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Measurement Of External Magnetic Field Of Induction Motor

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***Abstract*— this paper is describes analysis of magnetic leakage field of induction motor. Information about external field of induction motor is derived from these sources. The first one is a 2D computer motor model and the second one consists in measurement of external magnetic field of real motor. Machine is monitored in a different working condition. Time behaviors' of magnetic flux density are examined too. The measurement is executed by Bell's GAUS/TESLAMETER 5070 and Hall Effect sensor connected to oscilloscope. Acquired results are evaluated and create a conception of magnetic field character around** machine**. In the next the possibilities of practical utilization (measurement, fault diagnosis) of this knowledge are described.**

Keywords—external Magnetic field,computer motor model,induction motor,magnetic leakage.

I. INTRODUCTION

Electromagnetic field problems round the electric appliances are known mainly as electromagnetic compatibility problems. Electromagnetic fields round electric machines are usually low intensity and low frequency. The danger of electromagnetic disturbance of other appliances is only in proximity of machine. Otherwise the external magnetic field relates to processes inside the machine. Information about the field could be used for determination of working conditions and machine faults. Possibilities of utilization are examined presently.

II. COMPUTER MOTOR MODEL OF INDUCTION MOTOR

A computer motor model is generated upon geometrical machine dimensions, properties of used material and circuit values (see fig.1). Self-computation is performed on Finite Element Method by the help of computer programmer (FEMM), which is specialized for solving static and low frequency problems in magnetic. Because of impossibility of model creation with reference to all properties of real motor is necessary to accept some simplification. The model of induction motor supplied by direct current is presented on fig. 2.
The magnetic field is only excited by stator current and it has four pole shapes. Voltage induced to rotor is zero. In case of 3-phase A.C supply the magnetic field revolves and creates a circular rotating field. The value of magnetic flux density in motor iron is out of range of grey scale. The magnetic field is displayed by the magnetic flux lines in this area.

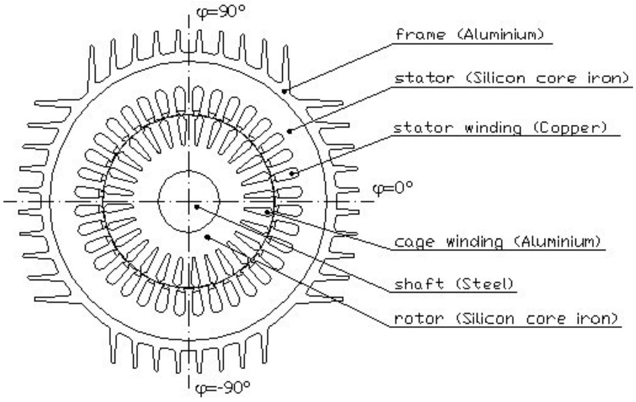

Fig.1. 2D induction motor mode

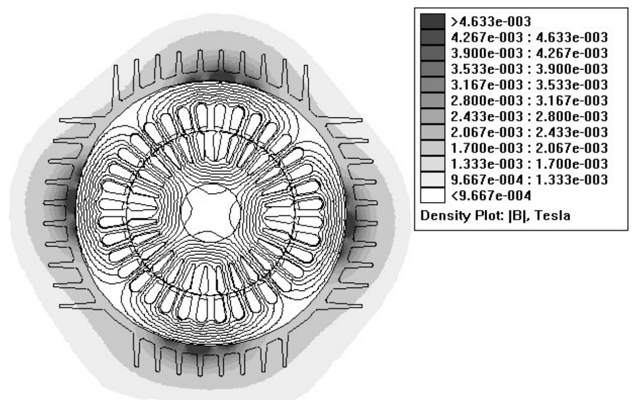

Fig.2. Static analysis of induction motor leakage field

- DC supplied motor measurement

The external magnetic field measurement of real motor is necessary for model precision determination, because a simplification in model generation can evoke errors. The magnetic flux density is measured in suitable points for comparison of measured and calculated values. Points are located in distance of 5mm above the motor frame surface along circular arc (see fig.1). Curves of acquired values of |B| for motor supplied by D.C. are shown in fig.3. This measurement is executed on Bell's GAUS/TESLAMETER 5070, using a Hall-effect sensor.

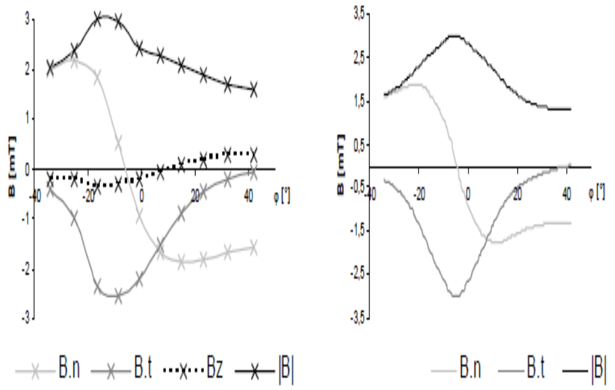

Fig.3. Magnetic flux density distribution above the Frame of motor.

- Time behaviors' of magnetic flux density measurement.

The measurement is performed by simple teslameter connected to oscilloscope. The main part of the meter is linear Hall Effect sensor A3516. This BiCMOS monolithic circuit integrates a Hall element, temperature-compensating circuitry to reduce the intrinsic sensitivity drift of the Hall element, a small-signal high-gain amplifier, and a rail-to-rail low impedance output stage. A dynamic offset cancellation technique, with an internal high-frequency clock, reduces the residual offset voltage, which is normally caused by device overmolding, temperature dependencies, and thermal stress. This technique produces devices that have an extremely stable quiescent output voltage, are immune to mechanical stress, and have precise recoverability after temperature cycling. Many problems normally associated with low-level analog signals are minimized by have the Hall element and amplifier in a single chip.

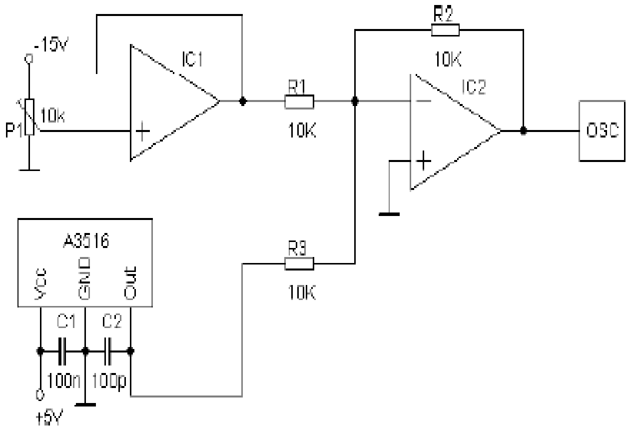

Fig .4.General View of circuit for time behaviors' of magnetic flux density measurement.

Hall-effect sensors A3516 provide a voltage output that is proportional to the applied magnetic field and have a quiescent output voltage that is approximately 50% of the supply voltage. However, the zero quiescent output voltage is preferable for measuring by oscilloscope. Additional circuit consisting of two high precision, low noise operational amplifiers connected as a follower (IC1) and summing amplifier (IC2) fixes this problem. The unity-gain circuit allows set the quiescent output voltage by potentiometer P1 (see fig.4). The time behaviors examples of phase current and tangential component of magnetic flux density are measured in the point that is located in distance of 5mm above the motor frame surface in position ϕ=0°, z=40mm (see fig. 1).

Time behaviors of B and IU

T=0,6N.m, Y-connection, 400V, position: ϕ=0°, z=40mm

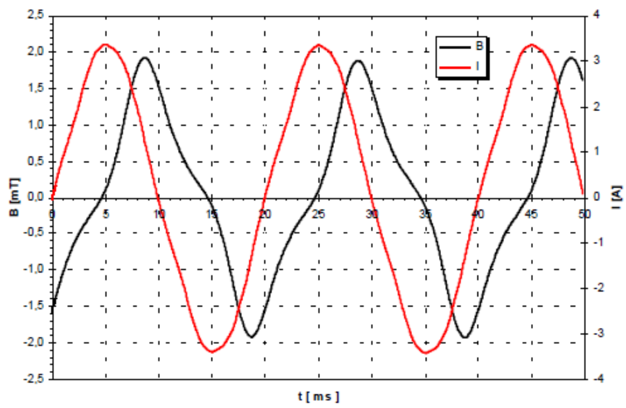

Fig.5. Time behaviors of B and IU for T=0.6 N.m.

Time behaviors of B and IU

T=10 N.m, Y-connection, 400V, position: ϕ=0°, z=40mm

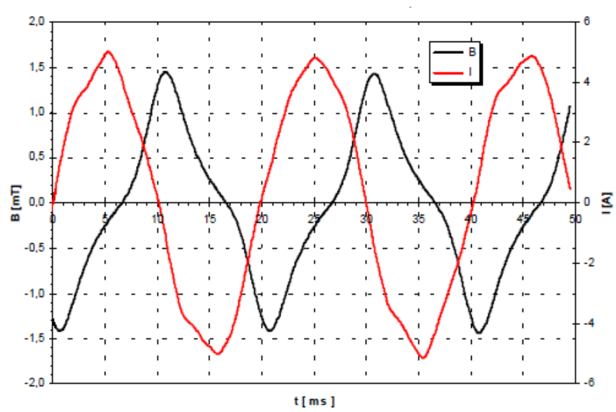

Fig.6. Time behaviors' of B and IU for T=10 N.m

The time behaviors' in fig. 5 and 6 present the external magnetic field and its relation to current in one phase. Motor is supplied by 3-phase voltage 400V / 50Hz and it is loaded by torque 0.6 N.m (fig.5) and 10 N.m (fig.6).

III. CONCLUSIONS

External magnetic field of electrical machine has only little disturbing influence on other electric appliances because of low field frequency and intensity. More interesting is utilization of information about magnetic field round machine for machine monitoring. Magnetic field distribution inside machine and its alterations dependent on working conditions is possible to analyze by external field measuring. The value of supply voltage, load, direction and speed of rotation and machine defect influence the properties of external magnetic field. Close investigation of these relationships is subject of further work.

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