Characteristics of Combined Motor of Separator Drive

V A Kim¹, Ya M Kashin¹ and L E Kopelevich¹

¹Kuban State Technological University, 2, st. Moskovskaya, Krasnodar, 350072, Russia

E-mail: vladk-kub@mail.ru

Abstract. The paper describes the characteristics of a combined motor of a separator drive. Simulation experiment provided the characteristics of a combined motor of a separator drive, which allow considering the impact of the line voltage parameters (the supply voltage amplitude and frequency) and the resistance moment created by the separated product on the electromagnetic torque of a combined motor of the separator drive and the rotation speed of the working body of the separator with a combined motor.

1. Introduction

An electric drive is an electromechanical system comprising a motor and conversion, transmission, and control devices, designed to drive the working bodies of a machine and control this motion. The drive of a separator with a combined motor [1-3] contains a control device and a combined motor consisting of the motor stator and a massive rotor, which serves as a working body of the separator drive – the drum. The paper studies a combined motor of a separator drive. Fig. 1 shows a separator with a combined motor, comprising a housing 1 with the motor stator 2, 3 and a massive rotor 4 in the form of a separator drum (hereinafter – rotor-drum), mounted therein. The motor stator is installed in housing 1 and contains a magnetic core 2 with winding 3 in the grooves.
The combined motor of the separator drive operates as follows. When voltage is applied to the winding 3 in the grooves of the stator magnetic core 2, a rotating magnetic field arises, which induces eddy currents in the rotor-drum 4 rigidly connected to the axis mounted in the housing 1 in bearing supports. The interaction of the rotating magnetic field created by the current in winding 3 and the magnetic field created by the eddy currents in the rotor-drum 4 creates a torque rotating the rotor-drum 4 around the axis.

2. Materials and methods
To comprehensively study the combined motor of the separator drive (CM SD), its mathematical model was built based on differential equations describing the electromagnetic and electromechanical processes in the CM SD, which allows obtaining functional relationships between the dynamic characteristics and parameters of the CM SD developed. This mathematical model was implemented in the MatLab Simulink software package [4].

Fig. 2 shows a block diagram of a digital laboratory bench to study the CM SD operating modes.
3. Results
Figs. 3–6 show the characteristics obtained in the simulation experiment. Fig. 3 shows the dependence of the starting electromagnetic torque of the combined motor of the separator drive on the supply voltage amplitude at various supply voltage frequencies. Fig. 4 shows the dependence of the steady-state rotor-drum (the working body of the separator drive with a combined motor) rotation speed on the supply voltage amplitude at various supply voltage frequencies. Fig. 5 shows the dependence of the electromagnetic torque of the combined motor of the separator drive on the resistance moment created by the multiphase separated products of different densities. Fig. 6 shows the dependence of the steady-state rotor-drum (the working body of the separator drive with a combined motor) rotation speed on the resistance moment created by multiphase separated products of different densities.
Figure 3. The Dependence of the Rotor-Drum Rotation Speed (the Working Body of the Separator Drive with a Combined Motor) on the Supply Voltage Frequency and Amplitude $\omega_{\text{EM, start}} = f(f, U)$.

Figure 4. The Dependence of the Rotor-Drum Rotation Speed (the Working Body of the Separator Drive with a Combined Motor) on the Supply Voltage Frequency and Amplitude $\omega = f(f, U)$.

Figure 5. The Dependence of the Electromagnetic Moment of the Combined Motor of the Separator Drive on the Resistance Moment Created by the Separated Product.
4. Discussion
The analysis of the characteristics in Fig. 3 shows that an increase in the supply voltage amplitude leads to an increase in the starting electromagnetic torque of the combined motor of the separator drive, which confirms the provision $M = U^2$ described in [6]. The analysis of the characteristics in Fig. 4 shows that an increase in the supply voltage amplitude leads to an increase in the rotor-drum (the working body of the separator drive with a combined motor) rotation speed, which confirms the provision $\omega = U$ with a constant resistance moment $M_R$ (the shaft load) according to [7].

Figs. 5-6 show the control characteristics of the combined motor of the separator drive at various loads created by the separated multiphase product.

5. Conclusion
The study results:
- implementing the mathematical model of the combined motor of the separator drive in the MatLab Simulink software package,
- determining the dependence of the starting electromagnetic moment of the combined motor and the rotation speed of the rotor-drum of the separator with a combined motor at various supply voltage amplitudes and frequencies; with an increase in the supply voltage amplitude or frequency, the starting electromagnetic torque of the combined motor and the rotation speed of the rotor-drum of the separator with a combined motor increase,
- obtaining the control characteristics of the combined motor of the separator drive for various separated products.

6. References
[1] Gaitov B Kh, Written V Ya, Bykov E A 09/30/1988 Patent SU 1427501 A1 Separator for liquid
[2] Gaitov B Kh 08/10/2016 Patent RU 2593626 C1 Oil separation plant
[3] Kashin Ya M, Kopelevich L Ye, Samorodov A V, Kim V A 11/15/2019 Patent RU 2706320 C1 Separator for polydisperse liquid systems
[4] MATLAB for Students Retrieved from: https://www.mathworks.com/products/matlab/student.html
[5] GOST 32144-2013 Electric Energy Electromagnetic compatibility of technical means Standards for the quality of electrical energy in general-purpose power supply systems
[6] Kopylov I P 2012 Electric machines: a textbook for bachelors (Moscow: Yurayt Publishing House) 675
[7] Danilov P E, Baryshnikov V A, Rozhkov V V 2018 Theory of Electric Drive: A Study Guide (Berlin: Direct-Media) 415
[8] Kutsevalov V M 1966 Questions of theory and calculation of asynchronous machines with
massive rotors (Moscow: Energiya) 302

[9] Kostenko M P, Piotrovsky L M 1965 Electrical machines. AC machines (Moscow: Energy) 704

[10] Goldberg O D, Sviridenko I S 2006 Design of electrical machines (Moscow: Higher School) 430