Repurposing IC Engine Components for Emergency Air Compression and Tire Inflation

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Abstract-

This paper explores the engineering conversion of a standard internal combustion (IC) engine into a functional air compressor for emergency tire inflation. In a typical engine, fuel and air are ignited to produce power; however, in this conversion, the reciprocating motion of the piston is harnessed to pull in, compress, and discharge atmospheric air into a storage tank. By utilizing the vehicle's own cylinder, the system provides a portable, self-sustaining solution for roadside air filling without requiring external electrical power. The study details the mechanical modifications, design of pressure vessels, and Finite Element Analysis (FEA) used to validate the structural integrity of the system.

Keywords: IC Engine, Air Compressor, Tubeless Tires, FEA, Pressure Vessel, Repurposing.

I. INTRODUCTION

An internal combustion (IC) engine is a machine that converts the internal energy of fuel into mechanical energy through combustion. These engines are broadly classified by fuel type (petrol, diesel, gas) and by their operating cycle (2-stroke or 4-stroke).For compression purposes, 4-stroke engines are preferred over 2-stroke designs due to their dedicated valvetrains and superior lubrication systems, which ensure durability during continuous compressor duty. This project repurposes these components to address the needs of modern tubeless tires, which require immediate pressure restoration during punctures to maintain safety and fuel efficiency.

The project's theoretical foundation is built upon established mechanical standards:

- **Pressure Vessel Design:** D. R. Moss and McGraw-Hill documentation provide the ASME Section VIII codes necessary for calculating tank wall thickness and hoop stresses.
- **Engine Fundamentals:** J. B. Heywood's work explains the induction and exhaust processes modified for compression.
- **Pneumatic Systems:** S. R. Majumdar's research guides the selection of non-return valves (NRVs) and pneumatic circuit logic.
- **Industrial Standards:** Normex Valves specifications ensure that the discharge valves used in place of spark plugs meet high-frequency operating standards.

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II. LITERATURE OF SURVEY

III. SCOPE OF THE PROJECT

The project scope encompasses the mechanical conversion of a standard cylinder into a compressor, the development of a lightweight portable chassis, and the implementation of sustainable engineering by reusing decommissioned parts. It also covers performance evaluation, specifically measuring the time required to fill a tire and the durability of the modified cylinder head.

IV. METHODOLOGY

The conversion involves four key mechanical modifications:

1. **Ignition Disabling:** The spark plug is replaced with a high-pressure discharge fitting or specialized "Project Plug".
2. **Valvetrain Modification:** The original intake valve is retained for air entry, while a one-way check valve is installed at the spark plug port to prevent backflow from the tank.
3. **External Drive:** The crankshaft is connected to an external motor via a V-belt to drive the reciprocating motion.
4. **Filtration:** An air filter is added to prevent dust from scoring the cylinder walls.

V. DESIGN

The core of the system is a cylindrical pressure vessel with hemispherical ends, often termed a "bullet". CAD software was utilized to optimize the tank's geometry and ensure that materials and tolerances conform to application-specific conventions.

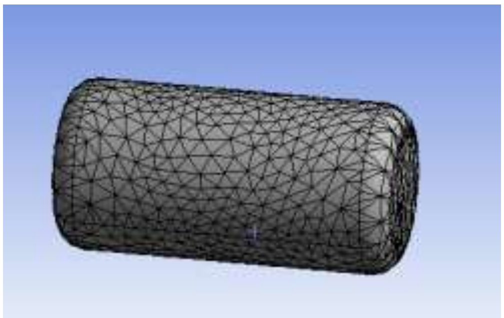
The system operates by drawing air through the inlet valve during the intake stroke and forcing it through the project plug into the storage tank during the compression stroke.

Fig.1: 3D View of Compressor

VI. FINITE ELEMENT ANALYSIS (FEA)

To ensure safety, the storage tank underwent extensive FEA.

- **Meshing:** The tank was divided into smaller elements to accurately simulate stress distribution.



Statistics	
Nodes	10354
Elements	5216

Fig.2: Meshing of tank

- **Structural Validation:** Simulations applied internal pressure to determine total deformation, total stress, and safety factors.
- **Fatigue Analysis:** The analysis predicted the service life and potential damage zones of the tank under cyclic loading.

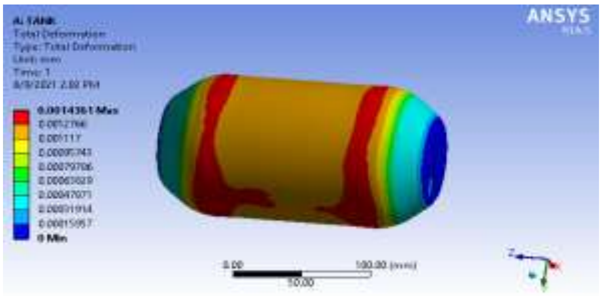


Fig.3 Total deformation in tank after applying a pressure

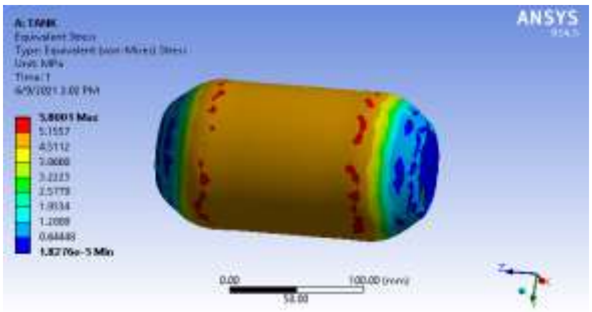


Fig.4 Total Stress in tank after applying a pressure

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VII. CONCLUSION

Repurposing IC engine components into a portable air compressor is a viable and sustainable engineering solution. The project successfully demonstrates that a modified engine can provide on-demand air generation for emergency tire inflation without specialized industrial equipment. Structural analysis confirms that with proper design and valve selection, the repurposed system can operate safely under high-pressure conditions.

VIII. RESULT AND APPLICATION

- **Results:** The system achieved functional air compression capable of filling two-wheeler tires. FEA results confirmed a stable factor of safety for the storage tank.
- **Applications:**
  - **Emergency Roadside Assistance:** Portable air filling for vehicle punctures.
  - **Sustainable Manufacturing:** Extending the lifecycle of old engine components.
  - **Pneumatic Tools:** Serving as a base for small-scale industrial pneumatic circuits.

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