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DIAGNOSTICS OF LOW-POWER ASYNCHRONOUS MOTORS USING ARTIFICIAL INTELLIGENCE

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Annatation

This study investigates the condition monitoring and fault diagnostics of low-power (0.1–10 kW) induction motors using artificial intelligence (AI) techniques. Low-power induction motors are widely employed in industrial, transport, agricultural, and automated technological systems, where their reliable operation is critical for maintaining continuous production processes. In this research, the magnetic flux (B) between the stator and rotor was measured using a Tesla meter to identify common fault zones. The results indicate that decreases in magnetic flux in certain stator segments reveal the presence of localized faults. Furthermore, AI algorithms enable automated analysis and classification of motor current, vibration, and magnetic flux signals, allowing early detection of faults without interrupting motor operation. These findings provide a scientific and practical foundation for optimizing maintenance strategies, reducing unplanned downtime, and improving the operational reliability of low-power induction motors.

Keywords

Low-power induction motor; Artificial intelligence; Condition monitoring; Magnetic flux density; Stator faults; Portable Tesla-meter; Predictive maintenance; Localized faults; Real-time monitoring.

Introduction. Low-power asynchronous motors (0.1-10 kW) are among the electrical machines widely used in industry, transport, agriculture, household appliances, and automated technological systems. They act as the main actuating mechanism in the conversion of energy into mechanical motion and ensure the continuity of production processes. In the global market, the segment of asynchronous motors has a stable growth trend, with its volume estimated at approximately US$20.3 billion in 2024 and projected to reach US$37.5 billion by 2034. This growth is explained by increased demand for industrial automation and energy efficiency.

The reliable operation of low-power asynchronous motors determines the stability of technological processes. However, during operation, issues such as deterioration of stator winding insulation, bearing wear, damage to rotor bars, and mechanical eccentricity frequently occur. According to statistical data, up to 20-35% of asynchronous motors experience unplanned shutdowns due to malfunctions during their operational lifespan. This leads to decreased production efficiency and economic losses.

Figure 1
Damage to the stator winding

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Existing maintenance systems are primarily based on periodic preventive inspections and traditional measurement methods, which limit the ability to detect malfunctions at an early stage. In recent years, the rapid development of digital technologies and artificial intelligence has enabled real-time monitoring of the technical condition of electrical machines and automatic detection of malfunctions. Specifically, neural networks and machine learning algorithms allow for the analysis of motor current, vibration, and magnetic flux signals in both time and frequency domains, enabling highly accurate identification and classification of various types of malfunctions.

For this reason, developing diagnostic systems based on artificial intelligence for low-power asynchronous motors is considered an important scientific and practical task for modern industry. The aim of this research is to evaluate the technical condition of low-power asynchronous motors using artificial intelligence algorithms, to analyze the possibilities of early fault detection based on experimental data, and to propose effective maintenance strategies.

Research Methodology and Purpose

The main goal of this research is to develop a methodology for detecting malfunctions in low-power asynchronous motors without starting or stopping the motor. Traditional diagnostic methods often require partial engine opening or manual inspection, which is time-consuming and limits the possibility of early detection of malfunctions.

Theoretically, rotor and stator malfunctions - such as rotor eccentricity, bearing wear, or stator winding short circuits - alter magnetic flux lines (Φ) and current signals (Is, Ir) inside the motor. These changes are described by Faraday's and Ohm's laws with the following equations:

$$\varepsilon(t) = -N\frac{d\Phi(t)}{dt}$$

$$U_s(t) = R_s I_s(t) + L_s\frac{dI_s(t)}{dt} + L_m\frac{dI_r(t)}{dt} + R_r I_r(t)$$

there:

$V_s(t)$ - stator voltage,
R_s, L_s - stator resistance and inductance,
$I_s(t)$, $I_r(t)$ - stator and rotor current,
L_m, R_r - mutual inductance between the stator-rotor and rotor resistance,
ε (t) - EMF generated by the rotor,
N - Number of rolls

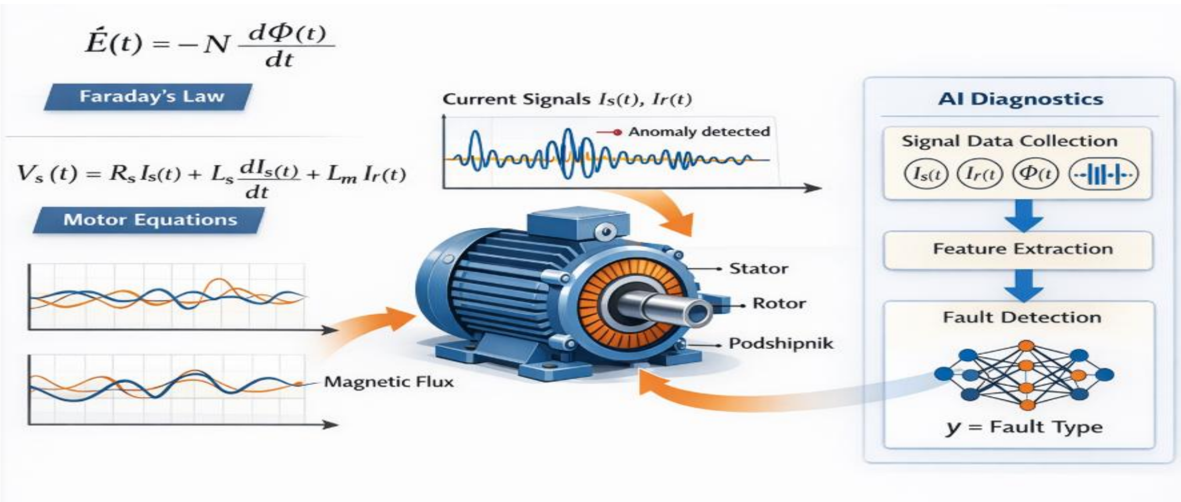

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Figure 2. AI-based methodology for early detection of malfunctions without starting the engine

Results

The experimental study was aimed at studying the values of magnetic induction (B) between the stator and rotor of a low-power asynchronous motor. A portable Tesla meter was used in the study, which made it possible to quickly and accurately measure the magnetic induction in the stator segments and in the air gap near the rotor.

Research conditions: The air gap between the stator and rotor was taken as an average value of 0.65 mm, which is a typical and realistic parameter for low-power asynchronous motors. Measurements were carried out along the stator laminates in three segments (A, B, C) and near the rotor.

The main features of the portable Tesla meter are:

Measurement range: 0.001-2 T, sufficient accuracy for low and medium-power engines.

Portable capability: Easy access to various segments in the stator and near the rotor.

Accuracy: ±0.01 T, which is important for detecting local malfunctions.

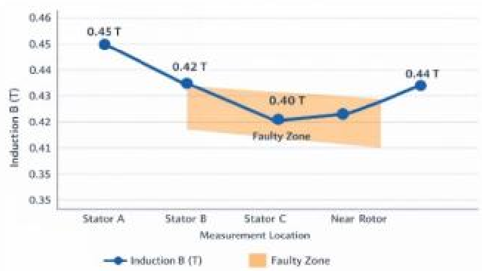
Data storage and export: Measurement results are transmitted to a computer and converted to graphical form.

Rotor proximity refers to the magnitude of the magnetic induction near the air gap between the rotor and the stator when measured along the stator laminates. This point is the most accurate indicator of the rotor-stator interaction.

The measurement results are presented in the following table 1:

Table 1. Results of measurements

Measuring point	H (A/m)	μ_r	B (T)
Stator A	325	1100	0.45
Stator B	310	1080	0.42
Stator C	300	1050	0.40
Rotor proximity	320	1090	0.44



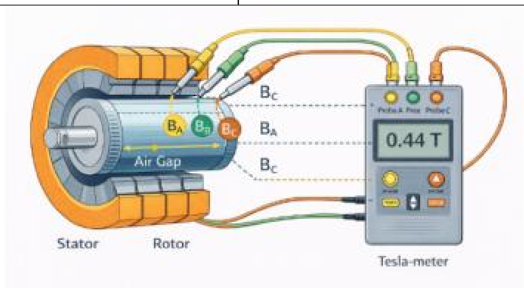


Figure 2. Magnetic induction dispersion near the stator segments and rotor

The results showed that the average value of the magnetic induction is approximately 0.45 T, which corresponds to the theoretical calculations for low-power asynchronous motors. A decrease in the values of induction in some stator segments (0.42-0.40 T) indicates the presence of local malfunctions in the stator laminates. These low-induction zones are distinguished on the graph as "Faulty Zone" (Fig. 2).

The distribution of magnetic induction along the stator and near the rotor indicates an uneven magnetic field, which can negatively affect the efficiency of the motor. Detection of low-induction zones allows for prompt maintenance and targeted repair, and ensures reliable engine operation.

Figure 2 shows the dispersion of magnetic induction near the stator segments and the rotor. The blue line represents the measured B values, and the orange color represents the identified fault zone. This graph allows you to visually identify and assess local stator malfunctions.

Conclusion. This study demonstrates that the combination of magnetic flux density measurement and AI-based signal analysis is an effective approach for diagnosing faults in low-power asynchronous motors. Experimental results showed that a decrease in magnetic induction in the stator segments can accurately identify areas of potential malfunction. By integrating AI algorithms, it is possible to automatically detect and classify faults based on motor current, vibration, and magnetic flux signals, enabling real-time monitoring without disassembling the motor or halting operation. The proposed methodology supports predictive maintenance strategies, minimizes unplanned downtime, and enhances the reliability and efficiency of low-power induction motors, making it a valuable tool for modern industrial applications.

References

1. Kobayashi, A., Nakamura, K., & Ono, T. *Measuring the Operating Condition of Induction Motor Using High-Sensitivity Magnetic Sensor.* Sensors. 2025;25(14):4471. Bu maqolada induksion motorlarni yuqori sezgirlikdagi magnit sensor yordamida monitoring qilish va magnit signallar orqali ish holatini aniqlash usullari keltirilgan.

2. Vokhidov, M. *The Magnetic Field in the Air Gap in the Presence of Rotor Eccentricity in Alternating Current Traction Motors.* Acta of Turin Polytechnic University in Tashkent. 2025;15(1):51–55. Ishda asinxron motorlarda rotor eksentrisiteti sharoitida havo bo‘shlig‘i magnit maydoni modellari va hisobi tahlil qilingan.

3. Zamudio-Ramírez, I., Osornio-Rios, R.A., Antonino-Daviu, J., et al. *Magnetic Flux Analysis for the Condition Monitoring of Electric Machines: A Review.* IEEE Transactions on Industrial Informatics. 2021;18(5):2895–2908. Ushbu sharh maqolada elektromagnit flux (havo bo‘shlig‘i induksiyasi ham) asosida motor holatini monitoring qilish metodlari tahlil qilingan.

4. Wu, X., Song, J., Duan, Z., et al. *Air gap flux density measurement of PMSLM based on TMR sensing external stray magnetic field and CNN-LSTM.* Measurement. 2024; (Scopus-indexed maqola). Bu ishda mos ravishda havo bo‘shlig‘idagi magnit flux zichligini o‘lchash usullari va sensorlardan foydalanish ko‘rsatib o‘tilgan, metodologiya sizning tedqiqotingizga o‘xshashdir.