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Development of simulation model of electric drive of decoiler

Abstract. *The article is devoted to questions of building of uncoiler electric drive simulation model at rolling mill. Model detects current, moment, electro driving power, magnetic flow and engine rotation speed.*

Streszczenie. *Artykuł poświęcony jest modelowaniu numerycznym napędu elektrycznego walcarki. Model pozwala na określenie prądu, momentu, mocy napędowej, strumienia magnetycznego i prędkości obrotowej silnika. (**Opracowanie modelu symulacyjnego napędu elektrycznego rozwijarki**).*

Keywords: numerical simulation, electric drive, rolling mill.
Słowa kluczowe: symulacja numeryczna, napęd elektryczny, walcarka.

doi:10.12915/pe.2014.11.45

Statement of the Problem

In sheet rolling mills there is important to adjust the tension of the strip which is unwound from the uncoiler reel and wound onto a coiler. Rolling of metal without creating tension is not possible because in this case the quality of the metal is reduced (appear different thicknesses plots ripple), possible rush band, i.e. the accuracy of maintenance of tension exerts a decisive influence on the course of the process. In order to ensure constancy of tension necessary for coiling strip a linear speed of remains equal to the strip speed at the exit of the mill and the angular speed of the drive motor uncoiler should vary in accordance with the roll diameter [1].

Unwinder works in continuous mode, the total time of acceleration, deceleration, and pause to refuel the new roll is negligibly small compared with the time to work steady speed. Mode of operation of the driving motor decoiler - generative (main technological regime) and motor as an auxiliary mode [1].

When calculating the capacity of the engine electric drive uncoiler [2-4] have to perform quite laborious calculations, since it is necessary to take into account the angular speed of the mechanism and change the radius of the roll in the operating cycle while maintaining a constancy of linear speed (V = ωR = const), and changing assortment of rolled metal. Thus, the use of computer technology to solve this problem is relevant and timely.

Analysis of earlier studies. Analysis of the technical literature on the development of the mechanical model of the drive uncoiler showed that rely heavily simplified models, reflecting the process of creating the strip tension in the area decoiler - rolls or decoiler - rolls, in order to study processes of dynamics in the strip during rolling [5-9]. Refined same model of mechanism decoiler almost never occur, and that was the objective of the study.

The research problem. To simplify and improve the accuracy of the calculations required static power decoiler considering assortment of rolled metal, it is necessary to develop a simulation model of the mechanical part electric drive decoiler, allowing to define the basic electrical and mechanical characteristics of the engine.

Research methods. Calculation of the required static moment for operation of the mechanism is determined in accordance with [1]:

$$M_P = F_P \cdot R_{TEK},\ N \cdot m \quad (1)$$

where F_p - the maximum working tension decoiler with a maximum diameter of the roll, N; R_{TEK} - the current radius of the roll, m.

Required power is defined as [1]:

$$P_P = M_P \cdot \omega_P$$

where ω_p-current speed, rad / s.

Model calculations of engine power to drive decoiler is presented in Figure 1. The initial data were taken data mechanism decoiler cold rolling mill 1700 JSC «ArselorMittal Temirtau».

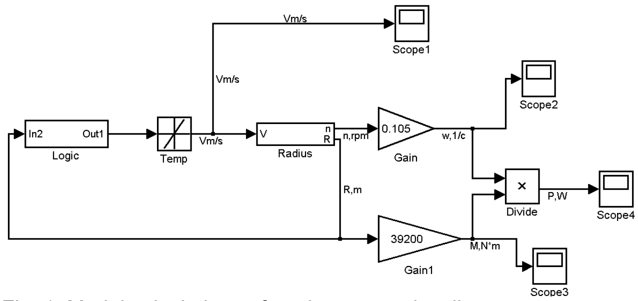


Fig. 1. Model calculations of engine power decoiler

Here block «Logic» - logic block that handles defining exposure rate of change of radius of the roll, and according to this, the level of the issuing job linear velocity. Block «Temp» - block limits slew rate of forms required by the pace of technology slew linear velocity. Block «Radius»- performs the computation number of turns mechanism and the change radius of the roll in accordance with the signal given linear speed, the metal thickness and minimum and maximum radii of the roll. Block «Gain» - power conversion signal proportional turns into a signal proportional to the angular frequency of rotation of console decoiler; «Gain1» - amplifier conversion signal, proportional to the radius of the roll.

Virtual oscillographs «Scope 1» - «Scope 4» respectively show the values the linear velocity of strip (Figure 2a), turns console mechanism of decoiler (Figure 2b), a change in the radius of the roll (Figure 2c), the required power of the engine (Figure 2d).

According to the technological process, decoiler works with dual-zone speed regulation. That is, if the engine speed, determined by the rolling speed and the radius of the roll is less than nominal, the motor operates with a nominal flow of excitation. If the engine speed is more than nominal, then that value of the magnetic stream varies in inverse proportion to frequency of rotation, or directly proportional to the diameter of the roll. So, to check of the engine, taking into account the dynamic component in model introduced the calculation of equivalent moment and equivalent circuit of the drive for the operating cycle. Also, take into account the maximum current, which should not exceed two and a half rated current of the motor. Calculation of EMF, bringing static moment, the calculation of dynamic torque produced by well-known equations of a DC motor [1].

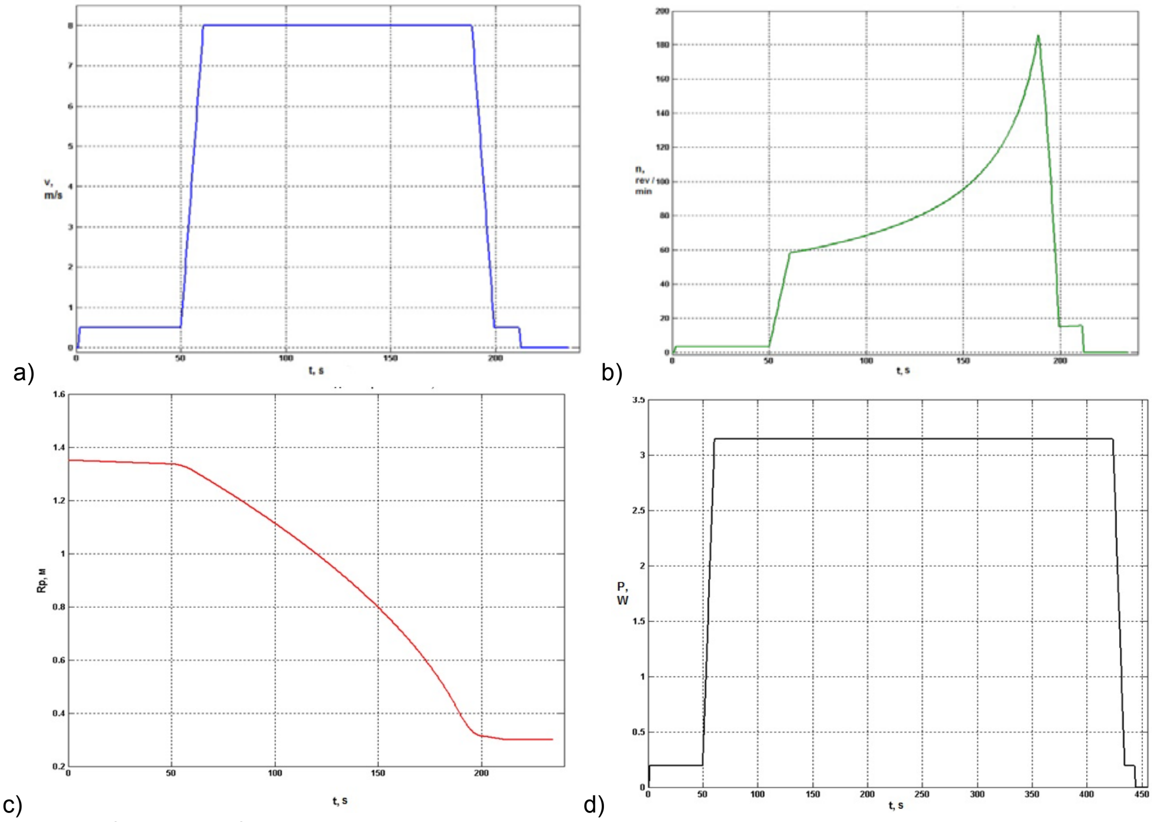


Fig. 2. The results of simulation of the mechanical parameters electric drive decoiler

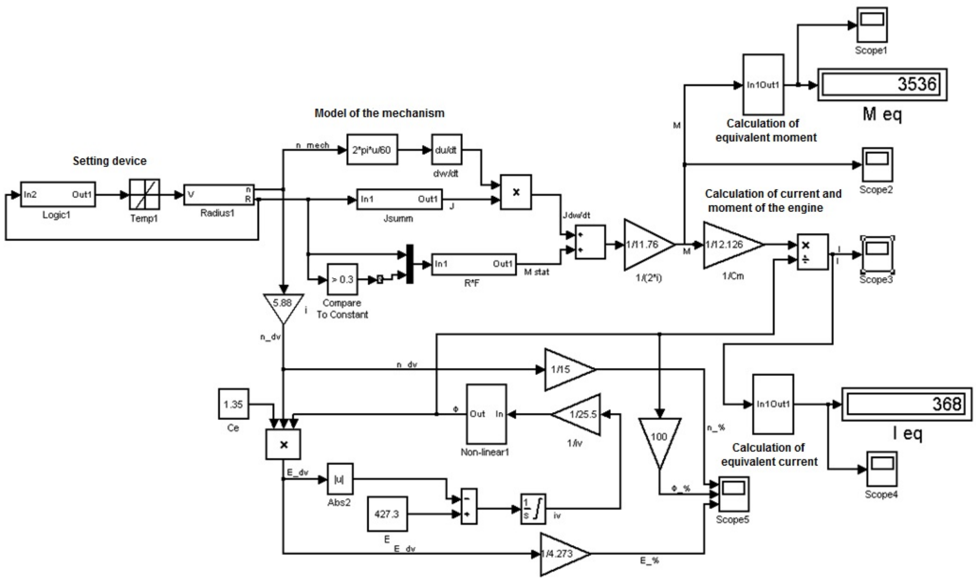


Fig. 3. Model electric drive decoiler

According to the technological process, decoiler works with dual-zone speed regulation. That is, if the engine speed, determined by the rolling speed and the radius of the roll is less than nominal, the motor operates with a nominal flow of excitation. If the engine speed is more than nominal, then that value of the magnetic stream varies in inverse proportion to frequency of rotation, or directly proportional to the diameter of the roll. So, to check of the engine, taking into account the dynamic component in model introduced the calculation of equivalent moment and equivalent circuit of the drive for the operating cycle. Also, take into account the maximum current, which should not exceed two and a half rated current of the motor. Calculation of EMF, bringing static moment, the calculation of dynamic torque produced by well-known equations of a DC motor [1].

Equivalent values of the current and the time will be calculated as a function of time in accordance with the formulas [1]:

(3) $$I_э = \sqrt{\frac{1}{t_ц}\int_0^{t_ц} I^2(t)dt}$$

(4) $$M_э = \sqrt{\frac{1}{t_ц}\int_0^{t_ц} M^2(t)dt}$$

where I and M - acting in the course of modeling current and torque values, respectively; $t_ц$ - the cycle time, s.

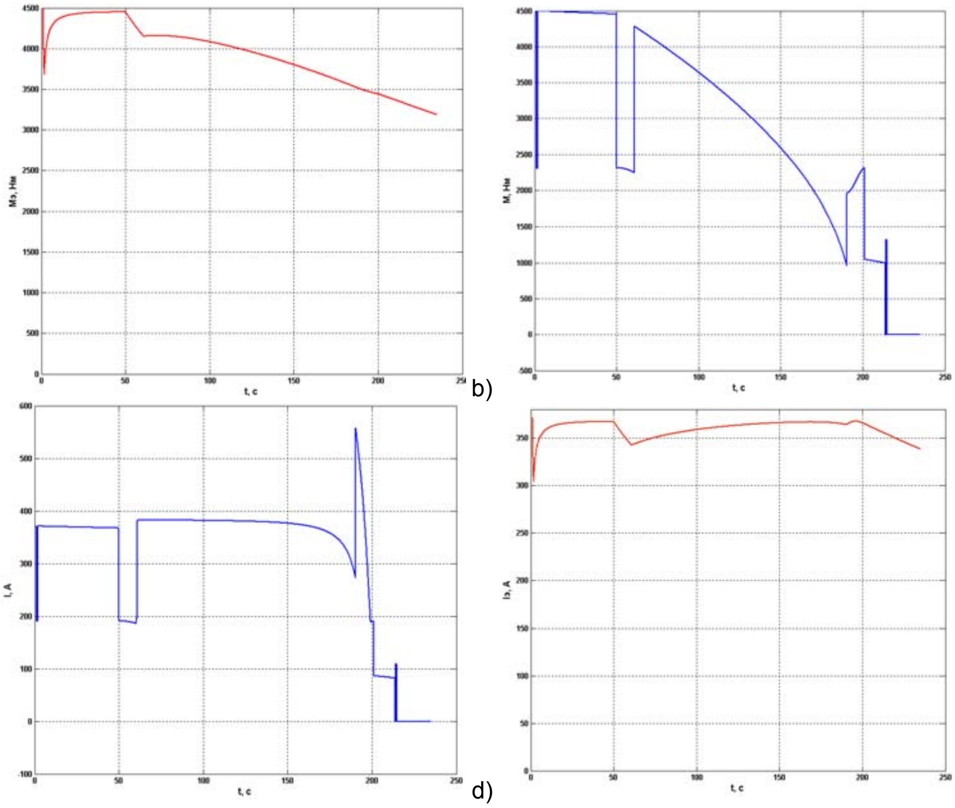
The resulting model for decoiler 1700 cold rolling mill with a product mix of strip thickness of 4,75 mm is shown in Figure 3.

Roll weight in the model is calculated based on the current roll radius and width tackle:

(5) $$m_p = \pi(R_{\max}^2 - R_{\min}^2) b \rho, kg$$

where ρ - the bulk density of the metal, ρ =7850kg/m^3; b - band width, m; R_{max}, R_{min} - maximum and minimum radii of roll, m.

The calculated values of the equivalent torque and current are shown in Figure 3 on the virtual multimeters «Ieq» and «Meq» respectively. Contours of the excitation current and EMF accepted ideal. Dynamic parameters of roll are calculated in the block «Jsumm», static moment - in the block «R * F», the value of the differential - in the block «dw / dt». Calculation of current produced by a factor that is numerically equal to the reciprocal of the constant constructive machine, block «1/Cm». In block «1 / (2 * i)» is performed to bring the required torque to the shaft of one of the engine, block «i» - reduction of revolutions through the ratio. In the nonlinear conversion «Non-linear1» laid magnetization curve of the engine, reduced to basic values in the block «1/iv». The resulting transformation in the block «Non-linear1» magnetic flux is relative, that allowed us to use the coefficients «Cm» and «Ce» to calculate current and motor EMF. The results of simulation are shown in Figure 4.



a) b) c) d)

Fig. 4. The results of simulation

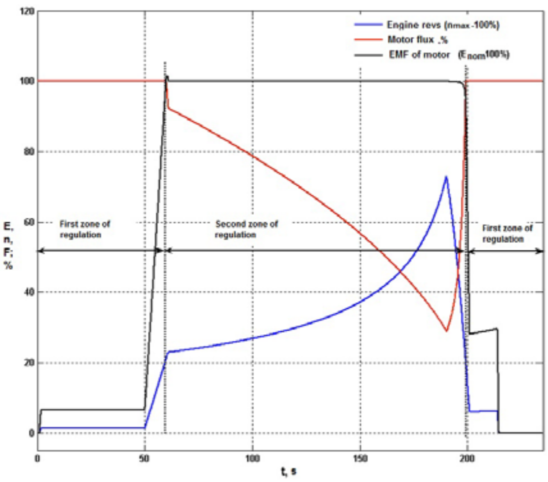


Fig. 5. Diagram of changes EMF stream and turns of the engine for the cycle of work decoiler 1700 cold rolling mill

In blocks of virtual oscillographs presented: «Scope1» - change equivalent moment as a function of time (Figure 4, a); «Scope2» - load diagram (Figure 4,b); «Scope3» - current chart (Figure 4,c); "Scope4 »- equivalent current change in function of time (Figure 4,d).

Figure 5 shows the variation of the EMF, the excitation current and turns of the engine reduced to 100% during the study cycle.

Conclusion

The obtained results are fully confirmed by the process data of work decoiler continuous cold rolling mill 1700 sheet rolling shop № 2 JSC «ArselorMittalTemirtau». The developed model can be used to calculate the mechanical part of the drive coilers and tension mechanisms of rolling mills and processing lines of the strip material.

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