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CALCULATE THE PARAMETERS OF EXCAVATOR ЭКГ- 8И

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ABSTRACT

In the mining industry in general and the open coal mining industry in particular, the excavator is one of the important equipment in the production line. With the advantage of productivity and the ability to load rock and rock with high hardness compared to hydraulic excavators, electric excavators are commonly used in open-pit mining in Vietnam, mainly machines. Russian electric contact. In this paper, we present the calculation of the ЭКГ- 8И ladle parameter. The research results prove this is an effective way to improve the quality in the main electric drive control of the excavator.

Keywords: Industry, Scooping Machine; Manufacturing Excavator.

I. INTRODUCTION

In the mining industry, due to the specific nature of the work, the machines used often have a large to very large working capacity [1-3]. The excavator is also one of the most used equipment in mining, especially in open-pit mines. With the requirements of working capacity, reach of bucket ..., the excavators used in the mining industry still have to use electric excavators [2-3].

In our country, the excavators used in the open-cast mining field are still commonly used as excavators of the former Soviet Union and later Russian Federation [4]. These excavators still use either Generator-Motor drive control systems (F-D systems) or magnetic amplification control systems. These systems have the disadvantage of being cumbersome and with a large loss of power [5-7].

II. METHODS

Calculate the parameters of excavator ЭКГ- 8И

To be able to study the properties of the Ward Leonard drive control system with IGBT excitation. The model is built to investigate the ability to control the system in bucket lifting / lowering work mode. In this model includes the generator and the used motor whose specifications are roughly equivalent to that of the generator, the ЭКГ- 8И excavator engine with the following basic specifications.

- ❖ Rated capacity ($P_{\text{đm}}$). 250 HP (190 kW)
- ❖ Rated voltage ($U_{\text{đm}}$). 270 V
- ❖ Rated swing speed ($n_{\text{đm}}$). 740v / ph
- ❖ Rated excitation (U_{kt}). 85 V
- ❖ Rated current 760A

For other parameters of the excavator, see annex A

We have the calculation formula in this chapter we calculate the specific parameters as follows:

Actuator from the generator

$$W_{ktmf}(s)=\frac{K_{mf}/R_{ktmf}}{T_{ktmf}\,s+1}=K_{mf}.W_{cdktmf}(s)$$

With $K_{kt}=K_f\frac{U_{\text{đ}mktmf}}{U_{\text{đ}k\text{đ}m}}=10\ \frac{38{,}5}{10}$ 38,5 Amplifier coefficient of excitation circuit

$U_{\text{đmktmf}}$: Rated voltage of the excitation coil from the generator (V)

$U_{\text{đkkt}}$: Rated control voltage (V)

K_f: Generator reinforcement constant

T_{ktm} = T_{dt} = 0.01s: The excitation time constant of the generator amplifier circuit

$$K_{mf}=\frac{U_{\text{đ}mmf}}{I_{kt\text{đ}mmf}}=\frac{nU_{\text{đ}m\text{đ}c}}{I_{\text{đ}m\text{đ}c}}$$

$U_{\text{đmmf}}$: Rated voltage of generator (V)

$I_{\text{ktđmmf}}$: Generator rated excitation current (A) n: number of motor rpm

$U_{\text{đmđc}}$: Rated voltage of electric motor (V)

$K_{mf} = \frac{560}{29} = 19{,}3103$

Transfer function of the excitation coil from the generator

$W_{cdktmf}(s) = \frac{{}^{1}/{}_{R_{kt}}}{T_{ktmf}s+1}$

With : $R_{ktmf} = \frac{U_{đmktmf}}{I_{đmktmf}}$

R_{ktmf}: generator coil resistance (Ω)

$U_{\text{đmktmf}}$: Rated voltage of the excited coil from the generator (V)

$I_{\text{đmktmf}}$: Rated current of the excitation coil from the generator (A)

$R_{ktmf} = \frac{38.5}{29} = 1{,}3276\ (\Omega)$

The T_{ktmf} generator excitation time constant is determined by the generator magnetization curve

$T_{\text{ktmf}} = 2.0718$ s

$W_{cdktmf}(s) = \frac{{}^{1}/{}_{1,3276}}{2{,}0718\, s+1} = \frac{0{,}753}{2{,}0718\, s+1}$

Actuator from the generator

$W_{ktmf}(s) = \frac{{}^{K_{mf}}/{}_{R_{ktmf}}}{T_{ktmf}\, s+1} = \frac{14{,}5453}{2{,}0718\, s+1}$

Armature transfer function has no response

$W_{\text{puh}}(s) = \frac{{}^{1}/{}_{R_u}}{T_u s+1}$

Side:

R_{u}: total resistance of the armature circuit (Ω); L_{u}: The inductance of the armature circuit (H); $T_{\text{u}} = \frac{L_u}{R_u}$ The time constant of the armature circuit

$R_u = \text{n}.R_{uđc} + R_{umf}$

n: Number of motors

R_{udc}: Motor armature resistance

$R_{uđc} = 1{,}24\ (R_{\text{uctc}} + R_{\text{uctf}}) + \frac{2}{I_{uđmđc}}$

R_{uctc}: Electrode armature resistance from the motor itself

$R_{\text{ưctf}}$: Resistance of the motor auxiliary magnetic armature

I_{udmdc}: Motor armature current

$R_{uđc} = 1{,}24(0{,}0039 + 0{,}00325) + \frac{2}{760} = = 0.01115\ \Omega$

$R_{\text{ưmf}}$: Generator armature resistance

$R_{umf} = 1{,}24(R_{\text{ctcmf}} + R_{\text{ctpmf}} + R_{\text{bck}}) + \frac{2}{I_{uđmmf}}$

R_{ctcmf}: Electrode resistance from the generator itself

R_{ctpmf}: Electrode resistance from generator auxiliary

R_{bck}: Generator reactor compensation resistance

I_{umf}: Generator armature current

$R_{\text{ưmf=}}\ 1{,}24(0{,}0075 + 0{,}00163 + 0{,}00516) + \frac{2}{895}$

So $R_{\text{u}} = 0.0355\ \Omega$

Total inductance of generator and motor

$L_u = \text{n}.L_{uđc} + L_{umf}$

L_{udc}: Motor inductance (H)

L_{lumf}: Generator inductance (H)

$$L_{\text{uđc}} = \frac{0{,}6U_{\text{udmđc}}}{p_n\omega_{\text{dmđc}}I_{\text{dmdc}}}$$

$U_{\text{uđmđc}}$: Rated voltage of the motor armature

p_n: Number of poles

ω_đđc: Motor rated angle speed, $\omega_{\text{đdc}} = \frac{2\pi n_{\text{đc}}}{60}$

$n_{\text{đc}}$: Rated engine speed

$$\omega_{\text{đmđc}} = \frac{2\pi n_{\text{đc}}}{60} = \frac{2\pi 740}{60} = 77{,}4926\ s^{-1}$$

$$L_{\text{uđc}} = \frac{0{,}6.270}{4.77{,}4926.760} = 0{,}0011461\ H$$

$$L_{\text{umf}} = \frac{U_{\text{uđmmf}}}{p_n\omega_{\text{đmmf}}I_{\text{đmmf}}}$$

$U_{\text{uđmmf}}$: Rated voltage of generator armature (V)

$I_{\text{đmmf}}$: Generator rated current (A)

p_n: Number of poles

$\omega_{\text{đmmf}}$: Generator rated angle speed $\omega_{\text{đmđc}} = \frac{2\pi n_{mf}}{60}$

n_{mf} : Generator rated speed (R / min)

$$\omega_{\text{đmmf}} = \frac{2\pi n_{mf}}{60} = \frac{2\pi 1000}{60} = 104{,}72\ s^{-1}$$

$$L_{umf} = \frac{560}{4.104{,}72.895} = 0.0014937\ \text{H}$$

So: $L_u = n.L_{\text{uđc}} + L_{\text{umf}} = 2.0.0011461 + 0.0014937 = 0.0037859$ H

$$T_u = \frac{L_u}{R_u} = \frac{0.0037859}{0.0355} = 0.1067$$

The transmission function of the motor generator will be:

$$W_{pu}(s) = \frac{1/R_{\text{ư}}}{T_u s + 1} = \frac{28{,}169}{0{,}1067.s + 1}$$

The generator's kinetic energy is proportional to the speed

$e_{\text{đc}} = C_e\omega$

with C_e: equivalent electromagnetic design constant of motor is calculated by the formula:

$$C_e = n\frac{U_{\text{đmđc}} - I_{\text{đmđc}}R_{\text{ưđmđc}}}{\omega_{\text{đmđc}}} = 2\,\frac{270 - 760.0{,}0011152}{77{,}4926} = 6{,}7497$$

The motor torque is determined

$M_{\text{đc}} = K.\Phi_{\text{đc}}I_{\text{ư}}$

The flux does not change then:

$M_{\text{đc}} = C_M\ I_{\text{ư}}$

C_M: Equivalent constant of the electromechanical structure of the motor. In the SI system, the electromechanical constant is equal to the structural constant of the motor.

So: $C_M = C_e = C$

C_M: Electromechanical structure constant; C_e: Structure constant of the engine; C: Equivalent structural constant of the motor.

Inrush current response factor from generator

$$k_{\text{okt}} = \frac{U_{\text{tckt}}}{I_{\text{kt}}} = \frac{10}{29} = 0{,}3448$$

Transfer function of the excitation control circuit

$$W_{\text{mđkkt}}\ (\text{s}) = \frac{T_{ktmf}}{T_\mu K_{kt}K_{okt}/R_{kt}} + \frac{1}{2T_\mu K_{kt}K_{okt}/R_{ktmf}}\frac{1}{s}$$

$$W_{\text{mđkkt}}\ (\text{s}) = 10{,}359 + 5\frac{1}{s}$$

Design of controller for drive system using PID

Building simulation models

The purpose of the simulation:

- Because the actual system is quite complicated to perform analysis, using simulation software will limit the deployment of surveys on the active device, Easy to survey changes when you want to improve a device. somehow, it does not affect actual machines outside the actual production
- Check, tweak equipment when choosing the plan and put it into use
- Evaluate the performance under expected conditions, or even in the system stage in the design or survey phase.
- Simulation to compare plans when using the most suitable and optimal alternative and control solution

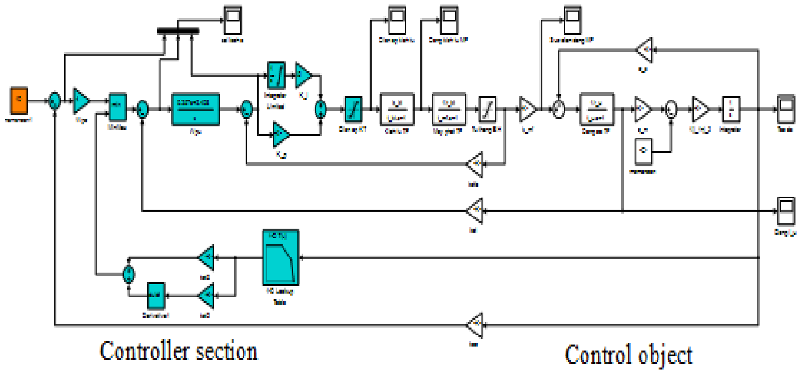

Figure 1.1 Simulation model of bucket lift control system using PID

The results obtained after performing the simulation

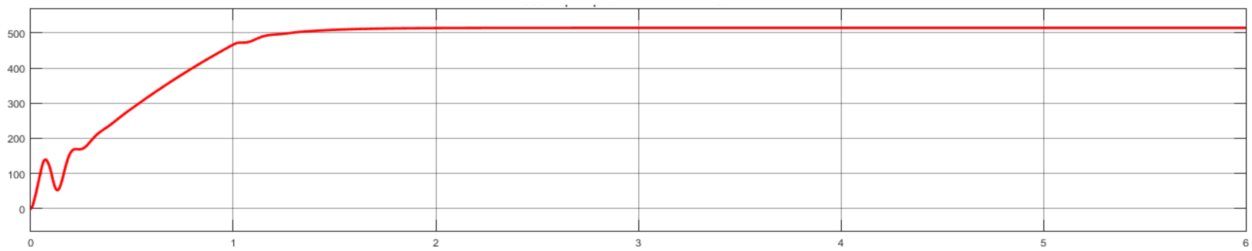

Figure 1.2. Generator electrodynamic level under load

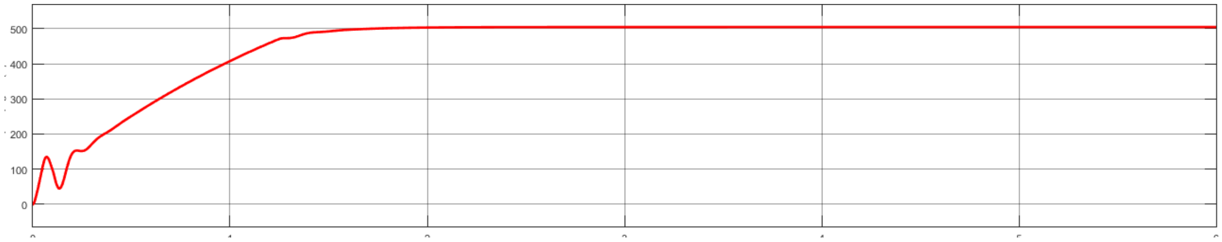

Figure 1.3 Generator dynamic level under rated load

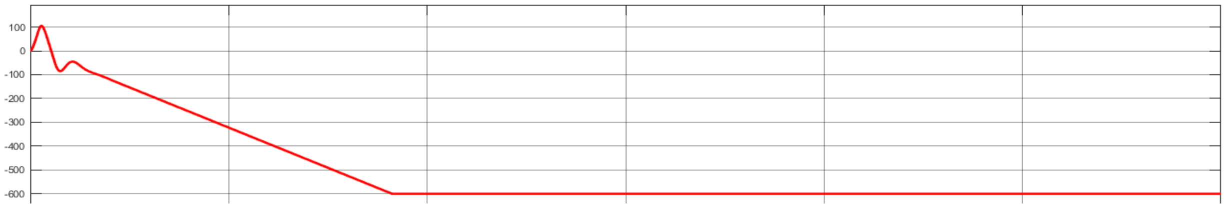

Figure 1.4. Generator electrodynamic level when overloaded

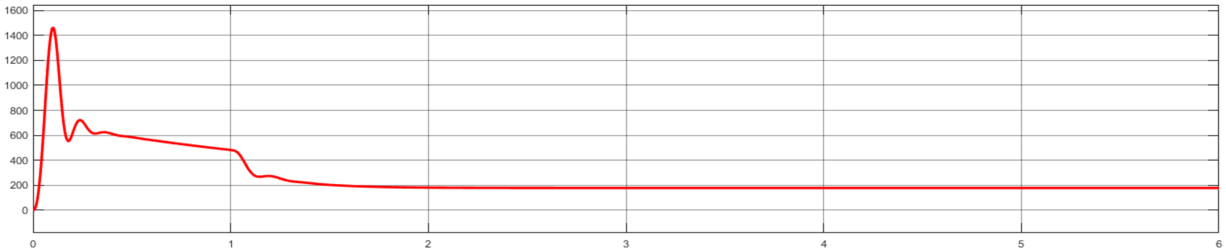

Figure 1.5 Armature current at under load

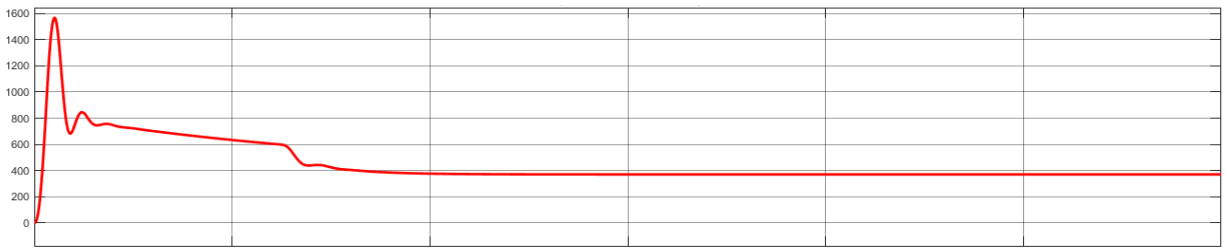

Figure 1.6 Armature current at rated load

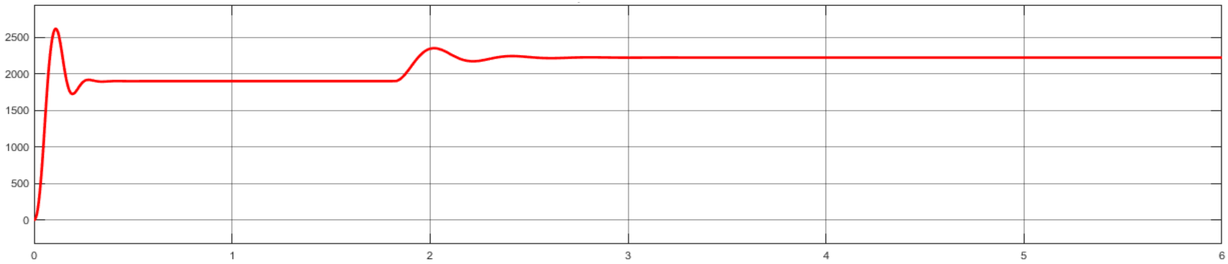

Figure 1.7 Armature current under overload

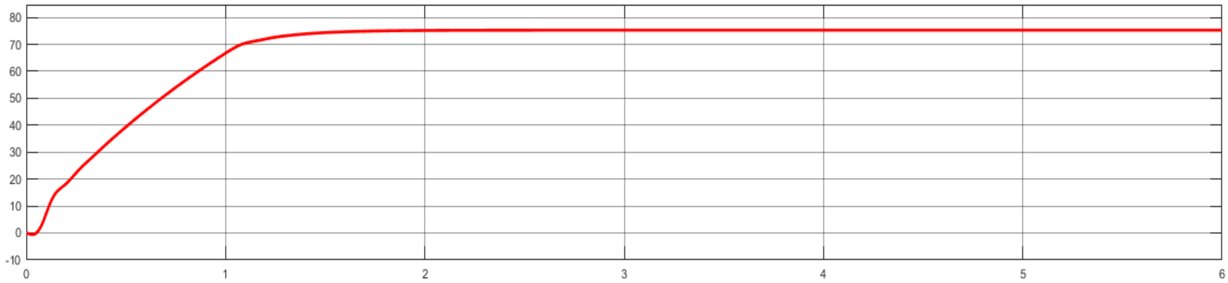

Figure 1.8 Engine speed under load

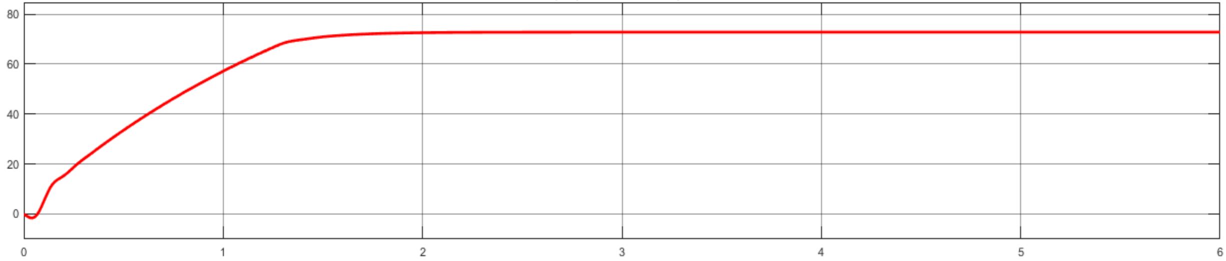

Figure 1.9 Motor speed at rated load

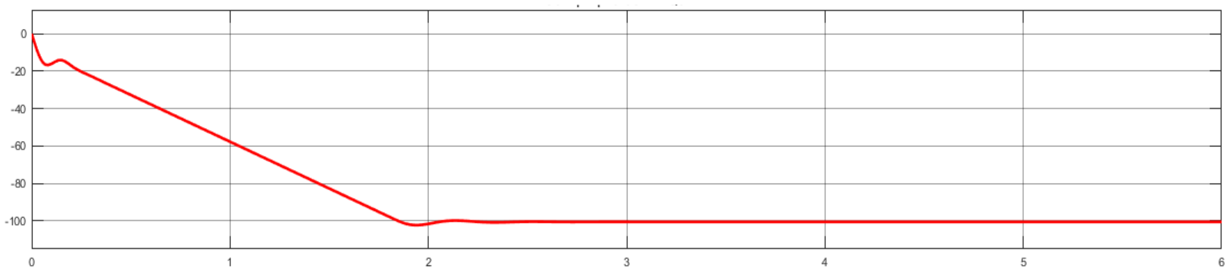

Figure 1.10 Motor speed when overloaded

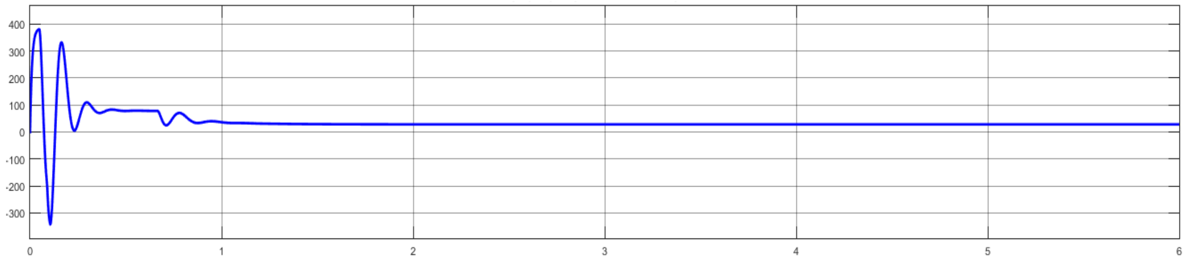

Figure 1.11 Excitation current from generator under load

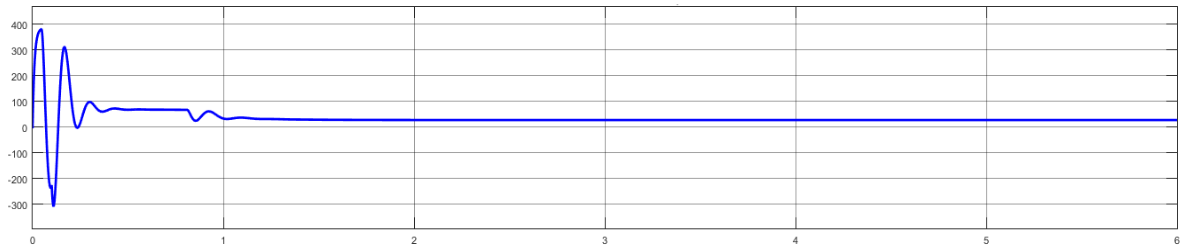

Figure 1.12 Excitation current from generator under rated load

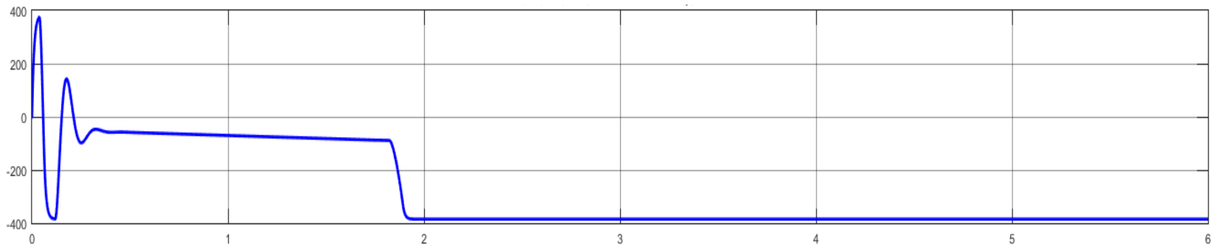

Figure 1.13 Excitation current from generator when overloaded

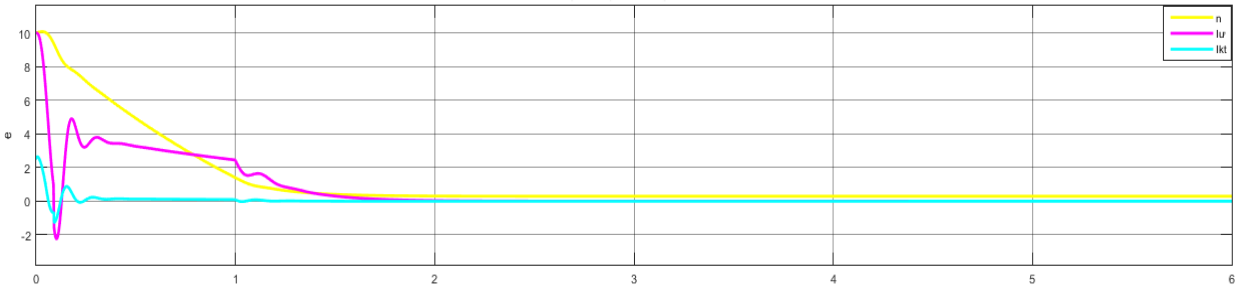

Figure 1.14 Deviation under load

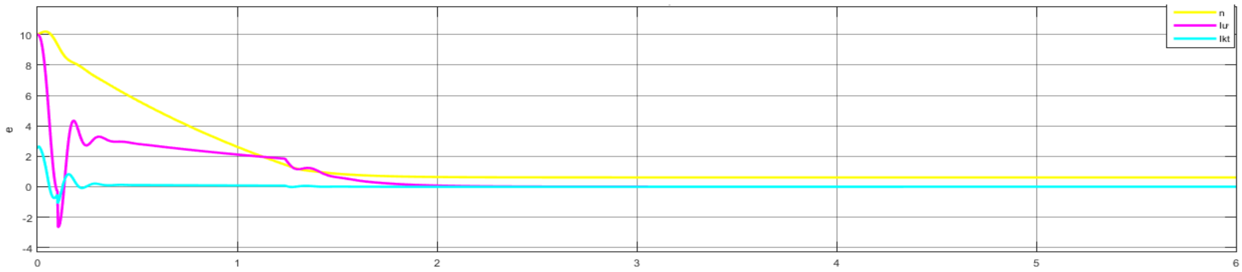

Figure 1.15 Deviation from rated load

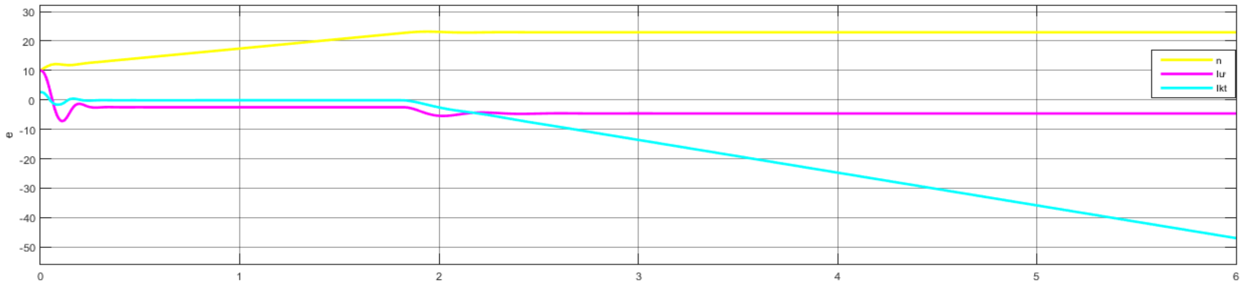

Figure 1.16 Deviation when overloaded

III. RESULTS

As shown inTable 1.1 we see as the speed load increases, the armature current decreases, the armature current increases, the excitation current decreases, the static deviation of the electromotive force increases, the armature current static deviation decreases. Moreover, the readings on the above figures are within the permissible parameter values of the excavator ЭКГ- 8И, when overloaded the armature current value 2,925 times the rated current is within the permissible value. From Figure 1.14, Figure 1.15; 1.16 We recorded the following parameters in Table 1.2

Table 1.1. Parameters of the different torque components

	under load	norms	Quá tảiQuá Over load
Speed n (rpm)	75.25	72.3	-100
Electric power generator E_u (V)	514	501	-600
Armature current I_u (A)	180	383.9	2223
Excitation current	27.84	27.76	
Static deviation of the electrodynamic force	600-514 = 86	600-501 = 99	1200
Static deviation of armature current	760-180 = 580	760-383.9 = 476.1	-1463

Table 1.2 Deviation e of different load

	under load	norms	Quá tảiQuá Over load
Deviation Speed n (rpm)	0.3	0.6395	23
Armature current deviation I_u (A)	-0.005	-0.007	-4.619
Inrush current deviation	-0.005	0.003	

From Table 1.1 and Table 1.2, we find that the recorded parameters are completely suitable for the ЭКГ- 8И excavator, the obtained values and the deviations which serve as the basis for the fuzzy control algorithm to improve the quality furthermore in the main electric drive control of the excavator.

IV. CONCLUSIONS

In this paper, we present the calculation of the ЭКГ- 8И ladle parameter. The research results prove this is an effective way to improve the quality in the main electric drive control of the excavator. In the mining industry in general and the open coal mining industry in particular, the excavator is one of the important equipment in the production line. With the advantage of productivity and the ability to load rock and rock with high hardness compared to hydraulic excavators, electric excavators are commonly used in open-pit mining in Vietnam, mainly machines. Russian electric contact.

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