savings to its maintenance cost center, as well as beyond a point of view, makes it possible to perform and maintain specific control over some components. Despite some of its components, it has a unit cost, several times, relatively low when compared to the equipment or machine, its control is essential to ensure the smooth operation of the whole as a whole and thus avoid costs with unscheduled shutdowns and very expenses with a solution deployment that seeks to correct a situation problem after it has occurred. In general, the specific controls are simple and can be used by any company, regardless of structure or size. Such as: control of hours worked, hours and speedometers, exchange of air purifiers, batteries, rolling stock, tires, among others.*

Keywords: *Contro1, economy, maintenance, components.*

1. INTRODUCTION

Periodic and predictive maintenance of machinery and equipment (mobile and fixed) are control measures that ensure a smooth operation and minimize the risk of breakage, while at the same time providing identification and the need for repairs in order to avoid terrible corrective maintenance. However, a management that aims to bring an economy to its maintenance cost center needs to go further and at this point it becomes interesting to perform and maintain a specific control over some components. Although some of these components have the unit cost, several times relatively low when compared to the equipment or machine, its control is essential to ensure the smooth operation of the whole as a whole and avoid costs with unscheduled stops and very high expenses with the implementation of solutions that seek to correct the problem situation after it has occurred.

2. DEVELOPMENT

Industrial mechanical maintenance is a large field, commonly linked to the area of mechanical engineering, which is responsible for maintaining the reliability and availability of machines and equipment and their components individually, preventing and correcting failures and mechanical problems related to them, and here defended as essential to any industrial plant, in which it has been spreading more and more in the big industries and factories, certain that the profitability of the company depends in addition to other sectors, directly of the good management of the maintenance in its industrial park.

For "things" to work well, any maintenance industry needs to have its goals and objectives well established, with timely and well-maintained maintenance controls and properly trained people. One of the most important data for the execution of all the maintenance management jobs is the control of hours actually worked or kilometers driven by the equipment. Another criterion that is being used by some companies is to establish the periodicity of the revisions according to the liters of fuel consumed .

Criteria such as excavated volume, calendar days, quantity of trips, volume produced, transported or pumped, may be the most indicated in specific situations. Work on these variables, however, should be carefully analyzed so that the

ranges indicated in the plans correspond to uniform working periods of the equipment and are within the specified limits.

In order to maintain maintenance control and planning, it is necessary to have reliable data, well-designed data (usually by the pointer) and well-calibrated or calibrated equipment. There is still the possibility of performing a monthly control for maintenance, but the great disadvantage of this method lies in its variability, which is often due to external factors that cannot be controlled, such as rainfall, equipment displacement from one front to another with totally different service characteristics, relocation of equipment and etc., make this control method unfeasible.

This variation requires that all analysis and scheduling work for maintenance management be based on the hours actually worked by the equipment, the miles traveled or another equivalent alternative, rather than the time schedule. The total hours worked will be significantly different from the hours corresponding to the respective service shifts, which implies maintaining a system of control of these hours, structured much more complex than in industrial maintenance. An important point: all the work of calculating operating costs, economic analysis and replacement of equipment should be done primarily with references in the hours or kilometers actually worked, which demonstrates once again the need for reliable control of hours worked.

The components or instruments that make it possible to collect this information (hours or kilometers) for the respective purposes mentioned above are the meters and speedometers. A good level of reliability will only be possible, therefore, by means of an efficient maintenance of the respective components

Later, in the future, when the maintenance sector has a considerable amount of information regarding the machines and equipment, it becomes possible to calculate the average fuel consumption for each model of equipment and to schedule maintenance in function of the volume consumed, with the adjustments that were required. However, it is emphasized that this option does not exclude the need for effective control by means of meters or speedometers.

The horometer cannot be seen as just a simple "clock" and so its importance is emphasized in this article. The time measured by it will depend on the degree of request of the equipment in service. In addition, reading and controlling the hours checked becomes very simplified, since it is enough to perform a reading at the end of each shift for example or day, to keep the system running. Therefore, users, usually the operators of such equipment and maintenance controllers, should be made aware of a failure in the horometer or speedometer as something that must be repaired as a priority, followed by an opening of an order to the responsible mechanic as soon as possible, even if it is not compromising the performance of the equipment.

The strategy of purchase and control of stock of spare materials must provide spare parts and supplies in quantity compatible with existing machinery and equipment in the company. The maintenance industry must pay special attention to the maintenance of these instruments, so that there is no loss of records.

It is important that the company has a good computerized system to control the maintenance of its fleet of equipment for storing the log and calculates the total hours of each equipment, which allows to predict and issue a maintenance plan alert a quantity of hours or kilometers before the expiration of each review

However, it is interesting to keep track of separate hours of some major components such as tires, engines, transmissions and undercarriage using the equipment data to do so. These individualized controls allow better programming of equipment stops for recovery of these components. It should be emphasized that the time record must be made for all components that, at the discretion of the maintenance management, justify the individualized control. In order to control the hours worked of the components, there is no need for daily recording, since the base is the hours of the equipment of which it is part, therefore, simply recording the accumulated at the time of installation.

For better control of hours worked and its schedule of preventive reviews, it is necessary to launch daily in the computerized system at work hours and by means of the respective accumulated values if you plan and schedule for such revisions. Based on this data, the revision controller will usually schedule the maintenance to be performed, issue the work orders (O.S) to the responsible sector and indicate the date on which those revisions were or should be performed.

2.1 Maintenance: Air Purifiers

We can exemplify this way if we remove the air purifier from an engine that is working in the normal environment of a road work, its life will be approximately 150 to 250 hours, and that is, it will suffer a drastic reduction, simply due to the lack of maintenance of a low cost component compared to the engine reconditioning. The use of a perforated filter element will introduce abrasive impurities into the motor, which will reduce its useful life to a greater or lesser extent (depending on the quantity).

On the other hand, operation with clogged filter elements above the limit will result in loss of power due to the characteristics of the resulting mixture, the poor burning of the fuel and the diesel mixture to the lubricant, with all the damages that such situations entail.

In other words, if a field control is not available that allows filter elements to be replaced in a timely manner and their inspection and maintenance are adequate, we may have machines operating under conditions of excessive demands or with accelerated wear due to the entry of abrasive material, which will substantially reduce the life of the components and cause great damage, due to the high cost of recovery and the downtime of the equipment.

Accordingly, particular emphasis should be given to the maintenance of air purifiers, with reference to:

- The selection of suppliers is fundamental, because possible price differences can be offset by the reliability and savings in the overall cost of maintenance;
- Periodic cleaning and checking, according to the technical procedures established by the Maintenance Management, based on the manufacturer's recommendations;
- Inspection and cleaning, for example, some companies work with two primary filter elements for each engine, keeping one of them as a spare for immediate exchange. In this way, the element is replaced daily and cleaned;
- Replacing the component in the correct period, so it is better to replace a filter element that could work a few hours longer than using a damaged element for some extra time;

The control of these components will only be done in the workplace, the cleaning services and periodic checking will be scheduled and the hours worked of each filter element will be controlled so that they are replaced in due time, or if necessary. Statistical follow-up of the useful lives, made by the Maintenance Assistance, can be a valuable subsidy in the selection of suppliers.

2.2 Maintenance: Battery

The parameter of evaluation of a battery is its cost per hour worked, function of the value of acquisition and the life of the component. To determine the average life, it will be necessary to have an individualized control, which accompanies the durability of each battery.

For this control, it is recommended to use an identification number for each battery, recording the dates of installation, removal and replacement, the hours worked of the equipment on each of these dates and the accumulated battery life. These records will be used only by the service fronts, which will pass the total duration of each battery to the Technical Maintenance Department, which will follow the statistical durability of each brand and calculate their hourly cost, subsidizing the Supplies area so that the products minimum durability and low hourly cost. In addition, such monitoring will serve to gain control over battery warranties.

However, certain care must be taken: equipment that is to be kept in operation for an extended period of time must have its batteries removed and applied to other equipment or placed under a slow load to avoid deterioration by sulfation.

2.3 Maintenance: Undercarriage

Wear control is done through periodic measurements of each of the components of the undercarriage as directed by the manufacturers. The removal and reconditioning schedule will be based on the data obtained from these measurements.

Removal of the rolling part will be done when component wear is close to the wear limits specified by the manufacturers. Maintenance Management should therefore dispose of these limits and establish the values for removal at each reconditioning, in order to guarantee the structural strength of the components to always receive the filler material on the base metal, not on the previous filler (for example, 85% of the wear limit for the first reconditioning and 95% for the second), the technical procedures for measuring wear, the items to be used in specific applications (eg treadmills and special shoes) to the subject. In addition, it is very important that the training area provides training for the operators and the correct operation of the machine or equipment.

The inspector and measuring officer should always analyze the conditions of the rolling stock as a whole, since it is common to wear out the entire fleet, checking for repetitive problems and staggering the reconditioning in order to avoid the stoppage of an excessive amount of equipment at the same time.

In summary, the maintenance of the rolling stock, due to its high cost, must be subject to a control that allows:

- Minimize downtime due to reconditioning of rolling stock;
- Avoid simultaneous stoppage of several equipment’s of the same model, especially on the same service front, by means of an appropriate staging of reconditioning;
- Avoid premature loss of components due to wear over specified limits and enable successive reconditioning;
- Minimize maintenance costs of rolling stock;
- Maximize component life;

2.4 Maintenance: Tires

The cost of tires is the third most important component of operating costs, second only to labor and fuel. If we consider that, this cost is much less predictable than the others due to the large number of variables involved, it becomes clear the need to work with suitable tires and to maintain them in order to maximize their useful life.

Although the development of tires over time has made them robust, able to work under severe conditions and even absorb a certain amount of overload and abuse, there is a need for some care in the selection, use and maintenance of tires, so that longer life, fewer equipment downtime, less premature loss, higher reconditioning rate, and consequently lower operating cost.

There are several software on the market for tire control, which is not intended to demonstrate this article. However, in view of the poor qualification of human resources involved in capturing and analyzing field data and in implementing solutions to correct observed deficiencies, manufacturers are investing in monitoring systems that are increasingly being offered in the market. The main current technological advance corresponds to the implantation of a chip in the carcass of the tire, for measuring the internal pressure and temperature, and its transmission to an on-board computer or a remote computer, through GPS systems.

The analysis of the collected data allows a better selection of the model and design more appropriate to each application, as well as the correction of ramps, curves and overlays and the elaboration of simulations for optimization of the performance.

The control is performed using two forms: the Daily Borage Report and the Tire File. In the first document will be released by drilling all the exchanges of tires made during the day, casualties, recoveries and casings sent for retreading. With this report, the Maintenance Control can, using the hours worked or mileage controls, complete the data of the respective Tire Sheets, in which the tire's tire history will be released by that date.

It is interesting to define the yield in hours worked per millimeter of wear and to compare the individual values with the averages of the fleet, for critical analysis.

Another factor that is intrinsically involved with tire wear is temperature, which in turn is directly linked to pressure: if this is inadequate, it will cause overheating, which will raise the pressure and so on.

Thus, there will always be a need for strict tire pressure control in service. Operation at or above recommended pressures is the most frequent cause of premature failure and excessive wear.

Manufacturers have a great deal of information about the causes of pressure reduction and the consequences of using inappropriate pressures that they make available to their customers. The relevant technical procedures shall be established by the Maintenance Management in accordance with these recommendations and transmitted to the personnel who will carry out the control in the field.

The responsible sector must carry out a first measurement of pressures before the beginning of the work shift. This measurement, made with the cold tires, will serve for the calibration of the same ones, that must obey the values and technical procedures determined by the Maintenance Management.

After this initial calibration, the team should periodically measure pressures throughout the day.

Pressure changes due to leakage or incorrect procedure (bleed) will be observed and corrected at the initial cold check. The checks with the hot tires are only intended to identify the variation of the pressure during the work shift, not having to make corrections.

In places where the ambient temperature varies between 20 and 30 ° C, any pressure variation greater than 35% may be considered abnormal. According to manufacturers, if cold sizing is done properly, this will correspond to the operating temperature limit of a tire.

Frequent cases of excessive pressure variation should be analyzed with temperature measurements throughout the day and with verification of design factors, access conditions and other possible causes. Corrective measures should be taken by consulting the Maintenance Management when necessary. The solutions taken should be informed to this management, so that they can be adopted in other works in which similar problems occur.

Cuts or small damage are often responsible for the premature scrapping of a tire. In most cases, repairs performed when these damages are still reduced will allow the tire to be used throughout its life, at a relatively low repair cost. For this reason, it is important that periodic inspections are carried out and that necessary repairs are carried out immediately.

Correctly and timely repairs will allow the full advantage of the tire reconditioning (retreading or retreading) advantages, when applicable.

In principle, rebuilding of tires is always advantageous for the company, since it can increase its useful life by up to 80%, at a much lower cost than a new tire. Good wear control, coupled with good maintenance, will enable three or even four reconditioning's of the same housing. The ideal time to remove the tire will be when the depth of the groove is 20% of that of the new tire.

Not always, however, the recovery of a tire will be possible: accidents, bursts, tarpaulins, loose, deep damage and other similar causes may condemn a carcass. In addition, equipment that works on poor roads and with overload may have the reconditioning of your tires inadvisable, even if such damages do not occur. In these conditions of use it is common to experience internal malfunctions that will only appear during the work period after reconditioning and will result in the premature loss of the tire.

In any case, refurbished tires should not be installed in front of any vehicles or equipment that travel at high speed.

Although this is a matter more related to the area of materials, it is necessary to establish technical procedures for this activity, as inadequate storage conditions may lead to a rapid deterioration of the tires. Thus, Maintenance Management should guide the area of materials on the correct way to stock the tires, participating in the layout of the

tank to avoid the proximity of fuels, lubricants and other chemicals, as well as electrical devices, which can cause ozone contamination. It should also be observed at room temperature and avoidance of open storage due to the negative influence of sunlight and rain.

The Maintenance assistance should verify the conditions of storage of the tires in their visits to the works, guiding those responsible when necessary.

3. CONCLUSION

It is clear and indisputable the need to implement strategic maintenance controls in organizations that want from their business to earn in economics, through "simple" procedures and sometimes not so simple.

Maintenance management goes from being a mere adjunct in the business scenario to an industry responsible for reducing failures or falling performance, ensuring greater reliability and availability of machines and equipment.

It is clear that it is necessary to have a reliable control, training of the human resources involved and attendance to the procedures elaborated by the maintenance management area.

In general, the specific controls are simple and can be used by any company, regardless of structure or size. In view of the foregoing, it was concluded that the interaction.

4. REFERENCES

Pereira, M.J.S., 2010. "*Técnicas avançadas de manutenção*". Rio de Janeiro, Brazil.
Pinto, A.K. and Xavier., 2001. *"Manutenção – função estratégica"*. Rio de Janeiro, Brazil.
Pires, F.A., 2005. *"Importância da manutenção na gestão dos sistemas produtivos*". UFOP, Ouro Preto, Brazil.
Santos, V.A., 2010. *"Prontuário para manutenção mecânica"*. São Paulo, Brazil.
Siqueira, I.P., 2005. *"Manutenção centrada na confiabilidade: manual de implementação"*. Rio de Janeiro, Brazil.
Souza, R.D., 2008. *"Análise da gestão da manutenção focando a manutenção centrada na confiabilidade: estudo de caso MRS Logística"*. UFJF, Juiz de Fora, Brazil.

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