International Journal of Engineering and Information Systems (IJEAIS)
ISSN: 2643-640X
Vol. 4, Issue 6, June – 2020, Pages: 87-89

Power Losses in Electric Machines

Urinov Shuhrat and Qulboyev Zohid
Faculty of Electro mechanics and Radio electronics, Jizzakh polytechnic institute, Jizzakh city, Uzbekistan
Uchqun8822@gmail.com

Abstract *- In This article is analyzing the various losses of asynchronous machines*

Keywords: Efficiency, DC machine, magnetic losses, Electrical losses.

Introduction

The conversion of mechanical energy to electrical energy in a generator and electrical energy to mechanical energy in an engine is accompanied by some energy losses, which are released as heat, heating the electric machine.

The power diagrams of the generator and engine (Fig. 1) clearly show the power balance in these machines. As you can see from them, when an electric machine is operating, there are power losses: electrical, magnetic, mechanical, and incremental.

Electrical losses occur as a result of the fact that each winding (in a DC machine, armature winding, field winding, additional poles, and compensation) has a certain resistance that prevents the passage of electric current along it. They are proportional to the resistance of the given winding and the square of the current flowing through it, i.e. they increase strongly with increasing load of the machine. Electrical losses cause heating of the winding wires. Electrical losses also include losses that occur when current flows through the brushes and through the transient resistance between the brushes and the collector; they cause the collector and the brushes to heat up.

Magnetic losses ΔR_M(losses in steel) occur in the cores of the armature and poles (mainly in the pole tips) as a result of the re-magnetization of the steel of these cores and the formation of eddy currents in them. Remagnetization of the steel core of the armature occurs because when the armature rotates, each of its points alternately passes under the North and South poles. The magnetization of the steel of the pole tips is caused by a change in the magnetic induction in the air gap of the machine within ±V when the gear armature rotates (Fig. 146). At the same time in the ferromagnetic adjacent to the gap

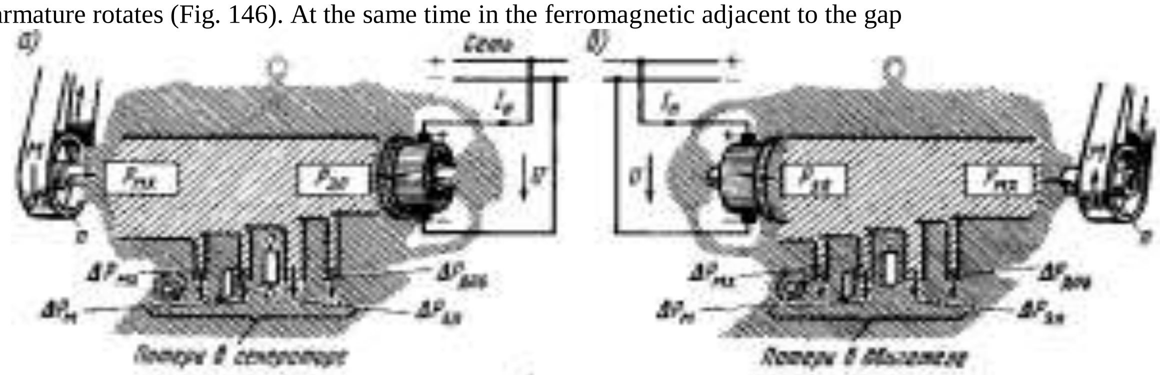

Fig. 1. Energy diagrams of a DC machine when running it in generator mode (a) and electric motor (b)

eddy currents that change with high frequency (1000 Hz or more) and are concentrated mainly on the surface of the magnetic system (pole tips and armature teeth) are induced. Therefore, the power losses created by these currents are called surface *ones*.

In machines with teeth on the stator and rotor (DC machines with compensation winding, asynchronous and synchronous), when the rotor rotates, there are noticeable ripples of induction in the teeth, which also leads to the formation of eddy currents and corresponding power losses. These losses are called ripple *losses*. Magnetic losses also occur in the steel bands that strengthen the armature winding, which when the armature rotates cross the magnetic field lines of the machine. Magnetic losses cause heating of the armature core and poles, they almost do not depend on the load of the machine, but increase sharply with increasing frequency of remagnetization, i.e., the speed of rotation of the armature.

Mechanical losses ΔP_{MX}occur as a result of friction: in bearings, brushes on the collector, machine parts against the air during ventilation. These losses cause the bearings, manifold and brushes to heat up, and they increase slightly with increasing load. When the speed of rotation of the armature of an electric machine increases, mechanical losses increase sharply.

International Journal of Engineering and Information Systems (IJEAIS)
ISSN: 2643-640X
Vol. 4, Issue 6, June – 2020, Pages: 87-89

The incremental loss ΔP_{EXT} are subject to various secondary phenomena that occurs during operation of electrical machines under load: the occurrence of eddy currents in the conductors of the armature winding, the uneven current distribution in the conductor cross section and the induction in the air gap of the machine, the influence of switching currents (in the DC machines) and variable flows of scattering (in AC machines) that induce eddy currents in the fasteners, etc.

When operating an electric machine under load, its conductors lying in the slots of the rotor and stator are penetrated by longitudinal and transverse groove flows (Fig. 147). With the ad Agency-

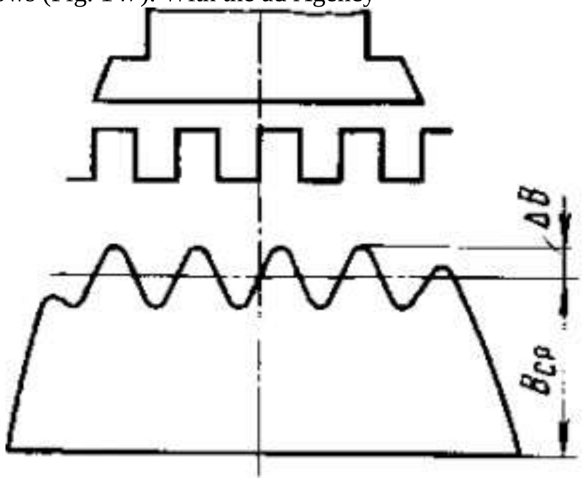

Fig. 2. Distribution of induction in the air gap of a gear armature machine

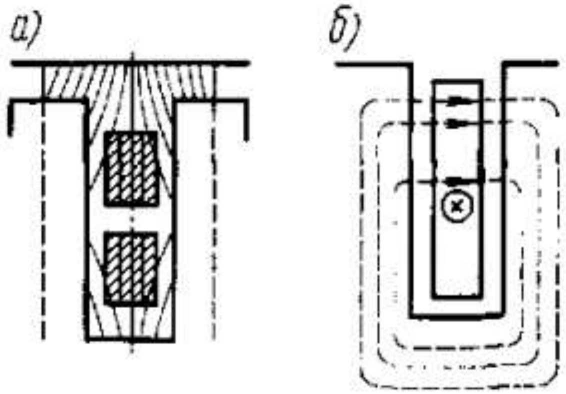

Fig. 3. Scheme of occurrence of longitudinal (a) and transverse (b) flows

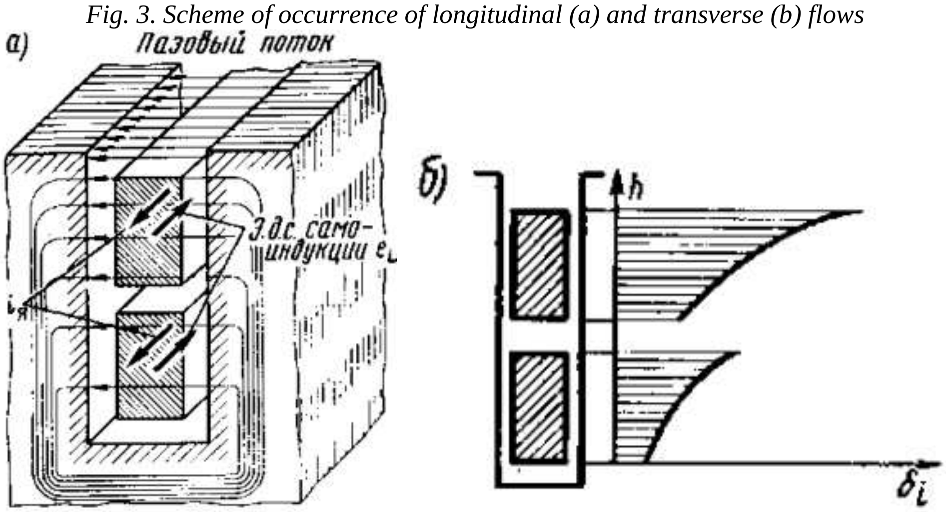

Fig. 4. Displacement of current to the upper part of the armature winding conductors (a) and distribution of current density δ_i over their height h (b)

when the armature is moved, these flows induce eddy currents in the conductors, since the armature, continuously moving, passes under different poles, as a result of which the longitudinal and transverse groove flows that permeate it change all the time. The same thing happens when the current changes in the conductors, i.e. the load of the machine.

Eddy currents not only increase electrical losses in the conductors of the windings, but also lead to an uneven distribution of current across the cross section of the conductors, causing the displacement of current in layers further removed from the bottom of the groove. This phenomenon occurs due to the action of self-inductions $e_L$induced by transverse sinus flows (Fig. 3, a), which tend to counteract the passage of load current $i_I$through the conductors . In the lower layers of each conductor , greater e. g. s. e_{L} are induced than in the upper ones, since they are covered by a large number of magnetic lines of force (from the bottom of the groove to the layer in question). Therefore, the current passing through the conductors is somewhat displaced in the upper part and the current density δ_i, of this part increases (Fig. 3, b). In this respect, the conditions of direct current passing through the armature winding conductors are similar to those of alternating current, which, as will be discussed in detail later, always tends to pass through the outer layers of the conductor. Uneven distribution of current across the cross-section of the conductor creates additional power losses, as it reduces the cross-section area and increases the electrical resistance of the conductors.

To reduce the additional losses associated with this phenomenon, traction motors tend to reduce the height of the armature winding conductors. To do this, the conductors are divided by the height of the groove into two or three parallel connected parts (Fig. 4, a) or arrange them in the grooves flat (Fig. 4,b). When dividing the conductors into several parts, each of them is isolated separately, so that eddy currents are closed only within one part.

References

[1] P. Arumugam, T. Hamiti, and C. Gerada. "Analytical modeling of a vertically distributed winding configuration for Fault Tolerant Permanent Magnet Machines to suppress inter-turn short circuit current limiting". in Electric Machines & Drives Conference (IEMDC), 2011 IEEE International. 2011.

[2] S. Zhigang, "Analytical prediction of the short-circuit current in fault-tolerant permanent-magnet machines," IEEE Trans. Component Parts, vol. 55, pp. 4210-4217, 2008.

[3] T.J. Juha Pyrhonen, Valeria Hrabovcova, "Design of rotating electrical machines," John Wiley & Sons, United Kingdom: Chichester, 2008, pp. 230–250.

[4] J.D. Ede, Z.Q. Zhu, D. Howe, "Optimal split ratio for high-speed permanent magnet brushless DC motors," Electrical Machines and Systems, 2001. ICEMS 2001. Proceedings of the Fifth International Conference on, vol.2, no., pp.909-912 vol.2, Aug 2001.

[5] D. Evans, Z. Azar, L.J. Wu, Z.Q. Zhu, "Comparison of optimal design and performance of PM machines having non-overlapping windings and different rotor topologies," Power Electronics, Machines and Drives (PEMD 2010), 5th IET International Conference on, vol., no., pp.1-7, 19-21 April 2010.