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MANAGING THE RISK OF ACCIDENTS FOR AXLE BEARINGS IN THE RAILWAY TRANSPORT

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Abstract: Risk management involves a set of management and technique methods that are used to reduce the potential risk of accidents. This paper present the usage of the remote control system while measuring the temperature of bearings at an axle assembly of railway vehicle (locomotive and wagon) in motion, as a precautions for reducing the risk of sudden accidents of bearings. Using this kind of devices the accidents of axle bearings in railway transport are avoided or just minimized.
Keywords: bearings, temperature, remote control system, risk

1. INTRODUCTION

Risk management involves a set of management and technique methods that are used to reduce the potential risk of accidents and consequences and on that way increased the potential for the results that are intended to be achieved [1, 2].

As the risk of breakage the machinery, appliances or some parts, primarily implyes the risk of damaging or destruction of them due to accidents or by insufficient care in some operation. The specificity of fracture risk is reflected in its manufacture process such as: defects in design, material and workmanship; direct action of the electric current: short circuit, atmospheric or other voltage, electric arc, etc .; decay due to centrifugal force; lack of water in steam boilers and steam appliances, except in cases of explosion; frost, pressure of ice or snow, or currently movement of ice; atmosperic pressure and subpressure (implosion); failure of the protection and control devices or failure of automatic control to which the machine is equipped; clumsiness, negligence or malicious intent of the worker or another person; fall of the secured object, impact or intrusion of a foreign body into the secured object; inadequate maintenance [2, 3].

The axle bearing temperature is a very important parameter based on which the bearing condition can be estimated [4, 5]. The special advantage of remote controling is that the complete measurement and monitoring takes place in real time and without interrupting the production or transport process. The need for this kind of monitoring and measurement is multifaceted. From an economic point of view, on this way the service life of the axle assembly bearings are extended and the gradual first replacement of those bearings that are heated above the expected temperature in particular exploitation are enabled, so it isn't necessary to replace all of the bearings whose guaranteed service life has passed. In a broader sense, this system reduces the probability of freight wagons accidents caused by the axle bearing overheating [6, 7]

2. MATERIAL AND METHOD

— Devices for measuring the temperature of axle bearing of railways vehicles in motion

The device for measuring the temperature of the axles assembly of the rolling stock (locomotives and wagons) in montion is used for timely detection and alarming of malfunctions of the axle assemblies, which can cause damage during the movement (the occurrence of overheating of the wheel bearings most often indicates on damage to the bearing, and as a consequence he accidents during movement).

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The measuring device consists of:

— The external part of the device (measuring point) is installed in front of the first entry turn of the station, with whom the measuring of the bearings temperaturethe is directly done, calculates, records and sends all the necessary data.

— Alarm-controling place, installed in the train dispatcher's office, and with whom the measured values of the temperature of the bearings on the train are recorded.

— PC (a computer place with software), with whom the processing and archiving of all results of the measuring the axle bearings heat of the vehicle are performed.

Alarm-controlling place has these following functions: receiving data from the measuring point, sending the data to a pc, displaying the temperature of all bearings of the axle assembly, displaying the temperature of the overheated bearings, sound and light alarms if there is an overheated bearing, setting the temperature limit value [6, 8].

— **Practical realization of the measurement system for measuring the temperature of bearings**

The conception of the measuring system is based on the contactless measurement of the absolute temperature of the cover of bearing of the axle assembly of the freight wagon in motion (3km / h to 40km / h) in the conditions of a large change of ambiental temperature (-40°C to + 70°C), of large electromagnetic interferences, of vibrations , of dust along the rails and weather conditions (sun, rain, snow). The bearing temperature is measured by the non-contact infrared (IR) detector located within the measuring spot next to the rail [6, 9,10]. The bearing temperature detection system must provide the reliable measurement of the absolute bearing temperature in the range of 40°C to 125°C with the measurement accuracy of ± 2°C. One of the basic requirements is that the whole system can continuously and independently work without an serviceman. The system is seted up on several spatially different locations. (Figure 1).

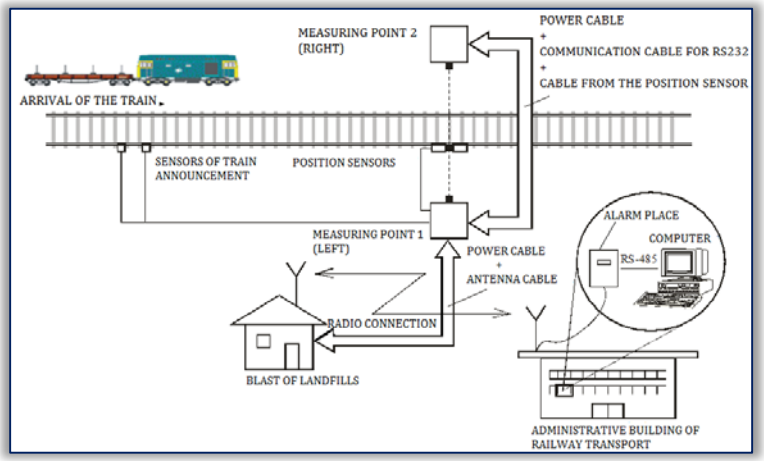

Figure 1. Spatial arrangement of measuring system

Nearbuy, an optical-electronic measuring devices are installed for measuring the temperature and the necessary sensors to control the overall measurement process. An alarming device is usually installed to the unloading station, which has the function of displaying the temperatures of all the bearings for particular train and function to alarm the elevated temperature of an bearing (from the set limit temperature) if such a case occurs.

Complete monitoring of the measurement process and the recording of all measurement results is done by an computer which is located in the remote control center.

The basic block-scheme for the whole measuring system is presented on Figure 2. The measuring device is a part of the whole measuring system, which is installed next to the rail at the measuring point where only the measurements are made and represented an complex synthesis of optical, mechanical, electronic-measuring, sensor, processor and telecommunication assemblies.

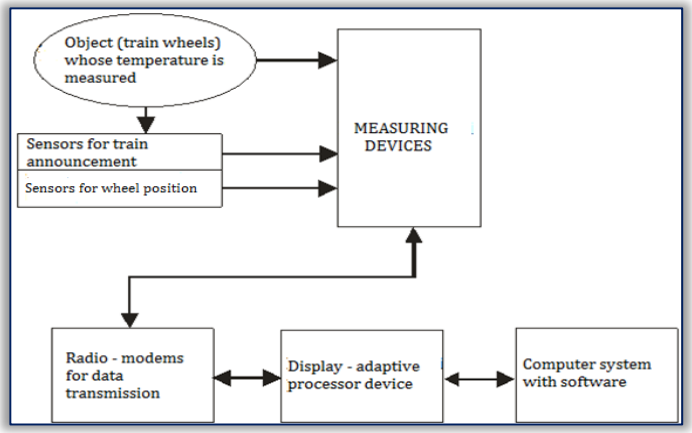

Figure 2. Basic block diagram of measuring system

— **The main parts of the measuring system**

The main parts of the measuring system are given on the block diagram on Figure 2. The object of measuring represents the covers of the axle bearings housing of the freight wagon whose

temperature is measured. Measuring devices are positioned on the measuring place on the both sides of the rail and they are used for measur, calculate, record and sending all necessary data. The measuring device basically uses infrared sensors.
Sensors for train announcement are placed at distance of 100m from the measuring place and they are used for announcing and logging out of the train (in order to prepare the measuring system for the measuring at the sufficient time - at least 5 seconds or more) in order to detect the direction of train movement.
Sensors for wheel positions are magnetic type and connected into one mechanical unit. They serve to define the position of the wheel in the spatial zone of measurement and the time interval in which the temperature is measured, or the time at which the measuring signal from the infrared sensor is taken as the desired temperature measure.
Radio - modems are installed at the measuring and also control-alarm places and they are used for wireless data transmission from the measuring place to the alarm place and vice versa.
Control - alarming processor device is located at the alarm-control place and it is used to receive data about the bearing temperatures of the current train, their processing in order to activate the alarms (sound and light) and further forward to the computer. During the passage of the train through the measuring place, the temperatures of bearings of the axle assemblies of the freight wagons are measured. Immediately after the train passsed, the measured values are processed and sent by radio connection (by radio modem). After receiving the data, the bearings are then controled to check if they are overheated at the alarm-control place, and then the data is sent to the personal computer. This device has the possibility of alarm if there is an overheated bearing of the axle assembly. The alarm-control place is consists of an display, keyboard, microprocessor card with a communicational multiplexer, radio modems, signaling LEDs, sirens and assembly for the power supply.

3. RESULTS AND DISCUSSION

After the complete measurement system has been installed and commissioned, it is necessary to carried out the final test under the realistic operating conditions and at different train speeds. One heater with temperature controller is installed on each side of the freight wagon. Positioning of the heating elements is performed on the cover of axle bearing, which ensures absolutely correct simulation of an certain overheated bearings during the testing. As the secondary standard etalon for checking the temperature of heating panels it would be used the handheld IC measurer Meterman IR610 (range is from -20°C to + 260°C; field of view is 100 mm at distances of 1m or 10: 1) and the thermovision camera.
Circular heating plates (ringla) with temperature regulators in declared measuring range and dimensions that match the dimensions of the cover of the axle bearing are used as the heating element. Using the thermovision camera, one thing can clearly see the expected inhomogeneous temperature distribution over the surface of cover of the bearing and the heaters. The temperature of the heating elements on the move and at the measuring place itself, can also be monitored by that camera. It should be emphasized that this system measures only the warmth of the cover of bearing and the warmness of the wheel rim from the brake pedal it just eliminat [6, 7, 11, 12].
Computer system with software is used to displaying and archiving the measurement results and also it is connected to the alarm-control place with an wired connection. The basic function is to display the temperatures of the axle bearings of the freight wagons on the diagram in the form of rectangular impulses (Figure 3) and to store the data in files of the appropriate format. The temperature data comes to the PC, on series connection from the microcontroller from the alarm place.

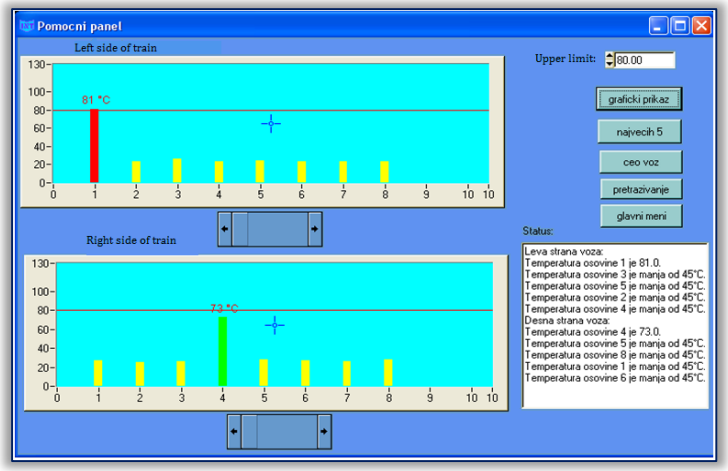

Figure 3. The measurement results presented on computer

The creation of the user masks is done on such way that the user can both numerically and visually (graphically) follow the ongoing measurement process (Figure 3).

4. CONCLUSIONS

Based on the global trends regarding the rationalization of the number of the executives, the increase in reliability (especially from the point of view of lower transport speeds and shorter sections), this system brings significant advantages and improvements in the transport of goods and passengers and also in the production process in the industries that are directly dependents from the railway transport.

By installing these systems, the multiple positive and economically justifiable effects are achieved on the rail, such as: Reduction the costs for replacement of still usable bearings, reduction of freight wagon immobilization, increase of reliability during mandatory inspection of the wagons, increase the reliability of transport due to reduction of accident risk .

It can be concluded, that the presented system serves for timely detection and alarming the malfunctions of bearings as parts of axle assemblies [6,8,11].

Note: This paper is based on the paper presented at IIZS 2019 – The 9th International Conference on Industrial Engineering and Environmental Protection, organized by Technical Faculty "Mihajlo Pupin" Zrenjanin, University of Novi Sad, in Zrenjanin, SERBIA, in 03–04 October, 2019.

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