ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 7, Issue 2 , February 2020

Resistance Power Losses Transmitted to the Network by Wound-Rotor Slip Recovery System

Tsypkina, Victoria Vyacheslavovna , Fayzullaev, Bahodir Khabibullaevich

Tashkent State Technical University, Tashkent, Uzbekistan

ABSTRACT: The article considers the operating principle of a wound-rotor slip recovery system to control a mill-fan induction motor, it also presents a methodology for losses calculation in the rotor circuit of an induction motor and determines the numerical values of resistance losses returned back to the network.

KEYWORDS: wound-rotor slip recovery system, loss reduction, energy efficiency, energy saving, resource saving

I.INTRODUCTION

Single-line diagram of a wound-rotor slip recovery system (WRSRS) used to control the mill-fan in the Novo-Angren TPP is shown in Figure 1

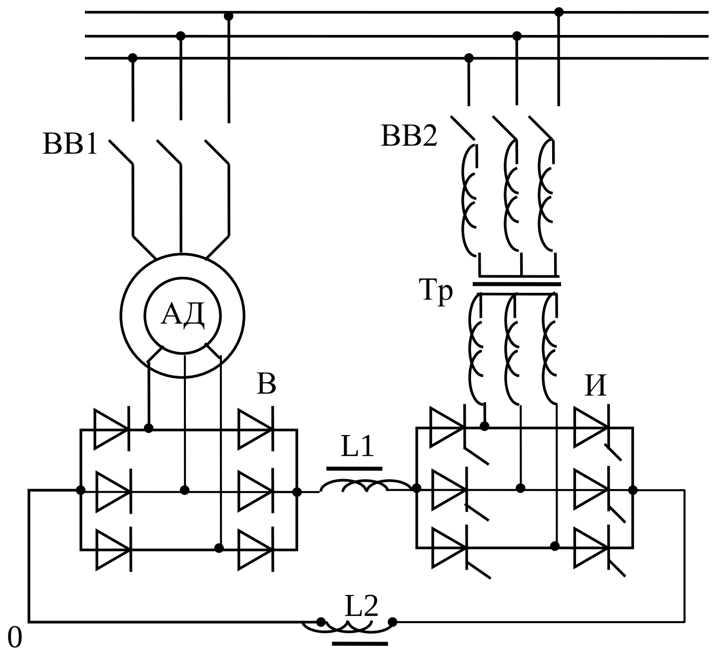

Fig.1. Single-line diagram of a wound-rotor slip recovery system:

BB1 иBB2 – high-voltage circuit breakers; АД- wound rotor induction motor B rectifier; L1 и L2 – smoothing inductor; И – invertor; Тр – power transformer

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 7, Issue 2 , February 2020

WRSRS works as follows. The voltage generated by the rotor АД is rectified by a rectifier (В), after it is inverted by an inverter (I) and is transferred back to the network [1, p. 576.2, p. 520.3, p. 194] through a power transformer (Tp).

Ratings of the mill-fans installed in the Novo-Angren TPP are following: drill angle productivity, 38 t / h; ventilation capacity, 140,000 m3 / h; rotor speed, 590 rpm.

Ratings of mill-fan driving motor are the following: motor type: wound rotor induction motor - - АКН3-2-15-57-10У3; rated power, pH = 630 kW; rated voltage, 6 kV; synchronous rotation speed, 600 rpm; rated rotation speed, 590 rpm; stator current, I1 = 77 A; coefficient of performance, 94.5%; power factor, 0.88; rotor voltage, 850 V; rotor current, 440 A.

Determine the power loss in the rotor circuit of the mill-fan driving motor transferred back to the network.

Rotor losses shall be determined using the following expression.

$$\Delta P_P = 3 \cdot I_P^2 \cdot r_P = 3 \cdot 440^2 \cdot 0{,}0125 = 7{,}26kW.$$

It is known, that the moment is directly proportional to the rotor current in the linear section of the induction motor mechanical characteristics, then from the expression

$$M = M_H \left(\frac{\omega}{\omega_H} \right)^3 = 10{,}2 \left(\frac{1{,}0 \cdot 62}{62} \right)^3 = 10{,}2kNm$$

$$M = M_H \left(\frac{\omega}{\omega_H} \right)^3 = 10{,}2 \left(\frac{0{,}8 \cdot 62}{62} \right)^3 = 5{,}2kNm.$$

$$M = M_H \left(\frac{\omega}{\omega_H} \right)^3 = 10{,}2 \left(\frac{0{,}6 \cdot 62}{62} \right)^3 = 3{,}2kNm$$

the following can be derived

$$I_P = I_{PH} \left(\frac{\omega}{\omega_H} \right)^3 = 440 \left(\frac{1{,}0 \cdot 62}{62} \right)^3 = 440A$$

$$I_P = I_{PH} \left(\frac{\omega}{\omega_H} \right)^3 = 440 \left(\frac{0{,}8 \cdot 62}{62} \right)^3 = 226A$$

$$I_P = I_{PH} \left(\frac{\omega}{\omega_H} \right)^3 = 440 \left(\frac{0{,}6 \cdot 62}{62} \right)^3 = 95A$$

In this case, rotor losses formula becomes

$$\Delta P_p = 3 \cdot I_{PH}^2 \left(\frac{\omega}{\omega_H} \right)^{3 \cdot 2} \cdot r_p = 3 \cdot 440^2 \left(\frac{1{,}0 \cdot 62}{62} \right)^{3 \cdot 2} \cdot 0{,}0125 = 16{,}5kW$$

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 7, Issue 2 , February 2020

$$\Delta P_P = 3 \cdot I_{PH}^2 \left(\frac{\omega}{\omega_H} \right)^{3\cdot 2} \cdot r_p = 3 \cdot 440^2 \left(\frac{0,8 \cdot 62}{62} \right)^{3\cdot 2} \cdot 0,0125 = 1,9 kW$$

$$\Delta P_P = 3 \cdot I_{PH}^2 \left(\frac{\omega}{\omega_H} \right)^{3\cdot 2} \cdot r_p = 3 \cdot 440^2 \left(\frac{0,6 \cdot 62}{62} \right)^{3\cdot 2} \cdot 0,0125 = 0,34 kW$$

Slip loss shall be defined as

$$\Delta P_S = M_H \left(\frac{\omega}{\omega_c} \right)^3 \cdot (\omega_c - \omega) = 10,2 \cdot 0,8^3 (62 - 61,7) = 3,7 kW,$$

$$\Delta P_S = M_H \left(\frac{\omega}{\omega_c} \right)^3 \cdot (\omega_c - \omega) = 10,2 \cdot 0,8^3 (62 - 50) = 62,7 kW,$$

$$\Delta P_S = M_H \left(\frac{\omega}{\omega_c} \right)^3 \cdot (\omega_c - \omega) = 10,2 \cdot 0,6^3 (62 - 37) = 0,6 kW.$$

Wound-rotor slip recovery system shall be defined as

$$\Delta P_{ABK} = (\Delta P_S - \Delta P_P) \cdot (1 - \eta_{ABK}) = (0 - 16,5) \cdot (1 - 0,9) = 1,6 kW,$$

$$\Delta P_{ABK} = (\Delta P_S - \Delta P_P) \cdot (1 - \eta_{ABK}) = (62,7 - 1,9) \cdot (1 - 0,9) = 6,1 kW,$$

$$\Delta P_{ABK} = (\Delta P_S - \Delta P_P) \cdot (1 - \eta_{ABK}) = (0,6 - 0,34) \cdot (1 - 0,9) = 0,023 kW.$$

Based on the obtained calculated loss parameters, we construct graphs of changes in the slip power loss, rotor and WRSRS(Figure 2).

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 7, Issue 2 , February 2020

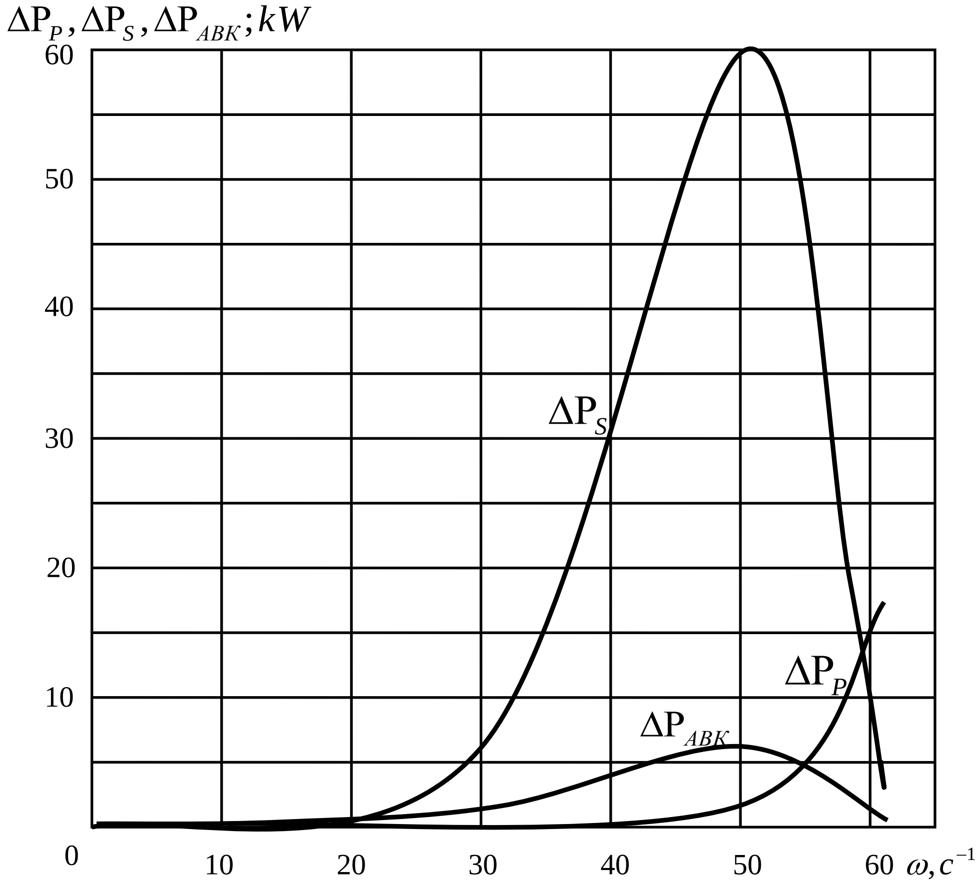

Fig.2. Slip loss, Induction motor rotor and WRSRS loss

When adjusting the speed using WRSRS, part of the slip energy is lost in the rotor and in the WRSRS, and part is returned back to the network.

Find the power returned to the network:

$$\Delta P_C = \Delta P_S - \Delta P_P - \Delta P_{ABK} = 62{,}7 - 1{,}9 - 6{,}1 = 54{,}7kW.$$

$$\Delta P_C = \Delta P_S - \Delta P_P - \Delta P_{ABK} = 0{,}6 - 0{,}34 - 0{,}023 = 0{,}24kW$$

Thus, taking into account the transfer of part of the slip energy back to the network, the power consumed from the network is determined as follows for the nominal mode

$$P_{1H} = \frac{P_H}{\eta_H \cdot \cos\varphi_H} = \frac{630}{0{,}945 \cdot 0{,}88} = 757{,}7kW.$$

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 7, Issue 2 , February 2020

According to the nominal mode of the electric drive of the mill-fan as per to the WRSRS diagram, the resistance power returned to the network is $\Delta P_C = 54{,}7kW$, that is, the power consumption from the network is reduced by 7.2%.

Thus, the use of WRSRS to control the driving induction motor of a mill-fan in the Novo-Angren TPP allows saving energy up to 479.2 MW * h for the year of its operation, which has a significant positive influence on the cost of generated electricity in a power plant.

REFERENCES

1. Koshimov O.O., Imomnazarov A.T. Electric Drive Basics. Part 1. Textbook for universities. - Tashkent: TDTU, 2004. -194 p.
2. Onishchenko G.B., Aksenov M.I. and others. Automated electric drive of industrial plants. - M.: RASNH, 2001.- 520 p.
3. Belov M.P., Novikov A.D., Rassudov L.N. Automated electric drive of production mechanisms and technological complexes - M.: Academy, 2007. - 576 p.

AUTHOR'S BIOGRAPHY

Tsypkina, Victoria Vyacheslavovna, PhD, Senior Lecturer, "EE" Department,Tashkent State Technical University,Tashkent, Republic of Uzbekistan, Tashkent, Universitetskaya str.,2

Fayzullaev, BahodirKhabibullaevich, Tashkent State Technical University named after Islam Karimov, Uzbekistan, Tashkent, Universitetskaya str.,2