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DESIGN AND FABRICATION OF MOISTURE REMOVER WITH CONTROLLED TEMPERATURE

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ABSTRACT

One of the main causes of corrosion, oxidation, and material deterioration on metal surfaces is moisture retention, which may have a big effect on how long metal components last and function. Complete moisture removal is crucial in many sectors to avoid long-term harm and preserve operational dependability. Conventional heating and natural evaporation are two traditional drying techniques that frequently fail to effectively remove remaining water, particularly from tiny and complex metallic equipment. The usefulness of a forced hot air circulation technique for effective moisture removal is examined in this work. This method ensures even heat distribution and avoids overheating while speeding up the evaporation of water droplets through the use of directed airflow and regulated heatingFor industrial, laboratory, and specialized applications where moisture-free conditions are crucial, this technology offers a cost-effective, energy-efficient, and scalable alternative. Experimental study shows that it improves drying efficiency when compared to passive procedures. Forced hot air circulation is a potential substitute for traditional drying methods, according to the findings, since it may greatly lower the risk of corrosion and increase the lifespan of metal equipment.

Keywords: Moisture Removal, Forced Hot Air Circulation, Metal Degradation, Corrosion Prevention, Drying Efficiency, Thermal Drying.

I. INTRODUCTION

One major problem that causes corrosion, oxidation, and long-term material deterioration on metal surfaces is moisture retention. Maintaining dry and moisture-free metal components is crucial for ensuring their longevity and performance in sectors including industrial, aircraft, medical equipment, and automotive. Remaining water droplets on metal surfaces cause electrochemical processes that shorten equipment lifespan, erode structural integrity, and speed up the formation of rust. Furthermore, moisture absorption might become a persistent issue in high-humidity situations, necessitating the development of effective drying methods.

Traditional drying techniques include chemical treatments, heat-based evaporation, and air drying frequently have drawbacks. While applying too much heat can cause thermal stress and deformation in some metals, air drying is a sluggish process that could not fully eliminate any remaining water. Although chemical drying agents can be useful, they may cause contamination or necessitate further cleaning techniques. A dependable, economical, and effective method for removing moisture from metallic surfaces is becoming more and more necessary in light of these difficulties.

The forced hot air circulation approach is investigated in this study as a potential substitute for efficient moisture removal. This method ensures complete drying without inflicting thermal damage by accelerating water evaporation through the use of regulated airflow and heat. The method provides uniform heat distribution, preventing localized overheating while maintaining the structural integrity of metal components. Unlike passive drying techniques, forced hot air circulation enhances drying efficiency, making it suitable for applications that require rapid and complete moisture removal.

Designing and testing a system that uses hot air circulation to remove moisture from tiny metallic equipment is the aim of this study. The efficacy of regulated temperature, airflow direction, and heat intensity in effectively removing leftover water is the main emphasis of the study. The results of this study will help to advance moisture management techniques in laboratory and industrial settings, providing a workable and expandable way to stop corrosion-related problems.

II. METHODOLOGY

Because it effectively and efficiently removes any remaining moisture from metal surfaces, the forced hot air circulation method was selected. Conventional drying techniques, such conventional heating and natural air

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drying, can lead to surface oxidation, uneven drying, and extended drying periods. Forced hot air circulation, on the other hand, guarantees even heat distribution, quickens the evaporation of moisture, and avoids localized overheating, which may otherwise harm delicate metal parts. Because it removes the possibility of contamination and the need for extra cleaning, this approach was chosen over chemical drying procedures. Forced hot air circulation is also scalable, energy-efficient, and appropriate for a variety of applications where moisture-free metal surfaces are necessary to stop corrosion and material deterioration.

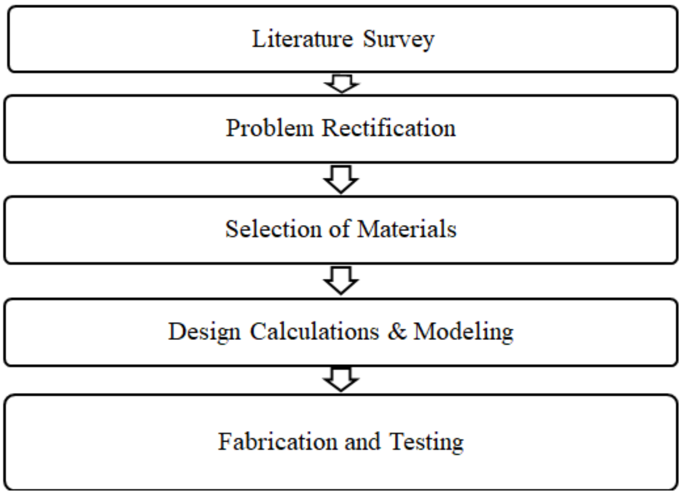

Fig 1.1: Methodology

III. WORKING PRINCIPLE

In order to ensure constant moisture evaporation, the device works by directing warm air over the metal surface. In order to maintain an ideal drying environment and avoid excessive heat exposure that might result in thermal stress or material deformation, the temperature is carefully controlled. By decreasing the boundary layer resistance surrounding the moisture droplets, The forced airflow increases the rate of evaporation, which expedites and enhances drying. The forced air circulation approach actively regulates temperature and airflow, which makes it a more dependable and repeatable process than passive drying techniques that depend on environmental factors. Air velocity, temperature control, and exposure duration are some of the variables that affect how well moisture is removed; they are all tuned throughout testing.

IV. SELECTION OF COMPONENTS

Efficiency, dependability, and exact control over the drying process were the main criteria used in the selection of the moisture removal system's components. Every part was picked with care to provide the best possible heating, control of airflow, and removal of moisture while preserving operational safety and energy economy.

1. Heating System

To supply the necessary thermal energy for moisture evaporation, a heating system is necessary. Without producing excessive temperature swings that might cause material deterioration or overheating, the chosen heating method guarantees even heat distribution. The heat source needs to be responsive, energy-efficient, and able to keep the temperature constant.

2. Air Circulation Mechanism

By continually circulating hot air across the metal surface, forced airflow is essential for quickening the evaporation process. To provide steady air circulation and avoid stagnant air pockets that can impede the drying process, a high-efficiency blower was used. In order to maximize drying time without generating excessive heat loss, the airflow rate is precisely regulated.

3. Temperature Control System

To prevent overheating and provide safe drying conditions, precise temperature control is essential. Because it can continually modify the heat output depending on real-time feedback, a PID temperature controller was used to maintain a constant temperature. This keeps the drying process within the ideal range for many kinds of metal equipment and avoids abrupt temperature spikes

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4. Temperature and Moisture Sensing

Temperature measurement accuracy is crucial for tracking and modifying drying conditions. Because of its great precision and quick reaction time, a thermocouple sensor was selected to enable real-time system modifications. By monitoring temperature changes and analyzing drying durations under controlled circumstances, moisture levels may be indirectly determined.

5. Power Supply and Control System

To guarantee that every component operates consistently, a dependable power source is necessary. A solid-state relay (SSR) was used to effectively regulate the heating system's power supply, reducing energy loss and guaranteeing seamless operation. The system's selection of these parts creates a balance between performance, safety, and efficiency, making it appropriate for specialized, industrial, and laboratory applications that call for the efficient removal of moisture.

V. DESIGN AND FABRICATION

Fig 2: Selection of Components

VI. DESIGN

The metal equipment is put in a heating chamber as part of the system to dry it. A forced convection system circulates heated air to guarantee quick moisture evaporation. The layout aims to accomplish:

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The heating element should be positioned to optimize heat transfer while avoiding localized overheating.

Strategic Airflow Direction: To ensure effective moisture removal, the blower is positioned to deliver hot air uniformly.

Temperature Monitoring Points: To enable accurate control, thermocouples are positioned at strategic points to offer real-time temperature feedback.

VII. FABRICATION

The system is fabricated using a methodical process to guarantee longevity and functionality.

1. Frame Construction:

To safely house the components, a heat-resistant enclosure is constructed.The material is selected based on its durability and thermal stability.

2. Heating Element Installation:

To guarantee that the drying area receives consistent thermal energy, the heating coil is installed within the chamber.

3. Blower Integration:

The blower is oriented to produce a regulated airflow that disperses heat throughout the chamber uniformly.

4. Temperature Control System Setup:

To precisely control and monitor the drying process, a thermocouple and PID controller are fitted.

5. Electrical connections and wiring:

With the inclusion of essential safety precautions like insulation and circuit protection, the power supply and control circuits are firmly coupled.

6. Testing and Calibration:

To make sure the airflow, temperature control, and drying efficiency meet the required performance criteria, the system is put through preliminary testing.

Fig 3: Fabricated Moist Remover

VIII. FUTURE SCOPE

Developments in automation, energy efficiency, scalability, and industrial uses are all part of the forced hot air circulation system's future potential. By combining AI-driven predictive algorithms with IoT-based monitoring, remote operation and real-time temperature and airflow optimization are made possible, improving drying efficiency while using less energy. More cost-effectiveness and sustainability may be achieved with the development of variable-speed blowers, solar-powered heating components, and energy recovery systems. Designing modular or multi-chamber drying systems to support bigger metal equipment or batch processing can help achieve scalability. Furthermore, performance may be optimized for various metal compositions by investigating material-specific drying profiles and utilizing cutting-edge drying methods like infrared or ultrasonic heating. Applications in industry can include fields where accurate moisture removal is crucial, such as additive manufacturing, food processing, medical equipment, aerospace, and automotive. The system may develop into a more intelligent, flexible, and energy-efficient drying solution appropriate for a variety of industrial and laboratory settings by putting these developments into practice.

IX. CONCLUSION

The forced hot air circulation system for moisture removal provides a dependable and effective way to get rid of any remaining water from metal equipment, extending its lifespan and halting deterioration. The technology minimizes energy consumption and thermal stress while ensuring uniform drying via the use of precise temperature management and regulated airflow. Better uniformity, quicker drying periods, and applicability to a range of industrial applications are some of the benefits the technology offers over conventional drying procedures. The system's ability to completely remove moisture is demonstrated by experimental study, which qualifies it for use in the industrial, automotive, aerospace, and medical sectors. Automation, energy optimization, and scalability are some future developments that might improve its effectiveness and usefulness even further. All things considered, this system offers a workable and expandable method of removing moisture, with the potential to have a big industrial influence and advance technical advancement.

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