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FABRICATION OF AIR COOLER

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Abstract:

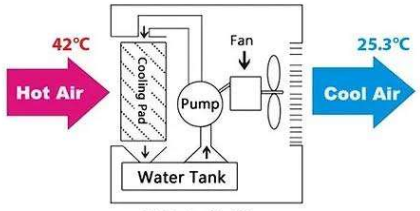
Air cooler is an economical and energy-efficient cooling device widely used in domestic and industrial applications . this project focuses on the design and fabrication of an air cooler using simple and easily available materials . the system works on evaporative cooling principle, where hot air passes through wet cooling pads resulting in temperature reduction. The fabricated air cooler is eco-friendly, low-cost, and consumes less electricity compared to air conditioners. The project demonstrates practical knowledge of fabrication, design, and thermal engineering concepts.

Keywords: Air cooler, evaporative cooling, fabrication, cooling pads, energy efficient, eco-friendly

1. INTRODUCTION

Cooling systems are widely used to maintain comfortable temperature in homes, offices and industries. Air conditioners provide effective cooling but they consume high electrical power and are costly . air cooler is an alternative cooling device which is economically and consumes less electricity . air cooler works on the principle of evaporative cooling . when hot air passes through wet cooling pads , water evaporates and absorbs heat from air . this results in decrease in air temperature . the cool air is then circulated into the room using a fan . air cooler are environment friendly because they use water as refrigerant instead of harmfull gases like cfc and hcfc used in air conditioners . they also require less maintenance and are easy to operate . the objective of this project is to fabricate an efficient air cooler using simple design and easily available materials , the fabricated model provides good cooling effect with low power consumptions . air cooler is environment friendly because it uses water as cooling medium .

It does not release harmful gases and does not cause pollution. Air cooler is simple in construction, easy to maintain and economical . the objective of this project is to design and fabricates an efficient air cooler using simple components and locally available materials . the fabricated air cooler should provide good cooling effect with minimum cost .



Working Principle Diagram of Evaporative Air Coolers

FIG. AIR COOLER

PROBLEM STATEMENT

High temperature conditions creates discomfort in daily life. Air conditioners are costly and not affordable for everyone . thus, there is a need to design a low-cost, energy-efficient cooling systems that can be easily fabricated and maintained .

2. LITERATURE REVIEW

Many researches and engineers have worked on evaporative air cooling systems to improve cooling efficiency, reduce energy consumptions, and develop eco-friendly cooling devices. Air coolers are widely used due to their simple construction, low maintenance, and low operating cost. The performance of air cooler mainly depends on air velocity, humidity, type of cooling pad material, and water distribution system .**Patil S. and Kulkarni R. [1]** studied the design and fabrications of a portable air cooler for domestic applications. In their research, they explained that evaporative air cooling methods compared to refrigeration systems. Their fabricated model used a small electric motor, fan, and cellulose cooling pads . they observed that the air cooler reduced surrounding temperature by 5 °C to 7°C under normal atmosphere conditions. Their study also showed that power consumption of air cooler is much lower than air conditioner, making it suitable for residential use .

Sharma A. [2] conducted performance analysis of desert air cooler and studied the effect of humidity on cooling efficiency . it was found that evaporative cooling works more effectively in dry climatic conditions. When humidity is low, evaporation rate of water increases which results in better cooling efficiency depends on environmental conditions such as temperature, humidity, and air flow rate. The research also suggested that proper air circulation improves cooling performance.

Kamble p. and Patil r. [3] developed an eco-friendly air cooler which uses low power dc motor and water pump system. The aim of their project was to reduce electricity consumption. Their fabricated model was compact and portable which can be used in small rooms and offices. They observed that proper distribution of water on cooling pads improves cooling efficiency. Their research also focused on use of alternative energy sources such as solar panel to operate air cooler in rural areas where electricity supply is limited .

Kulkarni S. [4] studied different types of cooling pad materials such as wood wool pads, honeycomb pads, and cellulose pads. It was found that honeycomb cooling pads have better water retention capacity and provide larger surface area for evaporation. Due to this, honeycomb pads provide better cooling effect compared to traditional cooling pads. The study also conducted that proper thickness of cooling pad improves cooling performance.

Deshmukh p. [5] worked on improving air flow distribution inside air cooler by modifying fan blade design. It was observed that proper fan blade angle increases air flow rate which improves cooling efficiency. The research suggested that selection of proper fan and motor is important for effective cooling .

From the literature review, it is observed that evaporates air cooling system is simple, economical, and environmental friendly. Cooling performance mainly depends on pads material, air flow rate, humidity, and water circulation system. Previous research shows that air cooler is best alternative to air conditioner for low cost cooling applications.

COMPONENTS USED

the fabrication of air cooler requires selection of suitable mechanical and electrical components which help in efficient cooling performances. Each component play an important role in working of the air cooler. The main components used in fabrication of air cooler are explained below :

Fan (blower)

Fan is one of the most important components of air cooler. It is used to circulate air inside the cooler and deliver cool air into the surrounding environment. The main function of fan is to draw hot air from atmosphere and force it through wet cooling pads. When air passes through cooling pads, temperature of air decreases due to evaporation of water.

Generally, axial fan or centrifugal blower is used in air cooler depending on design requirement. Fan blades are designed in such a way that maximum air flow can be achieved with minimum power consumption. The performance of air cooler mainly depends on air flow rate produced by fan. Higher air flow rate increases cooling effect. The fan is mounted inside the cooler body and connected to electric motor through shaft.

Electric Motor

Electric motor is used to rotate the fan blades. It converts electrical energy into mechanical energy. The motor provides necessary torque to rotate fan at required speed. Generally, single phase ac motor is used in air cooler because it is easily available and consumes less power. The motor capacity depends on size of air cooler and required air flow rate. Motor is connected to power supply using electric wire and switch. Proper insulation is provided to avoid electric hazards.

Functions of motor :

- Rotates fan blades
- Provides required speed
- Ensures continuous operation
- Converts electrical energy into mechanical energy.

Cooling Pads

Cooling pads are used to reduce temperature of hot air. Cooling pads are made of materials such as wood wool, cellulose fiber, or honeycomb paper material. These materials have good water absorption capacity. Cooling pads are placed on sides of air cooler. Water flows over cooling pads and makes them wet. When hot air passes through wet cooling pads, water evaporates and absorbs heat from air .

Cooling pads provide large surface area for evaporation process. Honeycomb cooling pads provide better cooling efficiency because they retain more water and provide better air contact surface.

Function of cooling pads :

- Absorbs water
- Provide surface for evaporation
- Reduce air temperature
- Improve cooling performance

Water pump

Water pump is used to circulate water from water tank to cooling pads. Continuous supply of water is required to keep cooling pads wet. Small submersible pump is generally used in air cooler. Pump operates on electric power and supplies water through pipe system. Pump capacity should be selected properly to ensure uniform distribution of water on cooling pads.

Functions of water pump :

- Circulates water to cooling pads
- Maintains wet condition of pads
- Ensures contribution cooling process

Water tank

Water tank is used to store water required for cooling process. Water tank is located at bottom of air cooler. Pump draw water from tank and supplies it to cooling pads. Tank capacity depends on size of air cooler. Proper tank capacity ensures continuous operations for longer time without refilling water. Plastic or metal tank is generally used .

Function of water tank :

- Stores water
- Supplies water to pump
- Maintain water level

Pipe and water distribution system

Pipe system is used to carry water from pump to cooling pads, small holes are provided in pipe for equal distribution of water. Pipes are generally made of plastic material. Proper water distribution improves cooling efficiency.

Function of pipes :

- Supply water to cooling pads
- Ensures equal water distribution
- Improves evaporation process

Outer Body (casing)

Outer casing of air cooler supports all components. It is generally made of plastic, fiber or sheet metal. The body should be strong enough to hold motor, fan, pump and cooling pads. Outer body also protects internal components from dust and damages. Proper design of body improves air flow direction.

Functions :

- Supports all components
- Protects internal parts
- Provides structure to cooler

Frame or supporting structure :

Frame is used to provide strength and rigidity to air cooler body. It is made of metal or plastic material.

Frame supports motor, fan and cooling pads in proper positions.

Functions :

- Provides mechanical strength
- Maintains stability
- Holds components in position

Switch and electrical wiring

Switch is used to control operation of motor and pump. Electrical wiring is used to supply power to motor and pump. Proper insulation is required for safety purpose.

Functions :

- **Controls On/Off operation**
- **Supplies electrical power**
- **Ensures safe operation**

Castor Wheels (optional)

Wheels are provided at bottom of air cooler for easy movement. Air cooler becomes portable and can be moved easily from one place to another .

Functions :

- Improves portability
- Easy movement
- User convenience

Overall selection of proper components is important to achieve efficient cooling performance. All components should be assembled properly to ensure smooth working of air cooler .

3.MECHANICAL METHODOLOGY

Methodology describes the steps by step procedure followed in design and fabrication of air cooler. Proper planning and systematic approach is required to achieve desired results .

The methodology of fabrication of air cooler is divided into main two main parts :

- System design
- Mechanical fabrication

System design

System design includes arrangement of various components such as fan, motor, cooling pads, water pump and water tank in proper position.

Following factors are considered during system design :

Size of air cooler

Space required for components

Positions of fan

Air flow direction

Position of water pump

Ease of maintenance

The design should be simple, economical and easy to fabricate.

Mechanical fabrication

Mechanical fabrication includes manufacturing and assembly of different components of air cooler.

Steps involved in fabrication process.

1. Preparation of design drawing using CAD software
2. Selection of suitable material for body
3. Measurement of required dimensions
4. Cutting of sheet metal according to dimensions
5. Bending of metal sheet to required shape
6. Drilling holes for assembly
7. Installation of fan and electric motor
8. Installation of cooling pads on three sides
9. Installation of water pump inside tank
10. Connection of pipes system for water distribution
11. Final assembly of all components
12. Testing of fabricated air cooler

Total used in fabrication:

Drilling machine, cutting machine, welding machine, measuring scale, screw driver, spanner

Proper care is taken during fabrication to ensure correct alignment of components.

FLOW CHART OF METHODOLOGY

Step1- problem identification

Step2- design of air cooler

Step3- selection of material

Step4- preparation of CAD model

Step5- cutting of material

Step6- fabrication of body

Step7- installation of motor and fan

Step8- installation of cooling pads

Step9- installation of pump and pipe

Step10- assembly of components

Step11- testing of air cooler

Step12- results and conclusion

DESIGN CALCULATION

Proper design calculation is required to ensure safe and efficient working of air cooler. Important parameters considered in design are air flow rate, motor power and cooling efficiency.

1.Air flow rate

Air flow rate is volume of air delivered by fan per unit time.

Air flow rate (Q)= area x velocity

Assume,

Area of fan outlet = 0.25 m^2

Velocity of air = 3 m/s

Q = 0.25 x 3

Q = 0.75 m^3/sec

Air flow rate = 0.75 m^3/sec

Higher air flow rate improves cooling performance.

2.Motor power calculation

Power required to rotate fan depends on air resistance and fan size.

Power = force x velocity

Assume,

Force = 50 N

Velocity = 3m/sec

Power = 50 x 3

Power = 150 watt

Therefore, motor of 150 w capacity is sufficient for air cooler.

3.Cooling efficiency

cooling efficiency of air cooler depends on temperature difference.

Efficiency = $(T_1-T_2) / (T_1-T_3)$

Where,

T_1 = outside air temperature

T_2 = air temperature after cooling

T_3 = wet bulb temperature

Assume,

T_1 =35^{o}C

T_2 =27^{o}C

T_3 =24^{o}C

Efficiency = (35-27) / (35-24)

Efficiency = 8 / 11

Efficiency = 0.72

Cooling efficiency = 72%

This show air cooler provides effective cooling.

To achieve proper performance of fabricated air cooler, systematic procedure is followed. Along with basic fabrication steps, some additional important considerations are included in methodology to improve efficiency, durability, and reliability of air cooler.

4.Requirement Analysis

Before starting fabrication process, requirements of air cooler are analysed. The main requirements include cooling capacity, size of cooler, power consumption, and cost limitation. The air cooler should be compact, portable and suitable for small room cooling application.

Important factors considered:

- Required air flow rates
- Cooling efficiency
- Power consumption
- Material availability
- Ease of maintenance
- Cost of fabrication

Requirement analysis helps in selecting proper components and materials.

5.Selection of material

Material selection is important step in fabrication process. Material should be strong, lightweight and corrosion resistant.

Material used in air cooler fabrication:

- Mild steel sheet or plastic body
- Cellulose cooling pads
- Copper or plastic pipe
- Plastic water tank

Proper material selection improves life and performance of air cooler.

6.CAD Modeling

Computer aided design (CAD) software is used to prepare design of air cooler. CAD model helps to understand structure and arrangement of components before fabrication.

Advantages of CAD modeling:

- Improves design accuracy
- Reduces fabrication error
- Helps in proper dimensioning
- Saves time and cost

CAD model shows position of fan, motor, cooling pads and water tank.

7.Dimension Calculation

Proper dimension of air cooler body are calculated based on required air flow rate and space availability.

Example dimensions considered :

Height = 750 mm

Width = 450 mm

Length = 450 mm

Proper dimension ensures good air circulation.

WORKING PRINCIPLE

The fabricated air cooler works on the principle of evaporates cooling. Evaporates cooling is a natural process in which liquid water changes into vapour by absorbing heat from surrounding air. When water evaporates, it requires latent heat of vaporization, which is taken from surrounding air. Due to this heat loss, temperature of air decreases and cool air is produced.

In air cooler, hot air from environment is draw inside the cooler with the help of fan. Cooling pads are placed on three sides of the cooler body. These cooling pads are continuously supplied with water using a small water pumps. The pump lifts water from water tank and distributes it uniformly over cooling pads through pipe systems.

Cooling pads absorbs water and remain wet. When hot air passes through these wet cooling pads, evaporation of water takes place. During evaporation process, water absorbs heat from hot air. As heat is removed from air, temperature of air decreases.

The cool air is then circulated into the room with the help of fan. This continuous circulation of air produces cooling effects inside the room.

The cooling effect depends on various factors such as :

- Humidity of air
- Temperature of surrounding air
- Air flow rate
- Water distribution on cooling pads
- Thickness and material of cooling pad

Evaporates cooling works best in dry climate where humidity is low. When humidity is high, evaporation rate decreases and cooling effect is reduced.

Working steps of fabricated air cooler :

1. Water is filled in water tank.
2. Water pumps circulates water from tank to cooling pads.
3. Cooling pads absorbs water and becomes wet.
4. Fan draws hot air from surrounding atmosphere.
5. Hot air passes through wet cooling pads.
6. Water evaporates by absorbing heat from air.
7. Temperature of air decreases.
8. Cool air is delivered.

4.RESULT

After completing the fabrication and assembly of the air cooler, testing was carried out under normal atmospheric conditions to evaluate its performances, cooling efficiency, and working stability. The fabricated air cooler was tested in a closed room environment to observe temperature reduction, air flow performance, and power consumption.

Initially, the water tank was filled with clean water and the water pump was switched on. The pump circulated water continuously to the cooling pads through pipe distribution system. It was observed that the cooling pads absorbed water properly and remained uniformly wet throughout the operation. Proper wetting of cooling pads is very important because evaporation process depends on moisture content present in pads.

When the fan was switched on, it started drawing hot air from surrounding atmosphere and forced it through wet cooling pads. During this process, evaporation of water took place and heat from air was absorbed by water molecules. As a result, temperature of air decreased and cool air was delivered into the room.

The temperature of the air was measured before and after operating the air cooler. It was observed that air temperature was reduced by approximately 5^{o}C to 8^{o}C, depending upon humidity level and surrounding temperature. Maximum cooling effect was observed during afternoon time when outside temperature was high and humidity was low.

The air flow rate produced by fan was sufficient to circulates cool air in the room effectively. The air distribution was uniform and no vibration or noise problem was observed during operation of air cooler.

The motor operated smoothly and consumed less electrical energy compared to conventional air conditioning systems.

Power consumption of fabricated air cooler was observed to be approximately 150 to 200 watts, which is very low compared to air conditioner which consumes around 1 to 1.5 kw power. This shows that fabricated air cooler is energy efficient and economical cooling solution.

5.CONCLUSION

The project “Fabrication Of Air Cooler” was successfully completed using simple design and easily available materials. The main objectives of this project was to develop an economical and energy efficient cooling system that can be used for domestic and small scale applications.

The fabricated air cooler works on evaporative cooling principle which is natural and environment friendly process. The system uses water as cooling medium and does not require harmful refrigerant gases such as CFC or HCFC. Therefore, air cooler does not cause pollution and is safe for environment.

The fabrication process helped in understanding practical knowledge of mechanical design, material selection, assembly process and working principle of cooling system. All components such as fan, motor, cooling pads, water pump and water tank were properly selected and assembled to achieve desired cooling effect.

The fabricated air cooler consumes less electrical power compared to air conditioner. Therefore, it reduces electricity costs and saves energy. The system is portable, easy to operates and requires very less maintenance.

The cooling performance of fabricated air cooler depends on humidity level, air flow rate and water distribution on cooling pads. It is observed that cooling efficiency is higher in dry climate conditions where evaporation rate is high.

The advantages of fabricated air cooler are :

- Low initial cost

- Low power consumption
- Eco-friendly operation
- Simple construction
- Easy maintenance
- Portable design
- Suitable for small rooms

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