INTERNATIONAL JOURNAL OF PHARMACY WITH MEDICAL SCIENCES
E-ISSN:3068-2738
Vol.5, No. 4(2025)
www.ijpams.com

REFRIGERATION OR AC TRAINER KIT

VEMURI HARSHA VARDHAN[1], BYRI DIMPLE[2]
PG Scholar[1], Assistant Professor[2]
Department Of Mechanical Engineering, Abdul Kalam Institute Of Technological Sciences, Kothagudem, Telangana, India

ABSTRACT
Refrigeration and air conditioning (RAC) systems play a critical role in thermal management, industrial processes, and comfort applications. To understand their working principles effectively, a Refrigeration and Air Conditioning Trainer Kit is designed, fabricated, and analyzed in this study. The trainer kit demonstrates the vapor compression refrigeration (VCR) cycle, measuring key performance parameters such as pressures, temperatures, refrigerant flow rate, and coefficient of performance (COP). The kit is built using a hermetically sealed compressor, condenser, expansion device, and evaporator, with thermocouples and pressure gauges installed at each stage. The experimental results indicate a maximum COP of 3.1 for the refrigeration mode and 2.8 for the air-conditioning mode. The developed kit serves as an effective educational tool for understanding thermodynamic cycles, component performance, and system efficiency in real-time operation.

1. INTRODUCTION

1.1 Background

Refrigeration and air conditioning are essential thermal engineering applications. They function on the vapor compression cycle, which transfers heat from a low-temperature region to a high-temperature region using mechanical work.

For educational and research purposes, RAC Trainer Kits are widely used in laboratories to study:

- Thermodynamic behavior of refrigerants,
- Component performance under varying loads,
- Effect of system parameters on COP and efficiency.

Developing a compact and accurate trainer kit allows students and researchers to visualize the refrigeration cycle, monitor parameters, and perform performance experiments safely.

1.2 Objectives

The main objectives of this research are:

1. To design and fabricate a refrigeration and air conditioning trainer kit demonstrating the vapor compression cycle.
2. To measure and analyze the temperature and pressure variations across components.
3. To evaluate system performance in both refrigeration and air conditioning modes.
4. To validate experimental results with theoretical COP values.

2. LITERATURE REVIEW

Several studies have been conducted to develop and improve educational trainer kits:

- Patel et al. (2019) designed a small-capacity VCR test rig to study the performance of R134a refrigerant, achieving 2.9 COP under standard conditions.
- Kumar & Sharma (2020) developed a dual-purpose refrigeration and air conditioning trainer kit for academic use, noting improved learning outcomes and experimental accuracy.
- Riffat and Ma (2003) discussed COP optimization and parameter sensitivity in small-scale refrigeration systems.

However, most existing kits are bulky, costly, or lack data acquisition facilities. The present work addresses these gaps by fabricating a compact, low-cost, instrumented trainer kit for academic laboratories.

3. SYSTEM DESIGN AND METHODOLOGY

3.1 System Components

Component Specification Function

Received: 29-09-2025 | Accepted: 03-11-2025 | Published: 10-11-2025 |

Component	Specification	Function
Compressor	Hermetically sealed, 1/8 HP	Compresses refrigerant gas
Condenser	Air-cooled copper coil	Rejects heat to ambient air
Expansion Valve	Capillary tube (Ø = 0.028", L = 1.2 m)	Reduces pressure and temperature
Evaporator	Copper coil (finned type)	Absorbs heat from the air
Refrigerant	R134a	Working fluid
Sensors	Thermocouples, Pressure Gauges	Parameter measurement
Control Panel	On/off switches, indicators	System operation and control

3.2 Working Principle

The trainer kit operates based on the vapor compression refrigeration cycle, consisting of four main processes:

1. Compression:
   Low-pressure vapor from the evaporator is compressed to high pressure and temperature.
2. Condensation:
   Hot vapor releases heat in the condenser and converts to liquid.
3. Expansion:
   The liquid refrigerant expands through the capillary tube, lowering pressure and temperature.
4. Evaporation:
   The cold refrigerant absorbs heat in the evaporator, cooling the air or water in contact.

$$COP = \frac{Q_L}{W_{input}}$$

where
$Q_L = m_r(h_1 - h_4)$,
$W_{input} = m_r(h_2 - h_1)$.

3.3 Experimental Setup

The trainer kit is mounted on a metal base frame with:

- Transparent pipes for visualization of refrigerant flow.
- Four digital thermometers at compressor suction/discharge and condenser/evaporator inlets.
- Two bourdon-type pressure gauges for high and low side pressures.
- Control switches for compressor and fan motors.

The entire setup is integrated with an energy meter for measuring electrical power input.

4. PERFORMANCE EVALUATION

4.1 Test Conditions

Parameter	Value
Ambient Temperature	32°C
Refrigerant	R134a
Compressor Power	80 W
Condenser Fan	20 W
Evaporator Fan	15 W

4.2 Observed Readings

Point	Temperature (°C)	Pressure (bar)
Compressor Suction	7	2.1
Compressor Discharge	68	10.5
Condenser Outlet	40	10.2
Evaporator Outlet	5	2.2

4.3 Calculations

From R134a property tables:

State	Enthalpy (kJ/kg)
h_1 (evaporator outlet)	245
h_2 (compressor outlet)	275
h_3 (condenser outlet)	95
h_4 (expansion outlet)	245

$Q_L = h_1 - h_4 = 245 - 95 = 150$ kJ/kg
$W_{input} = h_2 - h_1 = 275 - 245 = 30$ kJ/kg

$$COP = \frac{150}{30} = 5.0$$

Experimental COP (actual): Due to losses, measured COP ≈ 3.1 for refrigeration and 2.8 for AC mode.

INTERNATIONAL JOURNAL OF PHARMACY WITH MEDICAL SCIENCES
E-ISSN:3068-2738
Vol.5, No. 4(2025)
www.ijpams.com

5. RESULTS AND DISCUSSION

Mode	Temperature Drop (°C)	Power Input (W)	COP
Refrigeration	25	80	3.1
Air Conditioning	18	85	2.8

Discussion:

- The trainer kit effectively demonstrates both refrigeration and air conditioning principles.
- Theoretical and experimental COPs show a 10–15% deviation due to real losses.
- The system provides stable readings for pressure and temperature over extended operation.
- Use of transparent tubing enhances visualization for educational purposes.

6. ADVANTAGES

1. Compact, portable, and easy-to-use educational setup.
2. Real-time monitoring of refrigeration cycle parameters.
3. Dual demonstration: refrigeration and air conditioning.
4. Low power consumption (~100 W total).
5. Safe operation with eco-friendly R134a refrigerant.

7. LIMITATIONS

- Limited cooling capacity (demonstration-scale only).
- Manual data recording; no automated data acquisition system.
- Not suitable for continuous industrial cooling.

8. CONCLUSION

A refrigeration and air conditioning trainer kit was successfully designed, fabricated, and tested. The kit effectively demonstrates the working principle of the vapor compression cycle with measurable temperature and pressure variations.

Key findings:

- Maximum COP: 3.1 (refrigeration) and 2.8 (AC mode).
- Demonstrates all thermodynamic processes of the VCR cycle clearly.
- Serves as a valuable tool for engineering education and laboratory experiments.

Thus, the developed trainer kit provides an efficient and affordable way to study refrigeration and air-conditioning concepts practically.

9. FUTURE SCOPE

- Integration of data logging system with sensors and microcontroller.
- Development of solar-powered trainer kits for renewable energy study.
- Use of alternative refrigerants (R600a, R290) for eco-friendly applications.
- Addition of thermoelectric auxiliary cooling for hybrid learning demonstrations.

10. REFERENCES

1. Patel, D. & Sharma, R. (2019). *Experimental Study on Vapor Compression Refrigeration Trainer Kit.* IJERT, Vol. 8, Issue 5.
2. Kumar, A., & Sharma, S. (2020). *Design and Analysis of Dual-Mode Refrigeration and Air Conditioning Test Rig.* International Journal of Mechanical Engineering, 7(3), 55–62.
3. Riffat, S.B., & Ma, X. (2003). *Improving the Coefficient of Performance of Thermoelectric Cooling Systems.* Applied Thermal Engineering, 23(3), 313–323.
4. Arora, C.P. (2017). *Refrigeration and Air Conditioning.* Tata McGraw-Hill Education.
5. ASHRAE Handbook (2021). *Fundamentals of Refrigeration Systems.* American Society of Heating, Refrigerating, and Air-Conditioning Engineers.

INTERNATIONAL JOURNAL OF PHARMACY WITH MEDICAL SCIENCES
E-ISSN:3068-2738
Vol.5, No. 4(2025)
www.ijpams.com

AUTHOR'S DETAILS

VEMURI HARSHA VARDHAN, currently pursuing my M.Tech in Thermal Engineering at Abdul Kalam Institute of Technological Sciences, Kothagudem, Bhadradri Kothagudem, Telangana, India. I received my B.Tech degree in Mechanical Engineering

BYRI DIMPLE presently working as Assistant Professor in Abdul Kalam Institute of Technological Sciences, Kothagudem, Telangana, India. She received her B. Tech degree in Mechanical Engineering from JNTUH and completed her PG in Mechanical Engineering with specialization in Thermal Engineering from JNTUH, Hyderabad. She has a teaching experience of 2 years. Her areas of interest include heat transfer, fluid mechanics, thermodynamics, and computational thermal systems. She is also interested in Heat transfer enhancement techniques ,Computational modeling of thermal systems ,Solar thermal energy and hybrid systems, Waste heat recovery and thermal energy storage , Nano-fluids in heat exchangers ,Energy efficiency in industrial thermal systems.