Design and Development (Engineer’s Basics)

With the changing scenario of technology development in the world, it has become very essential to keep pace with the technological advancement to be in market. The design and development department of any company is mainly responsible for updating the existing product to match with the latest technology available and also to develop the new products anticipating the future need of the society. The basic function of the design and development department can be divided into following three categories.

INNOVATION

Innovation is the process of generating products that are unique in terms of performance, material or use.

RENOVATION

Renovation is the process of modifying the existing products to extend their life in the existing markets or to fulfill the needs of the future markets. This function is essential to be competitive in the market.

ELIMINATION

Elimination is the process of pruning the old or unprofitable products from the product range. Planned and purposeful elimination of old and unprofitable product is a key to innovation,

Because, it frees necessary resources and

It stimulates the search for new products to replace the old.

THE MAIN ACTIVITIES GENERALLY PERFORMED BY DESIGN AND DEVELOPMENT DEPARTMENT:

Design of new product using the latest know-how and computer aided facilities.

Redesign of the old products with a view of weight and cost reduction and/or performance improvement to meet the market requirement.

Development co-ordination of the new products

To provide technical support to the marketing department

Anticipating the need of the customer, nation, the company has to develop a new generation of products with the sole objective of total energy conservation, free from environmental hazards and to reach at affordable price to the users. Such new generation products are today universally acclaimed as the best in the world.

All such activities from design and development department have been grouped into a logical pattern or frame work and assigned to specific positions and people in the organization. The company has a line and staff concept and structure in the organization where each member of the group knows as to what

is expected of him to contribute in accomplishing the organizational objectives in measurable terms. The way by which the goals conceived in planning can be achieved is made known to each unit. This is accomplished through appropriate delegation of authority, power and accountability system as adopted in the organization. At each level, departments are accountable to someone at the next higher level in the organization. Due important has been given to safety and security of men, materials and machines in the factory. Thus, Design and Development Department has a remarkable focus towards the end users.

[**IMPORTANCE OF TRAINING TO ENGINEERS**](http://www.portal4engineers.blogspo.com)

Training has become the most essential part of an organization and every Engineer must undergo training to become more efficient and reliable. Training is quite essential for a newly appointed Engineer as well as an old employee of an organization. It helps the new Engineer to get the full knowledge of the productions and Machines that he has to operate the working technique and managing skills to different machines and tools depends upon the industrial segment. It has helps the old engineer to acquaint themselves with the new machines and tools of the company, to understand the new techniques of working operation and improve or increase their ability and efficiency. Therefore the company arranges for the training of new as well as old engineers.

The extent of training depends upon several factors such as the nature of the job, the educational qualifications of the engineer, their past experience, the nature of the tools or machines to be handled and the types of customers with whom the engineer have to deal. The aims and objects of giving training are various. The following are the common aims and objects of providing training or coaching to Engineers.

**AIMS AND OBJECTS OF TRAINING**

To acquaint the new engineer with the principles and techniques of handling machine and cost saving procedures

To increase or improve the efficiency of an old employee

To enable the engineers to get full knowledge of the production and operation and increasing the production rate skills of the organization where they are employed.

To enable the engineers to be familiar with the tools and machines practices of the plant and to render better services to the management.

To keep the engineers well informed about the laws regulating the warranty and guaranty, company policy, about the types of customers, about the position of the competing firms and about the ways of overall cost of the company.

To find in the course of training inefficient persons and weed them out

Thus, training is very important in producing effective, efficient and strong team of engineers. It is often said that a good engineer can handle anything and therefore a trained engineers affects the growth of any production system and under any circumstances. This is so because a trained engineer has thorough understanding of the task entrusted to him.

Foundry

WHAT IS CASTING?

A casting may be defined as a ‘Metal object obtained by allowing molten metal to solidify in a mould, “the shape of the object being determined by the shape of the mould cavity.” Founding or casting is the process of forming metal objects by melting metal and pouring it in to moulds. A foundry is a commercial establishment for founding or producing castings. Significant in these definitions is the use of liquid metal to cast the shape of the object directly, producing cast metal. Wrought metal products differ from cast metal products in that the metal has received mechanical working treatment such as forging, rolling, or extruding. Practically all metal is initially cast. Castings obtain their shape principally when molten metal solidifies in the desired form. Wrought objects, however, are cast as ingots and then plastically worked to approximately the desired shape.

METAL CASTING, “A PROCESS OF SHAPING”

The strength of the foundry industries rests on the fundamental nature of casting as a process for causing metals to take shapes that will serve the needs of man. There are other methods of shaping, machining, forging, welding, stamping, hot working etc. Each has applications in which it is unexcelled and others for which it is unsuited. Rarely is an engineering product completed which does not use several or all of the fundamental metal processing methods. The foundry industry is thus built on one of the truly basic methods available for shaping metals to useful ends.

Certain advantages are inherent in the metal casting process. These may form the basis for choosing casting as a process to be preferred over other shaping process in a particular case. Some of the reasons for the success of the casting process follow:

REASONS FOR THE SUCCESS OF THE CASTING PROCESSES

The most intricate of shapes, both external and internal may be cast. As a result, many other operations, such as machining, forging, and welding, may be minimized or eliminated.

Because of their metallurgical nature, some metals can only be cast to shape since they cannot be hot worked in to bars, rods, plates, or other shapes from ingot form as a preliminary to other processing. The highly useful and low cost cast irons, which exceed the total of all other metals in tonnage cast, illustrate this fact.

Construction may be simplified. Objects may be cast in a single piece which would otherwise require construction in several pieces and subsequent assembly if made by other methods.

Metal casting is a process highly adaptable to the requirements of mass production. Large numbers of a given casting may be produced very rapidly. The use of castings in the automotive industry provides ample illustration of this point.

Extremely large, heavy metal objects may be cast when they would be difficult or economically impossible to produce otherwise. Large pump housing, valves, and hydroelectric plant parts weighing up to 200 tons illustrate this application.

Some engineering properties are obtained more favorably in cast metals. Examples are:-

Mach inability and vibration damping capacity in cast irons

More uniform properties from a directional stand point, i.e. properly cast metals can exhibit the same properties regardless of which direction is selected relative to the original casting for the test piece. This is not generally true for wrought metals.

Strength and lightness in certain light metal alloys which can be produced only as casting.

Good bearing qualities are obtained in cast bearing metals.

In general, a wide range of alloy composition and properties is produced in cast form.

A decided economic advantage may exist as a result of any one or a combination of points 1 to 6. The price and sales factor is a dominant one which continually weighs the advantages and limitations of any process used in a competitive system of enterprise.

The list of disadvantages accruing to the metal casting process may be expanded beyond that given above. It is also true that conditions may be stated where the casting process must give way to other methods of shaping. Such conditions are those in the area of the principal advantages to be gained by the other metal processing methods. For example, machining produces smooth surfaces and dimensional accuracy not obtainable in any other way; forging aids in developing the ultimate of fibered strength and toughness in steel; welding provides a convenient method of joining or fabricating wrought or cast products into more complex structures; and stamping produces light weight sheet metal parts. Thus the engineer may select from a number of metal processing methods that one or combination which is most suited to the needs of his work.

2.0 REQUIRED BASIC STEPS IN MAKING SAND CASTINGS

Practically all the detailed operations that enter into the making of sand castings may be categorized as belonging to one of five fundamental steps of the process:

1. Pattern making (including core boxes)

2. Core making

3. Moulding

4. Melting and pouring

5. Cleaning

The detailed and technical process involved in each of the above operations is the source of the foundry man’s principal problems, other than personnel and marketing. The integration of the various steps to produce casting is briefly summarized for the benefits of those unfamiliar with the foundry. The processes and the equipment as explained.

2.1 PATTERN MAKING

Patterns are required to make molds. The mold is made by packing some readily formed plastic material, such as molding sand around the pattern. When the pattern is withdrawn, its imprint provides the mold cavity, which is ultimately filled with metal to become the casting. Thus, molding requires, first, that pattern be made. A pattern maybe simply visualized as an approximate replica of the exterior of a casting. If the casting is to be hollow, as in the case of a pipe fitting additional patterns, referred to as core boxes, are used to form the sand that is used to create these cavities.

2.2 CORE MAKING

Cores are forms, usually made of sand, which are placed into a mold cavity to for the interior surfaces of castings. Thus, the void space between the core and old cavity surface is what eventually becomes the casting. A core and core box for a mixing valve and cores are ordinarily made separately from molds in a designated area of the foundry referred to as core room. They are then transported to the molding department to be placed in the molds. Core boxes are required to produce cores, so that this operation is again dependent on the patterns department.

2.3 MOLDING

Molding consists of all operations necessary to prepare a mold for receiving molten metal. Molding usually involves placing a molding aggregate around a pattern held within a supporting frame, withdrawing the pattern to leave the mold cavity, setting the cores in the mold cavity and finishing and closing the mold. The old is then ready for pouring. A finished is mold ready for closing. Fig 1.1

2.4 MELTING AND POURING

The preparation of molten metal for casting is referred to simply as melting. Melting is usually done in a specifically designated area of the foundry and the molten metal is transferred to the molding area where the molds are poured.

2.5 Cleaning refers to all operations necessary to the removal of sand, scale, and excess metal from the casting. The casting is separated from the molding sand and transported to the cleaning department. Burned – on sand and scale are removed to improve the surface appearance of the casting. Excess metal, in the form of fins, parting line fins, and gates, is cut off. Defecting castings may be salvaged by welding or other repair. Inspection of the casting for defects and general quality follows. The casting is then ready for shipment or further processing, for example, heat treatment, surface treatment, or machining. A rough mixing valve casting and a cleaned casting are shown in fig.

The preceding paragraphs have briefly summarized the basic steps in the foundry process. There are, of course, other steps, not discussed which are exceedingly important in some foundries. For example, with certain alloys, every casting must be given a heat-treatment.

THE ENGINEER AND THE FOUNDRY INDUSTRY

Because of the scope of the industry and the widespread of castings, engineers often find themselves in a position where knowledge of foundry processes and casting problems becomes a vital part of their work. Design of castings, specifications, intelligent use of the properties of cast metals, purchasing of castings, and processing of castings, all require the application of engineering principles unique to castings and the foundry process. The engineer who designs a casting must have accurate information about the properties of the cast metal he would use. Further, he may achieve considerable economies by selecting a design that facilitates molding, coring, and other foundry problems. When specifications are more limiting than necessary, foundry problems and costs rise. Designs which make it difficult to obtain sound castings result in low mechanical properties in the cast metal, so that hand book data are not reliable. Many engineers face these problems in their work even though they themselves are not directly engaged in foundry work. Engineers are also finding increasing opportunity for professional work in the foundry field itself. To provide a foundation for work in this field, indirectly or directly, course work in the principles of metal castings finds a place in the educational preparation of student engineers. In addition, certain principles of material science and engineering are best studied in the foundry process.

FUNCTIONAL ROLE OF FOUNDRY RAW - MATERIALS

|  |  |  |  |
| --- | --- | --- | --- |
| SL.NO. | MATERIAL | PLACE OF USE | FUNCTIONAL ROLE |
| 01 | Sand | Core shop  Moulding. | Provide porous structure for gases to go out. |
|  |  |  |  |
| 02 | Core Oil | Core Shop. | To provide hot strength after baking. |
|  |  |  |  |
| 03 | Dextrine | Core and Mould. | Provide green strength in the sand. |
|  |  |  |  |
| 04 | Bentonite | Moulding. | Green strength with less gases. |
|  |  |  |  |
| 05 | Coal Dust | Moulding. | Increase permeability and improve surface finish. |
|  |  |  |  |
| 06 | Wax Rope | Core. | Venting for gases to go out at critical areas. |
|  |  |  |  |
| 07 | G.I. Wire | Core. | Provide necessary strength. |
|  |  |  |  |
| 08 | Stick Hard | Core. | For sticking the cores. |
|  |  |  |  |
| 09 | Graphite powder | Core. | Improve the surface finish. |
|  |  |  |  |
| 10 | Chaplet | Moulding. | Support to the core in the mould. |
|  |  |  |  |
| 11 | Chills | Moulding. | To increase the cooling rate to avoid shrinkage Defect |
|  |  |  |  |
| 12 | Pig Iron | Cupola Charging. | To base metal. |
|  |  |  |  |
| 13 | Coke | Cupola Charging. | To melt pig iron and to achieve required temperature. |
|  |  |  |  |
| 14 | Lime Stone | Cupola Charging. | To make slag fluid. |
|  |  |  |  |
| 15 | Ferro Silicon | Cupola/Furnace. | To maintain the required % of silicon in the metal to achieve the required hardness. |
|  |  |  |  |
| 16 | Innoculine | Cupola/Furnace. | To improve mach inability. |
|  |  |  |  |
| 17 | MS Scrap | Cupola/Furnace. | To increase tensile strength. |
|  |  |  |  |

WHAT IS PATTERN SHOP?

PATTERNS: Patterns are the foundry man’s mold – forming tool. The mold cavity, and therefore ultimately the casting, is made from the patterns.

Type of Patterns

Several types of patterns are used in foundries. Depending on the casting requirements, the pattern may conform to one of the following types:

1. Single or loose pattern

2. Gated pattern (loose)

3. Match plate patterns

4. Cope and drag patterns

5. Special patterns and devices

Each of the patterns types has characteristics uses.

PATTERN ALLOWANCES

Although the pattern is used to produce a casting of the desired dimensions, it is not dimensionally identical with the casting. For metallurgical and mechanical reason, a number of allowances must be made on the pattern if the casting is to be dimensionally correct.

SHRINKAGE ALLOWANCE ON PATTERNS

Shrinkage allowance on patterns is a correction for solidification shrinkage of the metal and its contractions during cooling to room temperature. The total contraction is volumetric, but the correction for it is usually expressed linearly. Pattern shrinkage allowance is the amount the pattern must be made large than the casting to provide for total contraction. It may vary from a negligible amount to 5/8 inch per feet, depending on the metal and the nature of the casting.

MACHINE FINISH ALLOWANCE

Machine finish allowance is the amount; the dimensions on a casting are made oversize to provide stock for machining. These allowances are influenced by the metal, the casting design, and the method of casting and cleaning. Other casting processes permit different finish allowances to be used, as is pointed out in a subsequent chapter. In general, machine finish allowances may be a minimum if the surfaces to be dimensional variation and other defects are usually least prevalent there.

PATTERN DRAFT

Draft is the taper allowed on vertical faces of a pattern to permit its removal from the sand or other moulding medium without tearing the mold cavity surfaces. A taper of 1/16 inch per feet is common for vertical walls on patterns drawn by hand. Machine – drawn patterns require about one degree taper. In some cases, even vertical is very smooth and clean and the drawing equipment is properly aligned. In the case of pockets or deep cavities in the pattern, considerably more draft is necessary to avoid tearing the mold during withdrawal of the pattern.

SIZE TOLERANCE

The variation which may be permitted on a given casting dimension is called its tolerance, and is equal to the difference between the minimum and the maximum limits for any specified dimension.

DISTORTION ALLOWANCE

Certain objects, such as large flat plates and dome are U shaped castings, sometimes distort when re produced from a straight or perfect pattern. In such cases, the pattern may be intentionally distorted, or ‘faked’. The distorted pattern then produces a casting of the proper shape and size.

FUNCTION OF PATTERNS

The main purpose of pattern is its use in molding. However, to produce a casting successfully and render it suitable for further processing, the pattern may be required to perform other functions besides producing a mold cavity. These are briefly considered as follows-

MOULDING THE GATING SYSTEM

Good gating practice for castings generally requires that the system of channels and feeding reservoirs (gates and risers) for introducing metal into the mold cavity be attached to the pattern. The gating system may then obtain the benefits of machine molding.

ESTABLISHING THE PARTING LINE

On a flat pattern plate, the parting surface is a simple plane. Many castings, however, require curved parting surface of their shape, and these are established by the pattern where match plates or cope and drag plates are used. Loose patterns follow board or match be constructed for establishing the parting surface in successive molds.

MAKING CORE PRINTS

When a casting requires cores, provision is made on the pattern for core prints. Core prints are portions of the patterns for core prints. Core prints are portions of the pattern and mold cavity which serve to anchor the core in proper position in the mold. The core print is added to the pattern, but does not appear on the castings because it is blocked off by the core.

ESTABLISHING LOCATING POINTS

The foundry, pattern shop, or machine shop employs locating points or surfaces on the casting to check the casting dimensions. Machining operations may also use the locating points in establishing the position of machined surfaces relative to the balance of the casting.

MINIMISING CASTING DEFECTS ATTRIBUTABLE TO THE PATTERN

Properly constructed, clean and smooth surfaced patterns are a necessity in making good castings. Patterns with rough, nicked surfaces and undercuts, loosely mounted, and in a generally poor condition contribute substantially to defective castings containing sand inclusions and other imperfections.

PROVIDING FOR RAM-UP CORES

Sometimes a part of a mold cavity is made with cores which are positioned by the pattern before the molding and is rammed. The ram-up core then is held by the sand which has been packed around it.

PROVIDING ECONOMY IN MOLDING

The pattern should be constructed to achieve all possible savings in cost of the casting. Here such items may be considered as the number of castings in the mold, the proper size of the pattern plate to fit available molding equipment, method of molding, and other factors.

**FUNCTIONAL ROLE OF PATTERN EQUIPMENTS**

|  |  |  |
| --- | --- | --- |
| SL.NO. | PATTERN EQUIPMENTS | FUNCTIONAL ROLE |
| 01 | Core Box. | Achieve required shape of the core. |
|  |  |  |
| 02 | Pattern. | Provide required cavity in the sand for producing casting. |
|  |  |  |
| 03 | Gating System. | To feed the castings. |
|  |  |  |
|  | Sprue. | To maintain a satisfactory level of the metal for feeding. |
|  |  |  |
|  | Runners. | To entrap the sand and slag in the flowing metal. |
|  |  |  |
|  | Ingots. | To feed metal. |
|  |  |  |
|  | Risers. | To feed the metal into thick section of the casting. |
|  |  |  |
|  | Flow Off. | To escape the gases. |
|  |  |  |
| 04 | Moulding Box. | To prepare a mould cavity of sand with adequate ramming and provide alignment between cope and drag. |
|  |  |  |

**MOULDING**

REQUIREMENT OF A GOOD MOULD

1. Good Finish
2. Sufficient Strength
3. Sufficient Venting
4. Proper Core Assembly
5. Proper Gating System
6. High Gas Permeability
7. Proper Box Closing

PRECAUTIONS IN MOULD MAKING AND POURING OF METAL

|  |  |  |  |
| --- | --- | --- | --- |
| SL. NO | ACTIVITY | PRECAUTIONS | CONSEQUENCES |
| 01 | Pattern Fixing | Check pattern for damage. | Casting dimensions and poor finish. |
|  |  |  |  |
|  |  | Avoid repairing of damage PTN. | Perfect repairs not. Feasible due to inadequate tools. |
|  |  |  |  |
|  |  | Use thin film of releasing agent. | Rough surface and pattern stripping is difficult. |
|  |  |  |  |
|  |  | Use correct size of under damaged box. | Mix-match, inadequate area for packing sand drop inadequate feeding head mould breakage. |
|  |  |  |  |
|  |  | Place chill, Chaples, gaggess reinforcement as specified. | Defective castings. |
|  |  |  |  |
|  |  | Loose pieces firmly at its position. | Defective castings. |
|  |  |  |  |
| 02 | Sand Filling and Ramming | Check moisture of sand by feel. | Blow hole, rough surface and swelling in case moisture more and sand fall erosion, inclusion in core moisture less. |
|  |  |  |  |
|  |  | Don’t add any water to the sand. | Non uniform sand. |
|  |  |  |  |
|  |  | Pack the facing sand reinforcly (2”-3”). | Desired effect of facing sand will not be achieved. |
|  |  |  |  |
|  |  | Take care in ramming the sand in deeper cavity. | Sand fall and poor finish at the cavity. |
|  |  |  |  |
|  |  | Ram the backing sand in layers to a hardness of 65 to 70 throughout the mould. | Swelling. |
|  |  |  |  |
|  |  | Fill the sand to the box height. | Mould may sag. |
|  |  |  |  |
|  |  | Start jolting after half filling the box with sand. Loose pieces should not change its position while jolting. | Shift in the loose piece cannot be noticed and sand may be loose at certain cases. |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  | Continue jolting for specified line. | Mould hardness will be less. |
|  |  |  |  |
|  |  | Squeeze head should be less by ½” around compare to box size. | Force will be on the box and not on the sand. |
|  |  |  |  |
|  |  | Release the moulding box evenly. | Damage the mould and pattern. |
|  |  |  |  |
| 03 | Venting Cope Assembly | Vent the box throughout. | Blow holes, pin holes. |
|  |  |  |  |
|  |  | Check the position of cope pattern with reference to drag. | Miss-match. |
|  |  |  |  |
|  |  | Fix the match plate in a position such that round bush of the box is on the same side of the pattern as in the drag. | Miss-match. |
|  |  |  |  |
|  |  | Place sprue, riser, flow off ram up core and chills as per the method cards. | Cold shuts, Shrinkage, and blow holes. |
|  |  |  |  |
| 04 | Box Removal | Remove the box slowly and evenly. | Mould Breakage. |
|  |  |  |  |
|  |  | Slag hammer round hammer should not use for wrapping the patterns. | Mould Breakage. |
|  |  |  |  |
| 05 | Venting | Vent the box throughout. | Blow holes or pin holes. |
|  |  |  |  |
| 06 | Mould Finishing | Repair minor damages. near corners etc. | Defective castings, dimensional in accuracy. |
|  |  |  |  |
|  |  | Scrap the mould in case of major damage. | De-formed castings. |
|  |  |  |  |
|  |  | Clean sand from chill surface sprue and riser seating. | Sand inclusion. |
|  |  |  |  |
|  |  | Drive away the loose sand by air. | Sand inclusion. |
|  |  |  |  |
|  |  | Provide venting ¼” to 3/8” wire the spigot surface and at the highest point of the mould. | Blow holes. |
|  |  |  |  |
|  |  | Venting to align the core venting and the centre. | Blow holes. |
|  |  |  |  |
|  |  | Agitate the coating mixture before using. | Poor coating finish. |
|  |  |  |  |
|  |  | Take core in coating deeper position like leg cavity. | Poor finish at the spots. |
|  |  |  |  |
|  |  | Avoids brush marks on the mould surface. | Poor casting finish. |
|  |  |  |  |
|  |  | Ignite or Dry the mould fully using a burner as specified. | Blow holes. |
|  |  |  |  |
| 07 | Core Assembly | Use Cheplet as specified. | Uneven metal thickness. |
|  |  |  |  |
|  |  | Place the core correctly without damaging either the core or mould. | De-shaped castings. |
|  |  |  |  |
|  |  | Check Core Assembly. | Out., extra metal. |
|  |  |  |  |
|  |  | Avoid repairing Cores. | Roughness, extra metal. |
|  |  |  |  |
|  |  | Avoid using under-baked, over baked, under coated cores. | Core Breakage, Sand. |
|  |  |  |  |
| 08 | Box Closing | Closing pins should go Wright through the bush freely. | Shift, Sand fall. |
|  |  |  |  |
|  |  | Check the box alignment. | Shift. |
|  |  |  |  |
|  |  | Clamp the box correctly. | Metal leak. |
|  |  |  |  |
|  |  | Keep the proper weight as specified. | Metal leak, swelling. |
|  |  |  |  |
|  |  | Match the marking while assembly the box. | Shift. |

**DESIGN OF GATING SYSTEM**

The quality of casting is determined to a large extent by the way in which the molten metal is transferred from the ladle in to the mould cavity. Though it would appear that casting manufacturing is so simple, lot of factors must be controlled if good casting is to be produced. Due consideration to the gating and riser is very important to produce the castings of required quality. This paper makes an attempt to give some information in this regard.

A proper gating system has to fulfill the following basic requirements-

1. To eliminate or reduce turbulence to minimize dross formation.

2. To eliminate or reduce aspiration of air and mould gases.

3. To decrease velocity to minimize mould erosion.

4. To eliminate premature freezing of casting.

5. To assist in developing proper temperature gradient.

6. To get the maximum casting yield.

7. It must be of simple design so as to facilitate moulding, particularly with machine moulding.

8. It must incur the minimum fettling and grinding cost.

9. It should assist to have a fast flow rate to avoid excessive pouring temperature.

BASIC ELEMENTS AND FUNCTIONS OF GATING SYSTEM

**Pouring Basin**:

The enlarged offset portion of the mouth of the mould into which molten metal is first poured

**Sprue:**

A vertical passage which conducts metal down in to the sprue base

**Sprue Base:**

The area directly below the sprue into which molten metal falls; this helps to streamline the flow of

Metal into the runner

**Runner:**

A horizontal passage way through which molten metal flows into the gates

**Gate:**

The short passage way that connects the runner to the mould cavity or riser

**Runner Extension:**

The part of the runner which extends beyond the farthest ingrate as a blind end

**Fig36**

**GUIDELINE FOR A BETTER PERFORMANCE OF A GATING SYSTEM**

Use pouring basin with generous radius into sprue opening.

Pour away from the sprue opening. Never directly down the sprue.

Keep the pouring lip low and the system full during the full period of pouring.

Use tapered sprue (big end up) to avoid aspiration of air or mould gases into the system.

Use either a well or enlargement at the base of the sprue.

Use well rounded corners in runners and ingates, enabling to eliminate the low pressure zone and thus aspiration effect.

Stepping of runner by an amount equal to each gate passed may help in getting equal flow from different ingates.

After the last ingate, a runner extension of 100 to 150 mm may be provided, so that, the first rush of metal which might have picked up some dirt or loose sand on the way is collected in runner extension.

Use a wide ingate, but the thickness of the ingate should be small.

Metal should be delivered to the mould cavity by shortest route possible to have a good yield. This also enables to eliminate the loss of temperature.

Ingates should never be provided near protruding points of mould sand and should never be arranged at the chill or studs. Possibilities of metal hitting the core directly should be avoided.

Casting may be divided into different parts which may be provided with individual gates so as to avoid hot spot conditions at ingates.

Attempt should be made to achieve unidirectional movement of metal to get the favorable temperature conditions of proper working of riser.

**WHAT IS GATING RATIO?**

Metal should flow in a full gating system with uniform pressure and velocity in all parts of the runners and gates. This condition can be achieved by using proper gating ratio. Gating ratio is the ratio between the cross sectional areas of three parts of the gating system that governs the flow of metal from sprue to mould. These parts in order are the bottom of down sprue (choke) the runners and the gates. Depending upon the nature of the metal or alloy and size, geometry and thickness of casting various gating ratios are used.

TYPES OF GATES

Metal can be directed into mould cavity in many ways. Design of each gating system depends upon its primary objectives. Improper gating system may lead to casting defects, such as:

1. Inclusions

2. Rough Surface

3. Entrapped Gases

4. Localized Shrinkage

5. Dispersed porosity

6. Miss run and Cold shut

7. Metal Penetration, etc.

In general, following are the some of the gating systems followed in various foundries:

1. PARTING LINE GATE

These are placed in the parting line separating the cope and drag portions of the mould.

1. BOTTOM GATE

Bottom gates are placed in the drag portion of the mould. A bottom gate is preferred in heavy castings to reduce erosion and gas entrapment and to prevent splashing which can result in cold shuts.

1. BRANCH GATE

Branch gate is designed either to feed a single casting at several points or a number of slag from the flowing metal.

1. WHIRL GATE

This gate employs centrifugal force to aid in the separation of slag from the flowing metal.

1. LAP GATE

In this, the gate is overlapping the mould cavity of the drag portion for a calculated amount of area. This gate considerably reduces the fettling time to a maximum extent.

FIG.

**PROCESS FLOW CHART- MOULDING**

PATTERN SAND FILLING VENTING BOX VENTING

FIXING RAMMING REMOVAL

KNOCK OUT POURING BOX CORE MOULD

CLOSING ASSEMBLY FINISHING

**CORE MAKING**

**REQUIREMENT OF A GOOD QUALITY CORE**

1. Good Finish
2. Sufficient Strength
3. Sufficient Venting
4. Gas Permeability High
5. Proper Baking
6. Proper Assembly
7. Dimensional Accuracies

**PROCESS FLOW CHART – CORE MAKING**

CORE BOX SAND FILLING RAMMING VENTING REINFORCEMENT

PREPERATION

**INSPECTION FINISHING BAKING CORE REMOVAL**

**PRECAUTIONS IN CORE MAKING**

|  |  |  |  |
| --- | --- | --- | --- |
| SL. No. | ACTIVITY | PRECAUTIONS | CONSEQUENCES |
| 01 | CORE BOX PREPERATION | Check pins and Bushes of Core Box. | Shift. |
|  |  |  |  |
|  |  | Check for warpage of Core Box. | Oversized core, pins. |
|  |  |  |  |
|  |  | Ensure proper clamping. | Pins and oversize cores. |
|  |  |  |  |
|  |  | Ensure parting media application. | Core will get damage while removing from core box. |
|  |  |  |  |
| 02 | Sand Filling | Ensure proper filling of Core Box. | Proper shape of core will not achieve. |
|  |  |  |  |
|  |  | Ensure the use of lamp free sand. | It will give a poor finish cracks. |
|  |  |  |  |
| 03 | Ramming | Ensure adequate ramming by using proper tools. | It will result core breakage and poor surface finish. |
|  |  |  |  |
| 04 | Venting Chills and Reinforcement | Ensure proper venting. | Blow hole in casting. |
|  |  |  |  |
|  |  | Ensure coated chills in right position. | Shrinkage in castings. |
|  |  |  |  |
|  |  | Ensure the position and size of reinforcement wire. | Core Breakage. |
|  |  |  |  |
| 05 | Core Removal | Ensure the leveling of the core. | De-shape or damage. |
|  |  |  |  |
|  |  | Use warpage free core plate. | De-shape during baking. |
|  |  |  |  |
| 06 | Core Painting | Ensure the proper density of coating material. | Poor surface finish. |
|  |  |  |  |
|  |  | Stir the paint before use for ensuring proper density of coating material. Check spray gun before use. | 1. Core Damage. 2. Core Finish. |
|  |  |  |  |
| 07 | Baking | Ensure the proper stacking of plates inside the oven. | Core damage, over loading. |
|  |  |  |  |
|  |  | Ensure the proper temperature and time for baking. | Under Baked or Over Baked Core. |
|  |  |  |  |
| 08 | Finishing | Use gauges for critical dimensions. | Over size or Under size cores. |
|  |  |  |  |
|  |  | Ensure the proper density of stick hard, in case of assembly of core. | Core will open out. |
|  |  |  |  |
|  |  | Ensure proper core slick on parting line. | Cavities in the linings. |
|  |  |  |  |
|  |  | Ensure proper stacking of finishing core. | Damage of core. |
|  |  |  |  |
| 09 | Inspection | Check critical dimension by gauges. | Problem is core assembly. |
|  |  |  |  |
|  |  | Ensure visual inspection. | Defects in the castings. |
|  |  |  |  |

MELTING OF CAST IRONS PROCESS

Historically, the development of the blast furnace for the reduction of iron ore gave birth to iron founding. At first pig iron from the blast furnace was used directly for making iron castings. As time went on and the use of iron castings became more common, smaller shaft type furnaces were introduced for re melting pig iron specifically for making grey iron castings. Thus evolved the cupola. The first English patent on a cupola furnace was granted in 1794, and the first American cupola was erected in 1820. Since that time the cupola has gradually developed into a furnace especially adapted to the needs of cast iron melting. Although, other types of furnaces are used, by far the greatest tonnage of iron is produced by cupola melting.

THE CUPOLA

Widespread use of the cupola for grey – iron melting rests upon its unique advantages, which includes:

1. Continuous melting. Foundry production is facilitated since a ladle of molten iron may be tapped from the furnace at regular intervals. The flow of molten metal’s and molds for pouring may be synchronized for quantity production as required by the automotive, agricultural equipment, and similar industries.
2. Low cost of melting. Raw materials and operating costs are lower than on any other type of melting furnace producing equivalent tonnage.
3. Chemical compositions control is possible by proper furnace operation with continuous melting.
4. Adequate temperature control for fluidity in pouring castings can be obtained. Certain limitations also are characteristics of the cupola furnace. Low carbon percentages in the iron below about 2.80% C are difficult to attain because of direct contact of molten iron and the carbonaceous fuel. Some alloying elements such as chromium and molybdenum are in part lost by oxidation in the cupola. Higher temperatures are obtained with air-furnace melting. The use of several furnaces by duplexing, i.e., transferring of the molten metal from one furnace to another, may be utilized to combine the advantages of each type of furnace. For example, white iron may be melted in the cupola and have its carbon percentage lowered from about 3.0 to 2.20 to 2.40 percent by decarburization in the air furnace.

MECHANICAL STRUCTURE OF A CONVENTIONAL CUPOLA

The structural features of a conventional cupola are illustrated in fig 19.1. It consists of a vertical shaft or shell built of ¼- 3/8- in. steel plate. The shell is lined with refractory bricks. A wind box and tuyeres for delivering air into the shaft are shown in fig 19.1. About 20 or more feet above the bottom an opening in the side is provided for charging the materials into stack. The cupola bottom is hinged so that the furnace may be emptied by dropping the bottom doors. The cupola bottom itself is generally of molding sand rammed in place on top of the bottom doors. At the bottom in front is a top-hole and spout for the molten iron. At the rear and above the tap-hole level is a slag hole. The stack is topped by a spark – arrester hood or dust suppressor. Finally, some type of blower and blast control is required to supply air for combustion.

Some of the dimensions of standard cupolas are given in table 19.1. The figures in table 19.1 define the characteristics of the various sizes of the common cupola and are worthy of some discussion, as follows:

1. Cupola size. Cupola is rated by number from 0 to 12 and varies in capacity designated as melting rate in tons per hour from approximately 1 to 35 tons per hour.
2. Shell Diameter. The outer shell diameter is the dimension which ultimately limits the capacity of the cupola. Shell diameter of common cupolas varies from 27 to 108 in, although they have been operated with much smaller and larger diameters.
3. Thickness of lower lining – This is the lining thickness in zones A & B (fig. 19.1.) where the maximum amount of refractory erosion occurs.
4. Diameter inside lining. The inside diameter establishes the operating cross sectional area of the cupola.
5. Area, inside cross sectional area in the melting zone. This dimension determines the range of the melting rates of a particular cupola size. A cupola melts approximately 10 lb of iron per hour per square inches of inside cross sectional area in the melting zone when the weight of iron and coke charges is in the ratio of about 10:1. Thus, the melting rate figure in the column under iron to coke ratio of 10 in table 19.1 expressed in pounds divided by 10 and the inside cross sectional area are the same. A No. 0 cupola has 254 sq. in, inside area and at a 10:1 iron to coke ratio, will melt approximately 2540 lb per hour or 1¼ tons per hour. Of course, within limits it may melt faster or more slowly than this figure, depending on the way in which it is operated.
6. Total area of tuyeres, square inches. The tuyere openings serve to introduce air for combustion of the coke. The combined area of the tuyeres in standard cupolas is usually cross sectional area of the cupola at the tuyere level, although much smaller and larger ratios are sometimes used.

Other information in table 19.1 will be considered relative to actual cupola operating procedures.

STEPS IN OPERATION

A cupola heat includes not only the actual melting operation but all the operations which precede and follow the period during which iron is being melted. A certain cycle of events occurs each time a heat is made, including the following:

1. Preparation of the refractory lining, bottom and tap hole and slag hole.
2. Lighting and burning in the coke bed.
3. Charging
4. Melting
5. Starting the air blast
6. Charging
7. Tapping and Slagging
8. Dropping the bottom

Each step above is an important one and must be properly carried out for a successful heat.

**MAIN FREQUENCY CORELESS INDUCTION FURNACE**

PRINCIPLE

If a primary coil of an inductor is placed as close as possible to metal contained in the crucible of an induction furnace, a magnetic field will be concentrated in the crucible. This magnetic field is induces eddy currents in the metal due to which heat in generated and melting is commenced. A higher current frequency is required for a smaller crucible and low frequency for bigger crucible.

The eddy current produced in the metal stir the metal in the crucible due to which temperature and composition homogeneity is obtained.

The charging of raw material is done from the top. The raw material consists of Cast iron scrap, borings, pig iron or steel depending upon the requirement, Ferro silicon, silicon carbide and carburizers are also added to maintain the carbon and silicon which generally decide the grade of grey iron made.

Fig

Coreless furnaces are preferred for intermittent melting and for production of several different compositions. They provide total melting flexibility for jobbing work.

ADVANTAGES OVER CUPOLA

1. One of the main advantages of induction furnace is the control over metal composition. Since this offers batch melting, the composition can easily be controlled. In the cupola the control is difficult as the process in continuous.
2. In induction furnace there is a great flexibility of raw material. Practically everything can be charged if it has sufficient metal value. Unlike cupola the shape and size do not affect much.
3. In jobbing foundries where the metal composition varies from casting to casting, induction furnace can be used without any problem regarding charging and composition control.
4. Easy charging and cleaner work atmosphere in a future of induction furnace. Now, when greater attention is being paid to pollution, the induction furnace scores over the cupola.

**DISADVANTAGES**

1. Cost of electricity is a major factor if the induction furnace is to be run economically. The availability of power and cost make the induction furnace suitable only at those places where the supply is uninterrupted and cheap.
2. The lining of the furnace has to be made carefully. The frequent wearing out of the lining makes the metal costly.
3. At those places where a continuous supply of metal is required the cupola is preferred.

METAL PREPARATION AND POURING

|  |  |  |
| --- | --- | --- |
| DESCRIPTION | PRECAUTIONS | CONSEQUENCES |
| Metal Preparation | Ensure the charge composition by weighing the material. | Grade of castings affected. |
|  |  |  |
|  | Conduct Chill test for every heat and adjust the process accordingly. | Grade of Castings affected. |
|  |  |  |
| Pouring | Check metal temperature. | Cold shut. |
|  |  |  |
|  | Bring sufficient quantity of clean metal. | Short poured. |
|  |  |  |
|  | Add innaculin if necessary. | Hardness. |
|  |  |  |
|  | Poured the metal in a continuous stream. | Miss-run. |
|  |  |  |
|  | Avoid intermittent pouring. | Cold Shut. |
|  |  |  |
|  | Allow the metal to overflow little. | Shrinkage. |
|  |  |  |
|  | Avoid use of dirty ladle. | Slag. |
|  |  |  |
|  | Light the escaping gases during pouring. | Blow holes, metal leaking. |
|  |  |  |
|  | Use strainer core for pouring. | Slag. |
|  |  |  |

CONSEQUENCES OF USING INCONSISTENT QUANTITY OF MATERIAL

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| SL.NO. | MATERIAL | PLACE OF USE | QUANTITY SPECIFIED | STATUS | CONSEQUENCES |
| 01 | Sand | Core Section | 100 kg | 120 kg | Less strength. |
|  |  |  |  |  |  |
|  |  |  | 60, 40 | 80 kg | More strength. |
|  |  |  |  |  |  |
|  |  |  |  | 40, 60 | Permeability gets affected. |
|  |  |  |  |  |  |
| 02 | Core Oil | Core Section | 1.2 to 2.3 | 1.0(less) | Less strength. |
|  |  |  |  |  |  |
|  |  |  |  | 1.0(more) | More strength. |
|  |  |  |  |  |  |
| 03 | Dextrine | Core Section | .9 to 1.1 | More | More strength. |
|  |  |  |  |  |  |
|  |  |  |  | Less | Less strength. |
|  |  |  |  |  |  |
| 04 | Bentonite | Moulding | 7 to 8% | More | Less permeability. |
|  |  |  |  |  |  |
|  |  |  |  | Less | Low strength. |
|  |  |  |  |  |  |
| 05 | Lime Stone | Cupola Charging | 4 to 5% | More | More oxidation. |
|  |  |  |  |  |  |
|  |  |  |  | Less | Low fluidity of slag. |
|  |  |  |  |  |  |
| 06 | Ferro Silicon | Cupola Furnace | 2kg/375kg of charge | More | Lower grade of the castings. |
|  |  |  |  |  |  |
|  |  |  |  | Less | More Hardness. |
|  |  |  |  |  |  |
| 07 | Innoculine | Cupola Furnace | 50gm/70kg | More and Less. | To improve the machinability by improving the structure/. |
|  |  |  |  |  |  |

**CONSEQUNCES OF USING SUBSTANDARD MATERIAL**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| SL.NO. | MATERIAL | QUALITY PARAMETER | STATUS | CONSEQUENCES | REMEDIAL MEASURES |
| 1 | Sand | Refractoriness | More | Low permeability. | Add medium/course sand in consultation with supervisor. Add fine/medium sand in consultation with supervisor. Wash the sand before use for core making. |
|  |  |  |  |  |  |
|  |  |  | Less | Sand sticking on surface of the casting. | Sand should be rejected. |
|  |  |  |  |  |  |
| 2 | Core Oil | Bending strength of the oil | Less | Core breakage more gases by the use of higher % in the sand mix. | Increase the oil % (2) such oil should be rejected. |
|  |  |  |  |  |  |
| 3 | Bentonite | Liquid limit | More | More gas evolution. | Reduce the % in the mix. |
|  |  |  |  |  |  |
|  |  |  | Less | Less strength breakage of mould, sand wash etc. | Material should not be used. |
|  |  |  |  |  |  |
| 4 | M.S.Scrap | C | More | Low tensile, low hardness and open grain structure. | Increase steel scrap up to 30% in the charge calculation. |
|  |  | P | More | Shrinkage, poor machinability, and lower impact strength | Mix with low P scrap. |
| 5 | Lime Stone | CaO | Low | More viscous slag than fluid slag. | Increase % of lime stone addition. |
|  |  |  |  |  |  |
|  |  | SiO2 | More | Reduces the effectiveness of the flux. | Mix with low SiO2 % lime stone with a maximum of 10% inferior quality. |
|  |  |  |  |  |  |

FELTING SHOP

FELTING SHOP OPERATION

There are several operations of cleaning castings in the felting shop. Here, three shot blasting machines and three tumbling barrels are placed in line one after another. Some castings are directly shot blasted and some are to be barreled for thirty minutes and then shot blasted.

1. Black castings hauling operation is done by forklift, the pallets are filled with castings and then directly taken to the required place.
2. After the barreling the castings for 20 to 30 minutes, maximum quantity of sand is removed, but the castings are not damaged in any way and the shot blasting time is also reduced. Due to gravity, the castings slide down to the shot blasting station.
3. After cleaning the castings in shot blasting machine, the operator unloads the castings on a chute for next operation.
4. Chipping operation: In this operation, the operator removes the ingates and extra metal from the castings. After chipping, the operator keeps the castings on a chute. Due to gravity, the castings slide down for the next operation.
5. In pedestal grinder, parting line of the casting is removed by grinders and castings are kept on a chute. Due to gravity, the castings slide down for the next operation.
6. Finishing operation: The castings are finished by pneumatic hand grinder. Motor body castings are prepared by flexible shaft grinder.
7. After completing the finishing operation, the same operator loads the castings on the conveyor.
8. After that, the inspection of the casting is done on the conveyor itself.
9. Castings are painted as the conveyor passes through the painting booth.
10. After painting, the castings travel to the drying zone for natural drying for about 20 to 30 minutes.
11. Thereafter the castings reach the unloading station where pellets are already kept below the conveyor. The operator takes out the castings and places them in the pallet. As soon as the pellets are full, they are taken to the required place in the machine shop.