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DESIGN OF AUTO CHARGING SYSTEM OF COPPER PLATES INTO THE FURNACE

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Abstract *- **This project report is detailed summarization about "Design of Auto Charging System for Copper plates into the furnace". It becomes difficult in industries for workers to lift heavy copper plates, and inserting them into the furnace. So, it increases the overall cost of manufacturing due to requirement of more labor and it takes more time to complete the entire process. To overcome this problem, a system is to be designed to lift copper plates from ground level and inserting them into the furnace with less or no human interference. The design process selected for this operation is EOT (Electric Overhead Travelling Crane). This project is carried under BRIGHT ENGINEERING. EOT will lift the plates with the help of mechanical grippers and gradually insert them into the furnace by considering suitable factor of safety and if the calculated values are less than permissible values, then the design is said to be safe.***

Keywords – EOT, Furnace, Copper Plates, Auto Charging, Hook, Rope Design, Rope Drum, Crosspiece, Shackle Plate, Clamp

I. INTRODUCTION

Cathode is a pure form of copper. Copper cathode are used in manufacturing of continuous cast copper rods which are further used for the wire, cable, and transformer industry. They are also used for manufacturing copper tubes for consumers. Induction furnace is an electrical furnace in which the heat is applied by induction heating of metal. Induction furnace capacities range from 1kg to one hundred tonnes, and are used to melt iron and steel, copper, aluminum and precious metals.

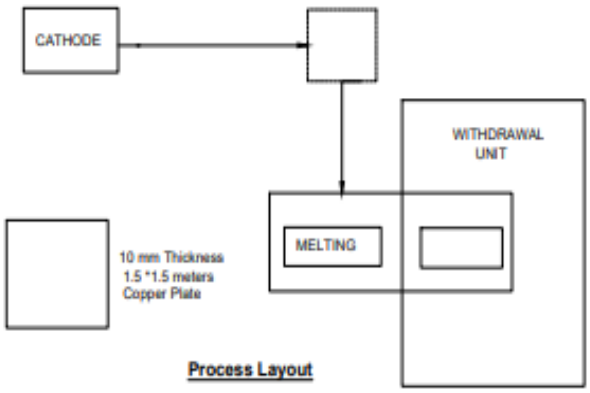
In this project a system will be designed to pick the copper plates using mechanical gripper from one place and insert it into the furnace without less or no human interference and for this purpose we are designing "ELECTRIC OVERHEAD TRAVELLING CRANE" [EOT]. Mechanical gripper is used as an end effector in a system for grasping the object with its mechanically operated fingers.

Types of EOT Cranes :

EOT cranes can be classified into different categories based on their capacity, application, and configuration. Some of the commonly used EOT cranes are single girder cranes, double girder cranes, gantry cranes, and underslung cranes. The selection of an EOT crane depends on various factors such as load capacity, span, headroom, lifting height, and duty cycle.

Design and Performance: The design of an EOT crane involves various factors such as load capacity, span, lifting height, and duty cycle. The structural components of an EOT crane include Hook, Rope Drum, Crosspiece, Shackle Plate, Vertical Lifting Clamp, Sheave Axle & Pulley. The design of these components must be optimized to ensure that the crane's performance meets the desired requirements.

Process Layout:



Process Layout

Calculations:

1. Rope Design: 6×37 rope is selected using 3 pulley system. By calculations, rope life is determined of 36.27 months which is satisfactory and passes required period of 12 – 18 months. Diameter of rope is selected as 10mm as per PSG Data Book.
2. Hook Design: Hook is designed by dividing it into 4 sections such as Section 1-1, Section 2-2, Section 3-3 and Section 4-4. Each section is designed by considering stresses acting on it. At Section 1-1 there will be direct tensile stress. Section 2-2 is the most critical section because of stresses acting on both inner and outer fiber. Hence it is subjected to tensile & bending stresses. Section 3-3 is subjected to Tensile, Bending and Direct Shear Stresses. Section 4-4 is subjected to Direct Shear Stress.
3. Rope Drum Design: As rope drum is subjected to torsional shear stress, bending stress, crushing stress due to rope action on the drum, brittle material is selected for rope drum.
4. Crosspiece Design: Crosspiece is subjected to bending moment. Assumed suitable length, width and height of crosspiece as per requirement.
5. Sheave Axle & Pulley: The axle is fitted inside plates and strengthened by shackle plates/straps.Thickness of shackle plate = 2 × thickness of slide plates. Selected material of axle as C45 with permissible tensile stress σt = 80N/mm^2. Here we take pulley diameter same as drum diameter.
6. Bearing Selection: Bearing is designed for 5 years assuming that the crane is working for 16 hours/day and 300 days/year. Equivalent Load on bearing is calculated by considering Radial Factor, Thrust Factor and Axial Load. Dynamic Capacity of Bearing is also considered. Hence, we selected Standard Rolling Bearing NU2205 having Inner diameter of 25mm, Outer Diameter of 52mm and Width of 18mm.
7. Motor and Gearbox Selection: Considering the range of rope drum speed is 7 rpm to 15 rpm. Hence Selecting Standard Motor of 960 rpm

   Gearbox ratio = $\frac{960\ rpm}{15\ rpm}$ = 64

   Selecting A Series Helical and Bevel Gearbox. When efficiency & versatility meet each other the A series is the first product to prove equally good in regard to efficiency and versatility within a highly competitive contest in both performance and price. Torque Range = 100 – 14000 Nm Mechanical rating (n1 = 1400 min-1) = 0.22 – 150kW having Gear Ratio = 5.4 – 1715.
8. Shackle Plate Design: Selected Plain Carbon Steel C20 material and assumed thickness of shackle plate. Shackle Plate is subjected to Tensile Stress, Double Shear Stress and Crushing Stress.
9. Vertical Lifting Clamp: Selecting VPC 1T having lifting capacity of 1 TON. It has jaw opening range i.e. (A) = 0-20mm and other dimensions B = 140mm, C = 280mm, D = 53mm, E = 50mm having weight 4.5kg.

CONCLUSION:

The task of designing a mechanism to lift copper cathode plates and charge into furnace with less or negligible human interference

Rope of Crane is designed by considering tensile and bending criteria and life of rope is determined. Hook is designed by considering all the sections and focusing mostly on its critical section. Brittle Material is selected for rope drum as rope drum is subjected to torsional shear stress, bending stress, crushing stress due to rope action on the drum. Crosspiece is designed considering bending moment. Sheave Axle and Pulley are designed by considering standard dimensions from PSG Data Book. Standard Bearing is selected based on calculations of axial and radial load acting on it. Standard Motor and Gearbox is selected from www.bonfiglioli.com considering rpm range of rope drum and gearbox ratio. Shackle Plate is designed to withstand failure from stresses such as crushing, tensile and shear. Selected Standard Vertical Lifting Clamp as per requirement.

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