

**VERUFICATION AND ANALYSIS OF THE
OPERATIONAL PARAMETERS OF THE NB-418K6
TRACTION ELECTRIC MOTOR**

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Annotation. *This article is devoted to the analysis and verification of the electro-traction parameters of the NB-418K6 type traction electric motor used in electric locomotives. Traction motors operate under various loading and temperature conditions, which makes it necessary to monitor such important parameters as current, voltage, torque, rotational speed, and temperature.*

In this study, the dependence of traction force and speed on current and torque was determined for different operating modes, including starting mode and field weakening modes. In addition, the tractive characteristics of the locomotive and the adhesion limits were calculated. The obtained results make it possible to assess the technical condition and operating efficiency of the traction electric motor and can be used in diagnostic and monitoring systems for modern electric locomotives.

Keywords: *traction electric motor, current, voltage, torque, rotational speed, tractive force, operating mode, adhesion coefficient, technical condition assessment.*

INTRODUCTION

The operational reliability and efficiency of electric locomotives directly depend on the technical condition of their traction electric motors (TEM). The traction system is the main source of mechanical energy for the locomotive, and the accuracy of its electro-traction parameters has a significant influence on the dynamic and operational characteristics of the train.

The NB-418K6 type traction motor operates under heavy loads, variable operating modes, and severe thermal conditions. During long-term operation, the motor is affected by constructive, technological and operational factors, which can lead to wear, overheating and a decrease in efficiency. Therefore, systematic monitoring and verification of its parameters are essential for ensuring reliable operation.

This article presents the results of a study aimed at verifying the electro-traction parameters of the NB-418K6 traction motor, determining the dependence of tractive force and speed on current and torque, as well as defining the tractive characteristics of the electric locomotive taking into account adhesion conditions.

CALCULATION OF ELECTRO-TRACTION PARAMETERS

The main electro-traction parameters of the traction motor were determined based on the following functional relationships:

$$F_t = f(I_m) \text{ and } V = f(I_m).$$

where:

F_t – tractive force of one wheel-motor unit, kN

I_m – motor current, A

V – speed of the locomotive, km/h

The calculation sequence is as follows:

The traction force and speed were calculated using the following formulas:

$$F_t = \frac{2\mu_r M_e \eta}{D}$$

$$V = \frac{60\pi D_w n_e}{1000 \mu_r}$$

where:

M_e – motor torque, kN·m

D – wheel diameter, m

n_e – rotational speed, rpm

The calculations were carried out for a motor current of $I_m = 800$ A in four operating modes:

- Starting Mode (SM)
- Field Weakening Mode 1 (FW1)
- Field Weakening Mode 2 (FW2)
- Field Weakening Mode 3 (FW3)

The obtained results are presented below:

$$SM-M_e = 7.72 \text{ kN}\cdot\text{m} ; F_t = \frac{2.52 \cdot 7.72 \cdot 0.94}{1.25} = 60.4 \text{ kN}$$

$$FW1-M_e = 4.71 \text{ kN}\cdot\text{m} ; F_t = \frac{2.52 \cdot 4.71 \cdot 0.94}{1.25} = 36.85 \text{ kN}$$

$$FW2-M_e = 2.83 \text{ kN}\cdot\text{m} ; F_t = \frac{2.52 \cdot 2.83 \cdot 0.94}{1.25} = 22.11 \text{ kN}$$

$$FW3-M_e = 1.57 \text{ kN}\cdot\text{m} ; F_t = \frac{2.52 \cdot 1.57 \cdot 0.94}{1.25} = 12.28 \text{ kN}$$

$$SM-n_e = 890 \text{ min}^{-1} ; V = \frac{60 \cdot 3.14 \cdot 1.25 \cdot 890}{1000 \cdot 5.2} = 40.3 \text{ km/h}$$

$$FW1-n_e = 1107 \text{ min}^{-1} ; V = \frac{60 \cdot 3.14 \cdot 1.25 \cdot 1107}{1000 \cdot 5.2} = 50.1 \text{ km/h}$$

$$FW2-n_e = 1713 \text{ min}^{-1} ; V = \frac{60 \cdot 3.14 \cdot 1.25 \cdot 1713}{1000 \cdot 5.2} = 77.5 \text{ km/h}$$

$$FW3-n_e = 1884 \text{ min}^{-1} ; V = \frac{60 \cdot 3.14 \cdot 1.25 \cdot 1884}{1000 \cdot 5.2} = 85.3 \text{ km/h}$$

Table 1. Calculations of F_t for current values from 600A to 1300A.

Operating mode	F_t	Current value I_m , A							
		600	700	800	900	1000	1100	1200	1300

SM	<i>kN</i>	45.3	52.7	60.4	67.6	108	185	300	330
FW1	<i>kN</i>	27.6	32.1	36.9	41.7	63	94.5	121.6	116
FW2	<i>kN</i>	16.6	19.3	22.1	26	38	56.7	79	89
FW3	<i>kN</i>	9.2	10.7	12.2	14.5	21.3	31	42.8	53

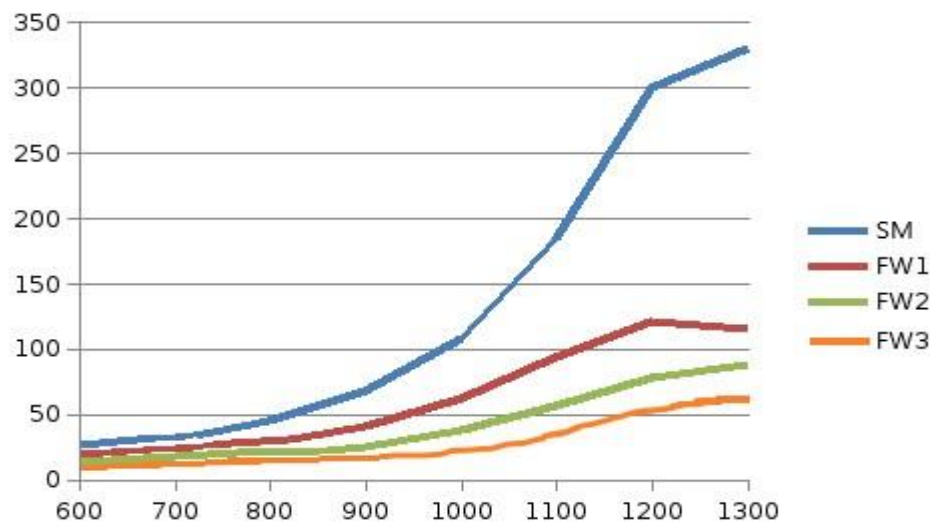


Figure 1. Dependence of $F_t = f(I_m)$ for four operating modes.

Table 2. Calculations of V for current values from 600A to 1300A.

Operating mode	V_d	Current vaule I_m , A							
		600	700	800	900	1000	1100	1200	1300
SM	<i>km/h</i>	76	56	40.3	26.9	16.8	9.8	6	5.5
FW1	<i>km/h</i>	93.6	69.9	50.1	34.4	22.7	15.3	11.7	12.4
FW2	<i>km/h</i>	137	105	77.5	54.9	37.5	25.1	17.9	15.7
FW3	<i>km/h</i>	149	115.5	85.3	60.4	41.2	27.6	19.7	17.2

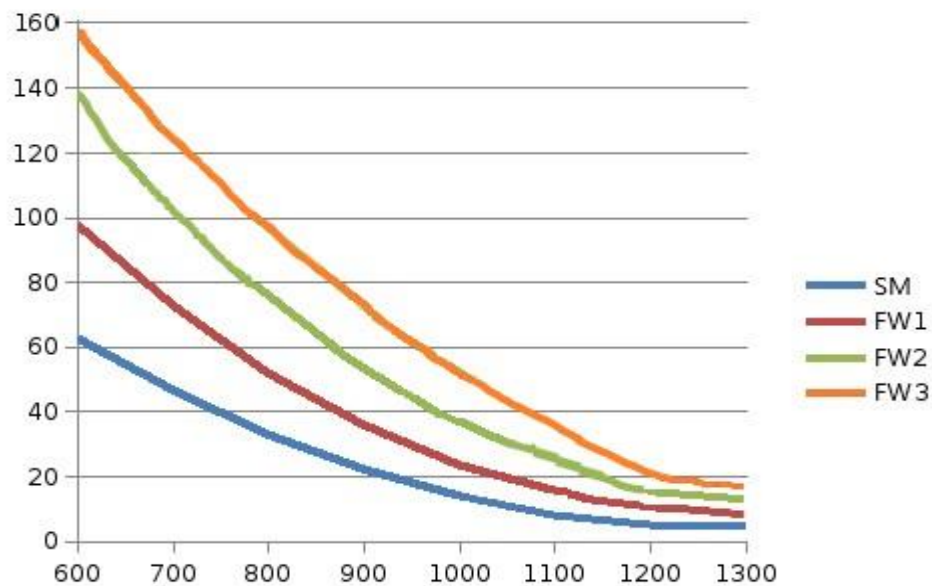


Figure 2. Dependence of $V = f(I_m)$ for four operating modes.

These calculations help analyze the performance characteristics of the traction motor at various current and speed values, which is important for ensuring efficient operation and optimizing the locomotive's traction parameters.

DETERMINATION OF THE LOCOMOTIVE'S TRACTIVE CHARACTERISTICS

The tractive characteristic of a locomotive represents the dependence of its tractive force on speed.

The tractive characteristic $F_K = f(V)$ is determined in the following sequence:

1. Several speed values of the locomotive are selected, and for each speed, the current is determined according to the $V = f(I_m)$ curve (corresponding to the operating modes SM, FW1, FW2, FW3, respectively).
2. Using the $F_t = f(I_m)$ curve, the tractive force F_t for a single wheel-motor unit is determined for each I_m value.
3. For each speed, the total tractive force of the locomotive is calculated using the formula:

$$F_k = m \cdot F_t$$

Where m is the number of wheel-motor units.

Considering Tractive Force Limitations

Since the adhesion properties of the wheels on the rails affect the tractive force, adhesion limits must be incorporated into the tractive characteristic. For this purpose, the following relationship is used:

$$F_{adh} = P_{sc} \cdot \psi_c$$

Where:

P_{sc} is the adhesion weight of the locomotive (taken based on the locomotive sample),

ψ_c is the calculated adhesion coefficient.

For the designed locomotive, the adhesion coefficient is calculated as:

$$\psi_c = 0.118 + \frac{5}{(27.5 + V)}$$

$$F_{adh} = 1920 \cdot 0.271 = 520.3 \text{ kN}$$

Similar calculations are performed for speed values of 10, 15, 20, and 25 km/h.

Calculation Results.

Table 3. Results of Calculating the Locomotive's Tractive Force.

Operating mode	F_t	Current vaule I_m , A							
		600	700	800	900	1000	1100	1200	1300
SM	kN	362.4	421.6	483.2	540.8	864	1480	2400	2640
FW1	kN	220.8	256.8	295.2	333.6	504	756	972.8	928
FW2	kN	132.8	154.4	176.8	208	228	453.6	632	712
FW3	kN	73.6	85.6	97.6	116	170.4	248	342.4	424

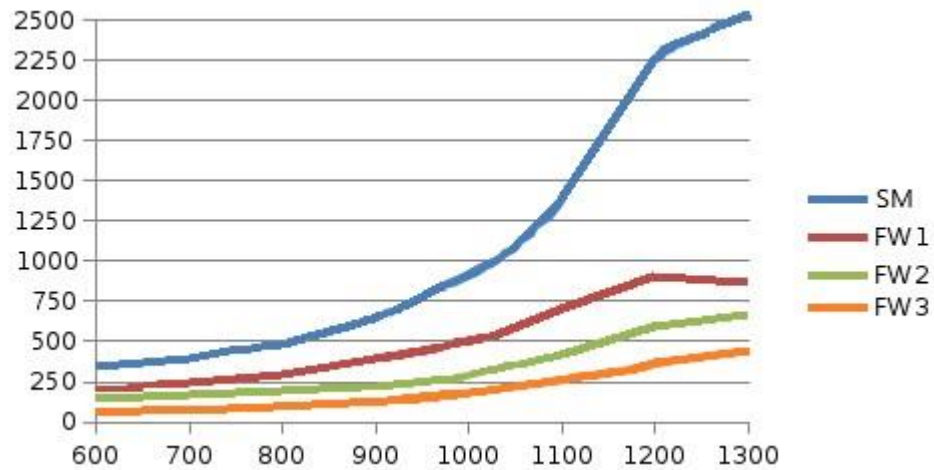


Figure 3. Dependence of $F_k = f(I_m)$ for four operating modes.

Table 3. Results of calculating the F_k limits of tractive force based on adhesion

V	km/h	0	5	10	15	20	25
ψ_c	-	0.29	0.271	0.251	0.235	0.223	0.213
F_{adh}	kN	575.6	520.3	482.5	452.4	428.1	408.9

Table 4. Results of calculating the tractive characteristics.

V		20	30	40	50	60	70	80	90	100	110	120
SM	I_m	828	736	644	552							
	F_k	540	483	421	362							
FW1	I_m				736	690	644	598				
	F_k				295	265	213	185				
FW2	I_m							736	690	662		
	F_k							176	150	129		

FW3	I_m									736	690	644
	F_k									97	85	76

Using these calculations, the variation of the locomotive's tractive force at different speeds and current values is determined. At the same time, by taking adhesion limits into account, the maximum tractive force boundaries are established.

CONCLUSION

In this article, the results of calculating the electrical-traction parameters of the NB-418K6 type traction electric motor were analyzed. The calculation results indicate that at higher current values, the tractive force increases, but the speed decreases. The maximum tractive force of the locomotive depends on the adhesion weight and should not exceed the determined values. The efficiency of the traction electric motor depends on its electrical and mechanical parameters, as well as on the load and operational conditions. Based on the calculations, the maximum tractive force was determined considering the locomotive's adhesion limits, and the variation of tractive force at different speeds and current values was analyzed. The results of this study serve as an important basis for ensuring the effective operation of locomotives and creating an optimal traction system.

LIST OF REFERENCES:

1. Khamidov, O., Ergashev, O., Abduvahobov, M., & Nematova, S. (2022). Development of a technology for installing gear transmissions of asynchronous motors on the rotor shaft. *Development of Pedagogical Technologies in Modern Sciences*, 1(4), 92–97.
2. Rustamovich, K. O. (2022). Development of a system for cold installation of a leading gear transmission on the electric locomotive of Uzbekistan ELR

Asynchronous Traction. Nexus: Journal of Advances Studies of Engineering Science, 1(4), 72–75.

3. Khamidov, O. R., Ergashev, O. E., Keldibekov, Z. O., & Zoirkhanov, S. T. (2018). Methods for diagnosing bearing units of asynchronous electric motors of “UZ-ELR” locomotives. In Proceedings of the International Scientific Conference “Science. Research. Practice”, GNII “National Development”, April 2018, pp. 44–49.

4. Ergashev, O. E., Abduvakhabov, M. E., Khamidov, O. R., Tursunov, N. K., & Toirov, O. T. (2022). Increasing the durability of gear transmissions of asynchronous traction electric motors. Web of Scientist: International Scientific Research Journal, 3(10), 1030–1036.

5. Khamidov, O., Ergashev, O., Abduvahobov, M., & Nematova, S. (2022). Assessment of the technical condition of the traction reducer of the “Uzbekistan” locomotive and the TE10M diesel locomotive. Current Approaches and New Research in Modern Sciences, 1(4), 37–42.