



SOLAR POWERED TIRE INFLATER A SUSTAINABLE EMERGENCY SOLUTION

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ABSTRACT :

Solar energy is a natural power source that never runs out. It helps to reduce pollution and protect the environment. A portable tire inflator is useful when a tire loses air suddenly. This project uses solar energy to power an air compressor. Solar panels collect sunlight and turn it into electricity. The inflator can work anytime without needing other power sources. It is small and easy to keep in a car's dashboard. This makes it quick to use in emergency. It save money and reduces harm to nature. The project makes travel safer and more eco-friendly. The inflator works well in remote areas where power is unavailable. This makes it a great solution for long trips and outdoor adventures. The solar-powered inflator is also cost-effective and low maintenance. Overall, this project promotes green technology and a sustainable future.

Introduction

A solar-powered tire inflator provides a reliable and eco-friendly solution. It uses solar energy to inflate tires without depending on external power sources. This ensures drivers can handle tire issues in remote areas. A flat tire is a common problem for vehicle owners. It can happen anywhere, making it stressful and inconvenient. Traditional inflators need electricity or a vehicle's battery, which may not be available in emergencies or in some remote areas. The device consists of a solar panel, rechargeable battery, DC air compressor, pressure gauge, and charge controller. The solar panel absorbs and converts the sunlight into electricity, stored in the battery. The air compressor then inflates the tire when needed. A built-in pressure gauge helps regulate airflow for the correct tire pressure. This prevents both over-inflation and under-inflation. Proper inflation improves safety and extends the durability of the tire. Unlike conventional inflators, this device runs on renewable solar energy. It reduces fossil fuel dependence and lowers carbon emissions. Eliminating disposable batteries also helps reduce electronic waste. The inflator is lightweight, compact, and easy to store in a vehicle. It works without a power outlet or car battery. This makes it perfect for remote areas, travellers, and emergency responders. Using solar power makes the inflator cost-effective and low-maintenance. It eliminates fuel and electricity costs while preventing battery drain. This ensures a more affordable and sustainable solution for drivers.

LITERATURE REVIEW:-

A solar-powered tire inflator is an eco-friendly solution that minimizes the challenges of roadside emergencies. It relies on solar energy to inflate tires, reducing the need for conventional electricity or fossil fuel sources, which may not be available in remote areas. Solar inflators store energy in batteries, ensuring continuous functionality, even at night or during cloudy weather. This technology supports sustainability by reducing carbon emissions, offering an efficient and practical alternative to traditional inflators (Jie Chen, 2019).

Several studies have explored machine learning (ML) for tire life prediction, improving tire maintenance (Chen et al., 2019). The integration of sensors and energy-efficient systems, such as solar-powered pumps, has shown to enhance tire safety and vehicle performance (Owczarzak & Sommer, 2016). Moreover, combining solar power with electric systems allows for portable tire inflation without relying on external energy sources like electricity and fuel based sources (Aminzadegan et al., 2020).

Advanced designs include smart control systems that monitor battery levels, tire pressure, and environmental factors, further enhancing safety (Sabrina Mohd, 2024). These innovations not only ensure accurate tire inflation but also contribute to fuel savings and reduced tire wear (Isa, 2024). Solar-powered systems also support vehicles in rural areas, promoting energy independence and reducing reliance on fossil fuels (Aydogdu et al., 2019).

The integration of solar energy into vehicle technologies is becoming important for sustainable transportation (Buhrmann et al., 2024). These systems ensure an accurate inflation and provide real-time data for tire maintenance, benefiting both commercial and personal vehicle users (Herllambang & Margana, 2022). Additionally, advancements in energy management and battery storage enhance the efficiency of solar-powered tire inflators (Zhu et al., 2024).

Objectives:

- **To use solar energy to inflate tires without electricity**

The use of solar energy to inflate tires without electricity or any fuel-based sources is a practical and eco-friendly innovation that promotes energy efficiency and sustainability.

- **To make it small and easy to carry anywhere**

A compact and lightweight solar-powered tire inflator provides a convenient solution for tire maintenance. Its portable design makes it easy to carry and use in remote areas, emergencies, and daily travel.

- **To work with different types of tires like cars, bikes, and tractors**

A versatile solar-powered tire inflator is designed to be compatible with various tire types, making it suitable for cars, motorcycles, bicycles, and even heavy-duty vehicles like tractors.

- **To help keep tires at the right pressure for safety**

Maintaining the correct tire pressure is essential for safe driving, better fuel efficiency, and longer tire life. A solar-powered tire inflator provides a reliable and eco-friendly way to keep tires properly inflated without relying on electricity.

Components used:

- Solar panels

A *solar panel* is a device that converts sunlight into electrical energy using *photovoltaic (PV) cells*. These panels play a crucial role in renewable energy systems, providing a sustainable and eco-friendly power source for various applications, from household electricity generation to portable power solutions.

**Fig 1 :Solar Panel**

- Battery

A *battery* is an energy storage device that converts and stores electrical energy in chemical form for later use. In solar power applications, batteries play a crucial role by ensuring power availability even when sunlight is not present. For a *solar-powered tire inflator*, a battery is essential to store solar energy and provide a stable power supply to the *air compressor*, which may require a sudden surge of current that a solar panel alone cannot provide.

**Fig 2 : Battery**

- Air Compressor

An *air compressor* is a mechanical device that converts electrical energy into compressed air by reducing its volume and increasing its pressure. It is widely used in various applications, including inflating tires, operating pneumatic tools, and industrial processes.



Fig 3 : Air Compressor

- Charge Controller

A *charge controller* is a crucial component in a solar power system that regulates the voltage and current from the solar panel to the battery. Its primary function is to prevent overcharging, over-discharging, and reverse current flow, ensuring the longevity and safety of the battery. Without a charge controller, a battery can be damaged due to excessive voltage or deep discharge, reducing its efficiency and lifespan.



Fig 4 : Charge Controller

- Led light

An *LED emergency light* is a high-efficiency lighting system designed to provide illumination during power failures or low-light conditions. These lights are widely used in solar-powered applications, ensuring safety and visibility in emergencies such as roadside repairs, power outages, or outdoor activities.



Fig 5 : Led Light

Results and Discussions

1. The time taken to recharge a 7Ah battery using a 25W solar panel is 3 hours 40 minutes under optimal conditions.
2. The time taken to drain a 7Ah battery using a compressor is 31 minutes.
3. The compressor can comfortably run to inflate all four tires at a time at maximum capacity.

4. The compressor can comfortably run at maximum capacity, producing 60 PSI air pressure.
5. Compressors have high vibrations, but *tight clamping* helps reduce them.
6. The compressor can run easily for about 50 minutes without breaking

Solar Panel:

- Average Power output is 25W per 1hour

Battery:

- Charging time = TOTAL ENERGY OF BATTERY / POWER OUT PUT BY SOLAR
- $7 \times 12 / 25 = 3.36$
 $= 3.36 \times 60 = (3 \text{ Hours \& } 21 \text{ Minutes})$

Compressor:

- Voltage = 12V
- Inflator Power (c) = $12 \times 12 = 144$ watts.
- Amp = 12 Amp
- Battery Capacity = $12 \text{ (V)} \times 7 \text{ (Ah)} = 84 \text{ Wh}$
- Run time of compressor = Battery Capacity / Inflator Power
 $= 84 / 144$
 $= 0.58$
 $= 0.58 \times 60$
 $= 35 \text{ in min}$

Vehicle Name	Tire Dimension in	Time Required to Fill from 0 to 35 PSI (Min)	Recommended PSI
Bicycle	5x5x4	3	40 PSI
TVS Bike	110/80-17	6	32 PSI
Maruti Suzuki Swift	165/80 R14	9	35 PSI

**Advantages:**

This technology eliminates the need for traditional power sources, making it a sustainable and cost-effective solution for vehicle maintenance. The advantages of a solar-powered tire inflator extend beyond environmental benefits, energy efficiency, and independence from conventional power sources. In the following discussion, we will explore the key advantages of this sustainable tire inflation solution.

- Eco-Friendly – Uses renewable solar energy, reducing dependency on electricity and fuel-based sources.

- Cost-Effective – Eliminates the need for electricity or fuel, reducing operational costs over time.
- Portable – Compact and convenient design allows easy transport and use in remote areas without power access.
- Energy Efficient – Solar energy is the reason to making it a sustainable alternative to traditional inflators.
- Emergency Readiness – Ideal for roadside emergencies where conventional power sources may not be available.
- Low Maintenance – Requires minimum maintenance as solar panels and air compressors have long operational life spans.

Limitations:

While solar-powered tire inflators offer a sustainable and convenient solution for maintaining tire pressure, they also come with certain limitations. Understanding these limitations is crucial for evaluating the suitability of solar-powered tire inflators in different scenarios. In the following discussion, we will explore the key challenges associated with this technology.

- Weather Dependency – Performance is affected by cloudy or rainy conditions, limiting charging efficiency.
- Slower Inflation – May take longer to inflate tires compared to high-power electric or fuel-based inflators.
- Initial Cost – Higher upfront cost due to solar panel integration and battery components.
- Limited Power Output – May not be suitable for inflating heavy-duty or large vehicle tires requiring high pressure.
- Storage Issues – Requires sufficient battery capacity to store solar energy for use during night-time or low-sunlight conditions.

Applications:

Portability and eco-friendly nature make them ideal for personal vehicles, commercial fleets, agricultural machinery, and roadside assistance services. By utilizing renewable solar energy, these inflators provide a reliable and cost-effective alternative to traditional air compressors. In the following discussion, we will discuss the various applications of solar-powered tire inflators.

- Personal Vehicles – Ideal for cars, motorcycles, and bicycles, ensuring proper tire inflation for safety.
- Off-Road Travelling – Useful for camping, off-road driving, and remote locations with no electricity access.
- Agriculture and Farming – Helps maintain tire pressure in tractors and other farm vehicles in rural areas.
- Public and Commercial Transport – Suitable for fleet management and transport companies to maintain vehicle efficiency.
- Emergency and Roadside Assistance – Can be used in rescue and roadside repair services for quick tire inflation.

Conclusion:-

The solar-powered tire inflator is an innovative device that uses the power of the sun to help maintain vehicle tires. It is a simple, eco-friendly solution that reduces the need for traditional energy sources, helping to protect the environment. By using solar energy, it lowers the carbon footprint, contributing to a cleaner and greener world. One of the biggest benefits of this inflator is its portability. The device is small and compact, making it easy to carry in your vehicle. This is especially helpful in emergencies, such as when you are in a remote area and there are no nearby power sources. You can rely on this inflator to assist you with tire inflation at any time. The system works by using a solar panel to capture sunlight. The energy from the sun is then stored in a battery, which powers the inflator's air compressor. The compressor inflates your tire to the right pressure. The device has a built-in pressure sensor to ensure that the tire is inflated safely and properly, preventing over-inflation. This tire inflator is designed to be user-friendly. It is simple to use, making it a great option for anyone, even if they do not have much experience with vehicle maintenance. The automatic pressure control system ensures the safety of both the user and the vehicle.

By using solar energy, this inflator saves money by eliminating the need to visit fuel stations to inflate tires. It also reduces fuel consumption and the need for electricity, making it a more cost-effective option. The device operates quietly, so it does not disturb the surroundings while in use. In addition, it requires little maintenance and has a long lifespan, making it a reliable choice for vehicle owners. This solar-powered inflator is also beneficial for reducing environmental impact. It helps to decrease the use of fossil fuels and minimizes carbon emissions, making it a great step toward a sustainable future. It promotes the use of clean, renewable energy, which is better for the planet.

In conclusion, the solar-powered tire inflator is a practical and green solution to tire maintenance. It is easy to use, reliable, and helps protect the environment by using solar power. This device is a smart investment for anyone who wants to ensure their tires are properly inflated without relying on traditional power sources. With its convenience, cost-effectiveness, and sustainability, this inflator is a great tool for vehicle owners.

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