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VEHICLE TYRE PRESSURE CONTROL AND MONITORING SYSTEMS

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Abstract
Based on the analysis of this article, it can be concluded that yres are affected by a large number of factors, understanding that their degree of influence depends on the tyre manufacturer, bus model, climate region, road condition, terrain, etc. It is possible, in the article, that the tyre pressure drops and the wheel spins faster than other wheels due to the reduced radius. Speed differences allow low pressure to be detected and a warning light alerts the driver, but these multi-parameter methods are difficult to implement and require periodic calibration.

Keywords: Car, road, tyre, lines, factors, car, event, wheel, pressure.

Introduction

Negative and often dangerous factors affecting safety and economy can be easily eliminated using tyre pressure monitoring systems (English Tyre Pressure Monitoring System) or TPMS [1-4]. It is a remote measurement system of vehicle tyre pressure and temperature, which is measured in real time, which prevents accidents related to tyre damage, and excessive wear due to abnormal pressure and also helps prevent excessive fuel consumption as a result of deceleration under pressure.

Two types of tyre pressure monitoring are currently in use. It is a direct measurement and an indirect measurement system. The direct measurement system measures tyre temperature and pressure directly and uses a transmitter. An indirect measurement system checks tyre pressure with differences in wheel speed. Types and examples of internal pressure control systems are presented [5-9].

The Main Part

The principle of any pressure monitoring system is very simple. Pressure sensors measure tyre pressure at certain time intervals, after which the data is transmitted via a radio channel to the control unit, where analysis is carried out (checking the measurements with standard values) if there is a puncture. and a rapid decrease in tyre pressure, pressure measurements by the sensor often occur, and the control unit reports this to the driver [10-15].

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The standard TPMS (Tyre Stress Monitoring System) architecture consists of:

a) Four wheel pressure measurement modules, each of which includes:

– pressure sensor;
– temperature sensor;
– signal conditioning and bus identification unit;
– radio signal transmitter;
– antenna;
– Crystal (quartz) resonator;
– battery.

b) receiver on the dashboard.

c) instrument panel signal processing unit.

Direct testing systems use sensors located inside the tyres, which directly measure the pressure and temperature of the gas in the tyres. Using a transmitter inside the sensors, the bus status is transmitted via frequency signals. The monitor (receiver) can be located both in the signal processing unit itself, which is located on the instrument panel, and outside it. The signal processing unit informs the driver about the current state of tyre pressure [2].

An indirect (indirect) system calculates the tyre pressure using the ABS system, including tyre pressure sensors and/or accelerometers and a local computer. If the tyre pressure drops, this wheel will spin faster than the other wheels due to the reduced radius. Speed differences allow low pressure to be detected and a warning light alerts the driver, but these multi-parameter methods are difficult to implement and require periodic calibration. The advantage of the direct system is low because battery sensors and radio transmission systems are not required. But it can't determine the pressure before the start of the movement, the paired tyres at one node, there are restrictions on speed and trajectory, for them there is no concept of the accuracy of absolute measurements, there is no way to determine the pressure on which wheel has dropped and to determine the slow decrease in pressure, they can only detect more than 30 per cent of the airflow.

Direct tracking systems, in turn, are divided into internal - when the module is mounted on the rim or tyre, and external - the module is screwed to the wheel nipple.

Internal sensors are installed instead of standard nipples, which is very inconvenient when the sensor is inside the tyre, as it requires additional tyre installation, but at the same time, the sensors are protected from external influences and vandalism. But since the battery life is 5-10 years, you can only deal with the initial disassembly of the tyre and the installation of the sensor, the battery when the tyres are replaced can be replaced later.

External sensors, unlike internal devices, are installed on standard nipples and do not require the installation of additional tyres. This allows not only to quickly install the system but also to use it in several vehicles.

For example, remove the sensors from an idle vehicle and apply them to a queued vehicle. However such sensors are not free from environmental interactions.

It is worth noting that the use of pressure sensors in trucks and buses is somewhat difficult due to their long length, in which case the signal from the sensor can be "lost". For this, use special repeaters, and signal amplifiers (repeaters). These systems act as an intermediate link in signal transmission from the sensors to the receiving device, minimizing the possibility of signal loss.

Energy saving is a very important aspect of the TPMS wheel module, which does not offer to replace the battery for 5-10 years. For this, an energy-saving system is used in the wheel module system. The meaning of this system is to switch to inactive mode when there is no movement and to switch to active mode when moving. There are also time intervals for pressure measurement, so during normal movement, measurements can be once every 45 seconds (depending on the manufacturer), and with a sudden pressure drop, the measurement interval can occur once every 15 seconds.

Analysis of tyres and rolling stock at the enterprise and characteristics of the rolling stock under inspection

"Fergana Sam Avtotex Servis" company uses a variety of rolling stock, almost every bus brand uses not only its tyre size but also its brand, which is explained by the tyres that came with the bus, which have not yet passed their service life. . . In the future, the purchase will be reduced to one brand, which is currently the majority. Of course, it is desirable to research the largest group of tyres and buses of the same brand. Currently, the most common buses are ISUZU NP 37 and ISUZU HD 50, and the most common Boto tyres are 124/120K16PR Boto (all season).
Since the weight load is a factor affecting the intensity of tyre wear, we will consider the characteristics of buses that affect this factor.

Tyre performance and durability

As we mentioned earlier, the company uses Boto tyres, the characteristics of which are listed in the table.
According to the reported data, 621 tyres of this manufacturer were analyzed. Most of the tested tyres have uneven wear (uneven means, in this case, the difference between the shoulder and middle tread zones) - 57% (Fig. 3), only 30% of tyres have the same and other types of wear and damage. z includes: longitudinal swelling-0.6%; longitudinal erosion-0.6%; longitudinal cracking-0.6%, cord wear-0.3% and separation of the tread from the cord-7.2%.
the figure shows a histogram of the empirical distribution of tyre life over the total population (621tyres), which is divided into 11 intervals, each interval is 15127 km long. As can be seen from the picture, the average number of people working in the tyre range is 145,000 km, and the average resource of the entire population is 153,387 km.
Statistical evaluation of the general population is very difficult (621 tyres), so the sample was determined using a non-parametric method [4].

1. $$N = \frac{\ln(1-\gamma)}{\ln(P(L))} = \frac{\ln(1-0,9)}{\ln(0,9)} \approx 27. \quad (1)$$

Here, g is the probability of confidence, and P (L) is the necessary probability of failure during a certain operating time. Weibull-Gnedenko tyre failure distribution law (V coefficient V = 0.088, parameter parameter b = 12.1537, permissible relative error d = 0.027, confidence probability g = 0.9, Pearson's criterion), we get$\chi^2 = 43.188$

2. $$N = \frac{\chi^2(1-\gamma)^b}{2} = \frac{43,188\cdot(0,027+1)}{2} = 30. \quad (2)$$

Thus, the minimum sample size for estimating the total population is 30 cars.

Figure 3 shows the obtained theoretical probability of tyre failure, distributed according to the Weull-Gnedenko law.

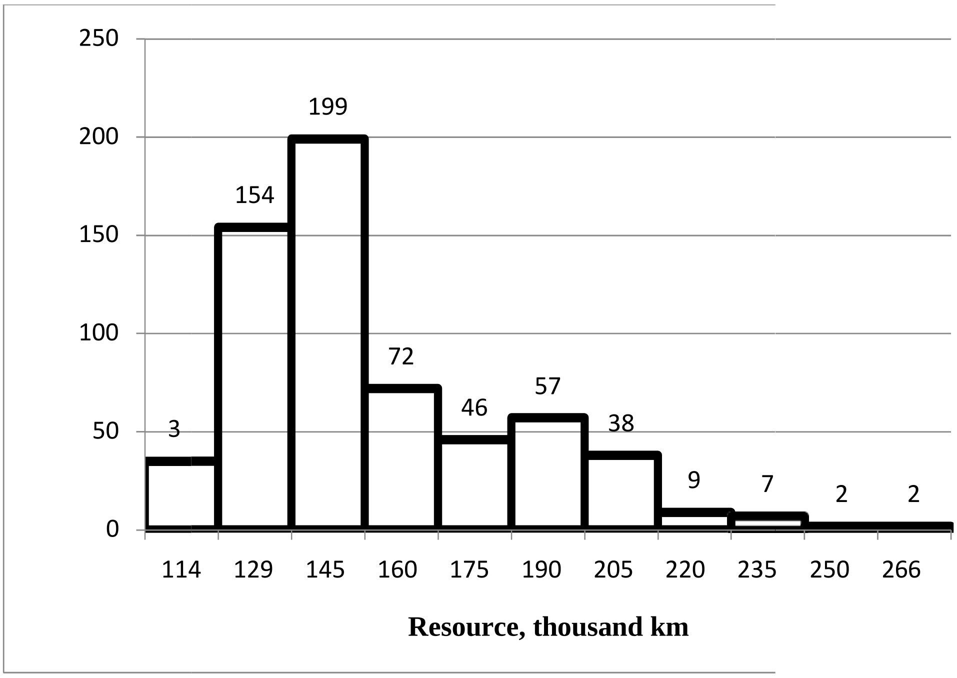

Figure 4. Histogram of distribution of empirical resources of tyres [3]

Based on the reported data, an analysis of the residual tread depth during tyre failure was also performed. The centre edge of the tread has a residual depth of 2.17mm, and the left and right edges are 1.98mm and 2.08mm, meaning more shoulder than the centre of the tyre at the end of life.

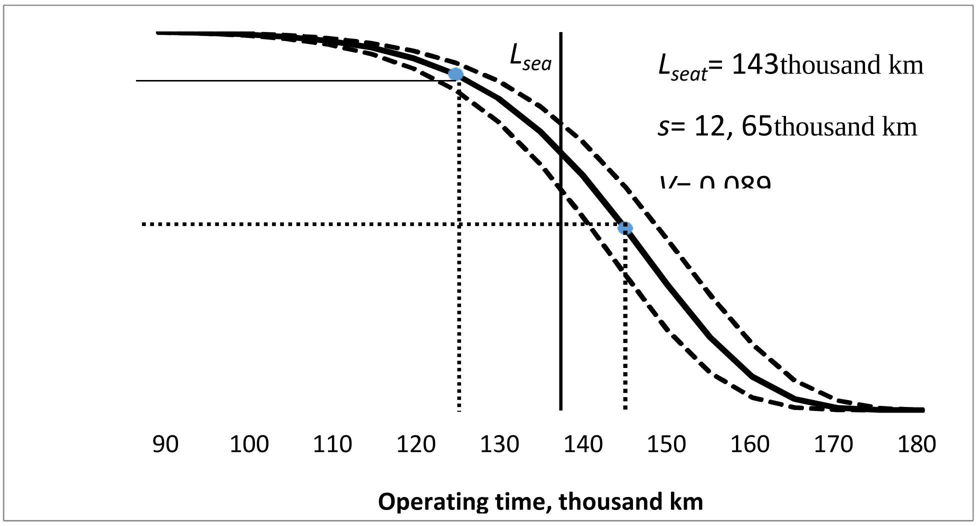

Figure 5. Probability of tyre failure [4]

Figure 5 shows the distribution histogram of the inner air pressure in the tyres. The pressure of 70 tyres was checked, their average pressure was 7.47 bar, which is 12.13% lower than the standard pressure (standard pressure is 8.5 bar), according to the standard pressure, only two tyres are resting.

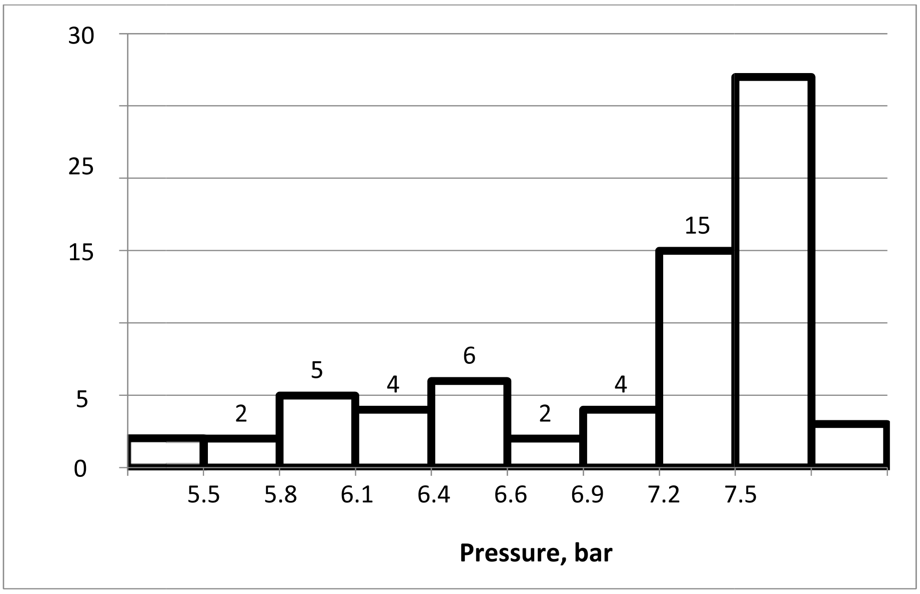

Figure 6. Histogram of the empirical distribution of internal pressure in Boto tyres [4]

Such a situation is caused by visual inspection, which does not give an accurate indication of the actual tyre inflation pressure. Each TXK-2 is checked with a pressure gauge, which is insufficient to maintain the standard pressure when the tyres are inflated with atmospheric air.

Conclusions

Based on the analysis of this article, the following can be concluded:

Tyres are affected by a large number of factors, and it can be understood that the degree of their influence depends on the tyre manufacturer, bus models, climate region, road conditions, terrain, etc.

The influence of individual factors on tyre life has been sufficiently studied, but it can be concluded that their combination needs to be studied sufficiently.

Universal tyres that take into account all the diversity of different climate zones, terrain, types of rolling stock and tyre manufacturers

it is necessary to develop a model of eating.

Statistical analysis showed that insufficient internal pressure in tyres has a great impact on their resources, fuel consumption, and road safety. It should be noted that sufficient attention should be paid to its control.

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