ASYNCHRONOUS DRIVE CONTROL OF A TRACTION VEHICLE USING TCMS SYSTEM

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ABSTRACT

In the last years in Poland, the intense development of the power supply technology and the control systems of traction vehicles drives has been observed. The systems developed in Poland provide maximum efficiency and minimum energy losses during train exploitation. In this paper we present the Train Control and Monitoring System (TCMS) simulator, which realizes complex and reliable service of a supervised unit. The simulator was designed and constructed within the framework of cooperation between the Kazimierz Pulaski University of Technology and Humanities in Radom and MEDCOM Ltd Company with head office in Warsaw. The simulator was installed in the Laboratory of the Ukrainian Academy of Railway Transport in Kharkov under the project, which was co-financed within the framework of the program of Polish developmental cooperation by the Ministry of Foreign Affairs of the Republic of Poland.
INTRODUCTION

Development of semiconductor inverter systems enabled application of alternating current engines in the traction vehicles, powered by direct voltage. An example can be asynchronous cage motors powered by voltage source inverters. Traction vehicles with asynchronous drives are characterized by, in comparison to typical DC drivers, among others, lowering the costs of exploitation and higher reliability. Introduction of alternating current engines enabled to increase almost twice the power of a drive and maximum speed of an electric traction vehicle, and also accelerate starting and delay braking. In addition, cage motors are characterized by simple structure, reliability, lower costs, ease of service and higher durability. Control of these systems is realized with the use of TCMS system (Train Control and Monitoring System), which provides complex and reliable service of a supervised unit. An example of such a solution can be a TCMS system, made by MEDCOM. Fulfilling the growing demands related to education of engineering staff, using high-tech control systems, Kazimierz Pułaski University of Technology and Humanities in Radom, together with its partner, a company MEDCOM Ltd., with a registered office in Warsaw, realized the project „Organization and equipping a laboratory of control systems and diagnostics of rail vehicles” for an Ukrainian Academy of Railway Transport in Kharkiv [3, 4]. The project was co-financed within the framework of the program of Polish developmental cooperation by the Ministry of Foreign Affairs of the Republic of Poland. A result of the project is equipping a laboratory of control systems and diagnostics of rail vehicles of the Academy in Kharkiv with modern simulator, and also organizing a cycle of trainings and seminars concerning the project. Simulator is an engine driver pulpit, together with a complete control system, that is, host computer, carriage and auxiliary controllers, input and output to the buses CAN, WTB, I/O.

ASYMCHRONOUS TRACTION DRIVE

Traction drive, in the rail vehicles equipped by the company MEDCOM, consists of two transistor inverters FT-500-3000-UF-M, four STDa315 X6EN asynchronous engines with speed and temperature detectors, two systems of soft switch-on and two line reactors (fig. 1).
Inverters FT-500-3000-UF-M are built using high-tech technologies. Direct air cooling guarantees high reliability within the wide scope of temperatures and eliminates the risk of coolant spill. Application of two independent inverters enables to drive (with a limited power) with a failure of one inverter. The system enables starting, driving with a set moment and speed (cruise control), rundown and braking of a vehicle. The system is adapted to cooperation with a recorder of parameters of tractions and parameters of an inverter, which allows to restore conditions of power supply in case of interferences in work or during failure of a drive system. Asynchronous traction engine applied in a drive system has twice as much power in comparison to the direct current engines – its rated power is 250kW, whereas an hour power is 300kW.

The effects of application of an asynchronous drive in the traction vehicles:
- better comfort of ride,
- lack of pulling while starting,
- increasing maximum speed,
- stabilization of speed,
- better traction parameters (power, acceleration),
- enabling of electrodynamic braking,
- reduces consumption of electric energy.

**TCMS system**

TCMS system made by MEDCOM meets four basic functions [3]:
- electric traction unit drive control,
- auxiliary unit control (door control, lighting, heating, air conditioner, ventilation control),
- data transmission,
- diagnostics of work of the systems,
- registration of events.

Applying modern, special computers and checked communication standards guarantee safe and reliable work of a drive system of rail vehicle [6, 7]. Drive control is realized by superior controller, which creates a signal of starting and braking torque and for a drive. On the engine driver pulpit, there are, among others, control panel, as well as power controller and brake controller (fig. 2, 3). Setting a starting torque during normal ride is realized by an engine driver, by displacing lever of ride controller.

![Fig. 2. Pulpit of an engine driver in a TCMS system [1]](image_url)
Many additional functions are implemented in TCMS system, as a result of applying modern programmable logic controllers (PLC), that is: diagnostics of a brake system, diagnostics of automatic doors, diagnostics of heating of a traction vehicle and registration of parameters of system work (fig. 4).

**Fig. 3.** Screen of a control panel in a TCMS system [1]

**Fig. 4.** Model diagnostic screens in TCMS system [1]

**DRIVE CONTROL IN STARTING AND BRAKING PHASE**

The process of starting an electric traction unit with asynchronous drive begins from switching on the batteries of accumulators and compressor of pantographs, which creates an air pressure in a pneumatic installation of pantographs [5]. Next action is an activation of a cabin of an engine driver. These actions are signalled by the messages on the control pulpit. Only one position of an engine driver can be active in a vehicle consisting of one or a few electric traction units. Then, the messages about the danger points, state of devices are automatically displayed on a control pulpit screen and all drive and braking systems are switched on. Then, current controller is lifted, traction...
voltage is given, quick switch is turned on, converters and traction inverters are launched. All states of system work: switching on, alarms, switching off the components of a drive are displayed on control panel screen. Main contractor of a given group is switched off in an emergency state of any device of one drive group (reactor, inverter, engine, braking resistor). Switching off is realized from the level of control panel. There is a possibility of continuing the drive with incomplete performance with one drive group. In such a situation, there is a message on control panel: „Emergency drive” and pictogram of the alarm. All diagnostic states, work states and analogue measurements of required amounts of traction inverters are displayed on a page of operator terminal „Inverters”. There is an information, on a main page of terminal, about switching on or switching off an electrodynamic brake. The drive starts when lever of power controller is leaned forward. The degree of leaning of lever is signalled on the terminal and shows the starting (current) torque of traction engines. Leaning, by an engine driver, a lever of power controller backwards, generates values of delay of braking for a brake system and starts electro-pneumatic or electrodynamic braking. Dislocation of lever of ride and braking controller breaks a safety loop and sudden braking starts.

Operator terminal of TCMS system placed in the last carriages. Terminals have the same software and the same way of functioning. Only terminal is active in a given moment. You must display an appropriate screen (program page) with an information about the state of components of a traction vehicle. You can find, on the main screen, values of voltages, currents, speeds, ride direction, pulpit activity, date, hour etc. and messages informing an engine driver about current state of a vehicle. Fig. 3 shows a terminal with main screen of the program, whereas fig. 4 present selected diagnostic screens of TCMS system. Pressing a button (in a bottom part of the screen) changes active page of the program. Buttons, which enable to switch on a specific page are short texts, e.g.: „train status”, „failure”, „inverter”, „doors”. You can return to a main screen, which is automatically charged after activation of cabin of an engine driver, from each level.

CONCLUSIONS

There has been a fast development of technologies of power supply and control of railway drives of traction vehicles in recent years in Poland. An example of solution, which ensures the work of a drive with a maximum efficiency and with minimal losses, can be an asynchronous drive controlled by TCMS system, worked out by MEDCOM. Therefore, the project, co-financed by the Ministry of Foreign Affairs of the Republic of Poland enabled to equip a laboratory of control systems and diagnostics of rail vehicles of the Ukrainian Academy of Railway Transport in Kharkiv, with a modern simulator of TCMS system. The best way to share knowledge and experience is to provide, to an Academy in Kharkiv, energy-efficient technologies and specialist technical solutions. Modern laboratory equipped with a simulator of TCMS system will allow to learn about the structure of control systems and diagnostics of railway traction drives, as well as about programming controllers. The project was realized in the Faculty of Transport and Electrical Engineering of the University of Technology in Radom, in cooperation with MEDCOM.

REFERENCES

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