



Design and Analysis of Flywheel in Petrol Engine

Pandiyarajan¹, Keerthana², Ragi Divya³

¹Department of Mechanical Engineering, Faculty, Sri sairam college of Engineering,
Bengaluru

^{2,3,4} Department of Mechanical Engineering, Student, Sri sairam college of Engineering,
Bengaluru

ABSTRACT

A flywheel is a mechanical device used to store and release energy during engine operation, acting as an energy reservoir. It smooths out the fluctuations in engine speed caused by the intermittent energy generation in internal combustion engines. This study focuses on the design, analysis, and optimization of a flywheel for a multi-cylinder petrol engine using CATIA for modeling and ANSYS for structural and fatigue analysis. The analysis compares the performance of flywheels made of gray cast iron and aluminum alloy to determine the optimal material for better performance and durability.

Keywords: Flywheel, Energy Storage, Structural Analysis, CATIA, ANSYS, Aluminum Alloy

1 Introduction

The internal combustion engine (ICE) generates power only during the power stroke, while other strokes (suction, compression, and exhaust) produce no power. To maintain a consistent speed and reduce vibrations, a flywheel is attached to the crankshaft. It stores excess energy during the power stroke and releases it during other strokes, thereby stabilizing the engine's rotation.

Flywheels have evolved from simple mechanical devices to advanced components using high-strength materials and complex geometries. The objective of this project is to design a flywheel that maximizes energy storage capacity while minimizing material weight and stress. The analysis involves a comparison between traditional materials (gray cast iron) and modern materials (aluminum alloy A360).

2 Recent Works

Historically, flywheels were simple stone wheels used to store mechanical energy. With technological advancements, modern flywheels are designed with composite materials and magnetic bearings, enabling them to operate at higher speeds and store more energy.

Key studies in flywheel technology focus on reducing vibrations and increasing energy efficiency. The introduction of dual-mass flywheels has significantly improved vibration damping and noise reduction. Research has also highlighted the benefits of using lightweight materials like carbon fiber and aluminum alloys, which offer high energy storage capacity and reduce the overall weight of the flywheel.



Flywheels are now used in various applications, including automotive, aerospace, and power systems, where they serve as energy storage devices and assist in dynamic balancing.

3 Proposed Work Explanation

The project methodology involves the following steps:

Design and Modeling: The flywheel is designed using CATIA V5, focusing on optimizing geometry for maximum energy storage. Parameters such as diameter, thickness, and mass distribution are determined based on empirical formulas.

Material Selection: Two materials are considered for analysis—gray cast iron and aluminum alloy A360. The selection is based on their mechanical properties and suitability for high-speed applications.

Analysis Using ANSYS: Structural analysis, fatigue analysis, and modal analysis are performed using ANSYS software. The objective is to evaluate the flywheel's performance under different loading conditions and determine the material that offers the best combination of strength, weight, and durability.

Validation: The capacity of the flywheel is validated by applying forces and evaluating its response to stress and fatigue using finite element analysis (FEA).

4 Results and Discussion

The analysis provided several insights into the performance of the flywheel:

- **Structural Analysis:** Both materials were subjected to stress tests. Aluminum alloy exhibited lower stress levels and higher resilience compared to gray cast iron, making it more suitable for high-speed applications.
- **Fatigue Analysis:** The fatigue life of the aluminum alloy flywheel was significantly longer, indicating better durability under cyclic loading conditions.
- **Modal Analysis:** The aluminum alloy flywheel displayed better vibration damping capabilities, reducing torsional vibrations and improving engine performance.
- **Energy Efficiency:** The aluminum alloy flywheel stored more energy per unit mass, providing better efficiency and reduced weight, which is beneficial for automotive applications.

Overall, the aluminum alloy A360 emerged as the superior material, offering enhanced energy storage, reduced stress, and longer fatigue life compared to gray cast iron.

5 Conclusion

The design and analysis of the flywheel using CATIA and ANSYS demonstrated the advantages of using aluminum alloy over traditional materials. The study highlighted the importance of material selection and geometric optimization in improving the performance and durability of flywheels in petrol engines.



References

1. Ahmet Nedim Eraslan; T. Akis, Year: 2006, "On the plane strain and plane stress solutions of functionally graded rotating solid shaft and solid disk problems," Acta Mechanica Vol: 181, pp. 43-63.
2. Ulf Schaper; Oliver Sawodny; Tobias Mahl; Uti Blessing, Year: 2009, "Modeling and torque estimation of an automotive dual mass flywheel", In 2009 American control conference, IEEE pp. 1207-1212.
3. Stephanos Theodossiades; M. Gnanakumarr; Homer Rahnejat; P. Kelly, Year: 2006, "Effect of a dual-mass flywheel on the impact-induced noise in vehicular powertrain systems", Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Automobile Engineering, Vol: 220, no: 6, pp. 747-761.
4. Sham Tickoo, "CATIA V5-6R2018 for designers", Year: 2018, Cadcam Technologies.