Conceptual Design of Casting Pattern

Jyoti katiyar¹, Surendra kumar², Er. D. P. Singh³
¹SITE, ²A.C.E.T, ³SITE

Abstract:- The present method of design of turbine blades is basically done by casting process named investment casting. Investment casting process includes lots of disadvantages like machining cost, labor cost, working skill etc. Hence in order to reduce these problems our main aim is to cast the same blade with an valid conceptually alternative design and this may reduce the entire problem associated with ongoing process. Since in these days we people have lots of modernized and advanced machine tools like Automated lathe, CNC, DNC etc. These machines can take care for all the machining after the job has been casted by say sand casting process and hence reduce surface roughness . so overall we can design number of conceptually alternative methods for casting of the turbine blades. But after having all those alternative methods we need to select the best suitable alternative method among them. Then we go for the casting if the blades.

In real world problems Investment casting process is generally used for casting of turbine blades which includes many problems like working skill, labor cost etc. now in these days we have lots of computer operated machines like CNC, DNC etc these are available which we can use for the machining and finishing operation of the sand casting products. Consider all those of issues one should opt for designing the turbine blades by alternative method which may lead to better accuracy and optimality.

Keywords:- Design; Analysis; Gas turbine blade; CNC

I. INTRODUCTION

Metal pouring is a assembling process by which a material in fluid form is typically put in to a mold, which hold an empty depression of the shape, and after that allowed to set. Throwing which is cemented part which is catapulted outside the box to finish the procedure. Throwing materials are typically different cool setting materials or metals that cure in the wake of combining two or more segments; cases are solids, epoxy, dirt and mortar. throwing is continually utilized for making complex shapes.

II. LITERATURE SURVEY

Throwing is an assembling process by which a material in fluid form is normally put in to mold, which hold an empty pit of the sought shape. The set part is called a throwing, which is thought or launched out outside the box to finish the procedure. Throwing is continually utilized for making complex shapes that might be generally uneconomical or troublesome to make by different systems. Casting is too much old process about 6000 years. The oldest surviving casting is a copper frog from 3200 BC.

Different Types of Casting Process:
- Investment casting
- Sand casting
- Continuous casting
- Permanent mold casting
- Centrifugal casting

Investment casting process

It is also called lost wax casting process. In which a wax pattern is coated with refractory ceramic materials, the wax is melted out and the molten metal is poured in to the cavity. the plastic pattern may also be used in this process and the pattern is destroyed in this process and then casting is done with the help of plastic and wax patterns. This process is used for small components and has been produced aircraft door frames, steel castings of up to 300kg and aluminum casting up to 30 kg.

In this process the steps are involved are:-
1) Produce a master pattern.
2) Mould making
3) Produce the wax pattern
4) Assemble the wax pattern
5) Investment
6) Dewax
Much complex geometry with undercuts can be cast. A very smooth surface is obtained with no parting line.

It is a modern procedure which also called as called lost wax throwing and also known metal framing systems from 5000 years back. to today’s high engineering waxes, hard headed materials and master composites, the castings permits the creation of parts with flexibility, and uprightness in a mixture of metals. This is large utilized for little castings and has been utilized to generate complete flying machine entry way casings, steel castings of up to 300kg and aluminum castings up to 30kg. It can handle convoluted shapes.

Permanent mold casting

Permanent mould casting is a metal casting process that uses reusable moulds (Permanent mould) which is made from metal. In this process uses a gravity to fill the mould and also uses a gas pressure or vacuum. Common casting metals are aluminum, magnesium and copper alloys.

The most typical parts included such as gears, gear housing, pipe fittings.

The advantages of this casting process are good surface finish and high dimensional accuracy and high production rate.

Tolerances are 0.4mm for the first 25mm (0.015 in for the first inch) and 0.02mm for each additional centimeter (0.002in per inch) and the surface finishes are 2.5 to 7.5µm.

Sub-Types Of Permanent Mold Casting
-Gravity die casting
-low pressure die casting
-High pressure die casting

Centrifugal Casting

It is a process that uses cast thin walled cylinders. In this process a permanent mould rotated about its axis at high speed (300 to 3000rpm) as the molten metal is poured. The metal is centrifugally thrown towards the inside mold wall where it solidify and cooled. This may be used to enhance the directional solidification of the casting and give good properties.

Size limits up to 3m & diameter 15m
Wall thickness ranges from 2.5mm to 125mm
Tolerance limit on the outer diameter can be 2.5mm and on the inner diameter can be 3.8mm

The three methods are used in centrifugal casting process are
1) Centrifuging
2) Semi centrifugal
3) True centrifugal

Continuous Casting

Constant throwing is utilized because of the easier expenses connected with consistent generation of a standard item Metals, for examples, steel, copper and aluminum are ceaselessly thrown. Consistent throwing is a refinement of the throwing procedure for the non stop, high volume handling of metal segment with a steady cross area. Liquid metal is put in to an open finished , water cooled copper mold which permits a “skin” of strong metal to structure over the still fluid focus. Cast size can extend from strip (a couple of millimeters thick by something like 5 meters wide) to billet (90 to 160mm²) to sections (1.25 wide by 230mm thick). Once in a while the strand may experience an introductory hot moving process before being cut.

Sand Casting Process

It is easiest sort of the throwing which is utilized for a long time.it takes modest clusters to be made contrasted with lasting mold throwing and an extremely sensible expense. there are no size operations are takes place, most metals to be thrown depending in the kind of sand utilized for the molds. It used for processing at high yield rates (1-20pieces/hr-mold), and is unsurpassed for expensive part creation. Green sand has very nearly no part weight limit, while dry sand has a down to earth part mass almost 2300-2700kg. Least part weight ranges from 0.075-0.1kg.
This process is utilized for long time. mold throwing and an exceptionally sensible expense. Not just does this the makers to make items for a great cost there are different profits to sand giving such a role as there are next to no size operations. Sand throwing additionally considers most metals to be thrown depending in the kind of sand utilized for the molds. utilizing green sand or substance fasteners, or polymerized oil, sand in most operations could be reused commonly and obliges minimal extra enter. Sand throwing, also called sand shaped throwing, is a metal throwing methodology portrayed by utilizing sand as the mold material. The expression sand throwing can additionally allude to an article generated through the sand throwing process. Sand casting are transform in particular plants called foundries. In excess of 70% of all metal castings are processed through the sand casting process.

Advantages and disadvantages of casting methods

Table-1 shows the advantages and disadvantages of sand casting process.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Low capital investment means that short production runs are viable.</td>
<td>1) Bad surface finish due to sand indentation and oxidizing medium etc.</td>
</tr>
<tr>
<td>2) Use of sand cores allow fairly complex shapes to be cast.</td>
<td>2) Not suitable for mass production, often used to produce few number of products compared with other casting processes which produce thousands and millions.</td>
</tr>
</tbody>
</table>

Table -2 shows the advantages and disadvantages of investment casting.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Very smooth surface is obtained with no parting line.</td>
<td>1) This process is expansive.</td>
</tr>
<tr>
<td>2) Dimensional accuracy is better.</td>
<td>2) Holes can not be smaller than 1.6mm.</td>
</tr>
<tr>
<td>3) It may be used to replace die-casting where short runs are involved.</td>
<td>3) This process requires very long production cycle time.</td>
</tr>
</tbody>
</table>

Objective of present work

The objective of this study is to design the blades of a single stage high pressure and high temperature steam turbine in a heavy conceptual way which may not look like as actual prototype but it should be designed in such a way that it will satisfy all the necessary mechanical strength, surface finish and defect free criterions. Now the design of the blade pattern can be thought of conceptually as a number of methods like:-
In order to design the specific shape of the product for this study several issues were considered. Some of these are as follows. First of all a preliminary issue is considered in CATIA software. Design

Through our prime job is to design the turbine blade, first I have analyzed the proper dimensions of a steam turbine blades using CATIA design software.

**Conceptual alternative**

The present technology for the casting of turbine blade i.e. investment casting process has got lots of disadvantages so our objective is to minimize the obstacle by casting the same product by sand casting process. but now a day due to the availability of CNC machines one can be able to provide proper shape and size. Hence we can think of some conceptually alternative pattern which can replace the problem with investment casting.

<table>
<thead>
<tr>
<th>Concepts</th>
<th>Strength</th>
<th>Cost</th>
<th>Surface finish</th>
<th>Rigidity</th>
<th>Feasibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loose-foam pattern</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>Yes</td>
</tr>
<tr>
<td>Loose piece pattern</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>No</td>
</tr>
<tr>
<td>Rubber bladder pattern</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
<td>No</td>
</tr>
<tr>
<td>Brick piece pattern</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>No</td>
</tr>
</tbody>
</table>

**Weighted average method for Prioritization:**

Let consider the following weights given to the various parameter in the determination of suitability

W1= Weight given to strength
W2= Weight given to cost
W3= Weight given to source finish
W4= Weight given to rigidity
X1= Importance of strength in overall design
X2= Importance of cost in overall design
X3= Importance of surface finish in overall design
X4= Importance of rigidity in overall design
IV. DESIGN AND FABRICATION

In order to design the specific shape of the product for this study several concepts were considered they are as follows-(a) complexity of the shape for the easily removal of the wax pattern form the mould; (b) complexity of the features, which can distort the shape easily; (c) Should have both unconstrained dimensions so that the variation between soft and hard tooling can be compared.

V. CONCLUSIONS

The objective of the work i.e. to conceptually design the casting pattern has been completed by taking all those issue in to consideration. And choosing the best alternatives among no need to withdraw it from the mould flask. Since foam melts under the temperature of molten metal. Finally the lost foam type casting method has been given the highest priority.

Advantages of foam casting:
1. cheaply available.
2. High surface finish
3. Low labor cost
4. Complex jobs can be easily manufactured.

REFERENCES