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THE WAYS TO IMPROVE PERFORMANCE OF ELECTRIC ENERGY RECUPERATORS

The use and conversion of potential and kinetic energy of a train into electric energy makes it possible to solve the problems of reducing the costs of electric traction of trains and ensure energy saving in industry [1]. When solving this complex technical problem, it is necessary to take into account limitations on the permissible braking force due to wheel-rail traction failure and the operation modes of the traction power supply system [1]. From the evaluation of the efficiency of electric energy recovery from traction electric rolling stock into the DC contact network, it follows that the engineering problems are mostly solved.

Single-phase and three-phase rectifier-inverter converters (RICs), driven by the network, and single-phase four-qS converters are currently used for electric braking of trains and electrical energy recovery into the AC power grid [1]. During the operation of this equipment, the effective AC mains voltage is reduced due to rectangular-shaped equalizing current loading, and the instantaneous AC mains voltage curve is distorted. The study is aimed at examining the energy processes in the known energy recovery devices to determine and eliminate the cause of their unsatisfactory operation.

The theory of energy processes in electric circuits with semiconductor devices is based on extraction of the fundamental harmonic of voltage and the first harmonic of current from the spectrum of harmonic components of non-sinusoidal voltage and current at the converter input. This method allowed simplifying the calculation of active power at the input of semiconductor converters with different pulse control methods of power semiconductor devices (PSC). The known theory of energy processes does not allow revealing the cause of unsatisfactory work of pulsed semiconductor converters. The developed in IrGPS power characteristics take into account reduction of irreversible transformation of electric energy into another kind

of energy due to non-conductive state of semiconductor devices of electric energy recuperators and reactive elements of electric power system [2, p. 1030]. Operation of electric energy recuperators can be improved by technical solutions, which allow eliminating the cause of reducing their energy efficiency.

As a result of the study, it was found that the voltage in the contact network increases during the recuperation of electric energy by the developed device, which allows increasing the productivity of the railroad. Instead of increasing the phase angle of the equalizing current relative to the alternating voltage in the network to 90 electrical degrees to control the active power of regeneration by the developed regenerator, the total argument of the total power at the regenerator output is maintained at the level of $\varphi\sum$ = 3-6 electrical degrees. This makes it possible to limit the magnitude of the reactive component of the equalizing current in the process of regulating the active power of the recuperator.

It is proposed to stabilize the argument of full power at the recuperator output at a given level when regulating active recuperation power by means of a smooth change in current in the excitation windings of traction motors and switching sections of the secondary winding of traction transformers of the electric rolling stock.

Total losses of active power in the traction transformer, in the developed EPS recuperator and in the AC contact network are reduced by 3 times in comparison with the total losses of active power in the traction transformer, EPS RPM and contact network.

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