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TEMPERATURE SENSOR ON INDIVIDUAL AXLE WHICH REPORTS DATA TO MOTORMAN'S CABIN

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Abstract – *Hot-box is one of the most crucial phenomena in Indian Railways which leads to accidents such as derailment or bearing seizure while in running condition. To avoid such unfortunate incidents, safety measures are to be taken before the failure occurs. The current systems of hot-box detection do not allow railways to identify threats before they occur. Thus, the new system provides measures to transmit data of temperatures on individual axles to the main server of motorman and central control room which facilitates the railway personnel to detect or identify the crucial temperatures which is unwanted in the Axle-box system. Detecting the failure in advance not only prevent possible accidents, but it could also be possible to prevent losses of lives and material loss. The system helps to make prediction and saves both time and cost. The study related to hot box design and application to the railways can be classified into three groups: risk analysis and probabilistic failure, axle box functioning in transient and steady state operation of trains, and axle box applications for railway operation in the country. This is possible by programming sensors (accompanying with the specially designed probe which is used in the system) to microcontrollers which detects the temperature within fraction of seconds and is read on to the screen. Thus, a temperature rises or falls trend can be estimated by reading these instantaneous temperatures and this projection can be used to tackle the upcoming problems such as bearing seizure, hot-box, axle breakage, derailment, bearing wear, burn-off or insufficient greasing.*

Key Words: **Axle-box system, burn-off, bearing seizure, Hot-box, microcontrollers, probabilistic failure, probe, sensors.**

1. INTRODUCTION

Welcome Railways are considered as safest means of transportation, but still every year there are some serious accidents. Majority of these accidents, especially in areas of freight traffic are caused due to defective bearings and brakes of wagon. If such defects go unrecognized, they lead to overheating of bearing or brakes. Also, it can lead to breakage of axle or of wheel. In such situation's temperature of hot axle box and wheels can indicate the upcoming failures of bearings and brakes. So in order to identify such problems at early stage, axle and wheel temperature detectors are used.

This, an intelligent temperature sensing system for detecting hot box due to bearing failure can be a useful tool in the hands of maintenance staff and can contribute to the safety and reliability in train operations.

The overheating of bearing mainly occurs due to the following reasons:

- In-correct fitting
- Improper mounting
- Improper handling
- Poor lubrication
- External contamination
- Excessive stressing
- Excessive load, etc.

A hot box is the term used when an axle bearing overheats on a piece of railway rolling stock. Hot box occurs when insufficient wheel bearing lubrication or mechanical flaws cause an increase in temperature. If it is not detected, the bearing temperature can continue to increase until there is a bearing "burn-off" which can cause journal damage resulting in derailment.

A detection system is therefore required to be developed to sense abnormal temperatures of axle boxes and wheels on a running train and communicate with central control for corrective action.

Another problem is brake binding, due to which the temperature of wheel rises. This can lead to skidded wheels, metal deposition on wheel tread causing wheel irregularity and other safety problems. Also, a wheel with temperature lower than the average is a case of ineffective brakes.

2. PROBLEM DEFINITION

Hot box occurs when an inadequate wheel bearing lubrication or mechanical flaws cause an increase in temperature. If undetected, the bearing temperature can continue to rise until there is a bearing "burn-off" which can cause journal breakage resulting in the derailment. Brake binding also contributes in temperature rising of wheel treads. This can lead to skidded wheels, metal deposition on wheel tread causing wheel irregularity and other safety problems. Also, a wheel with a temperature lower than the average is a case of ineffective brakes. A detection system is therefore required to be developed to sense abnormal temperatures of axle boxes and wheels on a running train and communicate with central control for corrective action. Axle-box breakdowns is categorized in mainly four groups:

poor lubrication, fatigue, not qualitative mounting and contamination (with metal admixtures, water). Bearing damage occurs due to, excessive load, excessive rotation speed, improper lubrication, inadequate mechanical properties insufficient operating clearance, radial stress caused by an external heat source, obstructed run due to the breaking of the cage, initially damaged bearing. The box-axle bearing mechanisms damage could be classified into two types: brine ling and spalling. Brine ling is the one which consists of indentations distributed over the entire raceway circumference that is subjected to static overloading. Each indentation affects and acts as a small fatigue site, as the bearing continues to operate; sharp impacts with the passage of the rolling element, eventually leading to the development of spalling at the sites as the bearing continues to operate. Under normal loading conditions, every bearing forms a minute cracks after a certain duration of usage due to material fatigue. The cracks progress to the surface with an increase in size during cyclic loading, and are manifested as spalling in the contact areas. Considering different research works performed by scientist Harward or completed by various companies in 2008 axle-box bearing defects are summarized as a wear, spun cone, corrosion, flaking, spalling, brine ling, peeling, smearing, and chipping.

3. LITERATURE REVIEW

Existing System:

Currently hot boxes are detected on running trains by station staff by listening to the whistling sound of bearings and visually due to discoloration of axle-boxes and grease oozing out. At station or in yards, when the trains stop, hot axle-boxes are detected by physically touching the axle-box cover. Of late, hand held non-contact infrared thermometers are also being used at major stations for checking the temperature of axle-boxes.

- Hot Axle Hot Wheel Detector Hot Axle Hot Wheel Detector (HAHW): -

Hot Box and Hot Wheel detectors are trackside devices designed to monitor axle, wheel, brake temperatures and to indicate any overheating which could lead to derailments and transmits this data to the traffic control and monitoring section. This is a pilotless system, to check the temperature in near axle and far axle, high speed pyrometers are installed at axle box level and at the track level; and to measure the wheel temperature. The cut-off limits and the alarm limits for flagging the hot axles, hot wheel & cold wheels can be set by the user.

The main problem of current systems for hot box and hot wheel detection is the need for very rapid and instantaneous measurement which will transmit real time data to servers. For example, a box which is approximately 200 mm wide, when travelling at 120 kmph will allow reading temperature in fraction of seconds. The alarm temperature for a hot box is around 80-90°C. Such fast measurements at these low temperatures are difficult. But in the case of hot wheel the situation is somewhat better. The length available for measurement is slightly more than for the 'box' (~300mm as against ~200mm) the alarm temperatures are far higher (between 200°C to 500°C). Such elevated temperatures can be easily measured than that of the lower temperatures in the case of a box.

- Disadvantages: -

1. Higher cost due to use of infrared sensor and pyrometers required for processing of data.
2. This system becomes complicated than previous systems due to large amount of data.
3. Complex installation of system.

4. IMPLEMENTED SYSTEM

The designed proposal can be installed in train bogey which eliminates the time window of detecting temperature. The proposed concept includes detection of temperature ranging from -50^0 C to 150^0 C, which is instantaneous in nature and transmits this temperature data to the server or cabin display of cockpit. The continuous data transfer helps keeping a watch on the axle box temperatures data whenever required and a LED, which is connected to the microcontroller circuit, alarms the motorman as soon as higher temperatures are detected. In the event of poor visibility in the cockpit, the buzzer's sound immediately along with the LED seeks complete attention of the motorman, and hence they can take corrective actions such as to halt the locomotive and rectify the problems. Thus, the motorman is alerted as soon as it crosses a certain set threshold of temperature (In this case let us say 80^0 C).

5. CONSTRUCTION AND WORKING

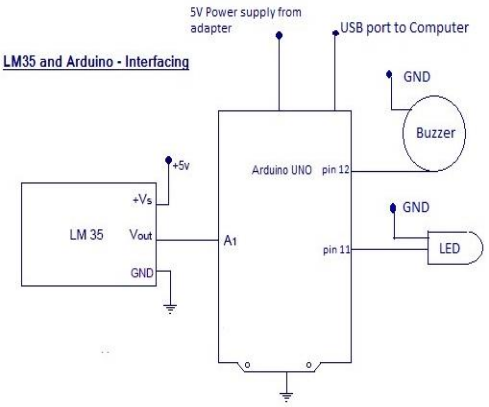

Figure 1 Circuit Diagram

LM35 is an analog, linear temperature sensor whose output voltage varies linearly with change in temperature. LM35 is three terminal linear temperature sensors from National semiconductors. It can measure temperature from-55 degree Celsius to +150 degree Celsius. The voltage output of the LM35 increases 10mV per degree Celsius rise in temperature. LM35 can be operated from a 5V supply and the stand by current is less than 60

When the diode of sensor comes in contact with Hot box, its temperature also increases. Due to this increases temperature. The voltage through diode change i.e. the temperature is directly proportional to voltage. The analog signal from LM 35 is sent to the microcontroller through copper wire via analog pins this raw data is processed in microcontroller and converted into ^{o}C by using formula

Data in ^{o}C = (Raw data from sensor in mV*500)/1023

This data is sent to serial monitor through USB port connected to computer. And the temperature will be printed on serial monitor or LCD as per the "if" condition works if the temperature goes above 80^{0} C. It will trigger the output of pin 11 and 12. It will send power signal to both LED and buzzer. The LED will glow and buzzer will make sound alarming the motorman of exceeding temperature of the particular axle. Hence the motorman can take necessary action to prevent issues.

As soon as the temperature goes below 80oC the next "if" condition will send the output of pin to LOW, restricting the power supply to buzzer and LED. The sound and LED glow will stop now.

6. TESTS AND RESULTS

This document explains the various activities performed as a part of testing of Hot Box Probe.

- Test conducted on two-wheeler engine

Table 1 Results of Test on Two-Wheeler Engine

Sr. No.	Time	Temperature
1.	1sec	85.50
2.	1sec	85.64
3.	1sec	86.24
4.	1sec	87.20
5.	1sec	88.64

- Test conducted on Two-Wheeler Silencer

Table 2 Results of Test on Silencer of Two-Wheeler

Sr. No.	Time	Temperature
1.	1sec	76.15
2.	1sec	74.71
3.	1sec	71.78
4.	1sec	69.82
5.	1sec	68.36

7. CONCLUSION

The railway is most commonly transportation facility used by common people and for transportation of goods. Utilising the implemented system will help the cause of safe travel. The proposed system is advanced hot-box detector system.it will help prevent major accidents which may occur due axle box failure.

This system will be very useful in hands of maintenance staff. Also, the data can be used for studying behaviour of axle box to various internal and external conditions.

It could be possible to place more than one hot box detector on a railway, which can perform measurement from various points in a sensor fusion fashion.

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BIOGRAPHIES

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