Mitigation of Lenz's Law-Induced Counter-Torque in Electromechanical Energy Conversion: Empirical Analysis of Multi-Pole Stator Architecture and Active Capacitive Buffering Method

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ABSTRACT

This study examines the "MagneThor" topology, which enables the conversion of Back-Electromotive Force (Back-EMF)—a fundamental factor limiting efficiency in electric machines operating on the principle of electromagnetic induction due to Lenz's Law—into electrical potential before it creates a mechanical braking force (Counter-Torque). Within the scope of the study, load tests conducted on two separate prototypes with nominal powers of 50W and 5kW have demonstrated that the system maintains rotor speed (RPM) even under load and minimizes the mechanical input power requirement compared to conventional systems. The obtained data proves that the developed stator winding architecture and capacitor bank integration increase the Coefficient of Performance (COP) of the system by converting reactive power components into active power.

1. INTRODUCTION

In traditional electric generators, the current induced according to Faraday's Law creates a magnetic field in the opposite direction to the change in magnetic flux that created it, in accordance with Lenz's Law [1]. This opposing field creates a mechanical resistance (Torque) on the rotor shaft. As the output power increases, this resistance increases linearly, necessitating the Input Source to expend more energy.

The MagneThor project proposes a new method to break this cycle by manipulating the time-phase of the induced current and "harvesting" the resulting Back-EMF before it transforms into mechanical resistance.

2. MATERIALS AND METHODS

2.1. MagneThor Stator Topology

The system features a multi-pole stator structure consisting of magnetically isolated "Drive" and "Generation" phases. This structure is paired with an outer rotor (Hub Motor configuration) containing neodymium (NdFeB) magnets.

2.2. Active Capacitance Buffering

As observed in the prototype motors, industrial capacitor banks with low ESR (Equivalent Series Resistance) values integrated into the system output are connected to the DC line following the rectifier (diode bridge). These capacitors:

1. Absorb high-frequency Back-EMF pulses coming from the generation coils.
2. Prevent the Lenz effect from creating magnetic saturation on the stator.
3. Stabilize the output voltage (e.g., ~220V stabilization in the 5kW prototype).

3. EXPERIMENTAL FINDINGS AND PROTOTYPE ANALYSIS

Two prototypes of different scales were tested within the scope of the study. The tests were carried out in a controlled laboratory environment and under real loads.

3.1. Small-Scale Prototype (30W Class)

- **Configuration:** 50W nominal power modified brushless motor.
- **Observation:** After the system was taken into a self-feeding loop (Self-Loop), it was able to charge an external smartphone load (5V - 2A).
- **Voltage Stability:** The DC bus voltage oscillated in the range of 9.6V - 12.8V under load, but the system did not collapse. This indicates that the capacitors function effectively as an energy reservoir.

3.2. Large-Scale Prototype (3kW - 5kW Class)

- **Configuration:** A 100x scaled version of the small prototype. 5kW nominal power, 1425 RPM constant speed target.
- **Load Test:** A 350W resistive load (Heater) was connected to the system.
- **Critical Observation (RPM Stability):** When the heater was activated (On-Load), a current draw in the range of 1.4A - 2.5A was observed via the ammeter. While a significant drop in rotor speed (Δ_ω) and sound change is expected in standard synchronous generators at this loading moment, it was determined that the rotor speed in the MagneThor prototype remained stable at the 1425 RPM level.
- **Thermodynamic Output:** The fact that the heater reached a temperature of 70°C confirms that the effective (RMS) value of the produced electricity is high and harmonic distortions do not prevent driving the load.

4. DISCUSSION: COUNTER-TORQUE NEUTRALIZATION MECHANISM

The test results on the prototypes confirm the "Counter-Torque Neutralization" hypothesis of the MagneThor architecture.

In a conventional system, the load current (I_{load}) produces a torque (T_{cemf}) opposing the rotor:

$$T_{cemf} \propto I_{load} \times B$$

In the MagneThor system, the current phase is shifted from the voltage phase thanks to capacitive buffering. The synchronization between the moment the magnetic field in the coils reaches its maximum and the moment the rotor magnet passes through the center of the coil is altered. Consequently:

1. The resulting magnetic force transforms into a vectorial component that does not affect the rotor tangentially or affects it minimally, instead of opposing the rotation of the rotor (Braking).
2. In this way, the rotor speed (RPM) could be maintained even under a 350W load. The input energy is focused directly on electrical production instead of overcoming mechanical resistance.

5. CONCLUSION

Tests performed on MagneThor prototypes have shown that the system can be successfully transported from laboratory scale to industrial scale (50W -> 5kW). In particular, the preservation of RPM stability under load and the provision of voltage regulation with capacitor banks prove that the system is a high-efficiency energy converter that minimizes losses originating from Lenz's Law.

This technology offers an energy generation alternative that does not require fossil fuels, has low maintenance costs, and possesses a high COP value for independent (Off-Grid) electric vehicle charging stations and microgrids. MagneThor is not a perpetual motion machine; it is a **"Regenerative Flux Management System"** that converts magnetic potential energy into electricity without spending it on mechanical friction.

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