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CONDITION MONITORING WITH PREDICTION BASED ON OIL ENGINES OF URBAN BUSES - A CASE STUDY

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ABSTRACT

This paper presents a case study and a model for condition monitoring of Diesel engines' oil of urban buses, through the accompaniment of the evolution of its degradation, with the objective to implement a predictive maintenance policy.

Along time, because the usage, there is some decay in the lubricant properties. However, in normal functioning conditions, the lubricants properties, at the time the manufacturers recommend its changing, usually, are within the safety limits. Then, based on the accompaniment of the lubricants' oil condition, the intervals of oil replacement can be enlarged what implies the availability increasing of the equipment.

The model presented in this paper shows its potential to be spread to other types of equipment and organisations that want to implement similar maintenance policies, to achieve the best availability based on the real equipment functioning conditions.

Keywords: condition monitoring, predictive maintenance, oil analysis, urban buses.

INTRODUCTION

Public transport, in general, and the city bus passenger transport, in particular, represents an important alternative to the use of individual transport. For this reason, it is essential to focus on the quality of service provided by the public transport network in order to make them attractive for its users.

Under the current context, where the users of public transport are increasingly demanding about the quality of services, the maintenance stands out as a competitiveness key factor.

This paper presents an approach to the analysis of lubricating oils for Diesel engines, validated on some models of urban buses, as is described along the paper.

The condition monitoring maintenance appeared in the 70-80's to designating a new approach to planned maintenance based on the knowledge of the state of equipment, using condition monitoring techniques, [1].

Condition monitoring maintenance is the maintenance carried out by means of an evaluation of the equipment state, usually carried out continuously, [2].

According to Pinto [3], the implementation of a condition monitoring system requires investment in equipment, specialized human resources and specific know-how. These systems are supported by computer tools that enable, in an efficient way, the analysis, study, recording and control of the data obtained, and also the establishment of some fault trend curves.

In condition monitoring, a common practice is based on recording the equipment condition, reading data in regular intervals and, since a reading is higher than a pre-set critical level, the equipment monitored is declared faulty and a maintenance intervention is triggered. However, surprisingly, both in practice and theory, little attention has been paid to whether or not the critical level and the monitoring interval are set in a cost effective way, [4].

Maintenance, in general, and the condition monitoring, in particular, aim to combine the increase of reliability with the lower costs possible, these being direct or indirect. In this type of maintenance, the ecological variables may overlap with the remaining ones. However, conventional indicators are not always fully compatible with environmental indicators, [5].

According to Ferreira [6], to increase availability implies reducing the number of breakdowns, repair and inspection times: It follows that it is not enough to have reliable equipment to obtain high availability rates - it is also necessary to ensure maximum speed in repair, maintenance and inspection operations.

According to Ahmad and Kamaruddin [7], the issue that most of the Condition Based Maintenance (CBM) studies focused on is the deterioration modelling process. Although deterioration modelling is one of the important processes in the CBM programme, the follow-up action toward maintenance decision-making is just very important.

RESULTS AND CONCLUSIONS

With this condition monitoring model several variables can be evaluated, that can help to understand the evolution of the degradation' state of the oils. The models exemplified here were applied in three ways:

1) Individually, to all vehicles (all parameters);
2) Homogeneous groups of different vehicles (all parameters);
3) To the group of vehicles that use biodiesel as fuel (all parameters).

The exponential smoothing was applied to the iron content (Fe) variable for a bus number XX_3 to determine the evolution of its degradation. When this variable has high values, the equipment is at a high risk level, and the oil must be changed. The second model applied to monitor the degradation of the iron content was based on the t-student distribution: it estimates the average of iron content (Fe) - the average content is 99,80 (ppm).

It is also possible to calculate more information such as the sample mean, the sample standard deviation and the upper limit of the parameter to determine the confidence intervals. If the value of 150 (ppm) is found in the iron content variable, with a 99% confidence interval, the hypothesis H_0 is not rejected. But, if the confidence level is 90%, H_0 is rejected. The value of t (2,35) cannot be greater than the value of the confidence interval (1,53).

If the value of t is used from the t-student table with 80% confidence interval (0,90) and a sample mean of 99.80, a mean value for a population of 70,48 is obtained.

Because the oil itself and the enormous influence that it has in the Diesel engines condition, the accompaniment of its degradation permits to maximize the bus availability itself and the bus fleet in general.

The paper demonstrates that using condition monitoring maintenance, the intervals of the interventions can be increased and, consequently increased the bus fleet availability, reducing the maintenance costs.

Table 1 shows the data about the company under study, such as the number of buses that constitutes the fleet, their availability, the need of buses for production, the number of buses under maintenance and the number of buses that correspond to the reserve fleet, based on a systematic preventive maintenance policy.

Figure 1 (radar map) shows the Availability *versus* Production Requirement (buses necessary to carry out the careers) of the company during a year.

Table 1 - Availability versus Need for buses: Systematic preventive maintenance

Months	Bus Fleet	Availability	Need	Maintenance	Reserve Fleet
January	115	107	90	18	7
February	115	104	90	21	4
March	115	105	90	19	6
April	115	106	90	18	7
May	115	107	90	18	7
June	115	106	90	19	6
July	115	102	90	22	3
August	115	103	90	22	3
September	115	106	90	19	6
October	115	107	90	18	7
November	115	109	90	16	9
December	115	106	90	18	7

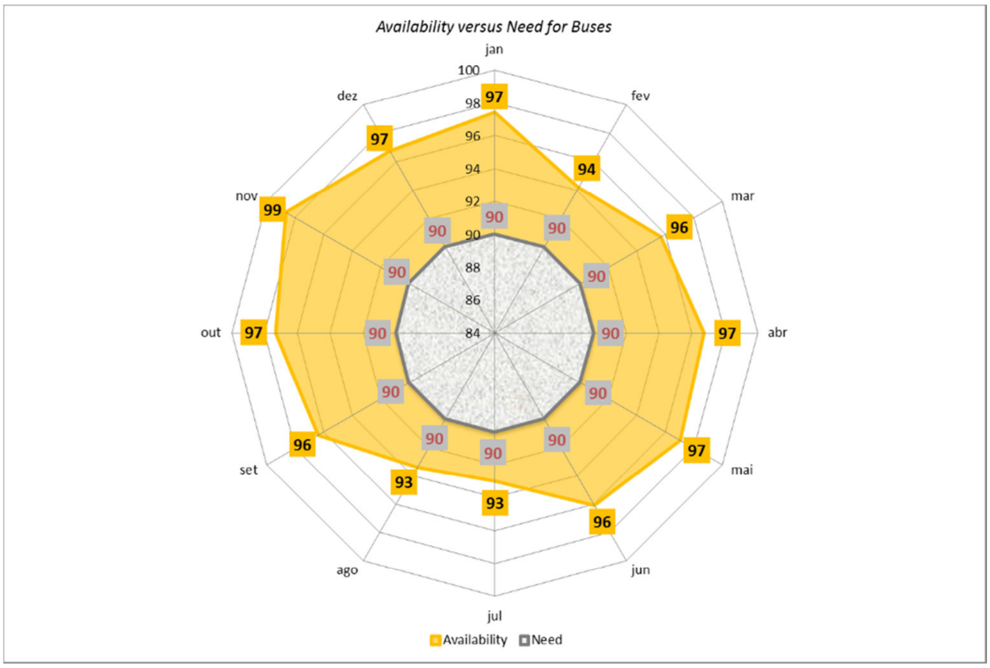

Fig. 1 - Availability versus Need for buses: Systematic Preventive Maintenance

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