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Design of an Induction Motor for Electric Two-Wheeler Applications

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Abstract- Electric two-wheelers are becoming popular due to increasing demand for eco-friendly transportation. Most electric scooters use BLDC motors, but they depend on permanent magnets which increase cost. In this paper, a squirrel-cage induction motor is designed for electric two-wheeler use. The motor is modeled using Altair FluxMotor software. Basic parameters such as dimensions, torque, and efficiency are studied. The motor produces around 3 kW power with efficiency close to 90%. The results show that induction motors can be used as an alternative to BLDC motors for electric vehicles.

Keywords— Induction Motor; Electric Two-Wheeler; BLDC motor

I. INTRODUCTION

The rapid development of electric vehicles (EVs) is mainly driven by the need to reduce environmental pollution and dependence on fossil fuels. Transportation is one of the major contributors to greenhouse gas emissions, and electric mobility is considered a sustainable solution to this problem. Among different types of EVs, electric two-wheelers have gained significant popularity due to their low cost, compact size, and suitability for urban transportation [1]. In most commercially available electric scooters, Brushless DC (BLDC) motors are widely used because of their high efficiency, good speed control, and compact design. However, BLDC motors depend on permanent magnets made from rare-earth materials such as neodymium. These materials are expensive and subject to supply constraints, which increases the overall cost of the motor and creates long-term sustainability concerns [2]. To overcome these limitations, alternative motor technologies are being explored for electric vehicle applications. Induction moFluxMotor allows engineers to design motor geometry, analyze electromagnetic performance, and evaluate efficiency and torque characteristics without the need for physical prototypes. This reduces development time and cost while improving design accuracy [5]. In this paper, a squirrel-cage induction motor is designed for electric two- wheeler applications. The motor parameters such as dimensions, winding configuration, and rotor design are determined using basic analytical methods. The performance of the motor is then evaluated using Altair FluxMotor simulation. The obtained results are used to study the feasibility of using induction motors as an alternative to BLDC motors in electric scooters.

II. MACHINE DESIGN AND ANALYTICAL METHODOLOGY

1. Design Specifications

The motor is designed for electric two-wheeler propulsion applications operating within the typical low voltage EV platform used in scooters and light electric vehicles.

Table I. Design specifications of the proposed induction motor

Parameters	Value
Rated Power	3 KW
Voltage range	48-72 V
Rated Frequency	100 Hz
Number of Poles	4
Rated Speed	3000 rpm
Motor type	Squirrel cage induction motor

These specifications are consistent with electric scooter propulsion systems reported in the literature [11] – [13].

2. Determination of Synchronous Speed

The synchronous speed of an induction motor is determined by the supply frequency and number of poles.

$$N_s = \frac{120f}{P}$$

where

Ns= synchronous speed (rpm)

f= supply frequency (Hz)

P= number of poles

Substituting the design parameters

$$N_s = \frac{120 \times 100}{4}$$

$$N_s = 3000\ rpm$$

3. Winding Design

- Stator slots: 36
- Rotor bars: 44
- 3-phase winding

This configuration helps reduce noise and improves performance.

4. Motor Dimensions

Using standard design equations, the main dimensions are calculated.

Table 2 Final Analytical Dimensions of the Designed Induction Motor

Parameters	Value
Stator inner diameter	140 mm
Stator outer diameter	200 mm
Rotor outer diameter	138 mm
Stack length	100 mm

3. Simulation Setup and Results

The designed motor is modeled using Altair FluxMotor. The geometry, winding configuration, and operating conditions are defined based on the design

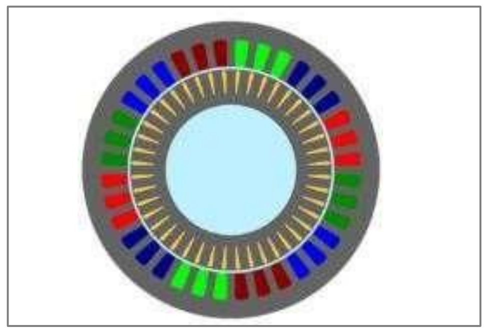

Fig. 1. Electromagnetic geometry of the designed motor generated in FluxMotor

The performance of the motor was then evaluated using working point analysis and performance mapping for different operating conditions

Table 3 Operating Conditions

Parameters	Value
Voltage	50 V
Frequency	100Hz
Slip	2%
Mode	Motor

Performance Results

Simulation results show:

- Output Power: 3 kW
- Torque: 11 Nm
- Efficiency: 90%

These values are suitable for electric two-wheeler applications.

2. Torque-Slip Characteristics

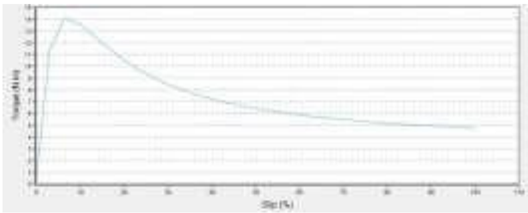

Fig. 2. Torque–slip characteristic of the designed induction motor

The motor produces high torque at low speeds and gradually decreases as speed increases.

This behavior is suitable for:

- Starting
- Acceleration
- Normal riding conditions

Efficiency

Efficiency is calculated as:

Efficiency = Output Power / Input Power

The obtained efficiency is around 90%, which is acceptable for EV applications

IV, COMPARISON WITH BLDC MOTORS USED IN ELECTRIC TWO- WHEELERS

To evaluate the effectiveness of the proposed induction motor, its performance is compared with a typical BLDC motor used in electric two-wheelers. BLDC motors are widely adopted in EV applications due to their high efficiency and compact size. However, induction motors offer advantages in cost, durability, and material availability.

Table 4 Performance comparison between BLDC motors and proposed induction motor

Parameter	Induction Motor	BLDC Motor	Observation
Efficiency	Slightly lower	Higher	BLDC advantage
Starting Torque	Moderate	High	BLDC slightl ybetter
Maximum Torque	High (~2× rated)	High	Comparable
Speed Control	Comple x (needs inverter)	Easier	BLDC advantage
Cost	Low	High	IM advantage
Maintenance	Very low	Low	IM advantage
Reliability	Very high	High	IM advantage
Thermal Performance	Better	Moderate	IM advantage
Noise	Low	Low	Comparable

Discussion

BLDC motors offer slightly higher efficiency. However:

- Induction motors do not require rare-earth materials
- They are more cost-effective
- They have better mechanical robustness

V. CONCLUSION

A squirrel-cage induction motor for electric two-wheeler applications has been designed and analyzed using simulation.

The motor delivers:

- 3 kW power
- 11 Nm torque
- 90% efficiency

The results show that the motor can meet the basic requirements of electric scooter operation. Although BLDC motors provide slightly higher efficiency, induction motors offer advantages in cost, reliability, and material availability. Therefore, induction motors can be considered as a suitable alternative for electric two-wheelers, especially in cost- sensitive applications.

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