

DESIGN AND FABRICATION OF MICROCONTROLLER BASED CENTRIFUGAL CASTING MACHINE

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Introduction:

Casting is a manufacturing process in which a liquid material is usually poured into a mold, which contains a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as a casting, which is ejected or broken out of the mold to complete the process. Casting materials are usually metals or various time setting materials that cure after mixing two or more components together. Heavy equipment like machine tool beds, ships' propellers, etc. can be cast easily in the required size, rather than fabricating by joining several small pieces.

In the centrifugal casting process, molten metal is poured into a preheated, spinning die. The die may be oriented either on a vertical or horizontal axis depending on the configuration of the desired part. By spinning a mold while the molten metal is poured into it, centrifugal force acts to distribute the molten metal in the mold at pressures approaching 100 times the force of gravity. The combination of this applied pressure and the engineering mechanics of controlled solidification and secondary refining produces components of superior quality. As the die begins to fill, the more dense molten metal is forced to the wall of the spinning die. Directional solidification of sound metal progresses from the outer diameter towards the bore, while the less dense material including impurities floats to the inner diameter.

The vertical centrifugal casting process consists of several stages. At the beginning, the molten metal is poured into a vertically oriented preheated rotating die. The centrifugal forces in the vertical spinning mold then cause the molten metal to spread horizontally and vertically along the inner diameter of the mold so that it assumes the specified shape. When casting vertically, the height of the casting will typically be less than twice the width.

Objectives:

1. Design and fabrication of vertical centrifugal casting machine using the existing mechanisms and direct motor shaft connection
2. Design and implementation of microcontroller-based system for vertical centrifugal casting machine using Arduino Mega 2560
3. Controlling process parameters like RPM of the motor and the time delay required for the molding purpose in a vertical centrifugal casting machine
4. Fabrication of simple vertical centrifugal casting machine
5. Fabrication of adaptable mold fixtures for vertical centrifugal casting with the help of slots that been provided in the rotating plate

Methodology:

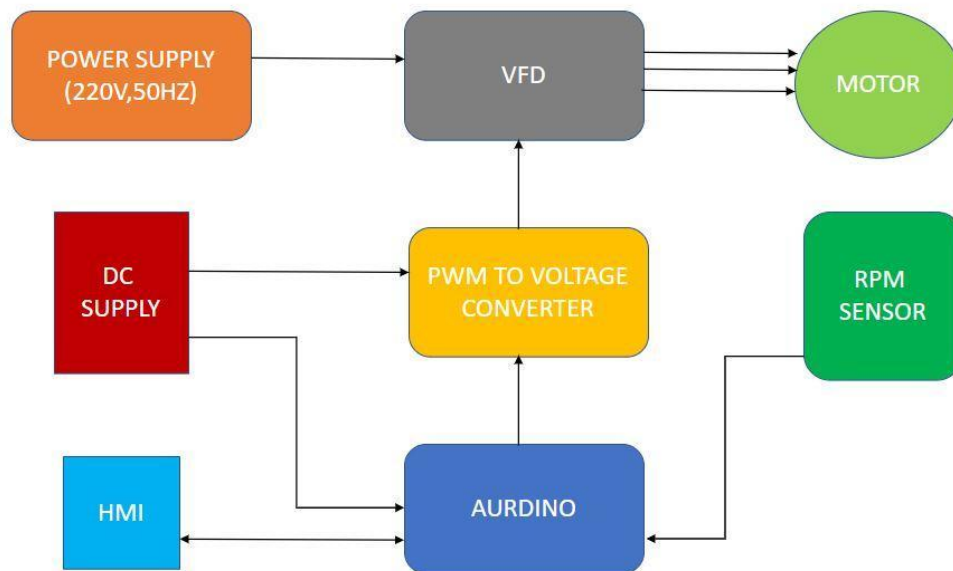


Figure 1 Block Diagram



Figure 2. Top View of Centrifugal casting machine



Figure 3 Side View of Centrifugal casting machine

Centrifugal Casting method is one of the commonly used to produce the functionally graded metal matrix composite materials and different cylindrical shaped objects. In the present industrial scenario the centrifugal casting machine is a high-cost device in which the process parameters like speed of rotation time of rotation of the mould is controlled manually. Automatic centrifugal casting machine is a low-cost solution for presently available machines with HMI (Human Machine Interface) and controller based.

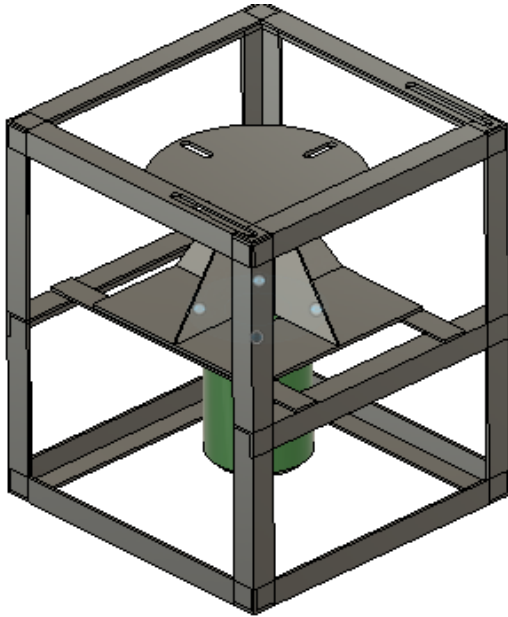


Figure 4: 3-D model of centrifugal casting machine

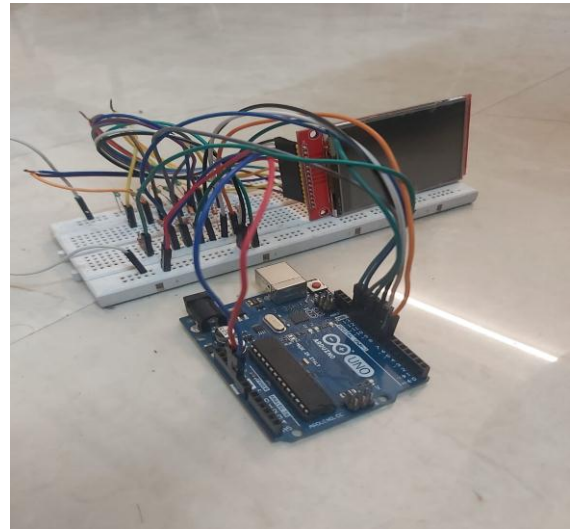


Figure 5: HMI connected to the Microcontroller

The inputs like Speed of rotation, time of rotation needs to be entered through the HMI (Human Machine Interface) which is a TFT display. From the Inputs given by the HMI and the program the controller gives the control signal to the motor through VFD (Variable Frequency Drive). The mould plate will be connected to the motor shaft. The speed of the motor will be controlled by the controller through with the help of VFD thus controlling the speed and time of rotation of the mould based on input entered in the HMI. A sensor senses the speed of rotation of the mould plate and gives feedback signal to the controller

Conclusion:

This project led to the design of axial load vertical centrifugal casting machine which is made up mold, shaft, belt, bearing, motor basically used for casting cylindrical components Principle behind Centrifugal Casting technique The design considerations that should be followed during the fabrication of centrifugal casting machine. The circuit design in order to keep motor RPM constant has been done with the help of VFD Technology. Decrease in pouring temperature leads to increases in all the mechanical properties due to fine grains in the matrix formed during the process. Also increase in Die-speed increases ultimate tensile strength due to the effect of centrifugal force acting on the metal. Mechanism of automated locking and unlocking of the covering plate in centrifugal casting machines has been observed. Integration of controller and HMI display is yet to be completed.

Scope for future work:

1. A mould needs to be attached to the mould plate which is used to cast cylindrical objects
2. A top cover can be designed to avoid the spilling of molten metal from the mould and a funnel can be used to pour molten metal into the mould.
3. Different sized mould can be attached to the mould plate to cast different sized object.
4. The same machine can be used for different types of automations by using different sensors and program to control other processing parameters of the centrifugal casting process