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Copper Separation from Burned Out Charcoal-Copper Mixture (Wastage Recycling)

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ABSTRACT

Cable manufacturing company is using upward die casting machine to produce 8mm diameter copper wires. Copper sheets are melted in induction furnace. Copper melting temperature is 1089°C. In order to avoid oxidization and stop heat dissipation of copper liquid, a layer of wood charcoal is floating on top of the copper liquid while burning in molten copper chamber. Normally wood charcoal burnt out within three to four hours due to high temperature. Then burnt out charcoal has to be removed from the molten copper chamber and new charcoal has to be added. While removing ash from molten copper bath using stainless steel shovel some amount of copper come out with the whole mixture. The copper particles which come out with the ash mixture do not have regular shape and around 25% (by weight) of copper consist of the whole mixture. There is an ash wastage mixture (around 4000kg) currently without a proper solution.

Objective of the study was to find a solution to separate copper from the existing ash wastage. Various separation methods were analyzed and finally sieving method with a vibrating unit was designed and fabricated to solve the problem. Cam was used to generate vibration to the sieves. Main challenge was dust generation. To overcome dust generation, dust extraction unit was designed. At the fabrication process reusable material was used. Therefore overall fabrication cost was reduced. Sieving cage angle can be adjusted using square thread bar. However the machine would be helpful for efficient copper recovering process.

Key words: Copper, burnt out charcoal, wastage mixture, low cost solution

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INTRODUCTION

Copper has been used in electric wiring since the invention of the electromagnet and the telegraph in 1820s [1]. Copper is the electrical conductor in many categories of electrical wiring. Copper wire is used in power generation, power transmission, power distribution, telecommunications, electronics circuitry, countless types of electrical equipment etc. Then small size of copper wires is drawn through the diamond dies using large diameter copper rods. According to the design of rod break down machines and international standards, diameter 8mm copper rod is used as initial input to rod break down machines. Diameters 8mm copper rods which used as input wire to rod break down machines are manufactured by casting of pure copper. Pure copper which use as raw material for melting furnace, comes as copper sheets (copper cathodes).

Many types of casting methods are available. Out of the available casting methods, upward die casting is one of successive method used in modern industries. In this casting process, the wire is drawn upward trough water-cooled graphite mould (die) that is immersed in the copper melt and subsequently formed into coils without further processing. Copper melting temperature is 1089°C and this much of higher temperature is generated using induction furnace [1]. About 70mm-90mm wood charcoal layer is maintained on the molten copper bath as a heat isolator and to stop contamination with environmental oxygen.

RATIONALE FOR STUDY

Upward die casting is a continuous process. According to the design of casting machine, production process cannot be stop. Therefore production is done throughout the year on shift basis. Due to continuous production, raw material requirement is very high and the output and wastage generation also lies at a higher rate. Therefore one of

the main problems is collecting wastage of copper mixed burnt charcoal/ash every day. For the daily production process, charcoal is used as a process requirement and after completely burning, ash has to be removed. Due to this removing process copper-charcoal wastage mixture collects more and more. Already factory has functioned for three and half years. During this period, large stock of wastage (around 4000kg) has being maintained without a proper solution. Therefore the company is now running short of sufficient storage facilities as well.

Some amount of copper has been eliminated from main production process. As we know, Copper is one of the expensive metals in the world. According to the survey, around 25% of copper out of the total quantity used for production process is containing in the whole wastage mixture. Therefore there is a need of some recovery mechanism to minimize the wastage.

DEVELOPMENT OF PROTOTYPE MODEL FOR COPPER SEPERATION

Copper Separation Design

Based on the information received from the survey and data analysis, the following mechanism was designed by combining few separation techniques such as screening , vibration and suction which can be suited for the requirement[3]. Conceptual copper separation machine as shown in Fig.1consist of mainly 3 sections namely feeding, sieving with vibration and dust collector .

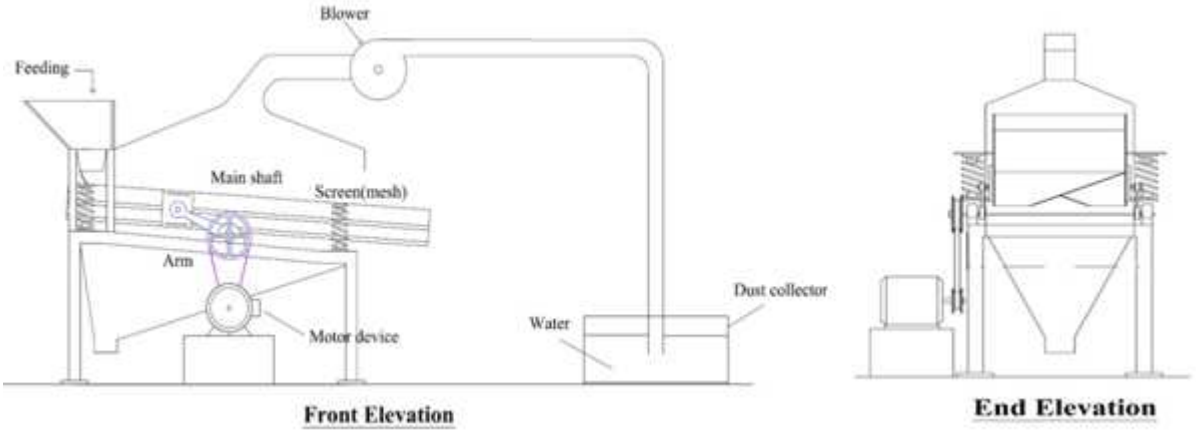


Fig.1Proposed Cooper Separation Machine

Overall process of the system can be represented by the following flow chart Fig. 2.

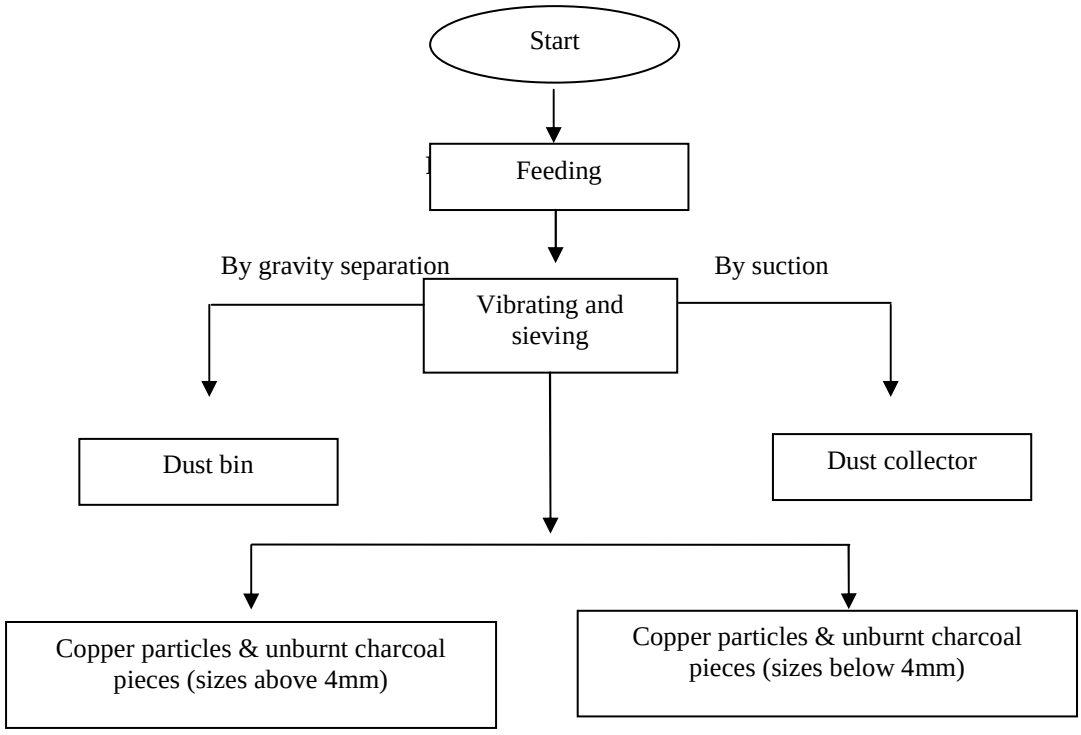
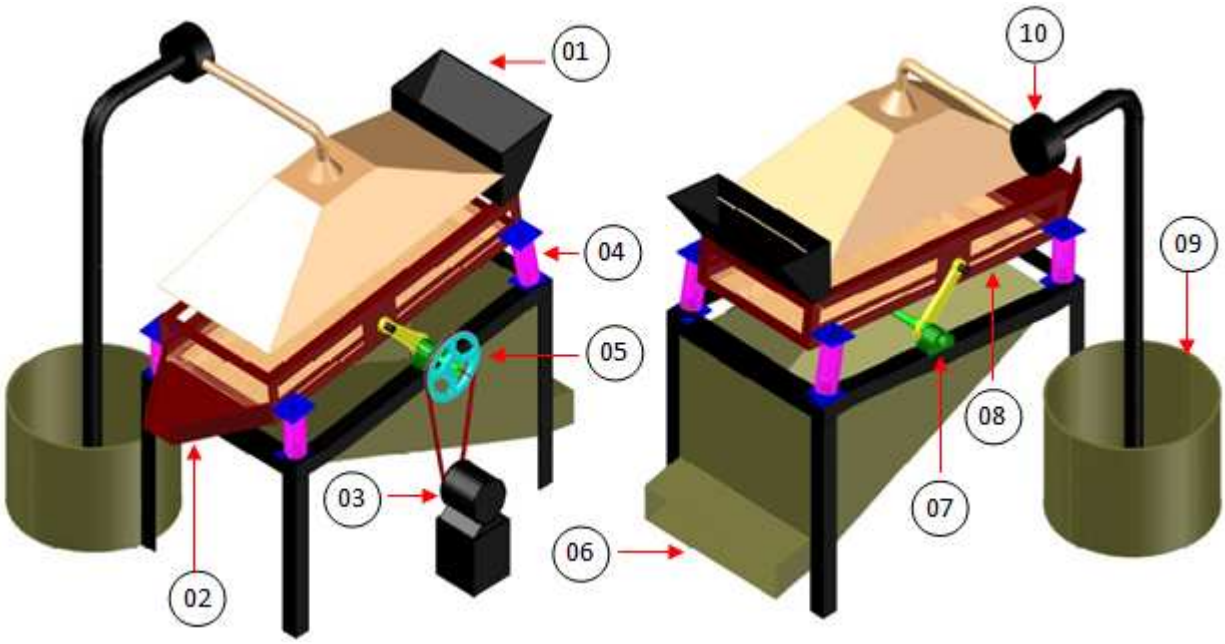


Fig. 2 Flow chart of separation process



01– Material feeding inlet, 02 – Separated material outlet, 03 – Main motor, 04 – Coil spring, 05 – Large pulley, 06 – Gravity dust collector, 07 – Plummer block bearing, 08 – Sieving cage, 09 – Water basin and 10 – Blower

Fig. 3 Three dimensional view of the proposed mechanism

The frame: The frame was constructed from equal angle iron channels. The frame dimensions are 900 *1500*900 mm (width × length × height).

The sieve unit [2]**:** The sieve unit consists of two sieves; the upper one is used for separating coarse materials (gauge 5 mesh) from the admixture. The lower sieve (gauge 20 mesh) is used to separate fine copper particles from ash. The cleaning unit has two discharge chutes. Mesh sizes were selected referring practical procedure.

The drive mechanism [5]: Vibration can be done by using various methods, rotating unbalance masses, rotating eccentric cam, unbalance motor etc. Among all methods, eccentric cam method was used for this project.

Arm[4]: The main shaft as shown in Fig. 4 was mounted on ball bearings by using Plummer block. Mechanism which performs horizontal oscillating motion of the sieve was transmitted from an eccentric cam fixed at the shaft by a pulley driven from an electric motor.

The feed hopper [4]**:** The feed hopper is designed for feeding copper-charcoal mixture to the sieve unit. Wastage mixture is feed to hopper by manually.

Bearings [4]: The rotational shafts have to fix into the body of the machine. Bearings are necessary for this operation. According to the design, load will apply radially on the bearing. Therefore radial bearing is necessary. Two point loads can apply in the bearing. Point load can be applied by the belt & load by the weight of the shaft & other components in the shaft.

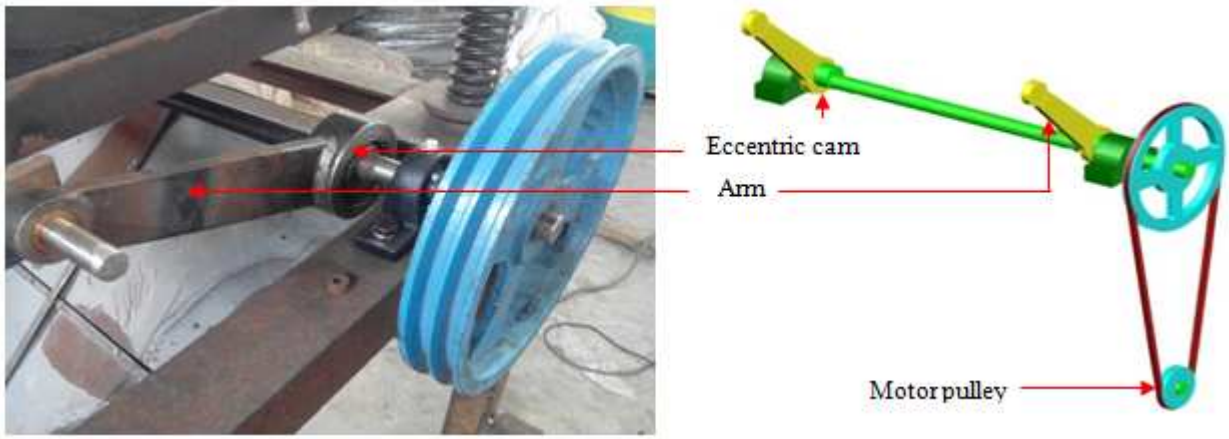


Fig.4 3-D main shaft assemble and fabricated unit

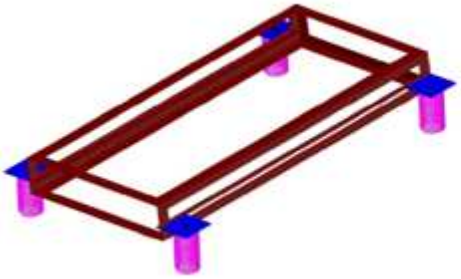


Fig.5 spring coils at four corners

Fig. 6 Completed sieving mechanism design

Centrifugal blower: A suction air stream is supplied by a centrifugal blower operated by an electric motor. The blower has impeller with a circular duct .The duct is placed over the intake of the blower. The air sucked by the blower moves through the duct and entrains the light particles (ash) from the mixture. The sucked light particles, as dust and ash pass through to the water basin.

Spring coil selection [4]:
Sieving unit placed on the four spring coils as shown Fig. 5 which located at four corners of the machine structure.
Completed sieving mechanism design is shown in Fig. 6 [1 – Upper mesh (gauge 05) 2 – Lower mesh (gauge 20)].

CONCLUSION

Main objective of the study was based on copper separation from existing wastage mixture of copper. Analysis was done to find out the best condition of the mixture by using existing solid mixture dissolving in water. By using practical experiments best condition was found. Then for separation of solid mixture, completed sieving mechanism as shown in Fig. 6 was used with vibration. Vibration was produced by mechanically using eccentric cam fixed in main shaft. When fabrication was going on some modification was done to overcome practical problems, such as fixing of angle adjustable screw. Main problem is dust generation when the separation process is going on. It was a big challenge. Finally it was overcome by using suggested method. Project budget was also reduced about half of the cost using re-usable material parts such as main motor, angle iron etc.

With the implementation of this proposed unit, company can recover about 25% of the wastage of copper from the total production capacity.

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