

Design and Fabrication of Portable AC

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Abstract— Abstract

The increasing demand for localized cooling systems has led to the development of compact and energy-efficient air conditioning units. Conventional air conditioners are effective but often expensive, fixed in one location, and require significant installation and maintenance. This research focuses on the design and fabrication of a portable air conditioner (Portable AC) that is economical, easy to transport, and suitable for small rooms, offices, hostels, and temporary workspaces.

The fabricated system operates on the standard vapor compression refrigeration cycle using a hermetically sealed compressor, condenser, capillary tube, and evaporator. The system is mounted on a wheeled chassis and enclosed in a compact body for ease of mobility. Experimental testing was conducted under different operating conditions to evaluate cooling capacity, coefficient of performance (COP), and power consumption.

The results indicate that the developed prototype effectively reduces room temperature by 6–10°C in a small enclosed space and provides a cost-effective solution for localized cooling applications..

The machine is semi-automated, meaning it can be manually operated for control but runs its waste collection mechanism automatically once activated. The use of renewable solar energy makes the machine sustainable and energy-efficient. The prototype was tested in controlled conditions and demonstrated high performance in collecting various floating wastes with low energy consumption. The proposed system represents an effective and eco-friendly solution for river and lake cleaning, promoting sustainable water resource management.

Keywords: Portable Air Conditioner, Vapor Compression Refrigeration System, Fabrication, Cooling Capacity, COP, Energy Efficiency

1. Introduction

The concept of thermal comfort has evolved from a luxury to a fundamental necessity in modern living and working environments. As global temperatures continue to rise due to climate change and urbanization, the demand for efficient air conditioning systems, This project focuses on the fabrication of a Portable Air Conditioning system, designed to bridge the gap between traditional fixed units and basic fans. Unlike conventional split or window ACs, a portable unit integrates all refrigeration components—the compressor, condenser, evaporator, and fans—into a single, compact chassis. The primary philosophy behind this design is localized cooling; rather than wasting energy cooling an entire 1.2

2. Background

- he pursuit of artificial cooling dates back to ancient civilizations, where simple methods like wind towers and water-soaked blankets were used to lower ambient temperatures. However, the modern era of air conditioning began in 1902 with Willis Carrier, who designed the first electrical air conditioning unit to control humidity in a printing plant. Since then, the technology has transitioned from massive industrial machinery to compact household appliances. The fundamental scientific principle behind this project is Thermodynamics, specifically the Second Law, which states that heat naturally flows from a hot body to a cold body. To reverse this process and cool a room,

work must be done. Most portable air conditioners achieve this through the Vapor Compression ---

3. Objectives of the Study

Design and Modeling

- To design a compact and ergonomic 3D CAD model of a portable air conditioner that optimizes internal space for cooling components. Component Integration and Fabrication
- To perform thermal load calculations to determine the exact cooling capacity (BTU) required for a standard small-sized room (e.g., 10x10 sq. ft).
- To select and integrate high-efficiency components, including a [insert your type: e.g., DC compressor or Peltier module], evaporator, and condenser, within a lightweight chassis.

- To develop an automated control system using [e.g., Arduino/Microcontroller] to regulate temperature and fan speed based on real-time environmental feedback
- Performance Evaluation • To test the cooling rate of the fabricated prototype by measuring.

4. Literature Review

Vapor Compression Refrigeration Cycle (VCRC): Research identifies VCRC as the most effective method for portable cooling due to its high Coefficient of Performance (COP). Recent studies on R23 and R600a refrigerants suggest they are viable, environmentally friendly alternatives for small-scale fabrication. for human consumption. Over the several technologies have been developed, each with its own advantages and limitations." years, " 2.1.1 Filtration Techniques • Thermoelectric vs. VCRC: Studies comparing Peltier modules (Thermoelectric) with compressor systems (VCRC) show that while thermoelectric units are quieter and have no moving parts, their low COP (0.38-0.45) makes them less efficient for cooling larger spaces compared to VCRC units (2.6-3.0 COP). Filtration methods such as sand filters, carbon filters, and membrane filtration are commonly used for removing particulate matter and some dissolved impurities. Reverse Osmosis (RO), a widely used technique, works by forcing water through a semi-permeable membrane that removes dissolved salts and contaminants. Although highly effective, RO systems are expensive and require high energy input, frequent maintenance, and replacement of membranes — making them unsuitable for rural or low-income communities."

2.1.2 Chemical and Biological Methods • Portability and Design Optimization: Previous development projects highlighted that a "monoblock" design—housing all components in a single chassis—is the standard for mobile units. Innovation often focuses on lightweight chassis materials and improved exhaust duct efficiency to prevent hot air from re-entering the cooled space. Chemical purification methods such as chlorination and ozonation ---

5. Methodology

The proposed system works on the principle of distillation using waste heat energy. In the setup, saline water is heated using captured waste heat, causing the water to then pass evaporate while leaving behind dissolved salts, heavy metals, and other contaminants. The vapor through a condensing plate or chamber, where it cools down converts back into liquid form — resulting in purified water. The process can be powered and h by multiple waste heat sources such as: Exhaust gases from vehicles or generators, Industrial machinery or boilers, Solar thermal collectors or domestic cooking stoves. used to For maintaining thermal efficiency, insulation materials like foam, glass wool, or thermocol are minimize heat losses. The condensed container, while residual waste is periodically removed.

6.1 Design Overview

To design a compact and ergonomic 3D CAD model of a portable air conditioner that optimizes internal space for cooling components. Component Integration and Fabrication • To perform thermal load calculations to determine the exact cooling capacity (BTU) required for a standard small-sized room (e.g., 10x10 sq. ft)..

6.2 Working Principle



The portable AC works on the vapor compression refrigeration cycle.

1. The compressor compresses low-pressure refrigerant vapor.
2. The condenser rejects heat to the atmosphere.
3. The capillary tube reduces refrigerant pressure.
4. The evaporator absorbs heat from room air.
5. A blower circulates cooled air into the room.

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7. System Design and Components

7.1 Mechanical Components

Component	Description
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Frame	Made of mild steel or aluminum; provides structural support.
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Rollers	Cylindrical shafts mounted at both ends of the conveyor; connected to the motor.
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Conveyor Belt	Rubber or nylon mesh belt designed to pick up debris.
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Waste Tray	Collection bin where debris accumulates after being lifted.
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Floatation Units	PVC pipes or drums attached to keep the machine buoyant.
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7.2 Electrical Components

Compressor

Hermetically sealed reciprocating compressor (1/6 HP to 1/4 HP).
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6.2 Condenser

Air-cooled fin-and-tube condenser with fan.

6.3 Expansion Device

Capillary tube.

6.4 Evaporator

Copper tube with aluminum fins.

6.5 Refrigerant

8. Design Calculations

Cooling Load Estimation

Assume room size:

- Length = 3 m
- Width = 3 m
- Height = 3 m
- Volume = 27 m³

Approximate cooling load:

9. Fabrication Process

The fabrication of the portable air conditioner was carried out systematically to ensure proper assembly, leak-free operation, and efficient cooling performance. The complete fabrication process is described below.

4. Floatation Setup:

.1 Design and Planning

The first step involved preparing the conceptual design and layout of the portable air conditioner. The dimensions of the casing, placement of the compressor, condenser, evaporator, blower, and electrical components were finalized. A compact box-type structure was selected to ensure portability and easy maintenance.

9.2 Fabrication of Supporting Frame

A rigid frame was fabricated using mild steel (MS) angle sections. The frame was cut according to the required dimensions and welded to provide a strong base for mounting all components. Four caster wheels were attached at the bottom to enable easy movement of the unit.

9.3 Preparation of Outer Casing

The outer casing was made using PVC sheets/ACP sheets to provide a lightweight and aesthetically pleasing enclosure. Openings were created for:

PVC pipes attached to sides for buoyancy.

10. Observation:

The performance of the fabricated portable air conditioner was tested in a closed room under controlled conditions. The initial room temperature was 35°C, and observations were recorded at intervals of 10 minutes.

11. Test Conditions

- Room size: 3 m × 3 m × 3 m
- Initial room temperature: 35°C
- Ambient temperature: 36°C
- Refrigerant used: R134a
- Compressor power: 0.25 HP
- Supply voltage: 230 V AC
- Test duration: 40 minutes

12. Advantages

The fabricated portable air conditioner offers several practical and technical advantages compared to conventional cooling systems. These advantages make it suitable for personal and small-space cooling applications.

12.1 Portability

The entire unit is mounted on caster wheels, allowing it to be easily moved from one room to another without dismantling or special tools.

12.2 No Permanent Installation Required

Unlike split air conditioners, the portable AC does not require wall mounting, drilling, or complex installation. It can be operated by simply connecting the power supply and arranging the exhaust.

12.3 Low Fabrication Cost

The system is fabricated using standard refrigeration components that are readily available in the market. This significantly reduces the overall manufacturing cost compared to commercial units.

13. Applications

Residential Use

The portable AC is highly suitable for cooling:

- Bedrooms
- Living rooms
- Study rooms
- Guest rooms
- Rental apartments

14. Cost Estimation

Total Material Cost	17,000
Total Labor Cost	3,500
Grand Total Estimated Cost	20,500

14.4 Comparison with Commercial Portable AC

15. Limitations

1.1 Limited Cooling Capacity

The system is designed for small rooms and cannot effectively cool large halls or open areas.

1.2 Higher Noise Level

Because the compressor and fans are housed within the same unit, the portable AC produces more noise compared to split air conditioners.

1.3 Lower Efficiency Than Split AC

Portable units generally have a lower coefficient of performance (COP) than larger split systems due to compact design constraints

16.1 Integration with Solar Power

The system can be powered using solar photovoltaic panels and a battery backup system. This will reduce electricity consumption and make the unit suitable for areas with limited power availability.

16.2 Smart Temperature Control

A microcontroller-based control system can be integrated to automatically regulate room temperature, fan speed, and compressor operation for improved energy efficiency.

16.3 IoT and Remote Monitoring

The portable AC can be connected to Wi-Fi and controlled through a mobile application. Users can monitor temperature, power consumption, and operating status remotely.

16.4 Use of Eco-Friendly Refrigerants

Future versions can use low global warming potential (GWP) refrigerants such as R290 or R32 to reduce environmental impact.

17. Conclusion

The present project successfully achieved the design and fabrication of a portable air conditioner based on the vapor compression refrigeration cycle. The primary objective was to develop a compact, movable, and cost-effective cooling system capable of providing efficient air conditioning for small enclosed spaces.

The fabricated unit consists of essential refrigeration components including a hermetically sealed compressor, condenser, capillary tube, evaporator, blower fan, thermostat, and an insulated casing mounted on a wheeled frame. All components were assembled using standard

fabrication and refrigeration techniques such as welding, brazing, leak testing, vacuuming, and refrigerant charging.

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