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Evaluating the Performance of Mobile Air Compressor Component of Radiator Unit Using the Application of Reliability

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Abstract

The application of reliability to monitor and predict the performance of mobile air compressor component of radiator unit was considered in this research. This study demonstrated some of the root causes of the radiator unit failure as effect of temperature and the nature of coolers used, because these two parameters cause corrosion, affect shortage on fluid level and in turn influence the internal heat generated by radiator unit of the mobile air compressor. Adequate measures are projected by the maintenance team to ensure that these two factors identified do not cause shutdown of the gas plant. During the period of investigation, it was revealed that the downtime values were increasing with decrease in the mean time between failures. The study further demonstrates that the reliability of the radiator unit component of the mobile air compressor decreases with time as the cost of unreliability increases. This menace can be controlled on the condition of regular check on each radiator fluid level and internal temperature circulation to avoid heating, which may reduce the thermal properties of tube and shell components of the radiator unit in the mobile air compressor.

Keywords: Evaluation, performance, mobile air compressor, component, radiator unit, application reliability

INTRODUCTION

This article highlights the operation of mobile air compressor components and literature survey carried out. Compressed air systems are very popular and widely used in industrial facilities [1–4]. Throughout recent years, efforts to reduce the energy consumption of the conversion process has been at the forefront of the manufacturing industry [5]. One of the most widely used and inefficient processes in a manufacturing facility is compressing air for pneumatic controls, machines, and tools [6]. Compressed air is considered the most expensive resource used in manufacturing [7]. This has led the industry to take a more systematic approach to reducing energy consumption in the compressed air process [8]. This research also provides information to engineers to identify and evaluate the component effects of the overall performance of radiator of the mobile air compressor, design more reliable parts and identify the potential improvement of the operation [9].

Current research will focus on the application of engineering knowledge and techniques to reduce the frequency of failures of performance radiator unit of mobile air compressor, identification and correction of the causes of failures, determine ways to cope with failures if the causes cannot be corrected for some time, and applying method of estimation while analysing reliability data [10–12].

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MATERIALS AND METHODS

Materials and Sampling Period

Material data sheet was obtained from the operation unit for this research for the period of 4 years. The concept of Monte Carlo reliability ideal was applied as the research covers a period of March 2, 2016 to October 31, 2019 and the parameters of interest were considered as presented in this research.

Operational Data

The operation data obtained for radiator unit component of a mobile air compressor sample was collected from Ebocha Oil Centre (EOC), Obrikom Gas Plant. The compressor make is HC-5320284 12 volt DC portable air compressor and the obtained information was translated to mathematical language using Microsoft Excel software.

Methods

Reliability Tools and Techniques Methodology

The concept of Monte Carlo is widely used due to its significance contribution in simulation as well as the logic application in handling issues of this kind as related to reliability and component failure of industrial facilities.

Using Existing Application: The application used for the evaluation of the useful parameters are as follows:

Mean Time Between Failure: The mean time between failures (*MTBF*) of the radiator is expressed as

$$MTBF = \frac{Operating\ time\ (PT)}{Number\ of\ failures\ (NF)} \tag{1}$$

Failure Rate: The failure rate (*FR*) of the radiator component was evaluated by considering the mobile air compressor as shown in Equation (2)

$$FR = \frac{1}{MTBF} = \frac{1}{PT/_{NF}} = \frac{NF}{PT} \tag{2}$$

Reliability Model: The reliability (*R*) of the radiator component of mobile air compressor was evaluated using Equation (3)

$$R = e^{-}\ (\frac{1}{MTBF})\ x \tag{3}$$

Unreliability Model: The unreliability (*UR*) of the radiator component of mobile air compressor was calculated using Equation (4)

$$UR = 1 - e^{-}\ (\frac{1}{MTBF})\ T\ xt \tag{4}$$

Availability Model: The availability (*AV*) of the air hose component of mobile air compress was calculated using Equation (5)

$$AV = \frac{Mean\ Time\ between\ Failure - Lost\ Time\ Per\ Year}{Mean\ Time\ between\ Failure} \tag{5}$$

RESULTS AND DISCUSSION

Computational Results of Reliability Analysis for the Radiator

The computation of the parameters was carried out by applying the existing mathematical concept project by Monte Carlo and the results obtained are presented in Table 1 as well as in Figures 1 and 2. Table 1 presents the results of reliability, unreliability, failure rate, mean time between failure, downtime and other parameters of interest, and the increase or decrease in these parameters over time can be seen.

Table 1. Results of reliability parameters for the radiator.

Parameters	Period (Year)			
	1	***2***	***3***	***4***
Uptime (UT) hours/week	2976	2784	2592	2352
Study interval (SI) (hours)	8760	8760	8760	8760
Downtime (DT) hours	67	72	77	81
Mean time between failures (MTBF) (hours)	595.2	397.7	288	213.8
Failure rate (FR)	0.000570	0.000799	0.00102	0.00125
Reliability (R)	0.183(18.3%)	0.108(10.8%)	0.071(7.1%)	0.052 (5.2%)
Unreliability (UR)	0.817	0.892	0.929	0.948
Availability (AV)	0.9779	0.9747	0.9711	0.9667
Unavailability (UA)	0.0221	0.0253	0.0289	0.0333

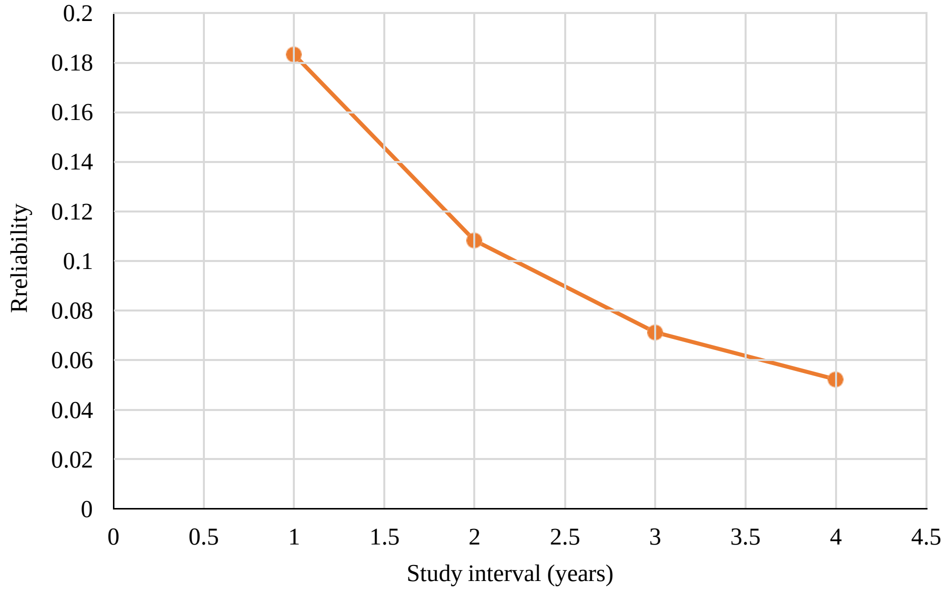

Figure 1. Reliability analysis of the radiator for a 4-year period.

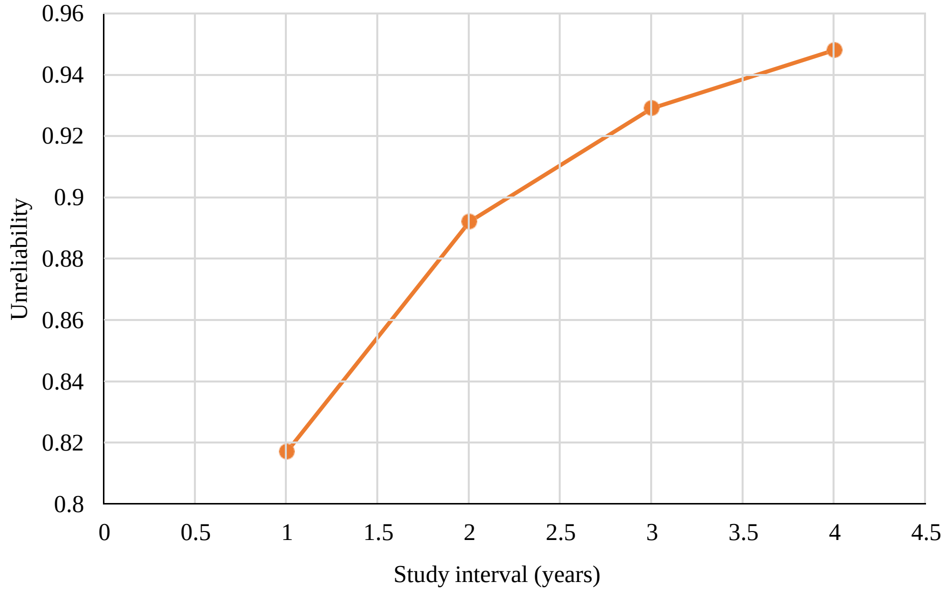

Figure 2. Unreliability analysis of the radiator for a 4 year period.

The reliability of the radiator unit was considered for investigation in a gas plant facility and the failures of the component were monitored. The investigation was conducted using data sheet of 4 years as demonstrated in Table 1 in terms of radiator values with operating time in the first year (2976 hours) to fourth year (2352 hours). The MTBF of first year is 595.2 hours and of fourth year is 213.8 hours and this process reveals decrease with increase in time. The down time shows increase from the first year (67 hours) to the fourth year (81 hours). The research further shows an increase in the failure rate from the first year (0.000570) to the fourth year (0.00125). The calculated values of availability is 90%, reliability is 18% with increase in the period of utilization. The reliability values as illustrated in Figure 1 of the radiator component in the air mobile compressor are: first year 0.183 (18.3%) and second year 0.108 (10.8%) and a sharp drop in the reliability in the third year 0.071 (7.1%) to fourth year 0.052 (5.2%).

Figure 2 shows increases in unreliability from the first year (0.817) to the fourth year (0.948). The unreliability of radiator unit continues to increase especially when adequate maintenance is not carried out as per manufacture specification. The investigation shows an increase in unreliability with increase in the period of study. To mitigate failures there is a need to check this unit component of the mobile air compressor before commencing daily operation. This measure will ensure smooth running of the gas plant as well as achieving high optimum performance with less downtime.

CONCLUSION

Considering the role of the radiator component of the mobile air compressor investigated in the gas plant facility, the following conclusions are drawn:

i. Radiator component of the mobile air compressor failed due to critical factors resulting from aging, lack of adequate maintenance, improper installation, and excessive usage.
ii. The maintenance strategy of the mobile air compressor should be improved by carrying out reliability-centered maintenance on the radiator component of the mobile air compressor before the recommended period to avoid failure.
iii. Adopting reliability analysis to improve the radiator component of mobile air compressor performance in order to reduce cost of maintenance in radiator breakdown was considered in this study and if the recommendations are adhered to strictly, less downtime will be experienced and increase in productivity will be achieved.
iv. The function of the radiator is to enhance cooling process in the mobile air compressor and inability to discharge its duty effectively will result to shutdown of the entire unit.

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