Vertical Axis Wind Turbine with Coaxial Shafts and a 30° Overrunning Clutch for Enhanced Self-Starting Performance

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Introduction

Wind energy is a key component of renewable energy systems, but vertical axis wind turbines (VAWTs) suffer from poor self-starting capability and unstable operation at low wind speeds.
To address these limitations, a novel VAWT design with coaxial shafts and a 30° overrunning clutch is proposed. This configuration enables phase synchronization and one-way torque transmission.
The aim of this work is to experimentally investigate the effect of this design on rotor acceleration and dynamic performance.

Methodology

Experiments were conducted in a custom-built wind tunnel (1250×1250 mm, length 4100 mm) with airflow velocities of 6–8 m/s.
A four-bladed Darrieus rotor with NACA0021 airfoil was tested. The rotor included coaxial shafts connected via a 30° overrunning clutch.
Rotational speed was measured using a laser tachometer (±1% accuracy). Each experiment was repeated three times to ensure reliability.

Fig.1. General view of the wind tunnel

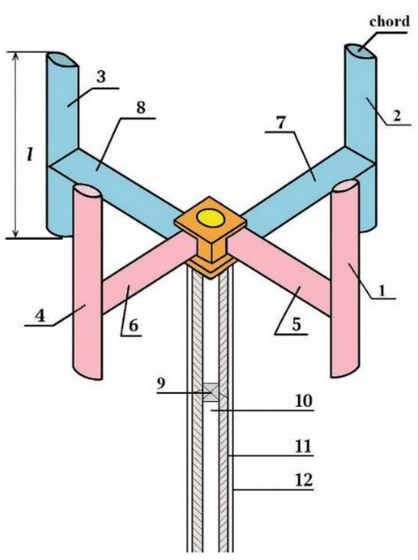

Fig.2. Configuration of the wind turbine: 1–4 – blades; 5–8 – support arms with NACA0021 profile; 9 – bearings; 10 – central shaft; 11 – outer shaft; 12 – housing.

Fig.3. 30° overrunning clutch

Results

The results show that rotor speed increases with operating regime for both configurations (0° and 30°).
At low regimes, the baseline configuration demonstrates slightly higher rotational speed. However, the 30° phase-shift configuration exhibits faster acceleration.
At intermediate conditions, the modified configuration surpasses the baseline, while at high regimes both configurations converge.
This indicates improved dynamic performance and

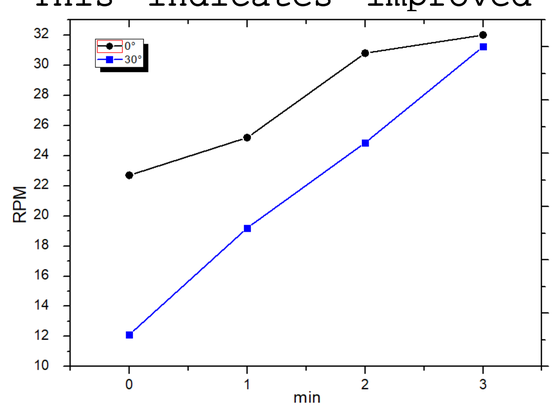

Fig.4. Fan rotational speed: 25 rpm at an airflow velocity of 6 m/s

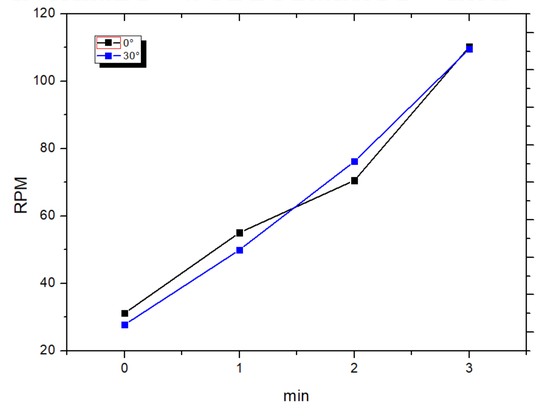

Fig.5. Fan rotational speed: 26 rpm at an airflow velocity of 7 m/s

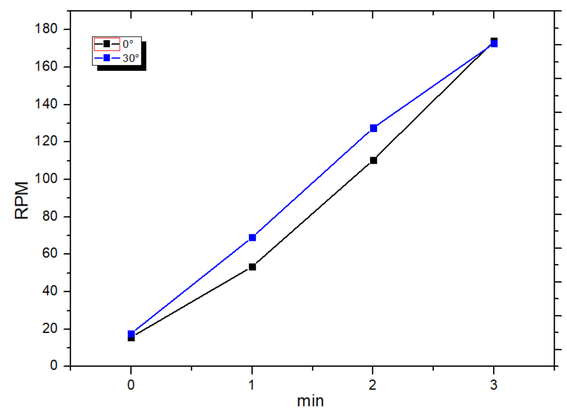

Fig.6. Fan rotational speed: 28 rpm at an airflow velocity of 8 m/s

Conclusion

The 30° phase shift enhances rotor acceleration by enabling more efficient torque transfer between coaxial shafts.

The overrunning clutch reduces torque fluctuations and improves rotational stability.

This design is particularly effective in intermediate operating regimes.

The proposed VAWT design with coaxial shafts and a 30° overrunning clutch improves self-starting performance and dynamic stability.

The system enhances acceleration in intermediate regimes and reduces performance gaps at higher airflow velocities.

This concept shows strong potential for

References

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Acknowledgements

This work was carried out within the framework of the competition for grant funding for scientific and (or) scientific and technical projects for 2024-2026, conducted by the Ministry of Science and Higher Education of the Republic of Kazakhstan. Project topic: AP23487726 "Planning and manufacturing of a semi-industrial wind turbine with a capacity of 5 kW of a unique design.".