THE AUSTRIAN HOT BOX DETECTION SYSTEM TK 99

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Abstract: *Due to the ongoing remote control in signalling technology train observation by employees is reduced at traditional locations e.g. place of a station manager. The Austrian Federal Railways (ÖBB) Infrastructure Operation Company has recognized this trend very early. Several years ago, they started the construction of a wayside detection system to control the temperature of passing trains because of the increasing discontinuation of station managers doing the observation of boxes and brakes. Outcome of this research and development activities is the hot box detection system TK 99 of the HOA-group at Infrastructure Service in the Infrastructure Operation Company of ÖBB which is used in the railway network of Austria over one hundred times at the moment. If an ineligible heating of a box or a brake is not discovered early enough, lubricating grease in the box will lose its function and a break-down of the box would follow. Thereby, inhomogeneous loads per axle are possible which can lead to a derailment of the boogie. Economic efficiency of a wayside hot box detection system can be demonstrated in comparison with the costs of prevented derailments.*

Key words: *wayside train monitoring, hot box detection, derailment prevention*

1. INTRODUCTION

Although railways rank worldwide among the safest means of transport, nevertheless every year there are some serious accidents. Some of these accidents, especially in the area of freight traffic are attributable to defective wheel bearings and brakes of a wagon in the train consist. If such effects can develop unrecognised, they lead to the overheating of the defective bearing or of the brake and to a breakage of the axle or of the steel tyre. A derailment of the wagon affected is the consequence. In order to identify such damage at an early stage, at appropriate distances along the track temperature measuring points (which are known as Hot Axle Box and Hot Wheel detection units HABD / HWD) are mounted on the track. These systems measure contactless the temperatures of the axle bearing boxes, wheels and brake discs passing over them. They are used on conventional lines as well as on high-speed lines. In that way, derailments due to overheated wheels and bearings can be prevented and trouble-free rail operations can be achieved.

The relative frequency of derailments, as a consequence of defective (overheated) bearings, in the network of the ÖBB in the early 1990s on one hand, as well as the absence at that time of appropriate solutions on the other hand, inspired the ÖBB to develop their own hot box detector of the type TK 99. The main feature is the patented measuring geometry (Patent AT 408 214 B), which is particularly adapted to Austrian requirements (RoLa – intermodal -Transport, Schlieren type bogies, Y25 bogies). Beside the bearings, the brakes are also checked with regard to inadmissible warming-up and/or overheating.

Since, from an operating point of view, only a minimal false alarm rate (alarming although there has not been any damage) is permitted, special attention had to be given to this requirement. A stipulation required no manual post processing of alarms had to be carried out by personnel. Therefore the equipment had to achieve the two objectives of high availability with a simultaneously low false alarm rate. After a trial phase a rollout into the complete network and across the whole area was able to be started which was essentially completed by the end of 2010.

2. FUNCTIONALITY

The Hot Box Detection System used in Austria by ÖBB Infrastruktur Betrieb AG consists of the following elements:

- Track-side equipment (scanners)
- Evaluation and control unit
- Data transmission equipment
- Visual display unit

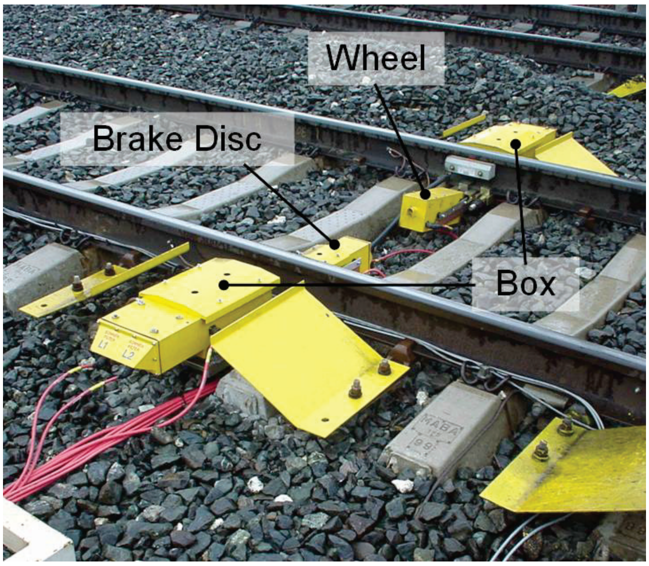

Fig. 1. Wayside Hot Box and Hot Brake Detection System TK 99

The track-side equipment includes (Fig. 1):

- The control and evaluation electronics accommodated within a cabinet
- The rail fastened measurement equipment with infrared sensors to record axle box and wheel temperatures and axle counters

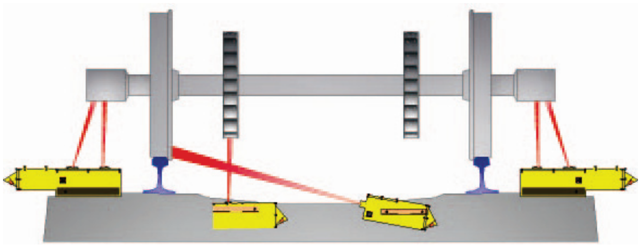

Fig. 2. Measurement Geometry of System TK 99

Two hot box detection sensors, one provided at each side of the track, measure surface temperatures of the axle boxes, thus, meeting the requirements of UIC 501 and the new version of the TSI Infrastructure. Simultaneously with the scanning of the axle box, a hot disk detection sensor scans the heating of the disk brakes. A hot wheel detection sensor measures the temperature of the wheel flange to detect critical temperatures of blocked brakes. Visualization of the results from measurements is possible on a customary PC with WINDOWS as operating system. Moreover, all data transmitted from track-side equipment, can be stored and if necessary exchanged to other systems.

In most locations, where a hot box detection system is positioned, there is also a hot wheel detection system and a hot disk detection system. The main reason for this accumulation of sensors is the installation costs for a single system. The shared use of power supply and a connection to the railway data network results in synergies.

The technical solution is able to check the temperature even in a temperature range which cannot be seen by a station inspector. The visual check of boxes leads only to an alarm if the box is already glowing but in the beginning phase a box doesn't glow. So, a technical solution will recognise an initial hot box earlier than one station inspector ever can. Moreover, the technical plant controls both sides of a train even if most glowing boxes can be seen from both sides of a train.

After the general decision to use a technical support for checking temperature of boxes, wheels and brakes, the question of locations for these systems and the maximum distance between two plants appear. For the choice of location the operational handling has to be taken into account because the alarm message has to be verified and afterwards the wagon has to be isolated from the train. The maximum distance can be calculated by a risk-analysis where the increase of the temperature has to be specified. In case of having no data from real-time operation it is possible to ask experts for their judgment how fast the temperature can increase.

Observations of occurred hot box alarms have shown that there are two differential cases of temperature increase: linear and exponential. So, an additional advantage of a continuous wayside train observation is the early recognition of linear temperature increases, which allow planning the operation handling in a more efficient way.

3. OPERATIONAL HANDLING

For real-time operation it is very important to develop the process in case of an alarm to assure immediate reaction. Only if a technical solution has a high reliability it will be acceptable to stop a train because of new European legislation. Wayside train observation plants are used by Infrastructure Manager to protect the infrastructure for production. Trains are owned by Railway Undertakings which pay a user fee for a time slot. So, if one train of one railway undertaking has a hot box, other railway undertakings may be influenced. Therefore, a balanced proceeding is a basic requirement for a discrimination-free handling.

So, in case of an alarm the Infrastructure Manager has to inform the driver of a train that a wayside hot box detection system has recognised a temperature exceeding a warning limit. It is also possible to declare two limits of temperature for warning and for alarming. In both cases an inspection of the axle has to be done. This will be done by technical inspectors in big stations or by the driver of the train. Important for the breaking process is the normal use of the braking power and to prevent an emergency brake because this could cause a derailment through high forces by heavy braking.

A driver can only prove visual if an axle journal is broken, an axle-bearing is glowing or a axle-box case is deformed. Even if none of these indicators can be found, the train will continue its journey with reduced maximum speed to the next place where a technical inspector is available. Otherwise - if the driver verifies the defect - the wagon has to be sorted out yet the locomotive has generated the alarm.

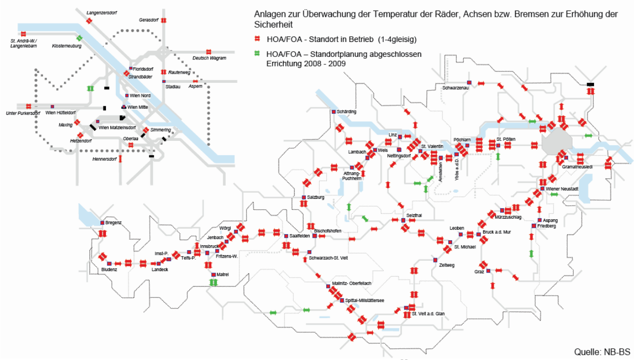

Fig. 3. Locations in the network of ÖBB equipped with system TK 99

During the last years Austrian Federal Railways invested in a large number of hot box detection systems. The number of warnings and alarms has changed in this period because of many factors. One technical aspect is the density of plants because if more plants are installed the probability is rising that hot boxes are recognised earlier than in former times. As an indicator for safety in railway operation it is, therefore, not possible to consult only the number of alarms and warnings in a network.

4. OUTLOOK

Today's hot box detection systems allow to control an important aspect of train observation but this is only one part of a general concept for automated wayside train observation. Advantages of technical plants for train observation can be seen in this example for hot box detection. Moreover, it is apparent that such a system has to be highly reliable and accurate for the usage in real-time operation. For this part of wayside train observation the cost-benefit analysis is simple due to the fact that each detected hot box could cause a derailment with high costs.

At present 240 equipments are in operation at 147 locations throughout the Austrian network. This results in an average distance of 30 km on main lines and about 50 km on supplementary lines. In order to be able to meet the requirement of high availability also in daily operations, the status of each individual unit is monitored by a maintenance control centre. In the process appropriate messages are sent by the unit to the maintenance personnel in the event of a malfunction. As a matter of fact, a very large time is shown between two malfunctions. The validation of the alarms is generally carried out by the engine driver of the train affected, in cooperation with the train dispatcher responsible. The way of proceeding and the responsibilities are in this case clearly and unambiguously regulated in what is known as ‘process instructions’. Over the last few years a validation rate of 99.5 % has been observed, i.e. the alarm signalled was actually verified on the wagon.

A specifically Austrian detail is the way of proceeding in the event of an alarm message ‘HBD hot’ being given. Here stopping takes place at the defined main signal (no routes are taken back by means of an emergency cancellation, but simply no new ones are made available any more) as well as unconditional taking out of service of the defective wagon– even if verification by the engine driver should once turn out to be negative. This measure shows very clearly the high level of confidence of the operational management bodies in the equipments of the type TK 99.

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