JIEE Časopispriemyselnejelektrotechniky
Journal of Industrial Electrical Engineering
ISSN 2454-0900
www.jiee.eu

Losses in DC motors

[1]BranislavFECKO, [2]Tibor VINCE

[1,2]Department of Theoretical and Industrial Electrical Engineering, Faculty of Electrical Engineering and Informatics, Technical University of Košice, Slovak Republic

[1]branislav.fecko@tuke.sk, [2]tibor.vince@tuke.sk

***Abstract*—The aim of this article is to describe the principles of DC motors and electrical losses in it. We describe the different types of unidirectional motors and their differences. In the second part of the article is the dividing of losses that are generated in DC motors.**

***Keywords*—DC motors, copper losses, eddy current loss, hysteresis loss, mechanical losses**

I. INTRODUCTION

Direct current (DC) machines are among the oldest used electrical equipment. They are used up to today, their advantage is simple control by changing the supply voltage. Engines are designed to work under certain conditions. In the event of disturbance of the conditions, it may cause damage to the engine or a reduction in its service life. The life of DC motors is closely related to their operating temperature. After some exceeding the operating temperature of the engine reduces its life, so it is advisable to know the heat source DC motors. By describing and defining the losses in the DC electric motor, we determine all the heat sources. Correct determination of heat sources allows predicting engine heating in specific conditions. Also, by creating the right thermal model, we can prevent electric motor temperatures which could damage the electric motor or reduce its life.

II. DC MOTORS

Fig. 1 shows a DC motor with a permanent magnet. The permanent magnet is used in the stator construction which is usually made of magnetic hard materials such as ferrite or neodymium, iron and boron compounds. The rotor contains electric coils which are mounted in grooves. Coil outlets are led to a commutator to feed the winding of the motor. The commutator's purpose is to switch poles of coils which change the direction of the magnetic field in the commutator. Thus, the forces acting on the individual poles of the motor which are maintained in a given direction cause the electric motor to rotate smoothly. Increasing the number of poles will ensure a smoother rotation of the electric motor. The most common four poles are used.[6]

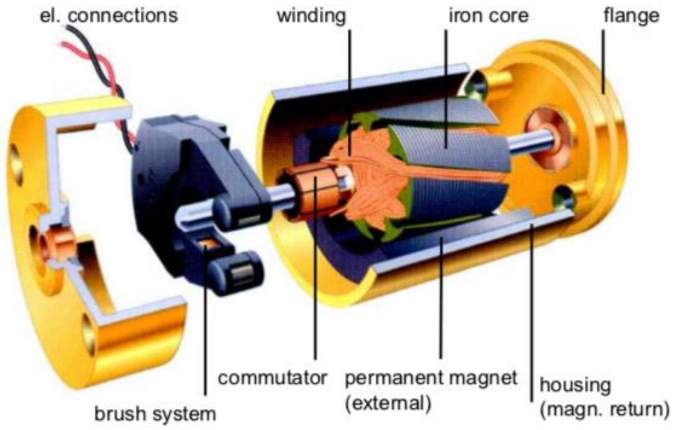

Fig. 1Illustration of DC motor [7]

Fig. 2 Parts of the DC motor

Fig. 2 shows the individual parts of the electric motor. In the upper part of the figure, the rotor is shown in a laminated steel sheet in which the winding is deposited. On the left side of the rotor are a commutator and a bearing, a pinch mechanism for clamping the cutting tool is attached to the right of the rotor shaft. The bottom of the picture shows carbon brushes, a permanent magnet stator and a fan motor for cooling the engine. Fig. 3 shows a completed magnet permanent DC motor. The individual parts of which can be seen in Fig. 2. This engine is used as a spindle CNC milling machine.

Fig. 3 DC motor(CNC spindle)

III. TYPES OF DC MOTORS

In the first part we briefly described the parts of the DC motor and its principle of operation on DC motor with permanent magnets. We will now familiarize you with other types of DC motors including the following electric motors:

A. Serial motor

The difference between a serial electric motor and an electric motor with permanent magnets is in the stator design. In the case of permanent magnet motors, the stator is a permanent magnet. In the serial motor the stator poles are made up of an electromagnet connected in series with the rotor winding. The name of this engine type result from the connection of the rotor winding and stator winding. The speed of this type of motor is inversely proportional to the load on the machine. Do not run the serial engine without the load. During the operation it must be secured so that it cannot be disconnected from the load because otherwise it would increase its speed and would be mechanically damaged. It is used to drive a crane bridge, train, subway, trolleybus and tramway.[8]

B. Shunt Motor

The derivative electric motor has a stator electromagnet connected parallel to the rotor winding. That's why this engine is often referred to as the parallel engine. The derivative engine must have a sufficient torque at startup. This is achieved by connecting the full-voltage drive winding. Shunt motor is most commonly used as a drive machine tools, rolling mills, locomotive turntables and similar devices [8].

C. Brushless motor

The advantage of a brushless motor is that it does not have a commutator. Commutator is a mechanical switch. It is very electrically stressed in it. The resulting sparking is a source of electromagnetic interference that needs to be mitigated by additional electrical circuits, which increases the cost of implementing the system. For all these disadvantages commutator comes to the fore brushless motor which it have not these disadvantages. The brushless motor stator is composed of permanent magnets and a stator from an excitation coils. The stator spools are alternately pulsed to create a rotating magnetic field that rotates the engine. The disadvantages of these motors are more complex control circuits.[8]

D. Stepper motor

It is a specific DC motor whose operating principle features a view of the individual losses of the engine were discussed in the article [9].

IV. Losses in DC machines

The DC motor changes electrical energy into mechanical. During this transformation in DC machines there are losses that we divide into:

A. Iron losses and additional idle losses

These losses include swirling losses and hysteresis losses in anchor iron core magnetization, fluid core flux losses induced by different pulses of magnetic field in the unloaded machine, fluid flow losses in all massive active components of the machine from scatter flows at idle.

These losses are considered to be independent of the load, i.e. they have the same value as when idle. It can be determined by methods dynamometer, calibrated engine, unladen engine, deceleration test and calorimetry after deduction of mechanical losses from the measured loss.[4]

B. Mechanical losses

These are all kinds of losses in the machine that are created by friction. These losses arise on bearings, friction on the commutator, friction of rotating parts of the machine on the inside of the machine, refrigerant friction, losses caused by the operation of fans, pumps and other auxiliary machines driven by the shaft of the machine, which ensure its proper functionality. These losses are determined at the same speeds at which the efficiency is determined.[4]

C. Basic losses in work winding circuits

The basic losses also called Joule losses are created by the load current in all windings of the motor. These losses are calculated from the current and the resistance of the winding measured by the DC current, calculated on the reference working temperature.[4]

D. Losses through the flow of brush current

Losses through the flow of brush current through brush and commutator points are given by the product of current and voltage drop in the transition layer which is considered as independent of the brush current and polarity. Count with 1V voltage drop values for each contact if brushes are carbon brushes and 0.3V if copper-carbon brushes or copper-graphite brushes.[4]

E. Losses in the driving circuit

Losses in the drive circuit are losses created by the excitation current in the drive winding and the resistors used to control and limit the excitation current.[4]

F. Additional losses

Additional losses are not yet included other losses. Additional losses in rated running on all machines except synchronous are envisaged as part of certain performance electric machine.[4]

V. CONCLUSION

Getting to know different types of DC motors and their principles of operation we can better investigate the sources of their losses. Subsequent defining of possible losses on DC motors enables us to characterize the possible heat sources of an electric motor. What can be practical use in predicting temperature conditions of the electrical motor.

REFERENCES

[1] Types of Losses in a DC Machines [online][19.12.2018.].Available online:http://www.mytech-info.com/2014/11/types-of-losses-in-dc-machines.html

[2] Losses in DC Machine [online][19.12.2018.]. Available online:https://www.electrical4u.com/losses-in-dc-machine/

[3] Kiran Daware.: Losses In A DC Generator And DC Motor. [online][19.12.2018.]. Available online:https://www.electricaleasy.com/2014/01/losses-in-dc-machine.html

[4] V. Hrabovcová, P. Rafajdus, M. Franko, P.Hudák.:Meranie a modelovanieelektrickýchstrojov. VydalaŽilinskáuniverzita v Žiline/EDIS-vydavateľstvo ŽU. 2014. ISBN 978-80-554-0852-1

[5] TUMA M., HAJACH T., ŠTELIAROVÁ E.:Základyelektrotechniky 1. Vydanie 6. Bratislava. Alfa-pres. 2004. 316s. ISBN 80-89004-76-8

[6] Holba J., RíhaJ., Kocman K.: ELEKTRICKÉ STROJE A PRÍSTROJE: pre 3. A 4. ročník SPŠE. Vydavateľstvo Alfa. 1991. ISBN 80-05-00997-6

[7] Collins D.:What are coreless DC motors? [online][20.12.2018.].Available online:https://www.motioncontroltips.com /what-are-coreless-dc-motors/

[8] Brandys F.:Jednosmerný motor a jeho riadenie [online][25.12.2018.]. Available online:http://www.posterus.sk /?p=3784

[9] Fecko B., Vince T.:Electromagnetic losses in stepper motors. Vol. 2, Issue 3 (2018) Journal of Industrial Electrical Engineering, Vol.2 (2018), Issue 3, pp: 30-33, ISSN 2454-0900