

DESIGN and DEVELOPMENT of TABLE TOP TRAY-DRYER

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ABSTRACT :

This article presents the development and performance evaluation of a compact Tabletop Tray Dryer, designed for laboratory-scale and household drying applications. The device features two removable trays for accommodating a variety of samples, providing users with flexibility in their drying process. This tabletop tray dryer's heating element, which has a variable power supply, is its central component. The device's mobility is a significant benefit that makes it appropriate for both field and laboratory applications. Its small size and light weight make it portable, allowing drying tests to be carried out wherever they are required. The temperature display on the Tabletop Tray Dryer makes monitoring and control easier. Real-time monitoring of the drying temperature is made possible by this function, ensuring that experiments stay within the appropriate temperature range. In conclusion, this paper proposes a Tabletop Tray Dryer for laboratory-scale and household drying applications that combines adaptability, accuracy, and mobility. Researchers looking to study drying processes for a variety of materials and situations will find it to be a useful tool because of its variable heating element, adjustable airflow, and temperature display.

KEYWORDS: Variable temperature, variable air flow, household, laboratory, fruit and vegetables, portable

I. INTRODUCTION:

In the processing of chemicals, food, colors, and other goods, among other things, it is the most dependable drying method. Due to the widespread usage of the wet-granulation technique in the expanding pharmaceutical and food industries, tray dryers are in great demand. The materials to be dried are loaded in oven and kept in batches in trays. Chemical and physical properties can have a big impact on the final product.

- Chamber: The main housing where the trays are stacked and drying occurs.
- Trays: Shelves where materials are placed for drying.
- Heating System: Generates hot air for the drying process.
- Air Circulation System: Ensures even distribution of hot air within the chamber.
- Exhaust System: Expels moisture-laden air from the chamber.

II. MATERIALS and METHODS

A. MAIN COMPONENTS of a TRAY DRYER:

Tray dryers consist of several essential components, including:

RATED WATTAGE	2000W
RATED VOLTAGE	230V, 50Hz, AC
FAN MOTOR WATTAGE	30W
FAN MOTOR RPM	2300RPM
THERMAL CUT-OUT/ THERMOSTAT	YES
PRODUCT DIMENSION(LxWxH)	250mm x 118mm x 240mm

III.COMPONENTS USED:

B.MILD STEEL(CABINET)

Mild steel is widely chosen for its affordability. It provides good performance at a lower cost compared to many other materials, making it ideal for large-scale manufacturing and construction projects.

- **Versatility:** Mild steel finds applications in numerous industries, including construction, automotive, manufacturing, and engineering. It is used in the fabrication of structural components, machinery, appliances, and more.
- **Structural Use:** In the construction industry, mild steel is often used to create structural frameworks, including beams, columns, and reinforcing bars. Its strength and ductility make it a reliable choice for ensuring the stability and safety of buildings and infrastructure.
- **Automotive Industry:** Mild steel is used in the automotive sector for manufacturing vehicle parts, chassis components, and body panels due to its strength and formability.
- **Manufacturing:** In manufacturing, mild steel is employed for creating a wide range of products, including bolts, nuts, pipes, and various industrial machinery components.
- **Furniture and Appliances:** It is used to construct furniture, appliances, and consumer goods, thanks to its versatility and ability to be shaped and moulded into various forms.
- **Railways and Transportation:** Mild steel plays a crucial role in the construction of railways, bridges, and transportation infrastructure, where its strength and durability are essential.
- **Earthmoving and Construction Equipment:** It is a common choice for manufacturing earthmoving and construction equipment, including bulldozers, cranes, and excavators.

C.NBR SHEET(INSULATION):

NBR, or Nitrile Butadiene Rubber, is a versatile synthetic rubber material known for its excellent properties. It is a copolymer of butadiene and acrylonitrile, and the ratio of these two components can be adjusted to achieve specific properties. NBR sheets are particularly prized for their exceptional oil resistance, making them ideal for applications

where contact with oils, fuels, and greases is common. NBR sheets exhibit a temperature resistance typically ranging from -40°C to 120°C, making them suitable for use in both cold and moderately hot environments. Their flexibility and resistance to abrasion make NBR sheets highly durable, a feature that is especially valuable in applications requiring resistance to wear and tear, such as gaskets and seals. One of the primary uses of NBR sheets is for sealing and insulation. Due to their excellent sealing properties, they are widely employed in the manufacturing of gaskets, O-rings, and seals. Additionally, NBR sheets serve well in applications requiring insulation and vibration damping, contributing to noise reduction and the maintenance of temperature stability.

They are utilized to create components such as gaskets, O-rings, hoses, and seals in machinery and equipment, thanks to their ability to withstand exposure to oils, chemicals, and various environmental conditions. In the oil and gas industry, NBR is highly sought after for its resistance to oil-based fluids, making it a top choice for seals and gaskets in pipelines, valves, and drilling equipment. In the automotive sector, NBR sheets are used in fuel systems, transmission systems, and engines due to their oil resistance and durability. They also find application in the food industry for non-contact applications like conveyor belts, where resistance to oils and fats is essential. Furthermore, NBR is used in the medical and pharmaceutical industry for applications that require resistance to chemicals and biological substances. Lastly, NBR sheets are used in HVAC and construction for insulation and vibration dampening in heating, ventilation, and air conditioning systems.

D.ROOM HEATER:

These heaters are particularly useful for supplementing central heating or for heating smaller rooms efficiently. Small room heaters come in various types, including ceramic, radiant, and fan-forced heaters, each with its unique features. Ceramic heaters employ a ceramic heating element that heats up quickly and provides a consistent, even warmth. They are energy-efficient and often come with adjustable thermostats and oscillating fans for better heat distribution.

Radiant heaters emit infrared radiation that heats objects and people directly, creating a cozy, instant warmth. They are ideal for personal heating and are often found in outdoor spaces or bathrooms. Fan-forced heaters combine a heating element with a fan to distribute warm air throughout the room rapidly. They are great for quickly raising the temperature in a small space. Small room heaters offer convenience and flexibility, allowing you to heat only the areas you need while potentially reducing overall heating costs. However, safety precautions are essential, such as placing them away from flammable

materials and ensuring they have built-in safety features like tip-over switches and overheating protection.

E.LCD TEMPERATURE DETECTOR and DISPLAY:

Temperature Sensor: The core component of an LCD temperature detector is a temperature sensor.

Signal Processing: The temperature sensor generates a signal that corresponds to the temperature it's exposed to. This signal is then processed by an integrated circuit (IC) or microcontroller to convert the analog signal into a digital temperature reading.

LCD Display: The LCD screen is used to visually display the temperature reading. LCDs are preferred due to their low power consumption and ability to display information clearly. The temperature reading is typically shown in degrees Celsius (°C) or Fahrenheit (°F), along with a numerical value and sometimes a graphical representation.

- **Calibration and Accuracy:** LCD temperature detectors are typically calibrated to ensure accuracy. Calibration involves adjusting the device's output to match a known reference temperature. The accuracy of these devices can vary, with more precise applications requiring more accurate sensors and calibration.
- **Power Source:** LCD temperature detectors usually require a power source, such as batteries or an external power supply. Many of them are designed to be energy-efficient to prolong battery life.
- **Applications:** LCD temperature detectors and displays have a wide range of applications. They are commonly used in thermostats to control heating and cooling systems, in weather stations for monitoring outdoor temperatures, in industrial settings to ensure equipment operates within temperature limits, and in laboratories for research and experimentation.
- **Additional Features:** Some LCD temperature detectors may include additional features, such as high and low-temperature alarms, data logging capabilities, and the ability to switch between different temperature scales.
- **User Interface:** LCD temperature detectors may also include user-friendly interfaces that allow users to set temperature thresholds, configure alarms, and access historical temperature data if the device has data logging capabilities.
- In summary, an LCD temperature detector and display is a versatile device that accurately measures

and displays temperature using a temperature sensor and an LCD screen. These devices are used in various settings to monitor and control temperature, and they often come with additional features to enhance their functionality and user-friendliness.

LCD Display: These testers are equipped with a digital LCD display that shows the temperature reading clearly and typically in degrees Celsius (°C) or Fahrenheit (°F).

Temperature Range: They can measure a specific range of temperatures, which can vary depending on the model. Common temperature ranges include -10°C to 150°C

Probe: Most testers have a temperature probe or sensor that needs to come in contact with the substance or environment you want to measure. The probe is usually attached to the main unit by a cable.

Accuracy: The accuracy of the temperature measurements can vary from one device to another, but they are generally suitable for everyday use and provide reasonably accurate readings.

Power Source: These testers are typically battery-powered, with common power sources being button cell batteries.

Switchable Scales: Many models allow you to switch between Celsius scales for temperature display.

F.POWDER COATING/ PAINT:

Powder coating is a popular method of applying a durable and decorative finish to metal sheets. It is a dry finishing process in which a fine powder made of a mixture of pigments, resins, and other additives is applied to the metal surface. The coated metal is then heated to melt and fuse the powder into a smooth and even film, which forms a tough and protective layer. Here are some key aspects of powder coating for metal sheets:

Application Process: The powder coating process typically involves four main steps:

- **Preparation:** The metal surface is cleaned and pre-treated to remove any contaminants, such as oils, rust, or old paint, and to ensure proper adhesion of the powder coating.
- **Application:** The dry powder is electrostatically charged and sprayed onto the metal sheet. The electrostatic charge attracts the powder particles to the metal, creating an even and uniform coating.

- Curing: The coated metal sheet is heated in an oven, usually at temperatures ranging from 350°F to 450°F (177°C to 232°C).
- Cooling and Inspection: After curing, the metal is allowed to cool, and the finished product is inspected for quality and durability.

1)Advantages:

- Durability: Powder coatings are highly durable and resistant to chipping, scratching, fading, and corrosion.
- Variety of Colours and Finishes: Powder coatings come in a wide range of colours and finishes, including glossy, matte, textured, and metallic.
- Environmental Benefits: Powder coating is an eco-friendly option because it produces no volatile organic compounds (VOCs) and can be more easily recycled.
- Efficiency: The process is efficient, with minimal waste, as overspray can be collected and reused.

2)Applications:

- Metal Fabrication: Powder coating is commonly used in industries that involve metal fabrication, such as automotive, construction, and machinery manufacturing.
- Architectural: It is widely used for architectural elements like aluminum windows, doors, and handrails.
- Furniture: Metal furniture, both indoor and outdoor, often uses powder coating for a decorative and protective finish.
- Appliances: Household appliances like refrigerators and stoves may have powder-coated metal parts.

3)Maintenance:

Powder-coated metal sheets are relatively low-maintenance. They require periodic cleaning to remove dirt and grime but do not usually need re-coating unless damaged. Overall, powder coating for metal sheets offers a durable and aesthetically pleasing finish that is widely used in various industries and applications. It is valued for its resilience, versatility, and environmental benefits.

IV.COST ESTIMATION:

CABINET (MILD STEEL)-4500

ROOM HEATER-1500

PERFORATED TRAYS- 700

LCD TEMPERATURE RELAY-150

NBR SHEET-2650

FABRICATION-700

V.SCHEMATIC DIAGRAM:

Fig.1

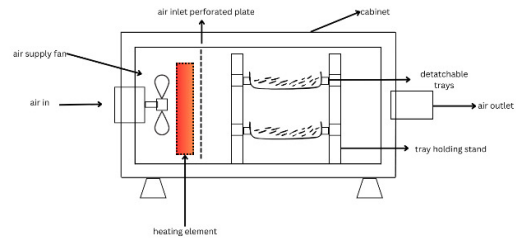
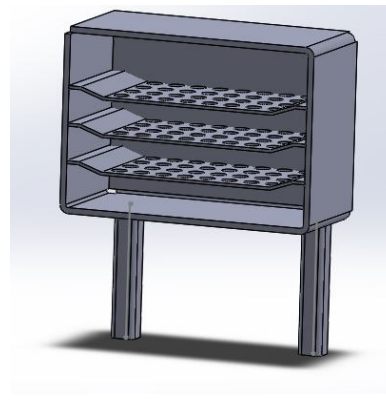


Fig.2



VI.PICTURE OF THE PRODUCT:

Fig.3



VII. ADVANTAGE OF TRAY DRYER OVER OVEN:

Tray dryers and ovens both serve the purpose of drying materials, but each has its own advantages and disadvantages. Whether a tray dryer is better than an oven for drying depends on the specific requirements of the drying process. However, there are several reasons why a tray dryer might be preferred in certain situations:

Uniform Airflow: Tray dryers are designed to have a more uniform and controlled airflow, which ensures that the drying process is consistent across all trays or shelves. This results in more even drying and reduces the risk of hotspots, which can be problematic in ovens.

Temperature and Humidity Control: Tray dryers often offer better temperature and humidity control. The ability to precisely control these parameters is crucial in many drying applications, such as pharmaceuticals, where the preservation of chemical stability and quality is essential.

Energy Efficiency: Tray dryers are generally more energy-efficient than ovens, as they are designed for the specific purpose of drying. They can be insulated to retain heat and have features like adjustable vents to control the drying environment effectively.

Customization: they accommodate various tray sizes and shapes, making them suitable for a wide range of drying applications.

Hygienic and Easy to Clean: Tray dryers are often easier to clean and maintain, which is crucial in industries like food and pharmaceuticals where cleanliness and hygiene are essential.

Higher Throughput: In industrial settings, tray dryers are capable of handling higher throughput compared to most ovens, making them more suitable for large-scale drying operations.

Reduced Contamination Risk: In applications where cross-contamination is a concern, such as in pharmaceutical or food processing, tray dryers can be designed with features that minimize the risk of contamination.

That said, ovens also have their advantages, particularly when drying is just one of several functions they perform. Ovens can be used for a wide range of heating and baking processes beyond drying, which can make them more versatile in certain situations. In summary, whether a tray dryer is better than an oven for drying depends on the specific requirements and constraints of the drying process. Tray dryers are generally favoured for their superior control, energy efficiency, and suitability for applications where precise drying conditions are critical.

VIII. APPLICATION OF SMALL-SCALE TABLE TOP TRAY DRYERS:

Small-scale tray dryers are essential for various applications due to their practicality, versatility, and cost-effectiveness. Here are several needs and reasons for using small-scale tray dryers:

Research and Development: Small-scale tray dryers are invaluable tools in research and development environments. They allow scientists and engineers to test and develop drying processes for new products, materials, or formulations on a small scale before moving to larger production.

Product Development: When developing new food products, pharmaceuticals, or materials, small-scale tray dryers enable companies to experiment with various drying conditions and formulations. This helps in achieving the desired product characteristics and quality.

Small Batch Production: Small-scale tray dryers are ideal for small batch or artisanal production of items such as specialty foods, herbal products, or artisanal crafts. They provide an efficient way to dry limited quantities of items without the need for large, industrial-scale equipment.

Customization: Small-scale tray dryers can be customized to specific requirements, making them suitable for niche industries or applications. This flexibility is essential for businesses with unique drying needs.

Cost-Efficiency: Small-scale tray dryers are more cost-effective for small and medium-sized businesses or startups that cannot afford large, industrial-grade drying equipment. They provide an affordable solution for drying small batches of products.

Product Testing: Small-scale tray dryers are used for product testing and validation. Before scaling up production, companies can use these dryers to ensure that the drying process meets the required specifications and standards.

Educational and Training Purposes: Educational institutions and training centres use small-scale tray dryers for teaching students and trainees about drying processes, equipment operation, and process control.

Laboratory Settings: Laboratories in different fields, including food science, chemistry, and pharmaceuticals, rely on small-scale tray dryers for research and experimentation.

Food Industry: In the food industry, tray dryers are employed for drying fruits, vegetables, grains, and various food products. They help extend the shelf life of these products by

reducing moisture content, thus preventing microbial growth and spoilage.

Chemical Industry: Tray dryers play a crucial role in the chemical industry, where they are used to dry chemicals, dyes, pigments, and various intermediate products. The precise temperature and airflow control of tray dryers help ensure consistent product quality.

Textile Industry: In the textile industry, tray dryers are used to dry dyed fabrics and textile materials. They aid in achieving uniform drying and maintaining the colour-fastness of the fabrics.

Agriculture: In agriculture, tray dryers are employed for drying crops like grains, seeds, and herbs. They help reduce moisture levels, preventing Mold and ensuring that the crops can be stored for extended periods.

Environmental Testing: Tray dryers are also used in environmental testing and research to determine the moisture content of various materials, which can be essential for assessing the quality and stability of materials.

Metallurgy: In metallurgy, tray dryers are used for drying samples and components before conducting tests or assessments. Controlling the moisture content is essential for accurate testing results. In summary, small-scale tray dryers serve a wide range of needs, from research and development to small batch production, quality control, and educational purposes. Their adaptability, cost-effectiveness, and versatility make them essential for businesses and institutions with limited drying requirements or specific drying conditions.

IX.RESULT AND DISCUSSION:

This study builds the apparatus and conducts the experiment to look into the effects of air temperature and velocity. The rate of evaporation is significant near the beginning of the process and tends to decrease as it goes along. Well, it is found that when an object has less water, the evaporation process requires more energy.

Mild steel used for the cabinet has reduced the overall weight by manifold. The room heater that is the source of heat is the main weight causing element. Otherwise, the NBR sheet and the trays are all relatively lower in weight and makes the dryer portable.

The temperature is adjusted by using the voltage regulator in the room heater. The temperature produced is proportional to the voltage. The possibility of short circuit and electrical accidents is avoided by, using the NBR sheet.

The basic integrity and structure are preserved by the components as the room heater has both heating element and fan, removable perforated trays and exhaust grill.

There are three fan speed settings which increase with each turn. The minimum temperature achieved is 70 degrees Celsius. There is no need for temperatures high such as 130 degrees, so the regulator is controlled at lower setting.

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