Chapter 4

Experimental analysis and results

4.1 Introduction

Water is recognized as an essential resource for plant growth, with its availability directly influencing plant health and survival. However, in urban environments, ensuring a consistent water supply for plants has been observed to be challenging due to busy lifestyles, frequent travel, and limited space for traditional irrigation methods. It has been noted that apartment residents, in particular, often face difficulties in maintaining regular watering schedules, resulting in the drying and deterioration of indoor and balcony plants.

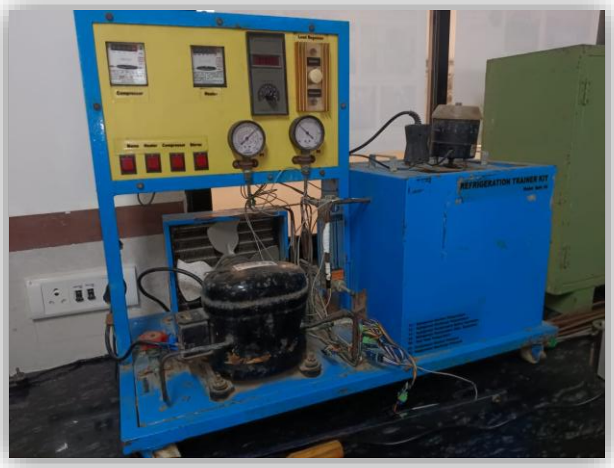

Fig 4.1 Refrigeration kit

In this study, a refrigeration-based atmospheric water generation system has been developed for automatic plant watering. The principles of vapor compression refrigeration have been applied to condense moisture from the air using an evaporator and a cooling mechanism. The water obtained through condensation has been collected and utilized for irrigation, thereby eliminating the dependence on an external water supply.

The primary objective of this study has been to optimize the condensation process by improving the evaporator design and enhancing airflow to increase water yield. An experimental analysis has been conducted to evaluate the effects of design modifications, including the integration of a blower to enhance forced convection. The results obtained have provided valuable insights into improving the efficiency and practicality of such systems for urban plant care.

In this chapter, a detailed experimental analysis is presented, including the methodology, system modifications, theoretical calculations, and key findings. Additionally, recent updates in system development are highlighted, and potential improvements for future implementation are outlined.

4.2 Aim of Experimental Setup

To optimize water condensation, this study examines the evaporator's design efficiency and the effect of forced convection on mass transfer using a compressor and a blower.

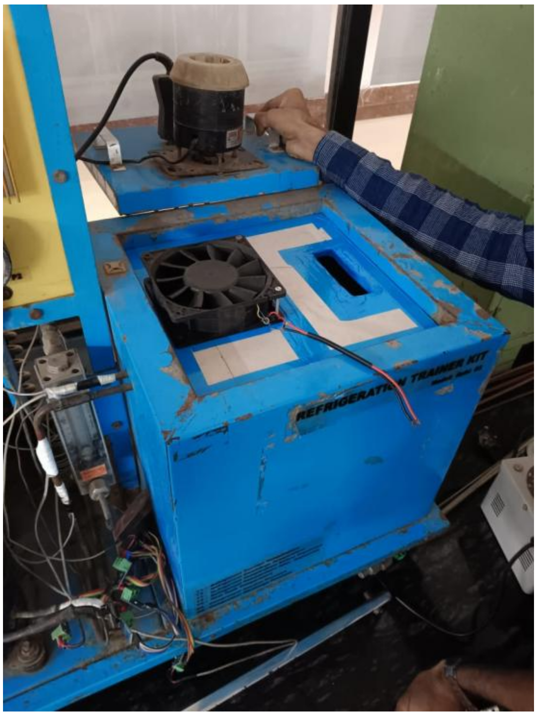

Fig 4.2 Experimental setup

4.3 Experimental Setup and Methodology

To optimize water condensation, this study examines the evaporator's design efficiency and the effect of forced convection on mass transfer using a compressor and a blower.

4.3.2 Modifications in the Experimental Setup

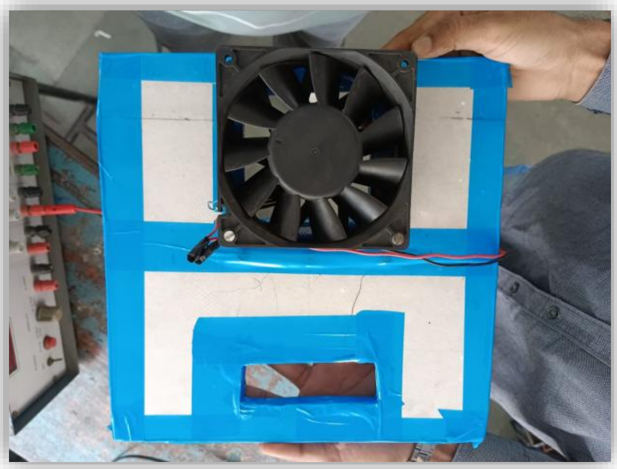

Fig 4.3 Experimental setup

- A cap was added to fix a blower on top of the evaporator, improving airflow and moisture condensation.

4.3.3 Experimental Conditions

The experiment was conducted under controlled conditions to evaluate the efficiency of the condensation process. The setup included an evaporator, a refrigeration cycle, and a blower to enhance airflow over the evaporator coil. The conditions and the corresponding results are presented in

Table 4.1 - Experimental conditions for evaluating the efficiency of atmospheric water condensation using a refrigeration-based setup with R134a refrigerant.

Sr. No.	Condition	Value
1	Ambient Temperature	26°C
2	Air Velocity (with blower)	2 m/s
3	Refrigerant Used	R134a
4	Suction Pressure (Compressor)	1.93 bar
5	Discharge Pressure (Compressor)	9.9 bar
6	Evaporator Shape	Circular Helical Coil
7	Cooling Capacity of Compressor	3 kW

4.3.4 Observations and Results

Table 4.2 - Observed results of water condensation performance, highlighting the influence of airflow enhancement and system efficiency under controlled experimental conditions.

Sr. No.	Observation	Result
1	Water Collected in 15 minutes	80 mL
2	Water Collected in 1 hour	200 mL
3	Effect of Blower on Condensation	Increased moisture condensation due to forced convection
4	Airflow Impact	Higher airflow improved condensation efficiency
5	Overall System Performance	Effective condensation observed under controlled conditions

4.4 Conclusion

The experimental setup of the refrigeration-based atmospheric water generation system was successfully tested under controlled conditions. The incorporation of a blower to enhance forced convection significantly improved moisture condensation, leading to the collection of 200 mL of water within one hour.

The results confirm that higher airflow velocity positively influences condensation efficiency, making forced convection a critical factor in optimizing water extraction. The effectiveness of the vapor compression refrigeration cycle in atmospheric water harvesting was validated. However, further refinements in evaporator surface area, airflow distribution, and insulation are recommended to enhance the system's overall efficiency.