INDUSTRIAL & LABORATORY FURNACE

A Major Project Report

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in

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by

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Udaipur **CHIRAG SONI**

13-04-2023

Abstract

This report provides an overview of industrial furnaces, which are used in a variety of high-temperature processes in industries such as metallurgy, glassmaking, ceramics, and chemical production. The report covers the different types of industrial furnaces, including fuel-fired and electrically-powered furnaces, and discusses their advantages and disadvantages for specific applications. Safety considerations associated with industrial furnaces are also discussed, as well as their potential negative environmental impacts. The report highlights the importance of proper design, installation, and operation of industrial furnaces in compliance with relevant regulations to ensure safety and minimize environmental harm. Finally, the report discusses advancements in furnace technology, such as the utilization of renewable energy sources, reduction of emissions, and increased energy efficiency, to meet growing demand for sustainable and environmentally-friendly manufacturing practices.

Acknowledgement

I take this opportunity to express my deepest sense of gratitude and sincere thanks to everyone who helped me to complete this work successfully. I express my sincere thanks to **Mr. Abhishek Sharma**, Head of Department, Mechanical Engineering, Techno India NJR Institute of Technology Udaipur for providing me with all the necessary facilities and support.

I would like to place on record my sincere gratitude to my project guide Mr. Abhishek Sharma, Assistant Professor, Mechanical Engineering, Techno India NJR Institute of Technology for the guidance and mentorship throughout the course. Finally, I thank my family, and friends who contributed to the successful fulfilment of this project work.

CHIRAG SONI

Contents

Chapter 1

Introduction

A furnace is a device in which heat is generated and transferred to materials with the object of bringing about physical and chemical changes. The source of heat is usually combustion of solid, liquid, or gaseous fuel, or electrical energy applied through resistance heating (Joule heating) or inductive heating. However, solar energy can provide a clean source of high temperature if focused onto a small area. This was recognized over two hundred years ago by Lavoisier who built a large mobile "magnifying glass" system, to bring about the combustion of metals in a sealed glass container and subsequently the demise of the phlogiston theory.

Furnaces employing combustion produce a hot gas which transfers heat to the material by radiation and convection. Solids are heated by direct contact, but fluids are usually heated indirectly, being carried inside pipes within the furnace. Alternatively, a may be used to transfer heat from the combustion gases. Indirect heating has the advantage of avoiding contamination by combustion products.

There are two principal categories of indirect heating furnace. The first is that of Boilers, where the heat is used to generate steam for power generation or process plant use. The second is that of furnaces designed to heat process fluids other than water. Some of the latter categories are conventional heaters used simply to increase the fluid temperature, others are process heaters used to bring about physical and chemical changes in the products, for example distillation, and pyrolysis of hydrocarbons or catalytic steam-gas reforming of synthetic natural gas.

FIG.(1) DIFFERENT TYPES OF FURNACES

Chapter 2

Laboratory Furnace

The laboratory furnaces are widely used in scientific experiments in the physics lab, rice laboratories, steel and paint industries, biotech companies and small industrial production etc.

Their major applications include general laboratory testing, annealing, ash determination, coal analysis, leaves carbonization and lime calcination etc. The other applications include Ignition tests, Heat treating steel parts and Gears, Coal sampling, Organic and inorganic Chemical analysis, soils aggregates cement Testing, Glass blowing lab, Plastic tensile strength test, Gravimetric analysis, Heat treating Gears, Quench testing, Research facilities in chemistry, Annealing Oss determination, Development of coatings and ceramics, Rice laboratory, Stoneware samples firing etc.

Standard Features

- Maximum operating temperature. 500°C to 1200°C.
- Silicon Carbide Muffle for Energy Efficient and better uniformity.
- Side way sliding door keeps heated surface away from the users.
- Door limit switch for making heating system off while door in open condition.
- Energy Efficient with reduce heat loss by using advanced insulation refractory.
- Over-temperature limiter with adjustable cut out temperature for thermal protection class 2 in accordance with EN 60519-2 as temperature limiter to protect the furnace and load
- Equipped with thermocouple break protection that help preventing thermocouple failure run away.
- Exhaust air outlet at rear wall of the furnace.
- Solid state relay provides low noise operation.

Chapter 3

Industrial Furnace

Industrial furnaces are usually rugged, refractory based construction or lightweight ceramic fibre board and insulation based in construction.

Heating elements could be Nichrome, KANTHAL A1/APM, silicon carbide or molybdenum disilicate depending on the temperature and process. These furnaces can be used for hardening, annealing, normalizing, sintering, tempering, stress relieving, pre-heating etc. The entire range, size and temperature can be determined by individual need and requirement. The door design can be Hinge Type or Vertical Lifting as per chamber size.

Industrial Furnace is a device used to provide heat for a industrial process, typically higher than 400°C. They are used to provide heat for a process or can serve as reactor which provides heats of reaction.

Furnace designs vary as to its function, heating duty, type of fuel and method of introducing combustion air. Heat is generated by an industrial furnace by mixing fuel with air or oxygen, or from electrical energy.

The furnace bottom is constructed as a shuttle, covered with good heat-conducting boards and is being moved trackless with a steering gear. Below the furnace guiding rails are installed for facilitate the running in of the shuttle.
The insulation is according to the application as well as to the maximum temperature and mainly consists of high insulating refractory light bricks. The heating spirals made of MoSi2 heating element or Silicon Carbide heating element or Canthal A1/APM heating wire on supporting tubes are in the three walls.

Standard Application

- Annealing
- Stress Relieving
- Hardening and Tempering
- Normalizing
- Post Weld Heat Treatment
- Heat Treatment

Chapter 4

Types Of Laboratory Furnace

• MUFFLE FURNACE

Muffle Furnace is box type heat treatment equipment used to change physical properties of samples at very high temperature. These laboratory furnaces are widely used in scientific experiments in physics lab, rice laboratories, steel and paint industries, biotech companies and small industrial production etc. Their major applications include general laboratory testing, annealing, ash determination, coal analysis, leaves carbonization and lime calcinations etc. The other applications include: Ignition tests, Heat treating steel parts and Gears, Coal sampling, Organic and inorganic aching, Chemical analysis, soils & aggregates cement Testing, Glass blowing lab, Plastic tensile strength test, Gravimetric analysis, Heat treating Gears, Quench testing, Research facilities in chemistry, Annealing loss determination, Development of coatings and ceramics, Rice laboratory, Stoneware samples firing etc.

• HIGH TEMPERATURE FURNACE

High-temperature furnaces are insulated with ceramic fibre material. Furnaces with ceramic fibre insulation achieve significantly shorter hang up mess because of the low thermal mass. Tempsens is ISO and CE carried Laboratory & Industrial furnace manufacturers and suppliers. Tempsens provide range general purpose HighTemperature Furnace in three temperature ranges i.e. 1400°C, 1600°C & 1800°C.

• TUBULAR FURNACE

Tubular furnaces are designed for sample testing under gas/vacuum atmosphere they are available in customize size and options with water-cooled flange. Maximum design temperature of the furnace is up to 1800°C. The various applications include ageing, annealing, brazing, calcination, catalyst research, CIM, coating, CVD, degassing, drying, hardening, MIM, mini-plants, pyrolysis, sintering, soldering, sublimation, synthesis, tempering, test fuel cells, thermocouple calibration. Tempsens is ISO and CE certified Laboratory & Industrial furnace manufacturers and suppliers. Tempsens

has wide range of tubular furnaces with different tube sizes and Temperature range up to 1800 ºC.

• DENTAL FURANCE

Dental Furnace is a bottom loading type heat treatment equipment used to change physical properties of samples at very high temperature. These laboratory furnaces are widely used in scientific experiments in dental laboratories. Its major applications are in sintering translucent zirconia and dental ceramics operations. This furnace provides the following advantages: easy loading and removal of samples like molten glass, dental zirconia etc. furnace use an electrically operated elevator hearth, which as it rises into the furnace chamber, lifts the load into the heated zone. Uniform heating achieved by locating elements in all side walls of the chamber. All the parameters are controlled and operated with the help of a PLC programming. Tempsens is ISO certified Laboratory & Industrial furnace manufacturers and suppliers. Our company makes these Furnaces in various temperature ranges and chamber sizes. Each unit is made with rugged construction and equipped with easy to use controller system and safety devices.

Chapter 5

Types Of Industrial Furnace

• CHAMBER FURNACE

All high temperature furnaces are designed in the most advance technology for heat treatment application with high temperature accuracy. Chamber furnaces are usually rugged, refractory based construction or lightweight ceramic fiber board and insulation based in construction. Heating elements could be Nichrome, Kanthal A1/APM, silicon carbide or molybdenum disilicide depending on the temperature and process. These furnaces can be used for hardening, annealing, normalizing, sintering, tempering, stress relieving, pre-heating etc. The entire range, size and temperature can be determined by individual need and requirement. The door design can be Hinge Type or Vertical Lifting as per chamber size.

• ANNEALING FURNACE

Annealing furnaces are designed for the processing of SS or Copper wire, rod, strand, strip and tube products. These furnaces are ideally suited for copper, copper alloy, nickel, nickel chrome, titanium, stainless steel and refractory metals. Annealing Furnace features heavy-duty construction, an energy saving combination of fiber and brick insulation, precise temperature control and requires minimal maintenance. The Furnaces are Electrically Heated. In electrical heating the heating elements are provided with either circular type or in grooved refractory. The design of heating element is very vital for long and trouble free life. Annealing furnace is fired in multiple zones to produce a uniform temperature and fast heat-transfer to the wires/Pipes

• CONVEYOR MESH FURNACE

The furnace is designed to work up to maximum temperature of 250ºC-1200 ºC. The main structure is made with high quality mild steel angles and the heating muffle of furnace is made of Stainless Steel grade. Outer body is made of CRCA sheets with neat powder coat finish. It consists of metal rollers/wheel for initial movement of material. The movement of roller is via VFD. Electric Conveyor mesh belt type furnaces are used for continuous heating purpose of large quantities of goods. Conveyor belt continuously rotate through the furnace electrically which poses the temperature (250°C to 1200 ºC). Material to be heated is kept at one end on belt which passes through the furnace.

- # BOTTOM LOADING INDUSTRIAL FURNACE

Industrial Bottom Loading Furnace is suitable for 1600°C as well as 1800°C application. The Industrial Bottom Loading Furnace is a kind of user-friendly operating system that comes with smooth bottom lifting arrangement.

The Industrial Bottom Loading is widely used for firing and sintering of advanced ceramics and high temperature glass melting application. Industrial Bottom Loading Furnace offers high temperature accuracy in a range of ±1°C

Chapter 6

Component Of Furnace

- ## OUTER BODY

Outer body is made up of powder coated ms sheets. Body is prepared by laser cutting and various bending operation

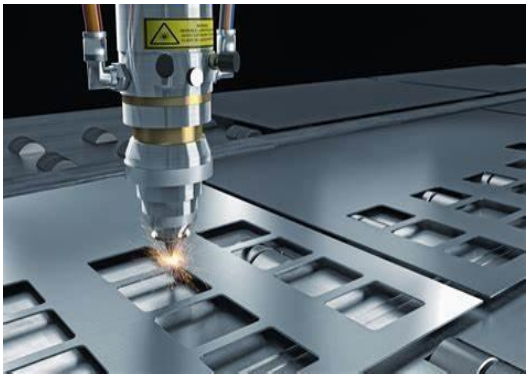


FIG.(2)Laser Cutting

- ## INNER CHAMBER

Inner chamber is made up of stainless-steel sheets of grade 304. inner chamber has perforation on its side for heat transfer phenomena.

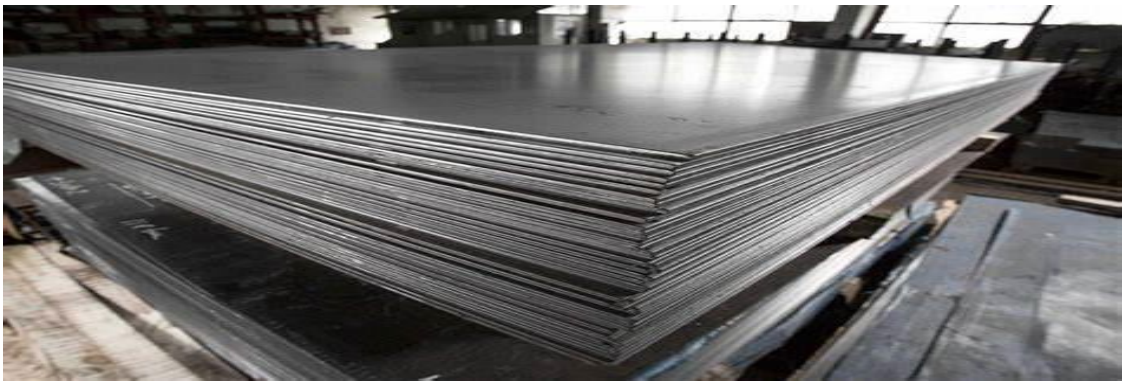


FIG.(3) SS Sheets

• INSULATION

Insulating chamber is constructed from ceramic high temperature resisting board

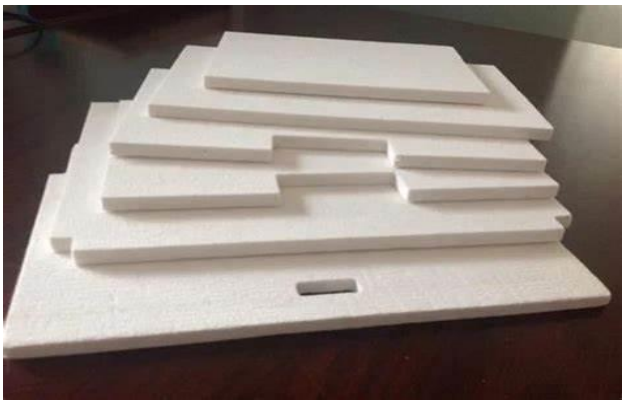


FIG.(4)Insulation Board

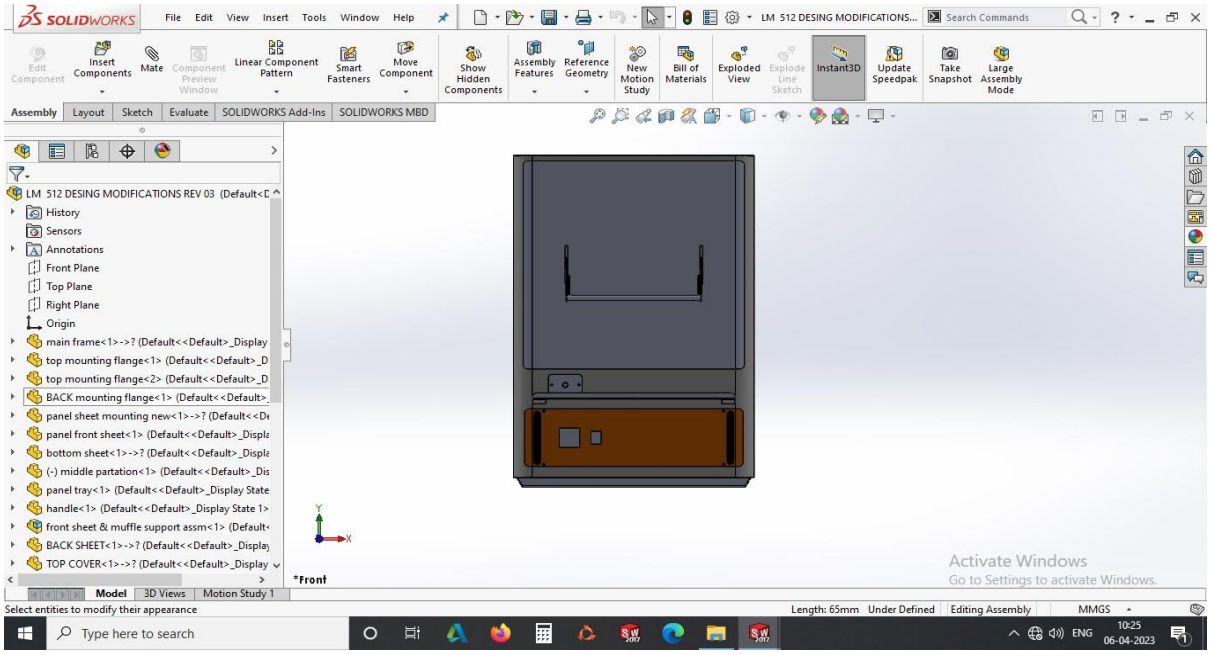
• HEATER AND THERMOCOUPLES

Canthal heater is used to reach at desired temperature. thermocouples is used to monitor the temperature.

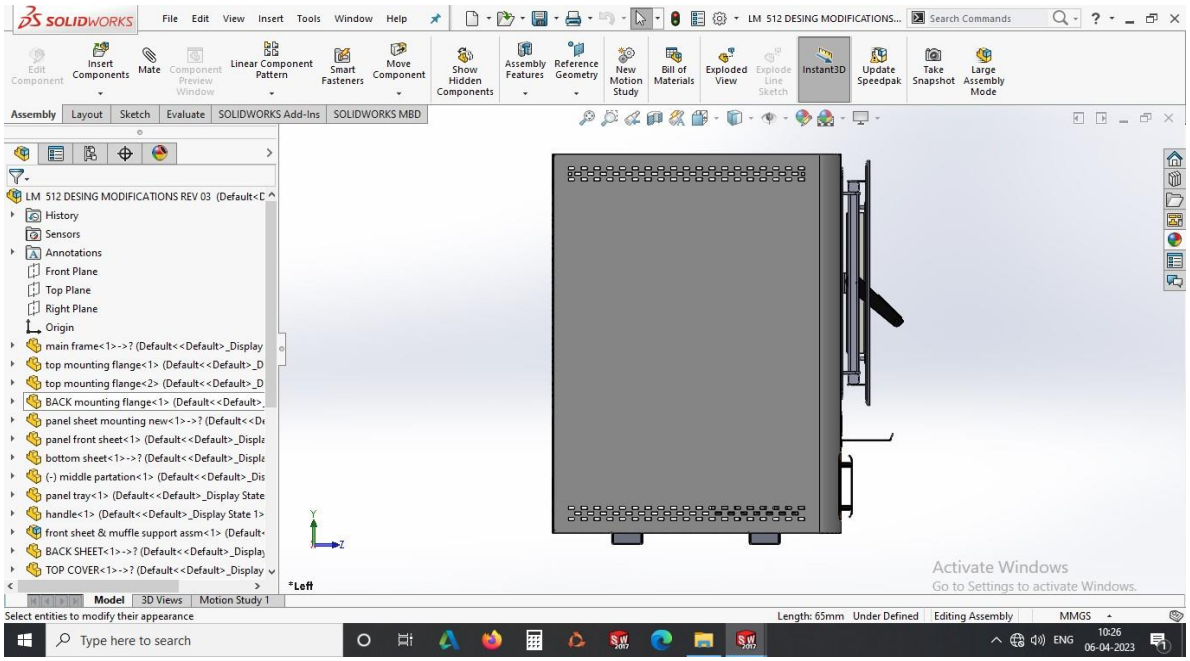
FIG(5)Heater and Thermocouple

Chapter 7

Solidworks Model Of Furnace



FURNACE MODEL IN SOLIDWORKS



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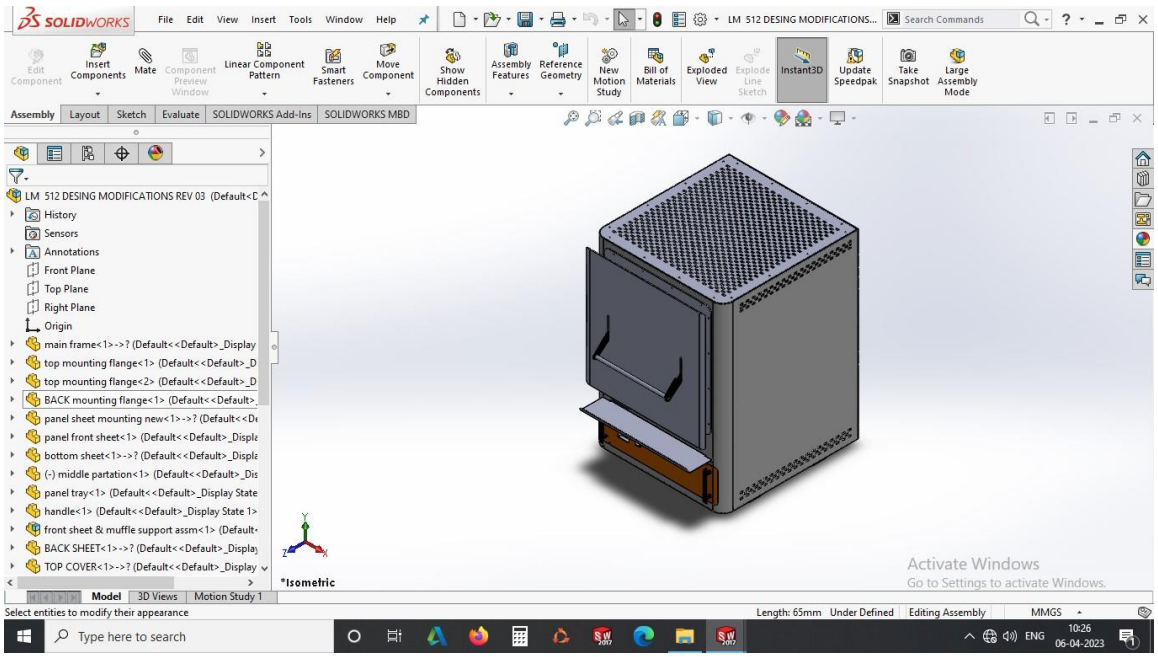
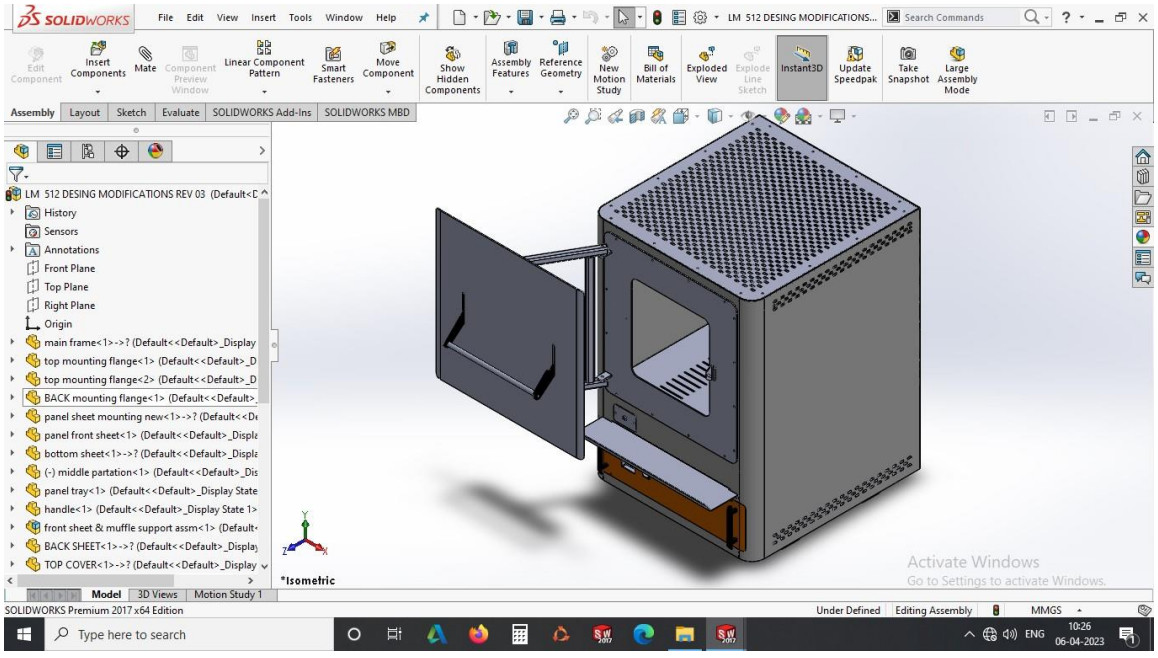


FURNACE MODEL IN SOLIDWORKS



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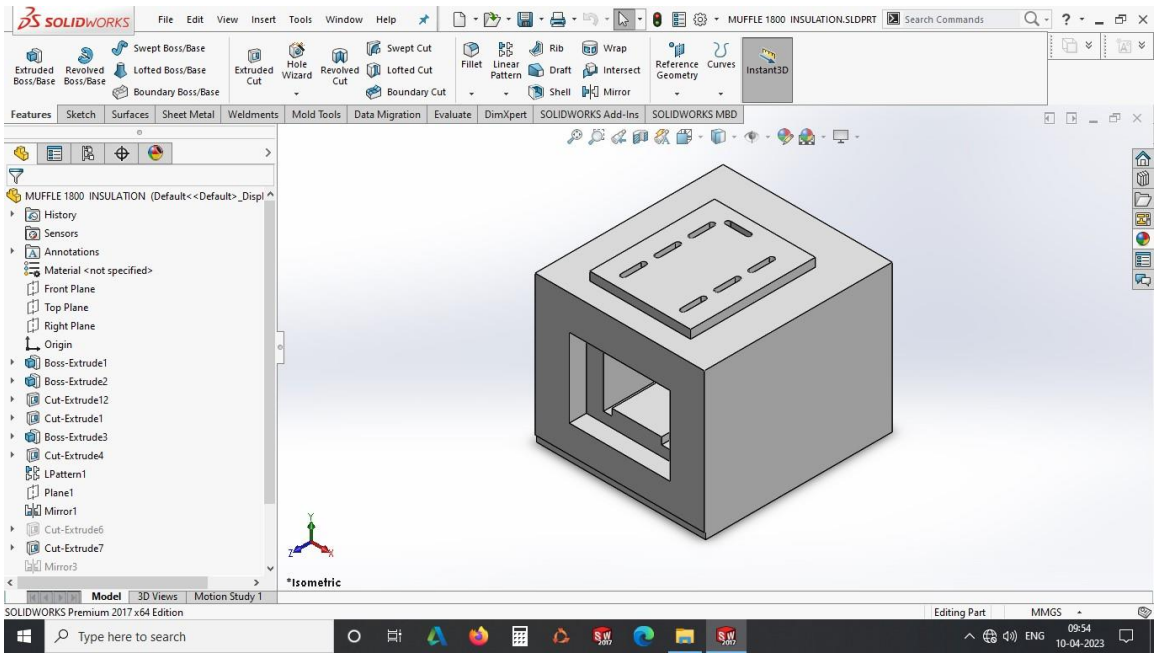
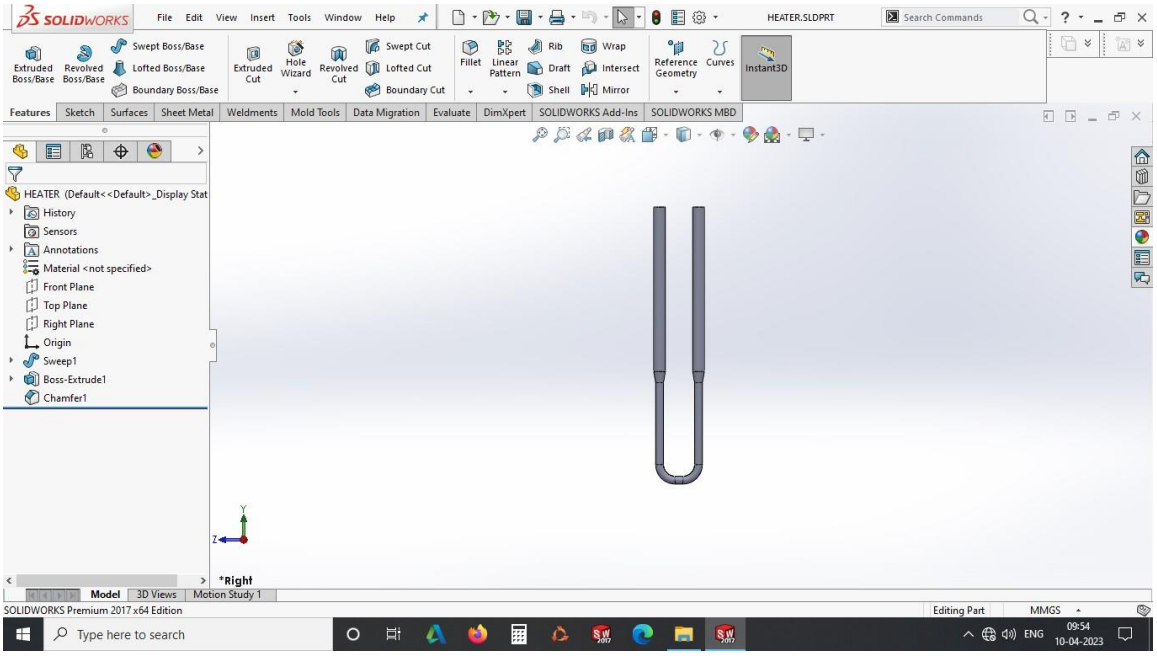


INSULATION MODEL IN SOLIDWORKS



HEATER MODEL IN SOLIDWORKS

Chapter 8

Conclusion

In conclusion, industrial furnaces play a crucial role in many industries that rely on high-temperature processes, such as metallurgy, glassmaking, ceramics, and chemical production. These furnaces come in various types, ranging from fuelfired to electrically-powered, and each type offers unique advantages and disadvantages depending on the specific application.

While industrial furnaces are essential for many industrial processes, they also pose significant safety risks and can have negative environmental impacts if not operated and maintained correctly. Therefore, it is crucial to follow proper safety procedures and ensure that industrial furnaces are designed, installed, and operated in compliance with relevant regulations.

As technology advances, we can expect further improvements in the efficiency, safety, and environmental impact of industrial furnaces. Additionally, with the growing need for sustainable and environmentally-friendly manufacturing practices, we may see more innovations in the development of industrial furnaces that utilize renewable energy sources, reduce emissions, and increase energy efficiency.

Overall, industrial furnaces will continue to be an essential part of many industries, and their importance will only grow as the demand for high-quality products and efficient manufacturing processes increases.

References

- Donaldson, A.D. (2006). Industrial Furnaces, Fourth Edition. Boca Raton, FL: CRC Press.

- Incropera, F.P. and DeWitt, D.P. (2006). Fundamentals of Heat and Mass Transfer, 6th Edition. Hoboken, NJ: John Wiley & Sons, Inc.

- National Fire Protection Association. (2019). NFPA 86: Standard for Ovens and Furnaces. Quincy, MA: Author.

- Reed, M. (2017). Industrial Furnaces: Principles, Design, and Operation, Second Edition. Boca Raton, FL: CRC Press.

- Selecki, R.M. and Warchol, J.K. (2018). Energy Efficient Industrial `Publishing AG.

- United States Environmental Protection Agency. (2020). Clean Air Act Standards and Guidelines for Industrial, Commercial, and Institutional Boilers and Process Heaters.
- Retrieved from https://www.epa.gov/industrial-boilers-processheaters/clean-air-act-standards-and-guidelines-industrial-commercial-and.

- United States Occupational Safety and Health Administration. (2022). Furnaces and Refractories. Retrieved from https://www.osha.gov/furnacesrefractories.