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Design and Development of Battery Drying Oven

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***Abstract:** In current era energy efficiency is most important part of life. Heat energy demand is tough challenge of scientists, engineers & industrialist entrepreneurs in the world. Heating is only one which we can use to dry the moisture content of the battery. Heating process become famous for all drying methods this technology used to extend the efficiency of the battery. In industrial application heat energy is used for multipurpose. This paper deals with how the conveyrised oven is used increasing the efficiency and life of battery. The plates of lead acid batteries are dried in drying oven in order to remove moisture. During the drying process, plates are suffered from burning & drying.*
Keywords- Heater, Oven, Blower, Conveyor Belt, Battery.

I. INTRODUCTION

In battery industries, while manufacturing any type of battery, moisture content is a serious issue in any type of lead acid battery. To resolve the battery moisture content issue , proper type of heating chamber is to be designed ,design of heating chamber is a scientific and statistical way of improving a system and process performance, conveyrised oven is the best solution for proper propagation of heating process. The function of drying oven is to remove moisture from product depending upon the process & production requirement. A batch or conveyor oven configuration is available but conveyor system is more economical for mass production. To meet process & safety requirements, the releasing system is developed to get the specific moisture release rate. Multiple heat sections provided to maximize the efficiency. Proper air flow ventilation is provided for uniform heating. For conveyor motion, planetary gear box with motor speed as an input is best way to achieve rotary motion of gear box to translator motion of conveyor. Generally drying oven is horizontal shaped use to dry & de-moisturize positive plates of lead acid batteries. It consists of steel conveyor belt with adjustable speed that carries plates, air blower, and temperature & safety controller.

II. LITERATURE SURVEY

Jim reeb, mike milota (1999) [1] says that, the oven drying test, combined with the stress test, is a very useful tool for the oven operator to have at his disposal. Often the oven operator is asked to defend the accuracy of moisture meter measurements or a customer simply does not believe moisture meter readings. In other situations, the operator may want to check meter readings for his own satisfaction. For situations in which moisture meters will give the same information immediately and with small effort, then they are the tools of choice.

Michel vollmer (2003) [2] says that, it deals with the generation of microwaves in the oven and includes the operation of the magnetrons, waveguides and standing waves in resonant cavities. It then considers the absorption of microwaves by foods, discussing the dielectric relaxation of water, penetration depths of electromagnetic waves in matter and in considering the possible chemical changes during the microwave heating, ionization or dissociation.

Yifan li, shujun li, zhao (2007) [3] says that, Combined drying of hot-air and microwave vacuum was applied for scallion. The effects of different drying conditions and drying methods on its sensory quality including colour & drying time, greater aspect and shape of dried scallion was analyzed. The effects of combined hot-air and microwave vacuum drying scallion under different microwave power and different cutting length was discussed.

Also the performance comparison of different drying methods including hot-air drying and microwave drying, combined hot-air and microwave vacuum drying were experimented.

Dr. Lash b. Mapa et.al (2012) [4] says that, it is an attempt to understand the factors that are significant in reducing the heat losses, with the goal of making design improvements to increase the efficiency of the oven or heat tunnel to provide value to the customers. Process heat, safety of oven equipment's, Temperature settings, environmental pollution and energy conservation are the major ones. As energy prices continue to increase, so the economic benefits of energy conservation should be examined.

Kanchanapiya premrudee et.al (2013) [5] says that, An integral part of automobile industry, lead acid battery manufacturing has exhibited large growth with increasing trends toward advanced manufacturing technology. This research aimed to study life cycle assessments of lead-acid automobile battery manufactured in Thailand by comparing conventional batteries with calcium maintenance free batteries.

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III. METHODOLOGY

A. *Project Design*

An oven is required to heat up lead acid battery components. The oven is 250mm high x 1720mm wide x 3540mm long and is lagged with 100mm of insulation. On top of the oven is an extraction duct, and air is exhausted from the oven through the duct at the rate of 4800m³ per hour. Inside the oven are steel trays with contained in these trays are lead battery components weighing a total 1500kg. The trays and components are to be raised from 20°C to 110°C in 30 minutes.

In this case there is only one calculation required, the heating up load.

Data required calculating this example:

Sp. Heat of Steel (MILD) = 0.502

Sp. Heat of Air = 1.004

Heat loss through 100mm lagging t = 110°C=0.25kW

Heat transfer coefficient= 4.5 w/m^2

M= mass of lead material= 1500 kg

Volume of system oven box = 1720 x 3540 x250

=1.522 x10^9 mm^3

= 1.522 m^3

Heat capacity of to heat lead plates along with box= $m \times c_p \times \Delta T = (1500 \times 0.159 \times 90)$

= 21.465 kW.

Heat capacity to panel or sheet= $m \times c_p \times \Delta T = (1.522 \times 0.502 \times 90)$

= 68.7639 W.

Heat loss or required to heat to doors= $2 \times h \times A \times \Delta T = 2 \times 4.5 \times 1.72 \times 3.54 \times 90)$

= 4.937 kW.

Heat loss due to air duct volume = $V \times C_P \times \Delta T = (\frac{4800}{3600}) \times 1.004 \times 90$

=120.48 W.

B. *Heat Balance Sheet*

SR.NO.	HEAT TO OBJECT	FORMULA	CALCULATED HEAT REQUIRED IN WATTS
	Lead plates	$m \times c_p \times \Delta T$	21.465 x10^3
	M.S. sheet of oven box	$m \times c_p \times \Delta T$	68.7639
	Mild steel doors(2 units)	$h \times A \times \Delta T$	4.93 x 10^3
	Heat loss due to air duct	$V \times c_p \times \Delta T$	120.48
	Other losses	10% total heat loss	2.65 x10^3
	Heat loss trough insulation (standard value for 100 mm)		0.25 x 103
		TOTAL	29.4913kW

Actual heat load= Safety Factor. x theoretical heat load

= 1.5 x 29.483

= 44.225 kW

C. *Conveyor System Design*

Conveyor System Drying Calculations

Belt Width: 10”

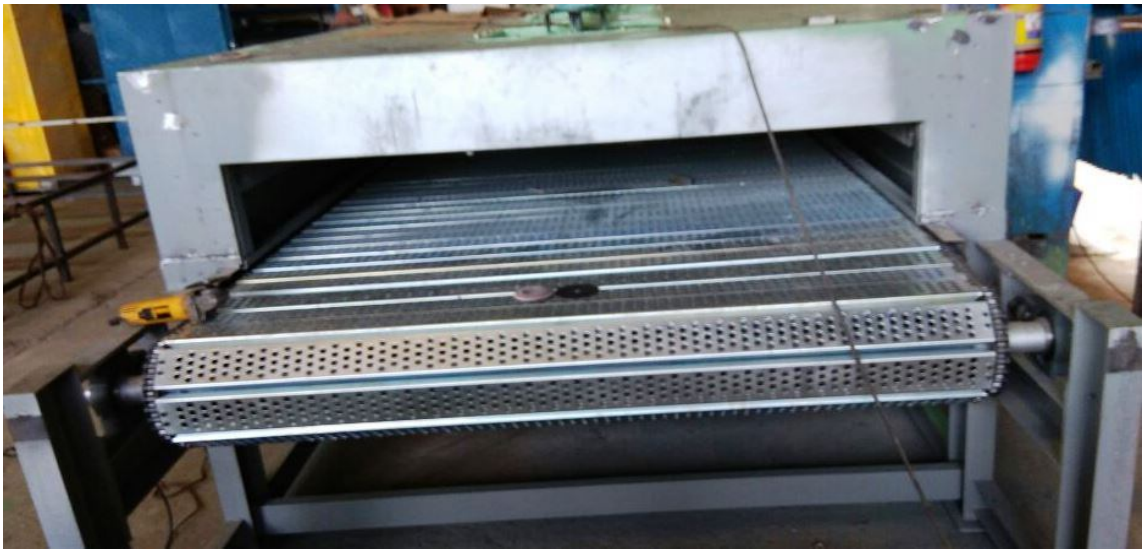
Belt Velocity= (2 x 0.51 /30) = 0.034 m/ min.
Total Belt Length Required:
150 unit battery Volume= 106950 cm^3= 150 unit
Total Belt Volume = 0.106950 m^3= 42.10 $x10^3$ cubic inches
Total Belt Volume = (Belt Length) x (10") x (21")
Belt Length= 196.85"= 5000 mm =5 m.
The belt length must start at X=O" and the end of the belt must finish at X=20"
Therefore, Belt Travel = 196.85" + 20" = 216.85"=5.5 m
Time Required = (5.5 m/ 0.034 m/min)
= 161.99minutes = 2.7 hrs.

D. Construction

1) Heater: it is a spiral type heater with nichrome wire having ceramic coating. This heater can be used as heating component for oven to produce and supply heating energy by using input as electrical energy its capacity may range from 1KW – 12KW typically heater is producing small amount of heat energy so in most of the system have multiple heaters can be installed in various application to cover required heating area .it works on joules heating law. Air heater is device are used for heating air in the enclosed area they include forced air product as well as all types of radiant & space heater. Forced air products moderate & control air temperature by circulating air through a heat source with a fan or blower. As air current flows through heater it absorbs thermal energy of heater & then exits heaters at an elevated temperature. Radiant heaters are used for radiating heat and heating object by using point source due to these temperature differential causes which results in free flowing convection cycle which heats up surrounding air mass.

2) Blower: blower which is also referred sometimes as a fan in some literature to deliver the gas or air with appreciable pressure rise to overcome some kind of resistance in the flow ,blower can achieve higher pressure than fan as 1.20 kg/cm^2. They are also used for negative vacuum pressure creation for industrial use. Forward curve fans are best suited for clean environment and work at moderate temperature and also well stabled for low tip speed and high airflow. They are also best suited for moving large volume of air against relatively, low pressure. There are only 2 types of blower i.e. positive displacement blower, centrifugal blower, centrifugal blower typically operate against 0.30 to 0.70 kg/ cm^2 , but can achieve higher pressure. centrifugal blowers provides directional air flow by maximizing static pressure, making them optimal for spot cooling and air flow through a duct.

3) *Conveyor:* conveyor is used for moving material through production line ,chain conveyor is used for continuous motion of product (Battery) in oven ,which is used for mass production product is loaded from one side and unloaded from another side. Chain conveyor utilizes power continuous chain arrangement as input for motion .it is popular, quick & efficient method for material handling. Conveyor material should withstand heavy loads without seizing due to deformation hence chain conveyor is best choice. the total cyclic process will be done by using chain conveyor by giving input from motor and gearbox for special purpose, required motion and time relation can be achieved by VFD (variable frequency Drive) for maintain the speed of conveyor .mostly 1" to 1.5" chains are used for conveyor system generally.



IV. SPECIFICATIONS

A. According To Heat Load Capacity of Oven Spiral Heater Selected

Heater type: electrical spiral heater
Weight of spiral heater: 450-500 Gms.
Capacity of heater: 1.5 kW
Operating voltage: 230V
Operating frequency: 50 HZ
Length of heater: 13" or 330.2 mm
Diameter of heater: 7" or 177.8 mm

B. According To Vertical Airflow and Considering Capacity of Heating We Selected Blower

Weight of blower: 4-5kg
Operating voltage: 230v
Volume of air to be circulated by blower: 4800m^3/hr.
Power capacity: 1HP or 786 W
Rpm of blower: 1400
No. Of blower: 3

C. Insulation Provided By Standard Assumptions

Type of insulator: open -cell PUF (polymer)
Sub type used: Rockwool
Density of insulator: 144 kg/m^3
Insulation factor: R-3.3

D. Controller Selected For Heating Oven

Type of controller: - P-I-D (Proportional-Integral-Derivative)
Sub type of controller: RTD SSR

Operating current: 32 Ampere
Operating voltage: 230 V
Phase: single
No. of units: 3 in HEAT SINK

V. WORKING

Drying oven consists of heater, blower, conveyor system, gearbox, motor etc. It uses 3 phase electrical energy to operate total system. Firstly convective heater system, conveyor system, blower system will be started, & waiting for optimum condition as to obtain specific temperature, airflow, motion of conveyor. the heating oven is kept open & empty till the temperature attain around 90^0 c, then battery lot fed through the loading side of oven on conveyor, then motion is transmitted through gear box to conveyor via chain & sprocket assembly for optimum & uniform heating. blowers & fans operating in 3 sections to provide forced convection heat transfer, pressure maintain in side oven is just above atmospheric pressure about 1000 mm of Hg. Travel time is around 180 min for 1500 kg of battery lot, PID controllers are used for maintaining the temperature between 90^0 to 110^0 c. heater each of capacity 1.5 KW with uniform spacing as 13 on either side & 13 on other side are used . Rockwool as insulating material to reduce heat losses to the surrounding it gives best performance in low cost. Safety controller is used for limiting the temperature range up to 110^0 c. Duplex RTD temperature sensors is used for measuring temperature of oven.

VI. CONCLUSION

According to above calculations and selections of different devices, the Design and Development of Battery Drying Oven is done successfully. By using this type of Battery Drying Oven the issue of moisture content of lead acid battery is resolved due to this efficiency and life of battery increased substantially.

VII. ACKNOWLEDGEMENT

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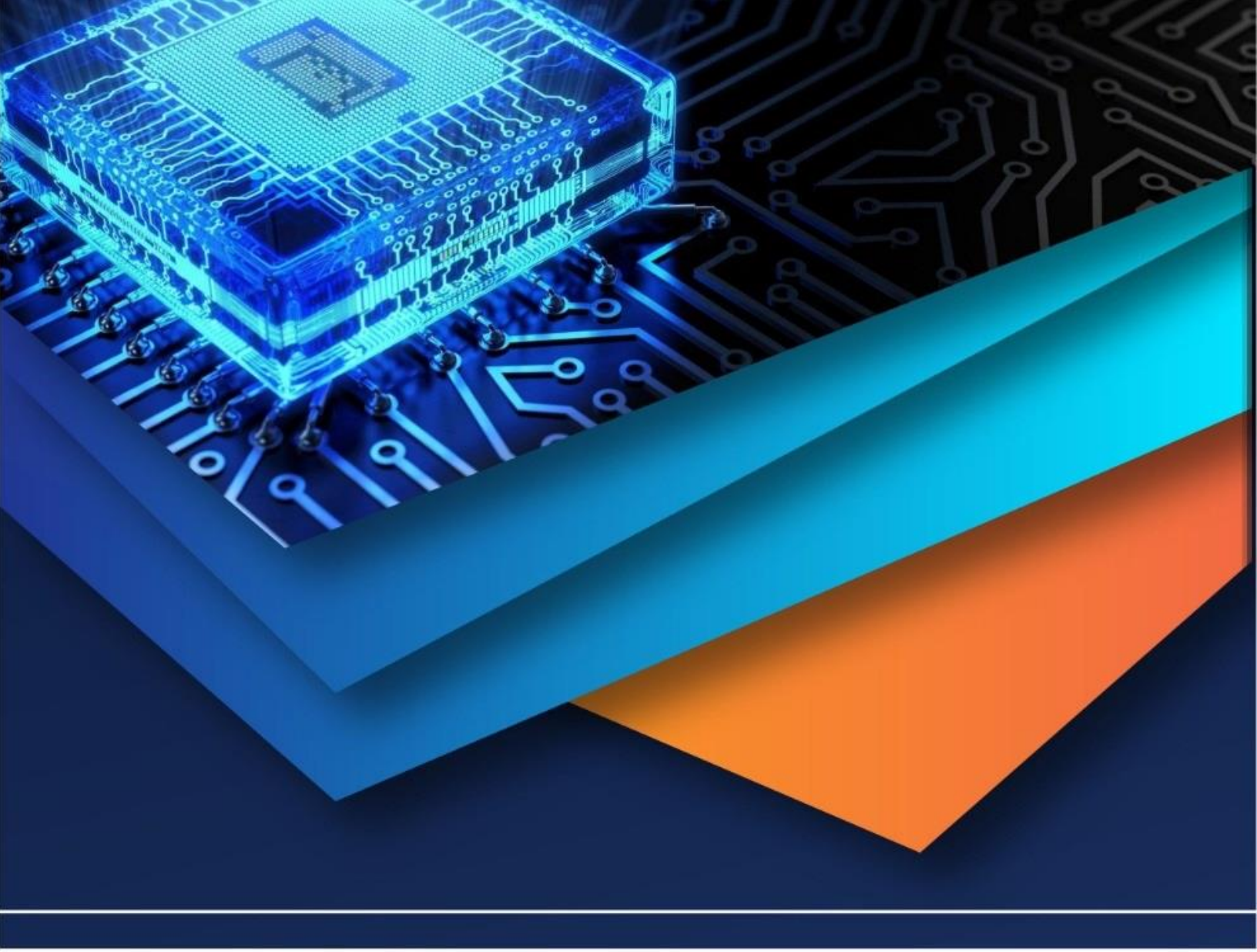

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