INPLANT TRAINING IN PEEKAY STEEL CASTINGS AND ROLLING MILLS

A training report

Submitted by

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PREFACE

This report has been prepared in fulfillment of in-plant training to be carried out in **PEEKAY STEEL CASTINGS (P) LTD** during the suggested duration for the period of one month, to avail the necessary information. The blend of learning and knowledge acquired during our practical studies at the company is presented in this report. The reasons behind visiting the casting industry and preparing the project report is to study the mechanical overview, machinery overview cycle and process of casting and details of control and instrumentation required in casting company. We have carried out this training under well experienced and highly qualified engineers of **PEEKAY STEEL CASTINGS (P) LTD** of department viz. Safety department, Patterns and methods, Moulding Melting, Machine shop, Quality and instrumentation depts. We have taken the opportunity to explore the Mechanical department, necessity of Casting Industry. We have tried our best to cover all the aspects of the Casting Company and their brief detailing in the project report. All the above mentioned topics will be presented in the following pages of this report. The main aim to carry out this training is to familiarize ourselves with the real industrial scenario, so that we can rotate with our engineering studies.

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CHAPTER 1

SAFETY DEPARTMENT

1.1.What is Industrial safety?

Industrial safety in the context of occupational safety and health refers to the management of all operations and events within an industry, for protecting its employees and assets by minimizing hazards, risks, accidents and near misses. The relevant laws, compliance and best practices in the industry have most of the issues addressed for the best protection possible. Employers are to make sure that these are strictly adhered to to have maximum safety.

1.2.Specific Health Hazards in Foundries:

1.2.1.Dust:

Dust is one of the most common hazards likely to be found in foundries. The dust will be in the form of fine respirable particles, and depending on the type of foundry and the processes used, may contain significant amounts of silica, lead, or other contaminant. The following paragraphs contain information about the various forms of dust in a foundry.

- **Respirable siliceous dust:**

In some metal casting processes respirable siliceous dust is produced as a product of furnaces, moulding sand, knockout and shakeout of castings, fettling and abrasive blasting.

- **Furnaces:**

Repeated heating converts the quartz of the firebricks and silica refractory lining furnaces to amorphous silicates of cristobalite and tridymite. Workers maintaining and replacing the refractory material may be exposed to dust containing significant amounts of cristobalite which is highly fibrogenic (causing the disease silicosis if inhaled into the lung). In the past grouting material used to retain the firebricks often contained asbestos but this has now been superseded. If in doubt about the safety of any product material safety data sheets should be referred to. A high degree of respiratory protection therefore will usually be required for workers during this process.

- **Moulding**

Heat from the molten metal in a sand mould produces two reactions. It reduces the sand-containing quartz in the mould to dangerously fine respirable particles and, it converts some into hazardous silicates, such as cristobalite. These forms of silica can cause the lung disease silicosis. This risk varies according to the efficiency of dust control, whether the sand is screened or not, and whether the mould is wet or dry. Some "Parting powders", contain a high content of fine silica dust, and add to this hazard and should not be used if possible. The use of compressed air to clean dust from moulds is likely to produce airborne respirable dust and should be avoided.

- **Sand handling**

Sand will be handled in a variety of ways in the metal casting process, ranging from manual, pneumatic, or conveyors. Each method will produce significant amounts of dust some of which will contain airborne silica. Appropriate measures must be taken to control dust emissions, or the wearing of personal protection, whenever this occurs.

- **Knockout/shakeout of castings and their dressing - fettling and abrasive blasting**

During the knockout process there are a wide variety of dusts produced of which alumino silicates and alumina are the most common. These processes also liberate fine silica dust into the air and the environment of the foundry. If this dust is inhaled there is a risk of silicosis. Because fine dust is raised from the floor as airborne particles by draughts, people walking over the floor, and movement of vehicles such as forklifts, total dust control is an important item in plant housekeeping and hazard management.

- **Pattern shop**

The increased use of particleboard in pattern making causes increased levels of wood dust and formaldehyde binders which are both recognised health hazards.

- **Core making**

There are a variety of mineral sands used in core making. These can include zircon, chromate, magnesite, alumina silicates. In keeping with good work practices exposure to these dusts should be avoided by the use of appropriate control measures.

- **Metal melting**

In this process, dust is generated, which will contain a wide variety of chemicals. These will be carried into the ventilation system where this is installed. If ventilation extraction is not installed appropriate protective measures must be taken for workers in the area.

- **Scrap handling**

During this process significant dust will be produced. Good work practices will need to be employed. Special attention must be given to the use of gas cutting where lead based paint is present on scrap metal.

1.2.2.Noise:

Excessive noise is a common hazard in foundries and causes permanent occupational deafness to those exposed. Sources of noise include:

- Metal impacting upon metal (shakeout, core, knockout tumbling, chipping, handling and transport of castings);
- Exhaust from compressed air operated machines and tools (moulding machines, chipping hammers, grinders, hoists);
- Electric furnaces, ladle heaters;
- Conveyors;
- Wood saws and other machinery in the pattern shop;
- Electric arc cutting;
- Core blowers, sand slingers and high pressure moulding machines; and
- Shot blasting.

1.2.3.Vibration:

Grinders, pneumatic chipping hammers, chisels and electrically operated rotary grinders can produce "dead hand" or vibration white finger if used extensively. Where people are exposed to whole or part body vibration the exposure must be controlled within limits that protect them from adverse health effects. Guidance on the limits can be found in the international standards ISO 2631 and ISO 5349. The condition usually affects both hands, with the index, ring and middle fingers suffering the most. As the attacks occur mostly in cold weather, thick winter gloves may help in preventing this.

1.2.4.Manual handling

Moulding and core making may involve the lifting, carrying and stacking of heavy objects. Proper workplace design, using ergonomic principles, will prevent long-term serious injury to workers. The economical benefits of are well recognised by increased production and less downtime or lost time through absenteeism. For more information refer to the publication Manual Handling from OSH.

1.2.5.Heat and molten metal:

Hazards from molten metal processes include the potential for serious and even fatal burns. The risk of injury depends on many factors including the type of operation, the degree of exposure, and the extent to which protective clothing is worn. Protective clothing is just one preventative factor and although it is known to reduce or prevent injury it must be regarded as the last line of defence after all other reasonably practicable measures have been taken. Prolonged exposure to heat may also cause heat stress and fatigue and even collapse. Recognition of these hazards must be incorporated in training of workers in foundries.

1.2.6.Other physical hazards

As is the case with many industries of this nature there are a number of physical hazards which have to be managed. Handling heavy objects can lead to crushing injuries, moisture in molten metal can cause explosions, rapid evolution of hot gases can cause lung damage and burns, and in the fettling shop flying objects can cause eye injury. In the finishing department of specialised shops ionising radiation from radiography may be a hazard. The hazard management process must be systematic in order to identify all hazards.

1.3.Personal protective equipment

Personal protective equipment is not a substitute for good administrative and practical engineering controls. However, if control methods are not possible, then personal protective equipment is needed wherever harmful substances can be contacted, absorbed, or inhaled. Special protective equipment is also needed against the hazards of molten metal, heat, or sparks in pouring or welding. Personal protective equipment includes respiratory and hearing protective devices, protective clothing and protection for the eyes, face, head and feet.

Fig 1.1. SAFETY EQUIPMENTS

All personal protective clothing equipment must be safety designed and must be carefully maintained. There are a range of joint Australian/New Zealand

Standards on personal protective equipment. In general terms all equipment should comply with these standards however it is acceptable to have equipment comply with standards produced in the major European or American markets.

- **Eye and face protection:**

Goggles, safety glasses or face-shields to suit the appropriate heat range should be worn if there is a chance of eye injury from flying particles, chips and sparks during grinding, cutting, welding and pouring. Proper eye protection filters are needed for the intense light given off during such operations as welding, cutting or the treatment of molten iron with magnesium. Some mould-release agents are highly corrosive and eye or face protection must be worn while using these and other corrosives.

- **Gloves:**

Properly selected safety gloves specific for the process should be used. Good hand protection in the metal casting process is vital to protect against burns, cuts and abrasions and chemicals. A thorough risk assessment of the requirements must be done for each task. Selection will be based on such factors as comfort, sensitivity, and impermeability.

- **Aprons, coveralls and leggings:**

Welders and metal pourers need adequate protection for the legs and bodies from flames, sparks and metal splashes. The selection of appropriate clothing to protect against molten metal is not straightforward. Different materials react differently when in contact with different molten metals and slag. It is essential that a full risk assessment be carried out before making a decision. The design, style and fit of a garment is one aspect to consider and needs to take into account ease of removal, lack of pockets, and flammability. The type of material will vary according to each particular circumstance but the usual choice of material will be leather, wool, or treated cotton. The type of fasteners will also need to be considered. Metal zips and domes get very hot in some applications while plastic ones will distort with heat.

- **Foot protection:**

Foot protection with steel toecaps and other special features should be worn when manually handling heavy parts or where there is danger from falling objects or spilt metal. Leather has been found to be the best material for footwear in many occupations. Sole material should be appropriate for foundry workers. In the foundry workers handling molten metal must ensure that trousers or leggings are worn outside the boot to prevent molten metal entering the top of the boot.

- **Hearing protection:**

Noise levels exceeding 85 dBA require the wearing of the appropriate hearing protection. Other factors may influence the type of hearing protection which can be used such as the need to wear other protective gear.

- **Head protection:**

Hard hats must be worn where there may be danger from falling or flying objects. In the metal casting industry PVC helmets may not be suitable due to distortion through heat. Fibreglass helmets will not distort so easily.

- **Aluminised reflective clothing:**

Reflective clothing should be worn if there is a danger from radiant heat, such as around furnaces or during pouring.

CHAPTER 2
PATTERN AND METHOD

2.1. Patterns:

The pattern is a geometric replica of the metal casting to be produced. It is made slightly oversize to compensate for the shrinkage that will occur in the metal during the casting's solidification, and whatever amount of material that will be machined off the cast part afterwards.

2.1.1.The requirements of a good pattern are:

- Secure the desired shape and size of the casting.
- Cheap and readily repairable.
- Simple in design for ease of manufacture.
- Light in mass and convenient to handle.
- Have high strength and long life in order to make as many moulds as required.
- Retain its dimensions and rigidity during the definite service life.
- Its surface should be smooth and wear resistant.
- Able to withstand rough handling.

2.1.2.The following patterns are commonly used.

- Solid or single piece pattern
- split or two piece patterns
- Multi piece pattern
- Gated pattern
- Match plate pattern
- skeleton pattern
- sweep pattern
- loose piece pattern

- cope and drag pattern
- follow board pattern
- segmental pattern

2.2.PATTERNS USED IN PEEKAY STEELS Pvt Ltd:

❖ single piece pattern
❖ multi piece pattern
❖ match plate pattern
❖ cope and drag pattern
❖ Skeleton pattern

2.2.1.SINGLE PIECE PATTERN:

Single piece pattern is cheap and it is best suited for limited production only. Since its moulding involves a large number of manual operations like gate cutting, providing runner and risers. so, such patterns are used for producing a few large castings for example, stuffing box of steam engine. It is the simplest of all patterns is made in one piece and carries no joints, partition or loose pieces.

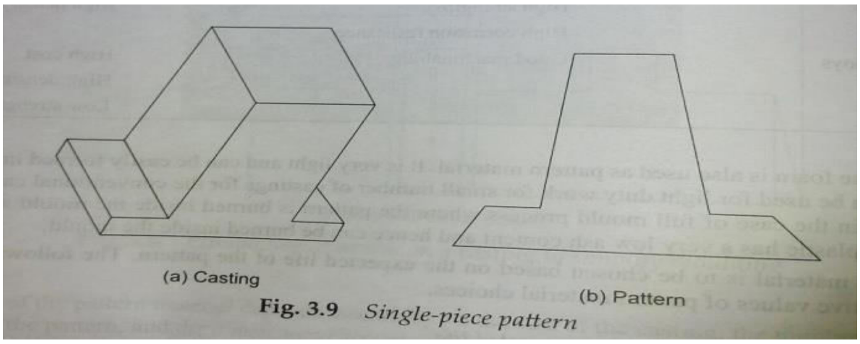


Fig 2.1 SINGLE PIECE PATTERN

2.2.2.MULTIPLE PATTERN:

Multiple pattern were split into more than two parts.It facilitates an easy moulding and withdrawl of pattern.Therefore they splitted as numbers based on the customer requirements.It also said to be as the loose piece pattern.Multiple pattern is expensive and so it requires high skilled worker**.**

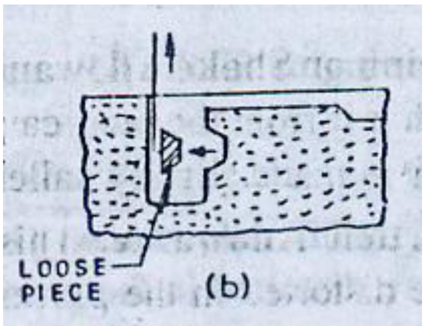


Fig 2.2 MULTIPLE PATTERN

2.2.3.MATCH PLATE PATTERN:

The match plate pattern is almost similar to the mounted pattern but it can have part of the casting in the cope and part in the drag like split piece pattern. These parts are generally attached to the plate / board in opposite sides in the perfect positions. When the plate is removed and moldis in close position the cavities in the cop and drag match perfectly.

2.2.4.COPE AND DRAG PATTERN:

These are similar to split patterns. In addition to splitting the pattern, the cope and drag halves of the pattern along with the gating and risering system are attached separately to the metal or wooden plate along with the alignment pins. They are called the cope and drag pattern. These types of patterns are used for castings which are heavy and inconvenient for handling as also for

2.3.PATTERN MATERIALS:

- ❖ Wood
- ❖ Metals and Alloys
- ❖ Plastics
- ❖ Plaster

- Epoxy casting and moulding
- Wax Casting

2.3.1Selection of pattern material are:

- Number of castings to be produced
- Shape, complexity and size of the casting
- Degree of accuracy and surface finish required
- Design of casting and Casting method to be used.

2.3.2PATTERN MATERIALS USED IN PEEKAY STEELS (P) Ltd:

- Aluminium.
- Teak wood.
- Country wood.

2.3.2.1ALUMINIUM:

Why Aluminium used?

- For making intricate shapes.
- Producing more number of components.
- No repair and rework.

2.3.2.2.TEAK WOOD:

Why Teak wood used?

- Producing lesser number of components.
- Used patterns can be re-altered based on customer need.

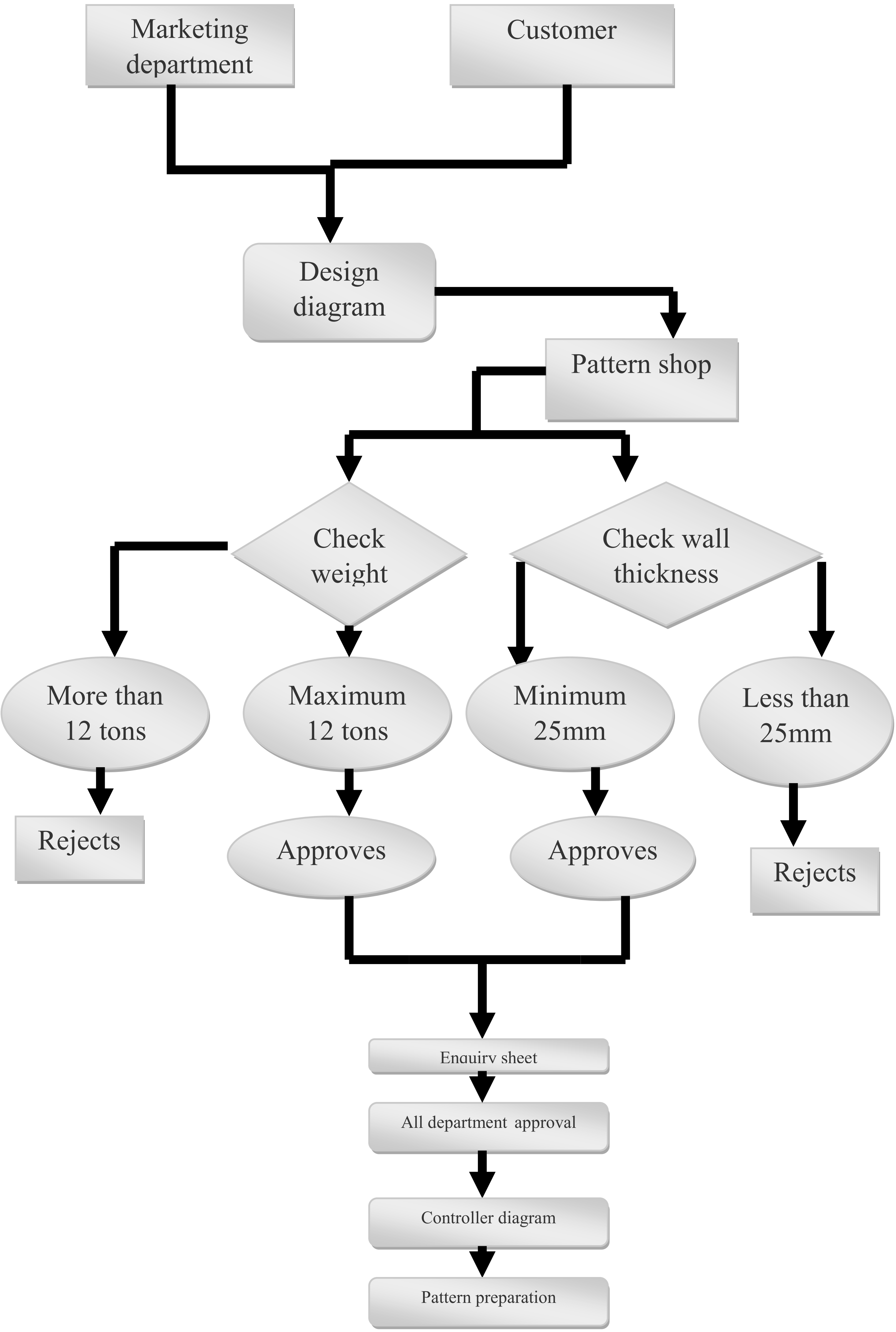
2.3.2.3.COUNTRY WOOD:

Why Country wood is used?

- Producing very less number of components.

2.4.PATTERN PREPARATION IN PEEKAY STEELS (P) Ltd:

- Marketing department analyse the customer needs and the customer provides the need in the form of design diagram.
- Manufacturing department sends the design diagram for verification to the pattern shop. After that pattern shop analyse the design whether it is valve component or engineering component.
- Next the pattern shop will calculate the total weight of the component if it is less than 12 tons they will approve the customer need, since the plant maximum capacity is 12 tons. They also analyse the wall thickness if it is less than 25 mm they will not go for production.
- If the component succeeds the above verification pattern shop will prepare the enquiry sheet and sends it through all other departments to verify and approve.
- After approval of enquiry sheet the controller diagram is generated. Based on the controller diagram the pattern is made.


Marketing department
Customer
Design diagram
Pattern shop
Check weight
Check wall thickness
More than 12 tons
Maximum 12 tons
Minimum 25mm
Less than 25mm
Rejects
Approves
Approves
Rejects
Enquiry sheet
All department approval
Controller diagram
Pattern preparation

2.5.METHODS AND DEVELOPMENT

Pro-CAST simulation software is used for the modelling of thermal heat transfer including radiations with few factors, liquid flow, including mould filling and also porosity modelling .

This department also takes care of the pattern allowances, runner and risers design, gating system design and prepares the product data sheet for the moulding.

The allowance provided are:

- Shrinkage allowance
- Draft allowance
- Machining allowance
- Shake allowance

2.6.FUNCTION OF PATTERN SHOP IN PEEKAY STEEL CASTINGS (P) LTD:

After receiving patterns from the vendors following process takes place such as

- They receive the pattern with all allowances and modifications to be made in the existing pattern.
- The chill positions are identified and marked with black paint as several cross mark in a square and circle.
- Re-altering the used patterns according to dimensions using section gauge.
- Non stick coating.
- Simulating the design of customer.

After completing these process patterns were sent to Moulding department.

CHAPTER 3

MOULDING

3.1.What is a mould?

A mould is a hollow-out block that is filled with a liquid like metal, plastic etc. The liquid hardens or sets inside the mould, adapting its shape.

3.2T.ypes of moulding used in peekay steels (p)ltd:

- ❖ Floor moulding
- ❖ Bench moulding
- ❖ Pit moulding

3.2.1.FLOOR MOULDING:

- ❖ This method of moulding is commonly used for preparing the mould of heavy and large size of jobs.
- ❖ In floor moulding the floor itself acts as a drag.
- ❖ It is preferred for such rough type of casting where the upper finish has no importance.

FIG:3.1Floor moulding

3.2.2.BENCH MOULDING:

- ❖ Bench moulding is done on a work bench of a height convenient to the moulder.
- ❖ It is best suited to the mould of small and light items which are to be casted by non-ferrous metals.

FIG 3.2 Bench moulding

3.2.3.PIT MOULDING:

- ❖ Large size of jobs which cannot be accommodated in moulding boxes are frequently moulded in pits.
- ❖ Here,the pits act as a drag. Generally one box i.e cope is sufficient to complete the mould.
- ❖ Runner and riser ,gates and pouring basins are cut in it.

FIG:3.3 Pit moulding

3.3.Properties of moulding sands:

The important properties are:

1. Strength
2. Permeability
3. Grain Size and Shape
4. Thermal stability
5. Refractoriness
6. Flow ability
7. Sand Texture
8. Collapsibility
9. Adhesiveness
10. Reusability
11. Easy of preparation and control
12. Conductivity

3.4.TYPES OF SAND USED IN PEEKAY STEEL CASTING (P)LTD:

- Silica sand
- Blend sand
- Thermal sand

3.5.SAND PREPARATION FOR MOULDING:

The main ingredients are:

a) silica grains (SiO_2)

b) clay as binder

c) resin to provide plasticity.

Some of add of silica in soil:

Cochin -1.2-1.4%

Mangalore -1.6-1.8%

Allahabad -1.8-2.0%

3.6.RESIN(FENOTEC-5519):

An ester cured alkaline phenolic resin binder.

3.6.1.why fenotec-5519 is used?

- ❖ For high productivity.
- ❖ No pungent smell.
- ❖ Tolerance to basic sands.

3.6.2.INSTRUCTIONS FOR USE:

- ❖ Choose a washed and graded sand of AFS 50-60.
- ❖ Select appropriate hardener suitable to achieve desired bench life and strip times.
- ❖ Add hardener to the sand and mix for one to one and half minutes and fenotec &mix it for another one to one and half minutes.

3.6.3.SHELFLIFE AND STORAGE:

FENOTEC (5519) has a shelf life of 3 months .when stored in covered area without exposure to sunlight at a temperature of 30 degree C. However cold storage is needed. Binders to be stored at the temperature 35 degree celcius. Hardener to be stored at 30 degree celcius.

3.7.HARDENER SELECTION TABLE:

HARDENER GRADE	BENCHLIFE AT 36 deg C (mins)	STRIP TIME AT 30 deg C (mins)
H720	3-4	12-15
H740	4-6	15-25
H760	6-8	25-40
H780	10-12	70-100
H800	12-16	120-160

Table:3.1 Hardener Selection table

3.8.TYPICAL STRENGTH VALUE:

Sand(AFS45-50) -100parts /washed Guntur sands.

Fenotec (5519) -1.8% based on sand.

Hardener H-720 -20% based on resin

3.8.1.SAND PREPARATION:

For the uniform mixing of various sand ingredients, IMF mixers are used.

The operator sets the program for IMF mixer with Siemens PLC for resin foseco-5519 mixing with hardener,

Hardener program	% of hardener	Gel time (mins)	Strip time (hours)
Program-1	100% Fast	7	1.0
Program-2	50 % Fast, 50% Slow	16	2.0
Program-3	30% Fast, 70% Slow	20	3.0
Program-4	100% Slow	25	4.0

Table:3.2 Hardener program table

The operator uses the following programs for sand proportion

NEW SAND:

SET 1	100% SS	0% MRS
SET 2	50% SS & 50% TS	0% MRS
SET 3	90% SS & 10% TS	0% MRS
SET 4	80% SS & 20% TS	0% MRS
SET 5	35% SS & 65% TS	0% MRS

Table:3.3 Setting New sand

BLEND SAND:

SET 1	50% SS	50% MRS
SET 2	25% SS & 25% TS	50% MRS
SET 3	40% SS & 10% TS	50% MRS
SET 4	45% SS & 5% TS	50% MRS
SET 5	35% SS & 15% TS	50% MRS

Table:3.4 Setting blend sand

- **SS - Silica sand**
- **TS – Thermal sand**
- **MRS – Mechanically reclaimed sand**

3.9.SAND RECLAMATION:

The economics of a foundry operation require sand reclamation to reduce the costs associated with new sand and the costs of landfill use, and to reduce the problems associated with the control of environmentally undesirable contaminants in the discarded sand.

3.10.MECHANICAL RECLAMATION:

It is the process of reclaiming sand used in casting process mechanically by allowing the sand to fall from the silo and the major dust particles are removed by the action of gravity. The sand getting out of this process is called mechanically reclaimed sand.

3.11.THERMAL RECLAMATION:

The sand coming out of the mechanical reclamation is again passed through thermal reclamation by which the reactive gases produced during the reaction of resin and hardener and during casting process is removed by passing the sand in temperature range of 540-600 deg C. The output sand is thermal sand.

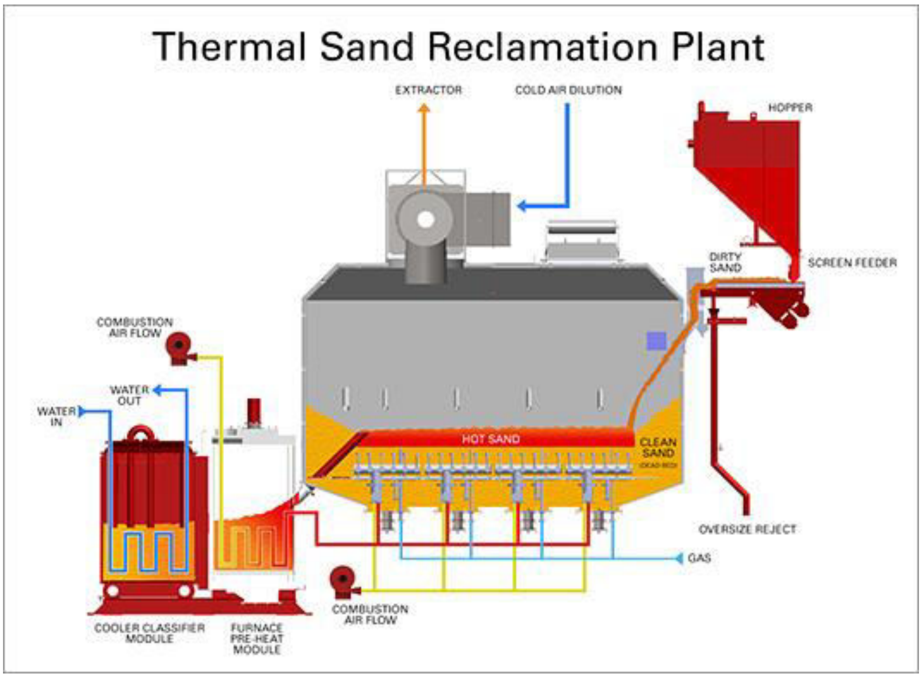


Fig:3.4 Thermal reclamation plant

3.12.INTERNAL SPECIFICATION OF SAND:

a).Compression strength requirements:

S. NO	COMPRESSION STRENGTH (hrs)	1	2	4	6	8	12	24
1	Mould(fresh silica sand)	8	10	13	16	18	20	23
2	Core(fresh silica sand)	5	8	12	14	17	19	21
3	Mould &core(blend sand)	8	11	14	16	18	20	21
4	Reclaimed sand	4	6	7	9	19	11	12

Table:3.5:Compression strength requirement

b). Sand specification of in process sand:

Properties to be tested	Acceptance standard		
	Fresh silica sand	**Chromite sand**	**Reclaimed silica sand**
AFS No	40-52	45-60	35-45
Moisture content	< 20%	< 20%	< 20%
Clay content	< 0.50%	NA	NA
PH	6-8	6-8	9-10
Acid demand	2 ml max	NA	12 ml max
Valve distribution	3 or 4 sieve	3 or 4 sieve	3 or 4 sieve
Fines content	1% max	2% max	1% max
Loss of Ignition	0.5% max	NA	1.5% max

Table:3.6:Sand specifications

Note:

- ❖ Acceptable limit for moisture - 0.2% max
- ❖ Acceptable limit for temperature – 45 deg C max

3.13.MOULD MAKING IN APNB PROCESS:

- ❖ Check the pattern for surface finish, extra projections, damage, undercuts, pins & lettering details and keep the pattern in the desired location of moulding areas.
- ❖ Keep the allocated box in the moulding location positioning with the pattern as per design in the method sketch and product data sheet.
- ❖ Bring all the raw materials(chills, strip coat, riser sleeves, refractory sleeves & reinforcement rods/pipes) near the box.
- ❖ Do the strip coat for easy removal of pattern from the mould.
- ❖ Verify the chills sizes are as per the method card and inspect that the chills are visually free from moisture and rust.
- ❖ Fabricate all reinforcement rods in the box to give adequate strength.
- ❖ Keep the chills in desired location as marked as per method card on the pattern weld the slanting chill wherever required with the fabricated rods to the box to avoid falling.
- ❖ Keep all the riser sleeves in desired location as shown in the pattern.
- ❖ Bring all the refractory sleeves as per gating system design in the method card, seal all the joints with paper and stick by adhesive tape.

- ❖ Moulding supervisor should check the pattern preparation as per method card, if ok in all respect, should clear for filling, if any discrepancy observed with respect to method card correct the location or consult methods.
- ❖ Make the required chromite sand in the batch mixer and put it in the lettering and marked area in pattern.
- ❖ Start the continuous mixer fill the pattern surface with facing / blended / reclaimed sand and do compaction with wooden rod or pneumatic runner to get good compaction in the riser neck and around the chills to avoid loose sand.
- ❖ Complete the above operation in the stipulated bench time.
- ❖ Fill the balance area with reclaimed sand and do the ramming within the bench life.
- ❖ Write the mould time on every mould to know the strip time.
- ❖ Strip the mould in stipulated time.
- ❖ Keep the mould on levelled sand base.
- ❖ Close all the refractory ingate & down sprue with cloth or wooden dummy pieces to avoid sand falling inside the gating system.
- ❖ Blow air and clean the mould to remove all the loose sand.
- ❖ Immediately warm the mould surface properly and avoid the flame in one location which may burn the surface resin.(warming is required only in rainy season)
- ❖ Clean all the chills surroundings and remove the loose sand.
- ❖ Blow the air to remove all dust.
- ❖ Do the pre-heating as per work instruction.
- ❖ Do the coating as per instruction.
- ❖ Wipe the mould surface with a piece of cloth, to make the mould surface smooth.
- ❖ For closing the mould please follow the procedure.

3.14.WORKING PROCEDURE OF MOULD PRE HEATING:

- ❖ Before final closing of mould pre-heating can be done by gas burner through out the mould and core surface to remove any moisture present in it.
- ❖ During heavy rain season ,extended pre-heating shall be done before pre-heating.
- ❖ After closing of moulds, open risers and down sprus shall be pre-heated with gas burners.
- ❖ Blow the air from pre-heater to remove dust in the mould.

- ❖ Switch on the air pre-heater and set the temperature at 150 degree C.
- ❖ Ensure that hot air come from the pipe and through the vent.
- ❖ After that pre-heat to be done and it is verified by process control engineer.

3.15.PROCEDURE FOR MOULD AND CORE COATING:

- ❖ Indent and collect type of coating to be employed for mould and core coating.
- ❖ Check batch number and expiry number of coating mixer.
- ❖ Use it before the expiry.
- ❖ Clean waste sand before coating.
- ❖ Verify chills ,risers, runners are placed as method card.
- ❖ Mix the coating bucket manually.
- ❖ Check Baum of the Coating.
- ❖ In this process coating should be done by spray, brushes etc.
- ❖ By torching process dry the mould and core.
- ❖ Bigger size mould and core are coated by segment coat.
- ❖ Clean mould and core with compression air.
- ❖ And store the coating bucket in safe area.
- ❖ Safety precautions in handling.

3.16.CORE MAKING IN APNB PROCESS:

- ❖ Check the core box for surface finish, extra projections, damage, undercuts, pins & lettering details and keep the pattern in the desired location of moulding areas.
- ❖ Check the fixed pattern no in thecore print area in the core sets for identification.
- ❖ Bring all the raw materials(chills, strip coat, riser sleeves, refractory sleeves & reinforcement rods/pipes) near the core box.
- ❖ Do the strip coat on core box for easy removal of cores from the core box.
- ❖ Fabricate the entire reinforcement rods / fabricated hollow rectangular section in the core box to give good strength to core.
- ❖ Keep the chills in desired location as marked as per method card on the pattern weld the slanting chill wherever required with the fabricated rods to the box to avoid falling.
- ❖ Keep all the riser sleeves in desired location as shown in the core.
- ❖ Moulding supervisor should check the core preparation as per method card, if ok in all respect, should clear for filling, if any discrepancy observed with respect to method card correct the location or consult methods.

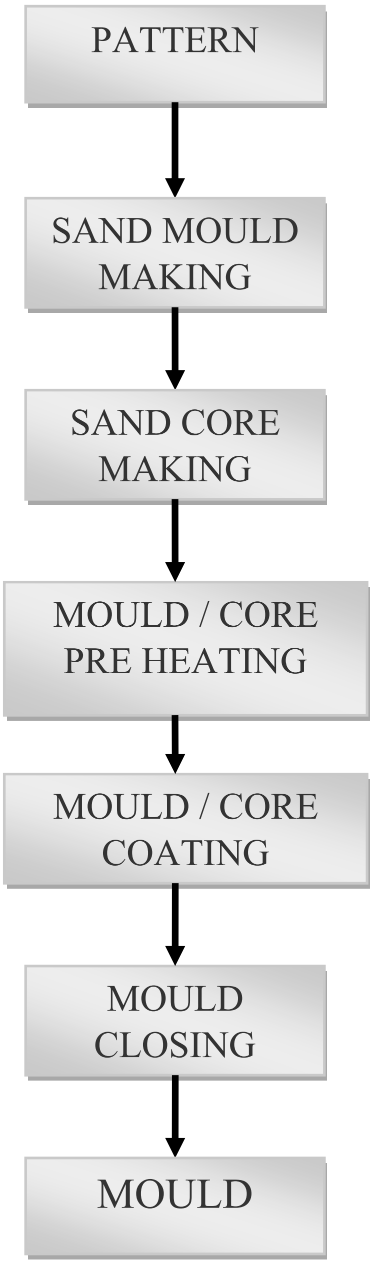
❖ Make the required chromite sand in the batch mixer and put it in the lettering and marked area in core.
❖ Start the continuous mixer fill the core surface with facing / blended / reclaimed sand and do compaction with wooden rod or pneumatic runner to get good compaction in the riser neck and around the chills to avoid loose sand.
❖ Write the time on every core to know the strip time.
❖ Strip the core in stipulated time.
❖ Immediately warm the core surface.(warming is required only in rainy season)
❖ Clean all the chills surroundings and remove the loose sand.
❖ Carry out the coating as per procedure.
❖ Ignite the coating so that all the spirit will burn off, coating will become dry.
❖ Rub the core surface with piece of waste cloth to make surface smooth.
❖ Join the both half check the core joining guage and do the welding in all the print area of the core joining carried out in bottom mould also.
❖ Fill the parting line gap with mixed sand / mould coat paste.
❖ Carry out the coating in parting line and warm the core.
❖ Core is ready for assembly in the mould.

3.17.INSTRUCTIONS FOR SAMPLE/BULK MOULD CLOSING:

❖ Place the prepared bottom mould on a properly loose sand level bed.
❖ Blow air to remove loose sand.
❖ Visual inspection to be done for the mould.
❖ Scratch hardness of the mould and core shall be checked and recorded.
❖ Place clay cake in bottom mould for wall thickness.
❖ Place identified core in the bottom mould.
❖ Check the clearance in the mould print.
❖ If more clearance absorbed in the print or movement in the core due to loose print. Inform pattern shop for corrective action and get clearance from them.
❖ Keep all location noted in the desired location.
❖ Blow air for remove sand from gating system , check every vent for circulation of air.
❖ Check wall thickness.
❖ Keep clay on the top for the wall thickness form.
❖ Place top and bottom box for moulding.
❖ Slowly remove top box which align with bottom.

- ❖ Remove clay cake from top and check wall thickness.
- ❖ Air blow bottom to remove loose sand.
- ❖ Weld the main reinforcement to the box.
- ❖ Remove all the dummy pieces.
- ❖ Put core gum and clay around the mould.
- ❖ Pre heat cope and drag.
- ❖ Place sufficient weight on top of the box.
- ❖ Weld the top and bottom securely.
- ❖ Finish part inline with top and bottom.
- ❖ Mould is ready.

3.18.MOULDING PROCRDURE FLOW CHART:



CHAPTER 4

MELTING

4.1.What is melting?

Melting is a process that converts the solid into liquid by the application of heat, for melting of steel lot of furnaces can be used.

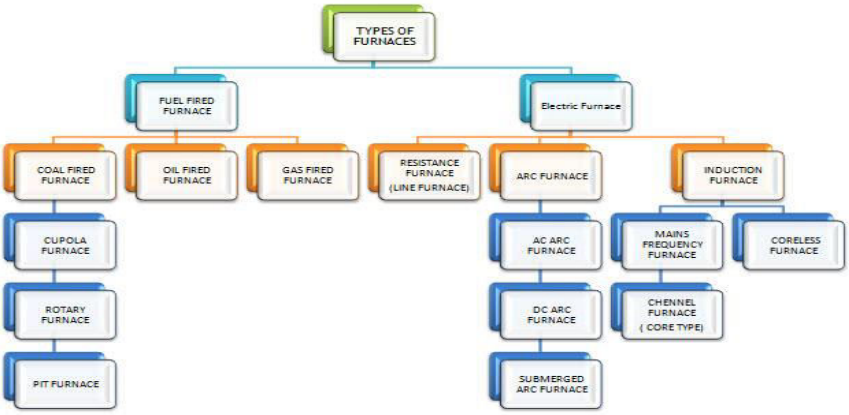


FIG:4.1:Types of furnaces

4.2.STEEL MELTING BY INDUCTION FURNACE – PROCESS:

The greatest advantage of the Induction Furnace is its low capital cost compared with other types of Melting Units. Its installation is relatively easier and its operation simpler. Among other advantages, there is very little heat loss from the furnace as he bath is constantly covered and there is practically no noise during its operation. The molten metal in an Induction Furnace is circulated automatically by electromagnetic action so that when alloy additions are made, a homogeneous product is ensured in minimum time.

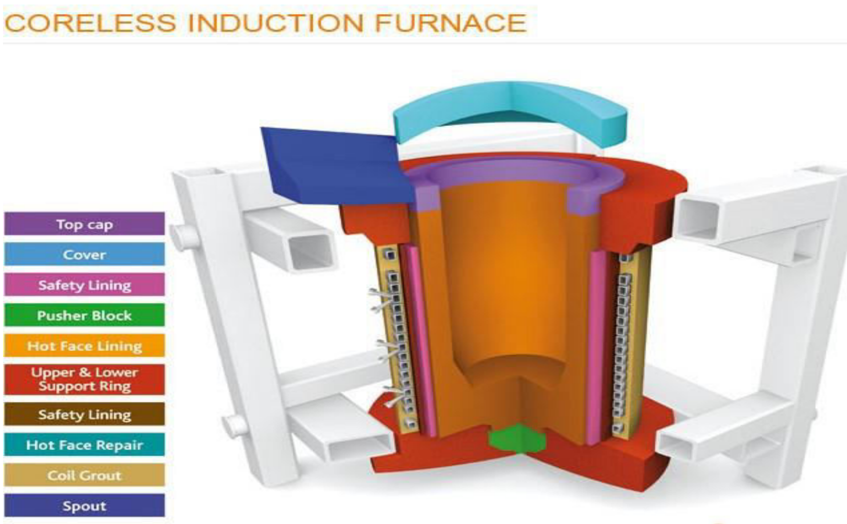


Fig 4.2Coreless Induction furnace

The time between tap and charge, the charging time, power delays etc. are items of utmost importance are meeting the objective of maximum output in tones/hour at a low operational cost. The process for manufacturing steel may be broadly divided into the following stages:

Melting the charge mixed of steel & Iron scrap. Ladle teeming practice for Casting (OR) Direct teeming practice for Ingot Casting unloadable teeming machine.

INDUCTION FURNACE IS USED IN PEEKAY STEELS AND TEIR MAXIMUM CAPACITY IS 12 TON .

4.2.1.INDUCTION FURNACE:

An induction furnace is an electrical furnace in which the heat is applied by induction heating of metal. Induction furnace capacities range from less than one kilogram to one hundred tonnes capacity and are used to melt iron and steel, copper, aluminium and precious metals.

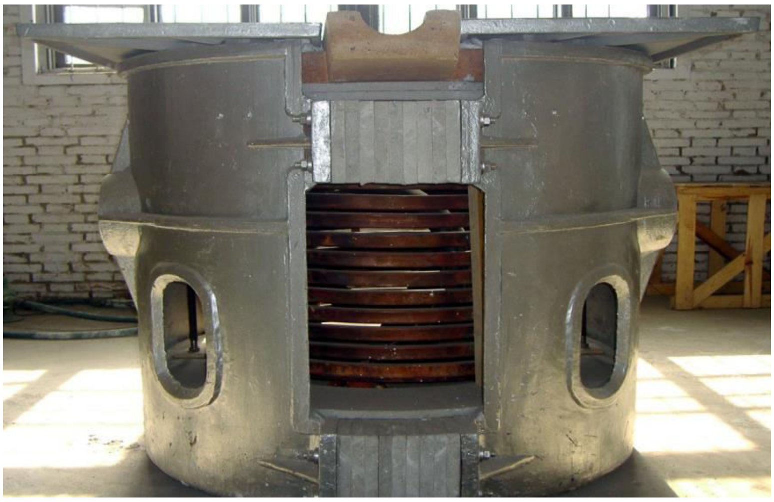


Fig 4.3 Induction furnace

4.3.SCOPE AND RESPONSIBILITY:

This work instruction is applicable for melting process of different material grades. It is the responsibility of the Management representative for quality to issue and maintain this document.

Head melting is important responsible to update this Procedure, When ever necessary. Supervision Melting is responsible to work as this procedure.

4.4.PROCEDURE FOR MELTING:

- ❖ Get melting schedule from melting department.
- ❖ Check the quantity of ferroalloys and other additives in the ferroalloy drums required.

- ❖ Check the furnace and ladle lining conditions. Repair if necessary.
- ❖ Check the cooling water and emergency water levels in coordination with maintenance.
- ❖ Charge fresh scrap and foundry return as following table.
  [for lining and patching ,sintering heat the return % is up to 70% and in that 70% of return LSF returns in 30% maximum]

S.NO	MATTER& SPECIFICATION	FRESH SCRAP/BILLET	FOUNDRY RETURN
1	cs&low alloy steel	50 to 100%	0 to 50%
2	Lcc &impact required heat	65%to100%	0 to 35%
3	CF8/CF8M	30 to 100	0 to 70
4	Ca15/high chrome steel	70 to 100	0 to 30
5	Nickel based steel	70 to 100	0 to 30
6	Duplex stainless steel like gr,4A,5A	100	_
7	C12A	100	--
8	CA6NM	100	--

Table 4.1 Selection of scrap

- ❖ Fill 3/4th f the furnace space with small and compactable scrap material.
- ❖ Switch on the furnace with reduced power and run for 30 min for coldstart.
- ❖ At redhot condition fill powder to furnace.
- ❖ Charge fresh scrap as soon as the volume of the scrap in the furnace decreases until desired amunt of scrap is melted.
- ❖ Chemical analysis is done for the molten metal.
- ❖ Keep the input power minimum so that the molten metal temperature remains as low as possible until chemail report of first sample from the lab.
- ❖ After sampling ,charge the furnace known chemistry foundry return /scrap.
- ❖ If any element has gone out of specification diute the bath with suitable scrap to bring it to the desired range if the element percentage has gone beyond the dilution limit.
- ❖ Add the alloys by using below mention formula to achieve target composition and sand second bath sample for chemical analysis.

$$\text{Quantity of ferroalloy to be added (kg/s)} = \frac{\text{Total changes (kgs)} \times \text{required(\%)}}{\text{Efficiency of the ferroalloy(\%)}}$$

Example: (% 0.02 carbon is to increased)

Coconut shell coke(Kgs) = 6000 Kgs × (0.02)/ 60

= 2 Kgs

- ❖ When the bath achieve the desired chemical composition ae per internal specification master / customer specifications increase the temperature of the melt as per the temperature chart given below. Temperature depends upon the section thickness of the casting and quantity of moulds to be poured.

SL. NO	MATERIALS SPECIFICATIONS	TEMPERATURE (deg C)				
		TAPPING			LADLE	POURING
		HSF	SMS	AOD		
1	Carbon steels, low alloy steels	1590-1620	1600-1630	1610-1640	1560-1580	1550-1570
2	Austenites, stainless steels like CF8, CF8M	1555-1585	1565-1595	1575-1605	1525-1545	1515-1535
3	CA15(Martensitic steel)	1560-159-	1570-1600	1580-1610	1550-1570	1540-1560
4	Ni based steel like CW12MW	1450-1480	1460-1490	1470-1500	1420-1450	1410-1430
5	Duplex stainless steel like Gr,4A,5A	1590-1610	1600-1620	1610-1630	1550-1570	1540-1560
6	CA6NM	1600-1630	1610-1540	1600-1630	1580-1600	1570-1590
7	C12A	1610-1630	1610-1630	1630-1660	1590-1615	1580-1605

Table 4.2 Pouring temperature selection

Above mentioned pouring temperature is general one (pouring temperature shall be followed as per the daily heat plan as mentioned in the method card)

- ❖ Try to maintain height between pouring cup and nozzle.
- ❖ Measure molten metal temperature by pyrometer and be confined of the desired value.
- ❖ Tap the molten metal at desired temperature into a preheated ladle.
- ❖ Add deoxidiser as per the table given below

SL. NO	MATERIAL SPECIFICATIONS	DEOXIDISER (Kgs/Ton) (Min/Max)						
		Al	Calcium silicide	selenium	Fesizr	Argon	FeTc	CaSiMa
1	Carbon steel	0.4-1.0	1.0-1.5	-	0.5-1.5	-	-	Optional 1 max
2	Low alloy steel	0.5-1.0	1.0-1.5	0.05-0.1	0.5-1.5	Optional	-	Optional 1 max
3	Austinitic steel CF8,CF8M	-	1.0-1.5	0.05-0.1	1.0-1.5	Optional	-	Optional 1 max
4	CA15(Martensitic steel)	0.4-0.8	1.0-1.5	0.05-0.1	1.0-1.5	Optional	-	Optional 1 max
5	Ni based steel like CW12MW	-	1.0-1.5	0.05-0.1	0.5-10	-	-	Optional 1 max
6	Duplex stainless steel like Gr,4A,5A	-	1.0-1.5	0.15-0.2	1.5-2.0	Yes	Optional	Optional 0.5-1.0
7	CA6NM	0.15-0.25	1.0-1.5	0.1-0.2	10-20	Yes	1.0-2.0	-
8	C12A	0.20max	1.5-3.5	0.1-0.2	0.20 max	Yes	0.20 max	Optional 0.5-1.5

Table 4.3 Deoxidiser selection

Addition of aluminium in steel melting shop(Bigger capacity furnace 12 tons) for CS / CAS heats range is 0.60 to 0.90 Kgs /tons.

- ❖ Percentage of de-oxidiser will be adjusted from the above table as per customer requirement.
- ❖ Cover the top surface of the molte metal in the ladle with insulating material.
- ❖ Pouring should be done as per work instruction.

4.5.POURING (GATING DESIGN)

A good gating design should ensure proper distribution of molten metal without excessive temperature loss, turbulence, gas entrapping and slags. If the molten metal is poured very slowly, since time taken to fill the mould cavity will become longer, solidification will start even before the mould is completely filled. This can be restricted by using super heated metal, but in this case solubility will be a problem. If the molten metal is poured very faster, it can erode the mould cavity. So gating design is important and it depends on the metal and molten metal composition. For example, aluminium can get oxidized easily.

Gating design is classified mainly into two (modified: three) types:

- ❖ Vertical gating
- ❖ Bottom gating
- ❖ Horizontal gating.

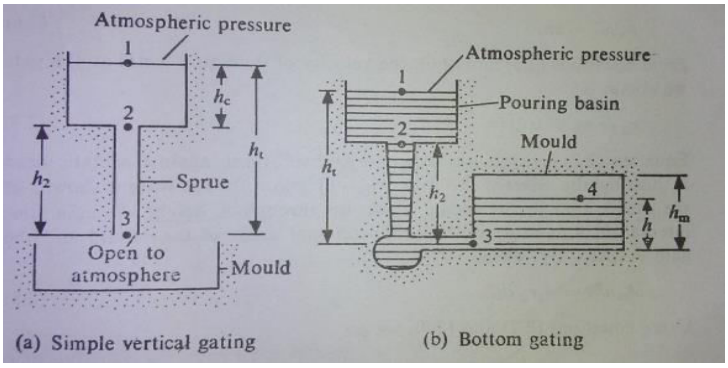


Fig 4.4 Gating design

4.5.1.Vertical gating:

The liquid metal is poured vertically, directly to fill the mould with atmospheric pressure at the base end.

4.5.2.Bottom gating:

Molten metal is poured from top, but filled from bottom to top. This minimizes oxidation and splashing while pouring.

4.5.3.Horizontal gating:

It is a modification of bottom gating, in which some horizontal portions are added for good distribution of molten metal and to avoid turbulence.

4.6.LADLES:

Ladles are used to transport molten metal from the melting furnace to the mould and vice versa. These ladles consist of steel shell lined with a suitable refractory material like fire clay.

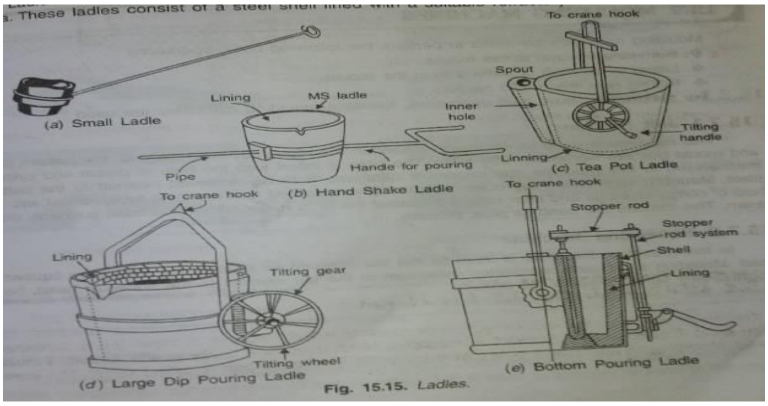


Fig 4.5 Ladles

4.7.WORKING INSTRUCTIONS FOR POURING OF CAST:

- ❖ Ladle pre-heating and setting shall be ensure as per the requirement.
- ❖ Empty ladle material weight should be measured before tapping.
- ❖ Before tapping place a triangular piece of ceramic wool on the surface of metal in front of the crucible spot.
- ❖ Maximum slag should be removed from molten metal before tapping
- ❖ Chesck the chemical composition of the furnace before tapping.
- ❖ Check the chemical composition of the furnace before tapping and ensure same in meeting the require.
- ❖ Check and record tapping temperature of the liquid metal as per the requirement and tap metal into pre-heated ladle.
- ❖ De-oxidants shall be added in the furnace and ladle as per the requirement.
- ❖ Ladle sample should be collected for chemical analysis and identify with heat number .
- ❖ Ladle temperature should be checked and recorded.
- ❖ Cover ladle with slag coagulant.
- ❖ Transfer ladle to desired area.
- ❖ Verify pouring box.
- ❖ And centralize nozzle to pour.
- ❖ Try to maintain minimum height between pourin cup and nozzle.
- ❖ Hold the ladle with steel to avoiding wobbling.
- ❖ Check the pouring temperature as per the requirements and record the same.

  If pouring temperature is higher than the requirements hold the metal and recheck the temperature till it reaches the required temperature. If the pouring temperature below the minimum temperature requirement metal has to taken back to the furnace and reprocessed.all subsequent operations are performed again. If two Or more moulds are poured in a single melt, measuring pouring time of first mould is sufficient.
- ❖ Open the nozzle and pour the liquid metal in to the mould. Pour slowly when metal reaches the riser top.
- ❖ Moulding supervisor should check the pouring time with stopwatch and record the same.
- ❖ Pouring time is calculated based on the methoding and same has been specified in the mould data sheet.

- ❖ Test blocks shall be poured after pouring first cast always.
- ❖ Riser treatment and re-pouring shall be done as given in method card.

4.8.SHAKEOUT MACHINE:

Shakeout Tables separate the poured mold into the flask, casting, and sand (green and no bake type). The casting deck configuration varies with the specific application. It can be made removable for change out.After the casting is reasonably cleaned of clinging sand, it is manually removed. The shakeout sand passes down through the casting deck openings and is collected for discharge through a bottom outlet. These Shakeout Tables are all powered by the Cinergy drive System. The available widths range from 2 ft. to 12 ft. in standard or heavy duty designs. The lengths are customized to our customer’s needs.Since the Cinergy drive System is energy efficient, power consumption is significantly reduced. It is adjustable in operating stroke and frequency by simple electrical control. This feature minimizes casting damage and noise. Maintenance checks are easily accomplished by the simple “look and listen” principle.

Fig 4.6 Shake out machine

4.9.MATERIALS SEPARATION:

In automatic foundry machines for the manufacture of castings in sand moulds it is known to perform the pouring while the casting moulds are carried on a conveyor on which the filled casting moulds are advanced to a knocking-out station provided with a grid. On this grid, the castings are separated from the mould material which drops down through the grid and is returned to the mould production apparatus. The intense heat from the metal poured damages the mould sand which therefore must be regenerated between the successive applications. As a rule, for the purpose of regeneration, a certain percentage of the mould sand is removed on its way from the knocking-out grid to the mould production apparatus and is substituted by unused material, which is mixed thoroughly with the remaining part of the mould sand, possibly with the addition of special components for improving the properties of the mould sand in various respects. Prior art foundry machines of this type cause a great deal of inconvenience, such as a high noise level and development of dust, heat and smell.

Fig 4.7 Materials separation

4.10.SHOT BLASTING MACHINE:

Shot blasting is a method used to clean, strengthen (peen) or polish metal. Shot blasting is used in almost every industry that uses metal, including aerospace, automotive, construction, foundry, shipbuilding, rail, and many others. There are two technologies used: wheel blasting or air blasting. When it comes to dealing with surface finishing and surface preparation problems, Rösler Offers the total process solution! Our customers can choose between two processing Technologies, Vibratory finishing or Shot blasting, which offer virtually unlimited Possibilities. Through extensive processing trials, we always find the right finishing solution For our customer’s needs. This includes not only the development of a specific finishing process, but also the selection of the right equipment and consumables.

Fig 4.8 Shot blasting machine

CHAPTER 5

MACHINE SHOP

5.1.COMPUTER NUMERICAL CONTROL(CNC)

A numerical control system in which the data handling,control sequence,and response to input is determined by an on-board computer system at the machine tool.

Computer Numerical Control (CNC) is one in which the functions and motions of a machine tool are controlled by means of a prepared program containing coded alphanumeric data. CNC can control the motions of the workpiece or tool, the input parameters such as feed, depth of cut, speed, and the functions such as turning spindle on/off, turning coolant on/off

5.1.1.Applications

The applications of CNC include both for machine tool as well as non-machine tool areas. In the machine tool category, CNC is widely used for lathe, drill press, milling machine, grinding unit, laser, sheet-metal press working machine, tube bending machine etc. Highly automated machine tools such as turning center and machining center which change the cutting tools automatically under CNC control have been developed. In the non-machine tool category, CNC applications include welding machines (arc and resistance), coordinate measuring machine, electronic assembly, tape laying and filament winding machines for composites etc.

5.1.2.Various popular CNC control systems:

- LECS
- NUM
- SELCA
- MARPOSS
- Z-16
- FANUC
- FAGOR
- FIDIA
- DECKEL

- ❖ SINUMERIC
- ❖ HINUMERIC
- ❖ HEIDENHAIN
- ❖ ECS
- ❖ GILDEMEISTER

Fanuc is used in peekey steels.

5.1.3.Advantages and Limitations

The benefits of CNC are

(1) high accuracy in manufacturing

(2) short production time

(3) greater manufacturing flexibility

(4) simpler fixturing

(5) contour machining (2 to 5 -axis machining)

(6) reduced human error

The drawbacks include high cost, maintenance, and the requirement of skilled part programmer.

5.1.4.ELEMENTS OF A CNC

A CNC system consists of three basic components :

1 . Part program

2 . Machine Control Unit (MCU)

3 . Machine tool (lathe, drill press, milling machine etc)

5.2.PRINCIPLES OF CNC

5.2.1.Basic Length Unit (BLU)

Each BLU unit corresponds to the position resolution of the axis of motion. For example, 1 BLU = 0.0001" means that the axis will move 0.0001" for every one electrical pulse received by the motor. The BLU is also referred to as Bit (binary digit).

Pulse = BLU = Bit

5.2.2.Point-to-Point Systems

Point-to-point systems are those that move the tool or the workpiece from one point to another and then the tool performs the required task.

5.2.3.Continuous Path System:

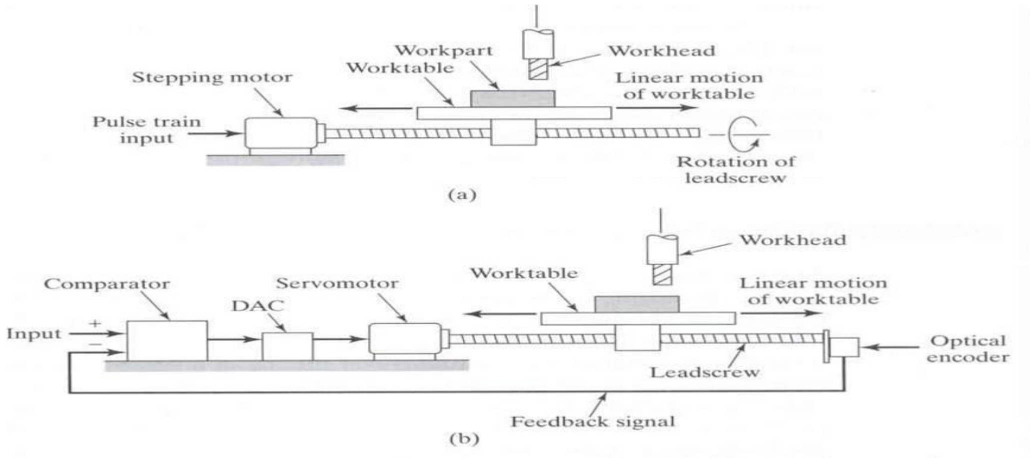
These systems provide continuous path such that the tool can perform while the axes are moving, enabling the system to generate angular surfaces, two-dimensional curves, or threedimensional.

5.2.4Open Loop Control System:

A Control system in which the final output value is not directly measured and checked against the desired value is know as open loop control system.

5.2.5.Closed Loop Control System

A control system in which the displacement of machine slide is balanced signal received from feed back devices is known as closed loop control system.



Two types of motion control in NC: (a) open loop and (b) closed loop.

Fig 5.1 Types of CNC motion

5.3.MILLING &TURNING:

These two process takes place in the peekey steels machine shop for the dispatch of the product and finalize to the customer.

5.3.1.CNC TURNING:

Turning is a slightly different process compared to CNC milling. CNC turning relies upon computer-controlled machines, but creates different end product. The process uses a single-point cutting tool that is inserted parallel to the material that will be cut. The material (metal, plastic, etc.) is rotated at varying speeds and the cutting tool traverses the 2 axis of motion to produce cylindrical cuts with exact depths and diameters.

5.3.2.CNC MILLING

CNC milling consists of a milling machine that uses commands, or G-codes, programmed into the machine via a computer software program. Each code entered into the program has a designated function that is performed by the machine. When codes are entered into a CNC program representing a potential finished product, the mill then drills and turns along axes to cut and shape the material to match the dimensions entered into the computer.

The milling machine can be programmed on three axes:

- The X axis controls the table movement left or right.
- The Y axis controls the table movement toward or away from the column.
- The Z axis controls the vertical (up or down) movement of the knee or spindle.

5.4.PROGRAMS AND MACHINE LANGUAGE:

Word address is the most common programming format used for CNC programming systems. This format contains a large number of different codes (preparatory and miscellaneous) that transfers program information from the part print to machine servos, relays, micro-switches, etc., to manufacture a part. These codes, which conform to EIA (Electronic Industries Association) standards, are in a logical sequence called a block of information. Each block should contain enough information to perform one machining operation. Word Address Format Every program for any part to be machined, must be put in a Circular Interpolation The development of MCUs capable of circular interpolation has greatly simplified the process of programming arcs and circles. To program an arc (Fig. 12), the MCU requires only the coordinate positions (the XY axes) of the circle center, the radius of the circle, the start point and end point of the arc being cut, and the direction in which the arc is to be cut (clockwise or counterclockwise) See Fig. 12. The information required may vary with different MCUs. 18 format that the machine control unit can understand. The format used on any CNC machine is built in by the machine tool builder and is based on the type of control unit on the machine. A variable-block format which uses words (letters) is most commonly used. Each instruction word consists of an address character, such as X, Y, Z, G, M, or S. Numerical data follows this address character to identify a specific function such as the distance, feed rate, or speed value. The address code G90 in a program, tells the control that all measurements are in the absolute mode. The code G91, tells the control that measurements are in the incremental mode.

5.4.1.CODES:

The most common codes used when programming CNC machines tools are G-codes (preparatory functions), and M codes (miscellaneous functions). Other codes such as F, S, D, and T are used for machine functions such as feed, speed, cutter diameter offset, tool number, etc. G-codes are sometimes called cycle codes because they refer to some action occurring on the X, Y, and/or Z axis of a machine tool, Fig. 13. The G-codes are grouped into categories such as Group 01, containing codes G00, G01, G02, G03. which cause some movement of the machine table or head. Group 03 includes either absolute or incremental programming, while Group 09 deals with canned cycles. A G00 code rapidly positions the cutting to

5.5.CNC MACHINES USED IN PEEKEY STEEL (P)LTD:

Fanuc series and siemens cnc were used in the machine shop.

- ❖ CNC horizontal boring and milling machine
- ❖ CNC vertical turning lathe(siemens)
- ❖ CNC vertical turning lathe(fanuc)
- ❖ CNC vertical turning center

These are the cnc machines used in the peekay industries.

5.6.TOOL INSERT:

Tool insert is used for the process in the cnc it is based upon the grade of the castings.

Fig 5.2 Tool inserts

5.7.Lathe Machine:

Lathes are designed for precisely machining relatively hard materials. With their inherent versatility, they are used in a wide range of applications, and can machine a broad range of material.

These lathe machine removes material from a rotating work piece via the linear movements of various cutting tools, such as tool bits and drill bits.

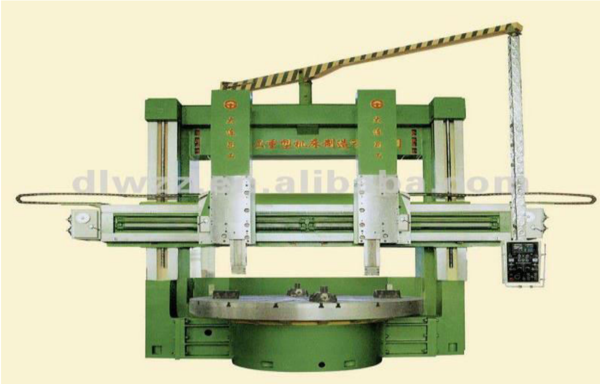


Fig 5.3 Lathe

5.7.1.Operations performed on a lathe:

- **Turning** – The diameter of a part can be reduced to desired dimension.
- **Facing** - A lathe can be used to create a smooth, flat, face very accurately perpendicular to the axis of a cylindrical part.

- **Parting** - Deeper and narrower than a turning tool. It is designed for making narrow grooves and for cutting off parts.
- **Drilling** - A lathe can also be used to drill holes accurately concentric with the centerline of a cylindrical part.
- **Boring** - Boring is an operation in which a hole is enlarged with a single point cutting tool.
- **Threading -** External threads can be cut with a die and internal threads can be cut with a tap.

5.7.2.Types of lathe:

- ***Centre lathe / bench lathe / engine lathe* -** The most basic type of lathe.
- ***Toolroom Lathe*** - Lathe optimized for toolroom work. It has all of the best optional features that may be omitted from less expensive models, such as a collet closer, taper attachment, and others.
- ***Turret lathes and capstan lathes* -** Used for repetitive production of duplicate parts.
- ***Multispindle lathe*** - Multispindle lathes have more than one spindle and automated control.
- ***CNC lathe* -** CNC lathes are rapidly replacing the older production lathes due to their ease of setting and operation. The part may be designed by the

Computer-aided manufacturing (CAM) process, the resulting file uploaded to the machine, and once set and trailed the machine will continue to turn out parts under the occasional supervision of an operator.

5.8.MILLING MACHINE:

A milling machine is a machine tool used for the shaping of metal and other solid materials. Its basic form is that of a rotating cutter, which rotates about the spindle axis (similar to a drill), and a table to which the workpiece is affixed. In contrast to the lathe machine, in the milling machine the workpiece moves longitudinally against the rotating cutter. Milling machines may be operated manually or by CNC.

Operations done in Milling machines:

- Roughing
- Finishing
- Drilling
- Boring (a) Rough (b) Finish (c) Counter boring
- Slotting
- Key way cutting
- Gear cutting
  - Spur
  - Bevel
  - Worm
  - Helical

5.9.WHAT IS MAGNETIC PARTICLE INSPECTION?

The purpose of these tests is not only to detect discontinuities present on the surface of ferromagnetic materials but also those that exist under the surface. The method is based on the application of a metal powder applied to the surface of the material under the influence of a magnetic field. The accumulation of metal around discontinuities in the material reveals their location. The particular advantage of this method is that it can be used even if additional materials such as paint are present.

5.9.1.WHAT DO THESE TEAMS USE FOR INSPECTIONS?

SCI possesses portable and stationary magnetic particle (coloured or fluorescent) inspection equipment incorporating the latest technologies and is something that sets SCI apart and has earned it a unique reputation in this sector.

5.9.2.CONTACT ELECTRODES EQUIPMENT UP TO 2000 A

With this equipment a circular current can be passed between the electrodes, the process enabling a magnetic field to be generated between them.

These yokes (designed for individual use) are available with both direct current and alternating current and their flexibility and small size make for optimum use in the field.

5.9.3.MULTIDIRECTIONAL INSPECTION

The benches are designed specifically for inspecting elements of forging, casting. These benches combine techniques of a central conductor, current flow and coil.

5.9.4.SOME OF ITS MOST ESSENTIAL ELEMENTS ARE:

Yokes portable AC and DC

Both circular and longitudinal magnetization. Equipment optimized for testing large series of parts.

5.9.5.ADVANTAGES OF THESE TESTS:

Performing these Magnetic Particle Testing has a number of specific advantages:
Results are immediate and very safe. Testing is faster than with liquid penetrant. They can be used in certain coatings components when the degree of cleaning component is not as critical as in liquid penetrant testing. Testing is cleaner than that made with liquid penetrant analysis. They can be applied to both large and small samples.

5.10.INSTRUMENT USED IN INSPECTION PROCESS:

5.10.1.VERNIER CALIPER:

A vernier scale is a visual aid that allows the user to measure more precisely than could be done unaided when reading a uniformly divided straight or circular measurement scale. It is a scale that indicates where the measurement lies in between two of the graduations on the main scale.

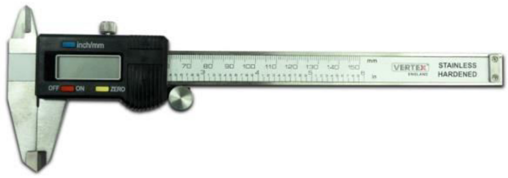


Fig 5.4 Vernier calliper

5.10.2.THREAD GAUGE PLUG:

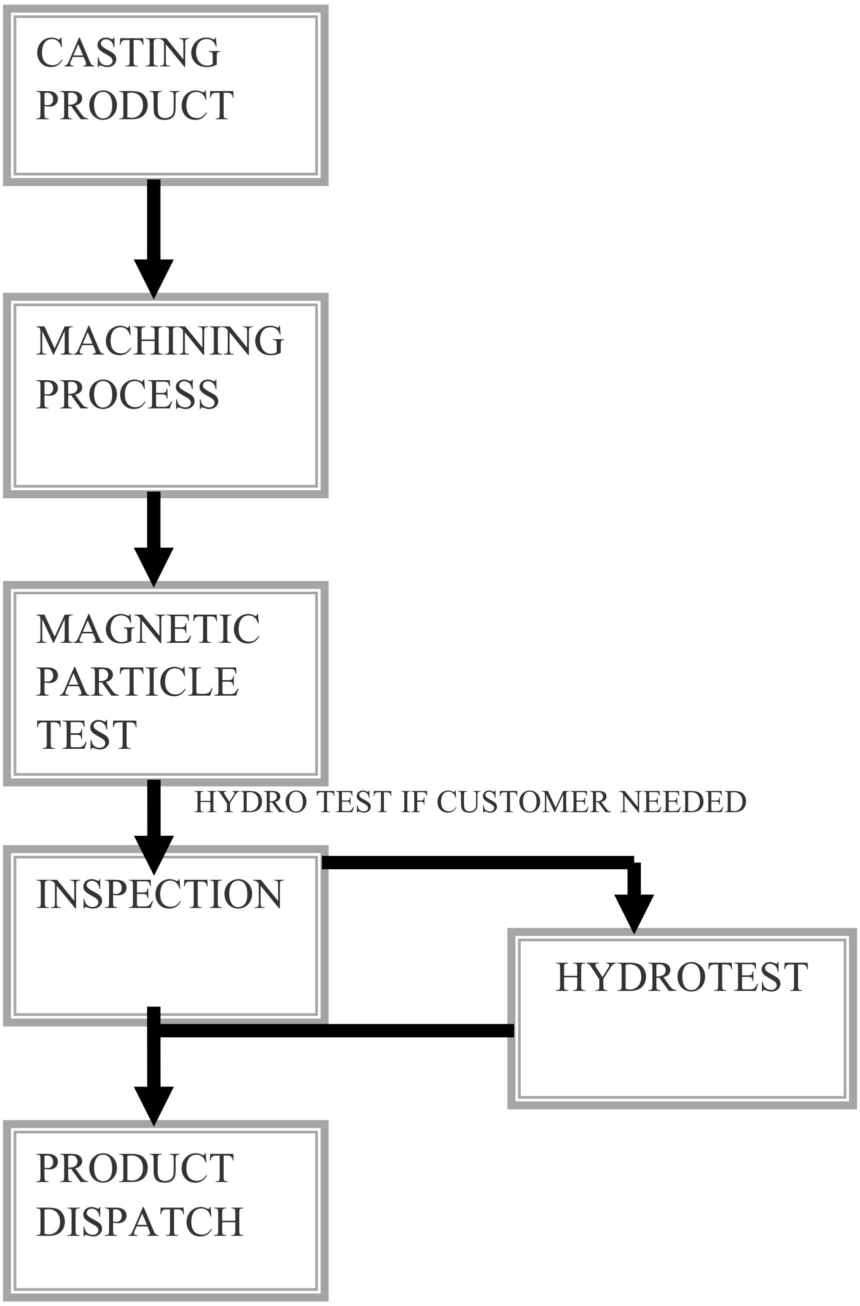
A go-no gauge (or go/no-go) refers to an inspection tool used to check a workpiece against its allowed tolerances. Its name is derived from two tests: the check involves the workpiece having to pass one test (*go*) and fail the other (*no-go*).

5.10.3.MICROMETER:

A micrometer allows a measurement of the size of a body.It is one of the most accurate mechanical device in common use.After the completion of the instrument inspection oil coating inspection taking place for the prevention of rusting and then it is packed to dispatch and deliver to the customer.

Fig 5.5 Micrometer

5.11.PROCESS IN MACHINE SHOP:



5.12.HYDRO TEST:

This test is carried out on castings required to be leak proof. All openings of the castings are closed and a gas or fluid under pressure is introduced init. Castings having porosity leak under this pressure. The leakage may be detected by submerging the casting in a water tank or using a soap film if the pressure is applied by compressed air. If a liquid is used for applying pressure the leakage can be found by visual inspection.

CHAPTER 6

QUALITY DEPARTMENT

What is Quality?

Quality is the totality of features and characteristics f a product or service, that bear on its ability to satisfy stated and implied needs of the customer.

Quality can be quantified as follows:

$$Q = P \div E$$

Q = Quality

P = Performance

E = Expectations

6.1.QUALITY SYSTEM:

6.1.1.PRINCIPLES OF QUALITY:

- ❖ *QUALITY ASSUARANCE*
- ❖ *QUALITY CONTROL*

6.1.1.1.QUALITY ASSUARANCE:

- ❖ Quality system.
- ❖ Testing in lab.
- ❖ Welding.
- ❖ Heat treatment method.

6.1.1.2.QUALITY CONTROL:

- ❖ It under come with two process such as Inspection and NDT(non-destructive test).

6.1.1.3.WHAT IS QUALITY CONTROL?

It is a system of routine technical activities to measure and control the quality of product.

6.1.1.4.WHAT IS QUALITY ASSURANCE?

All those systematic and planned activities which provides adequate confidence that the manufactured products are meeting the requirement.

6.2.QUALITY SYSTEM ISO 9001:2008:

FIG6.1:CLAUSES OF ISO 9001:2008

6.2.1. Scope :

6.2.1.1 General :

This International Standard specifies requirements for a quality management system where an organisation

- Needs to demonstrate its ability to consistently provide product that meets customer and applicable statutory and regulatory requirements, and
- Aims to enhance customer satisfaction through the effective application of the system, including processes for continual improvement of the system and the assurance of conformity to customer and applicable statutory and regulatory requirements.

6.2.1.2 Application:

All requirement of this international Standard are generic and are intended to be applicable to all organizations, regardless of type, size and product provided. Where any requirement(s) of this International Standard cannot be applied due to the nature of an organization and its product, this can be considered for exclusion. Where exclusions are made, claims of conformity to this International Standard are not acceptable unless these exclusions are limited to requirements within clause 7, and such exclusions do not affect the organization's ability, or responsibility, to provide product that meets customer and applicable statutory and regulatory requirements.

6.2.2.Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applied ISO 9000:2005, Quality Management Systems-Fundamentals and vocabulary

6.2.3.Terms and definitions

For the purpose of this document, the terms and definitions given in ISO 9000 apply. Throughout the text of this International Standard, wherever term "product" occurs, it can also mean "service"

6.2.4.Quality management system

6.2.4.1. General requirements

The organization shall establish, document, implement and maintain a quality management system and continually improve its effectiveness in accordance with the requirements of this International Standard.

The organization shall:

- determine the processes needed for the quality management system and their application throughout the organization
- determine the sequence and interaction of these processes,
- determine criteria and methods needed to ensure that both the operation and control of these processes are effective,
- ensure the availability of resources and information necessary to support the operation and monitoring of these processes,
- monitor, measure where applicable, and analyse these processes, and
- implement actions necessary to achieve planned results and continual improvement of these processes.

6.2.4.2.Quality manual

The organization shall establish and maintain a quality manual that includes

- ➢ The scope of the quality management system, including details of and justification for any exclusions
- ➢ The documented procedures established for the quality management system, or reference to them, and
- ➢ A description of the interaction between the processes of the quality management system.

6.2.5Management responsibility

6.2.5.1 Management commitment

Top management shall provide evidence of its commitment to the development and implementation of the quality management system and continually improving its effectiveness by

- communicating to the organization the importance of meeting customer as well as statutory and regulatory requirements,
- establishing the quality policy,
- ensuring that quality objectives are established,
- conducting met with the aim of enhancing customer satisfaction.

6.2.5.2. Quality policy

Top management shall ensure that the quality policy

- is appropriate to the purpose of the organization,
- includes a commitment to comply with requirements and continually improve the effectiveness of the quality management system,
- provides a framework for establishing and reviewing quality objectives,
- is communicated and understood within the organization, and
- is reviewed for continuing suitability.

6.2.5.3 Management review

6.2.5.3.1 General:

Top management shall review the organization's quality management system, at planned intervals, to ensure its continuing suitability, adequacy and effectiveness. This review shall include assessing opportunities for improvement and the need for changes to the quality management system, including the quality policy and quality objectives.

Records from management reviews shall be maintained

6.2.5.3.2. Review input:

The input to management review shall include information on:

- results of audits,
- customer feedback,
- process performance and product conformity,
- status of preventive and corrective actions,
- follow-up actions from previous management reviews,

- changes that could affect the quality management system, and
- recommendations for improvement.

6.2.5.3.3 Review output:

The output from the management review shall include any decisions and actions related to:

- improvement of the effectiveness of the quality management system and its processes,
- improvement of product related to customer requirements, and c) resource needs.

6.2.6 Resource management

6.2.6.1 Provision of resources

The organization shall determine and provide the resources needed

a) to implement and maintain the quality management system and continually improve its effectiveness, and

b) to enhance customer satisfaction by meeting customer requirements.

6.2.6.2 Human resources

6.2.6.2.1General :

Personnel performing work affecting conformity to product requirements shall be competent on the basis of appropriate education, training, skills and experience.

6.2.6.2.2:Competence, training and awareness

The organization shall

- determine the necessary competence for personnel performing work affecting conformity to product requirements,
- where applicable provide training or take other actions to achieve the necessary competence.
- evaluate the effectiveness of the actions taken,
- ensure that its personnel are aware of the relevance and importance of their activities and how they contribute to the achievement of the quality objectives, and
- maintain appropriate records of education, training, skills and experience

6.2.6.3. Infrastructure

The organization shall determine, provide and maintain the infrastructure needed to achieve conformity to product requirements. Infrastructure includes, as applicable,

- buildings, workspace and associated utilities,
- process equipment (both hardware and software), and
- supporting services (such as transport, communication or information systems.

6.2.6.4 .Work environment:

The organization shall determine and manage the work environment needed to achieve conformity to product requirements.

6.2.7.Product realization

6.2.7.1. Planning of product realization

The organization shall plan and develop the processes needed for product realization. Planning of product realization shall be consistent with the requirements of the other processes of the quality management system. In planning product realization, the organization shall determine the following, as appropriate:

- quality objectives and requirements for the product;
- the need to establish processes and documents, and to provide resources specific to the product;
- required verification, validation, monitoring, measurement, inspection and test activities specific to the product and the criteria for product acceptance;
- records needed to provide evidence that the realization processes and resulting product meet requirements.

6.2.8.Monitoring and measurement

6.2.8.1.Customer satisfaction

As one of the measurements of the performance of the quality management system, the organization shall monitor information relating to customer perception as to whether the organization has met customer requirements. The methods for obtaining and using this information shall be determined.

6.2.8.2. Internal audit

The organization shall conduct internal audits at planned intervals to determine whether the quality management system

- conforms to the planned arrangements, to the requirements of this International Standard and to the quality management system requirements established by the organization, and
- is effectively implemented and maintained.

An audit programme shall be planned, taking into consideration the status and importance of the processes and areas to be audited, as well as the results of previous audits. The audit criteria, scope, frequency and methods shall be defined. The selection of auditors and conduct of audits shall ensure objectivity and impartiality of the audit process. Auditors shall not audit their own work.

A documented procedure shall be established to define the responsibilities and requirements for planning and conducting audits, establishing records and reporting results. Records of the audits and their results shall be maintained

The management responsible for the area being audited shall ensure that any necessary corrections and corrective actions are taken without undue delay to eliminate detected non-conformities and their causes.

6.3.SAND TESTING

The moulding sand after it is prepared should be properly tested to see that require properties are achieved. Tests are conducted on a sample of the standard sand. The moulding sand should be prepared exactly as it is done in the shop on the standard equipment and then carefully enclosed in a container to safeguard its moisture content. Sand tests indicate the moulding sand performance and help the foundry men in controlling the properties of moulding sands. Sand testing controls the moulding sand properties through the control of its composition.

The following are the various types of sand control tests:

- Moisture content test
- Clay content test
- Grain fitness test
- Permeability test
- Strength test
- Mould hardness test

6.3.1.MOISTURE CONTENT TEST:

Moisture is the property of the moulding sand it is defined as the amount of water present in the moulding sand. Low moisture content in the moulding sand does not develop strength properties. High moisture content decreases permeability.

- Procedures are:
- 20 to 50 gms of prepared sand is placed in the pan and is heated by an infrared heater bulb for 2 to 3 minutes.
- The moisture in the moulding sand is thus evaporated.
- Moulding sand is taken out of the pan and reweighed.
- The percentage of moisture can be calculated from the difference in the weights, of the original moist and the consequently dried sand samples
- Percentage of moisture content = (W1-W2)/(W1) %
- Where,

W1- Weight of the sand before drying.

W2- Weight of the sand after drying.

6.3.2.Clay content test:

Clay influences strength, permeability and other moulding properties. It is responsible for bonding sand particles together.

FIG.6.2:Stregth tester(Mullen type)

- **Procedures are:**
- Small quantity of prepared moulding sand was dried
- Separate 50gms of dry moulding sand and transfer wash bottle.
- Add 475cc of distilled water + 25cc of a 3%NaOH.
- Agitate this mixture about 10 minutes with the help of sand stirrer. 5. Fill the wash bottle with water up to the marker.
- After the sand etc., has settled for about 10 minutes, Siphon out the water from the wash bottle.
- Dry the settled down sand.
- The clay content can be determined from the difference in weights of the initial and final sand samples.
- Percentage of clay content = (W1-W2)/(W1) * 100
- W1-Weight of the sand before drying.
- W2- Weight of the sand after drying.

6.3.3.Grain fitness test:

The grain size, distribution, grain fitness are determined with the help of the fitness testing of moulding sands. The apparatus consists of a number of standard sieves mounted one above the other, on a power driven shaker. The shaker vibrates the sieves and the sand placed on the top sieve gets screened and collects on different sieves depending upon the various sizes of grains present in the moulding sand. The top sieve is coarsest and the bottom-most sieve is the finest of all the sieves. In between sieve are placed in order of fineness from top to bottom.

FIG:6.3:Sieves

Procedures are:

- ❖ Sample of dry sand (clay removed sand) placed in the upper sieve.
- ❖ Sand is vibrated for definite period.
- ❖ The amount of same retained on each sieve is weighted.
- ❖ Percentage distribution of grain is computed.

6.3.4.Permeability test:

The quantity of air that will pass through a standard specimen of the sand at a particular pressure condition is called the permeability of the sand.

- ❖ Following are the major parts of the permeability test equipment:
- ❖ An inverted bell jar, which floats in a water.
- ❖ Specimen tube, for the purpose of hold the equipment
- ❖ A manometer (measure the air pressure)

Procedures are:

- ❖ The air (2000cc volume) held in the bell jar is forced to pass through the sand specimen.
- ❖ At this time air entering the specimen equal to the air escaped through the specimen
- ❖ Take the pressure reading in the manometer.

- ❖ Note the time required for 2000cc of air to pass the sand
- ❖ Calculate the permeability number
- ❖ Permeability number (N) = ((V x H) / (A x P x T))

  Where,

  V-Volume of air (cc)

  H-Height of the specimen (mm)

  A-Area of the specimen (mm2)

  P-Air pressure (gm / cm2)

  T-Time taken by the air to pass through the sand (seconds)

6.3.5.Strength test:

Measurements of strength of moulding sands can be carried out on the universal sand strength testing machine. The strength can be measured in compression, shear and tension. The sands that could be tested are green sand, dry sand or core sand. The compression and shear test involve the standard cylindrical specimen that was used for the permeability test.

a. **Green compression strength**:

Green compression strength or simply green strength generally refers to the stress required to rupture the sand specimen under compressive loading. The sand specimen is taken out of the specimen tube and is immediately (any delay causes the drying of the sample which increases the strength) put on the strength testing machine and the force required to cause the compression failure is determined. The green strength of sands is generally in the range of 30 to 160 KPa**.**

b. **Green shear strength**:

With a sand sample similar to the above test, a different adapter is fitted in the universal machine so that the loading now be made for the shearing of the sand sample. The stress required to shear the specimen along the axis is then represented as the green shear strength. It may vary from 10 to 50 KPa.

c. **Dry strength**:

This test uses the standard specimens dried between 105 and 1100 C for 2 hours. Since the strength increases with drying, it may be necessary to apply larger stresses than the previous tests. The range of dry compression strengths found in moulding sands is from 140 to 1800 KPa, depending on the sand sample.

Procedures are:

1. Specimen is held between the grips.
2. Apply the hydraulic pressure by rotating the hand wheel.
3. Taking the deformation use of the indicators.

6.3.6.Mould hardness test:

Hardness of the mould surface can be tested with the help of an "indentation hardness tester". It consists of indicator, spring loaded spherical indenter. The spherical indenter is penetrates into the mould surface at the time of testing. The depth of penetration to the flat reference surface of the tester.

Mould hardness number = ((P) / (D – (D2-d2))

6.4.MECHANICAL TESTING

Mechanical testing gives an evaluation of the metal and the casting to determine whether the properties are in compliance with the specified mechanical requirements. Following are common mechanical tests used in metal casting facilities.

6.4.1.Hardness testing:

The most commonly used procedure for mechanical property testing, it provides a numerical value and is nondestructive. Hardness values generally relate to an alloy's machinability and wear resistance. The brinell hardness test uses a 10-mm diameter carbide ball to indent a 3,000-kg load. The impressions are large enough to provide a dependable average hardness. Rockwell hardness tests make smaller indented impressions, which also can be satisfactory if the median of several values is used.

6.4.2.Tensile and impact testing:

Conducted on test specimens of standardized dimensions, the two most common types are tensile and Charpy impact. Tensile testing provides ultimate tensile strength, yield strength, elongation and reduction of area data. Charpy impact testing determines the amount of energy absorbed during fracture and is used to gauge ductility and strength**.**

6.4.3.Service load testing:

Usually conducted on the entire casting to evaluate its properties, it can be conducted in a number of ways. Castings that must carry a structural load can have a load applied in a fixture while the deflection and the load is measured.

Pressure-containing parts can be hydraulically tested to a proof load or destruction. Rotating parts can be spin tested. These types of tests check the soundness of the casting, as well as its properties.

FIG:6.4:Mechanical tests

6.5. WELDING

What is Welding?

Welding is defined as the process of joining together (metal pieces or parts) by heating the surfaces to the point of melting using a blowtorch, electric arc, or other means, and uniting them by pressing, hammering, etc.

6.5.1.WELDING TYPES:

- ❖ Arc welding
- ❖ Oxy fuel welding
- ❖ Resistance welding
- ❖ Solid state welding

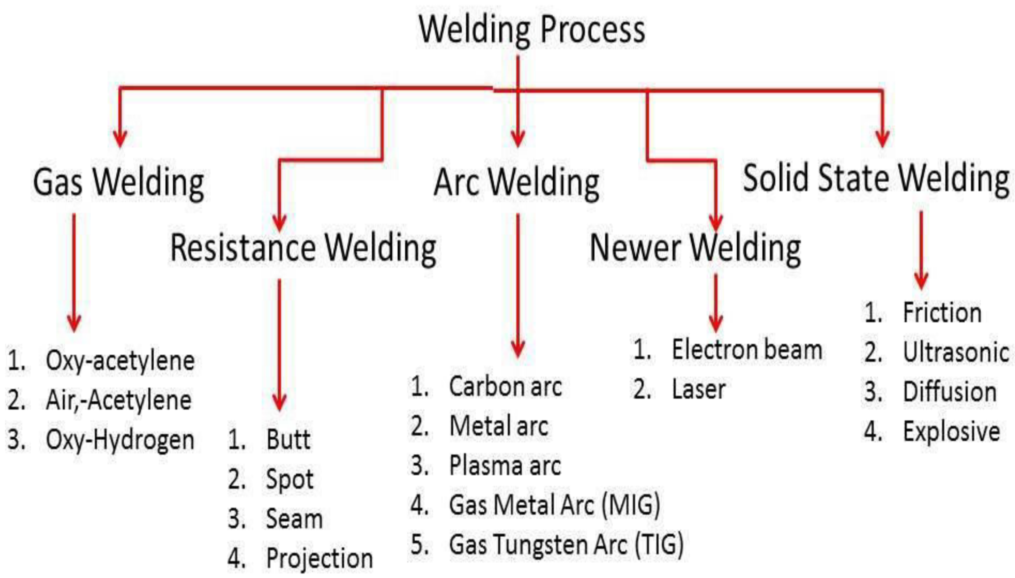


FIG:6.5:Welding types

6.5.2.WELDING USED IN PEEKAY STEEL CASTINGS (P) LTD:

6.5.2.1.GMAW WELDING

What is GMAW?

- GMAW is defined as arc welding using a continuously fed consumable electrode and a shielding gas.
- Produces high-quality welds.
- Yields high productivity.

EQUIPMENTS:

To perform gas metal arc welding, the basic necessary equipment is

- a welding gun
- a wire feed unit
- a welding power supply
- an electrode wire and a shielding gas supply.

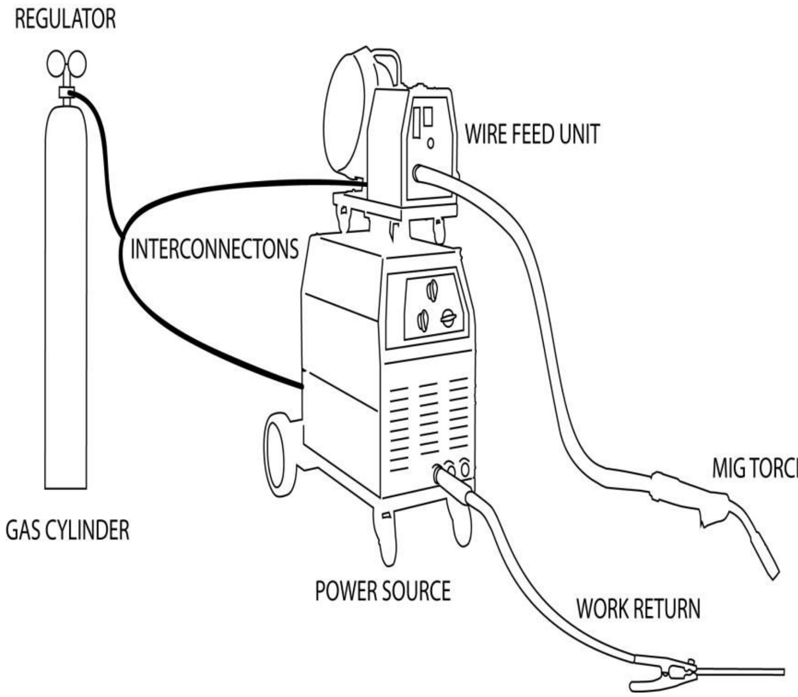


FIG:6.6:GMAW welding

PROCESS:

Definition Gas Metal Arc Welding (GMAW), by definition, is an arc welding process which produces the coalescence of metals by heating them with an arc between a continuously fed filler metal electrode and the work. The process uses shielding from an externally supplied gas to protect the molten weld pool. The application of GMAW generally requires DC+ (reverse) polarity to the electrode. In non-standard terminology, GMAW is commonly known as MIG (Metal Inert Gas) welding and it is less commonly known as MAG (Metal Active Gas) welding. In either case, the GMAW process lends itself to weld a wide range of both solid carbon steel and tubular metal-cored electrodes. The alloy material range for GMAW includes: carbon steel, stainless steel, aluminium, magnesium, copper, nickel, silicon bronze and tubular metal-cored surfacing alloys. The GMAW process lends itself to semiautomatic, robotic automation and hard automation welding applications.

Advantages of GMAW:

The GMAW process enjoys widespread use because of its ability to provide high quality welds, for a wide range of ferrous and non-ferrous alloys, at a low price. GMAW also has the following advantages:

• The ability to join a wide range of material types and thicknesses.

• Simple equipment components are readily available and affordable.

• GMAW has higher electrode efficiencies, usually between 93% and 98%, when compared to other welding processes.

• Higher welder efficiencies and operator factor, when compared to other open arc welding processes.

• GMAW is easily adapted for high-speed robotic, hard automation and semiautomatic welding applications.

• All-position welding capability.

• Excellent weld bead appearance.

• Lower hydrogen weld deposit — generally less than 5 mL/100 g of weld metal.

• Lower heat input when compared to other welding processes.

• A minimum of weld spatter and slag makes weld clean up fast and easy.

• Less welding fumes when compared to SMAW (Shielded Metal Arc Welding) an and FCAW (Flux-Cored Arc Welding) processes.

Benefits of GMAW:

• Generally, lower cost per length of weld metal deposited when compared to other open arc welding processes.

• Lower cost electrode.

. • Less distortion with GMAW-P (Pulsed Spray Transfer Mode), GMAW-S (Short-Circuit Transfer Mode) and STT™ (Surface Tension Transfer™).

• Handles poor fit-up with GMAW-S and STT modes.

• Reduced welding fume generation.

• Minimal post-weld cleanup.

Limitations of GMAW:

• The lower heat input characteristic of the short-circuiting mode of metal transfer restricts its use to thin materials.

• The higher heat input axial spray transfer generally restricts its use to thicker base materials.

• The higher heat input mode of axial spray is restricted to flat or horizontal welding positions.

• The use of argon based shielding gas for axial spray and pulsed spray transfer modes is more expensive than 100% carbon dioxide (CO2).

6.5.2.2.TIG WELDING

What is TIG welding?

Gas tungsten arc welding (GTAW), also known as tungsten inert gas (TIG) welding, is an arc welding process that uses a non-consumable tungsten electrode to produce the weld. The weld area is protected from atmospheric contamination by an inertshielding gas (argon or helium), and a filler metal is normally used.

A constant-current welding power supply produces energy which is conducted across the arc through a column of highly ionized gas and metal vapors known as a plasma.

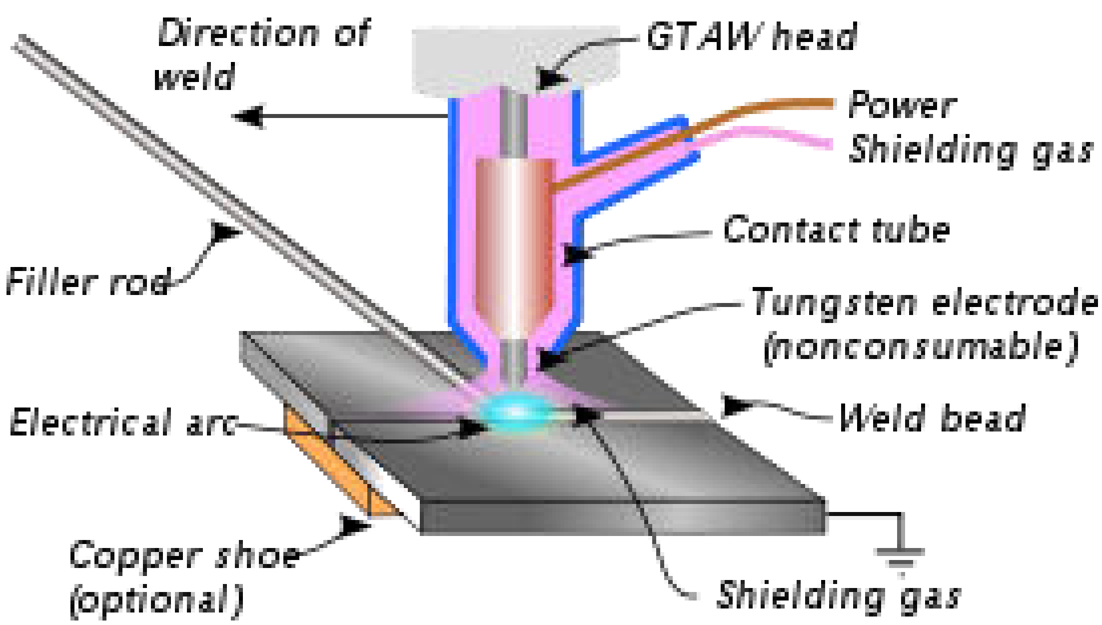


FIG:6.7:TIG welding

OPERATION:

- Manual gas tungsten arc welding is often considered the most difficult of all the welding processes commonly used in industry. Because the welder must maintain a short arc length, great care and skill are required to prevent contact between the electrode and the workpiece. hand while manipulating the welding torch in the other
- Similar to torch welding, TIG normally requires two hands, since most applications require that the welder manually feed a filler metal into the weld area with one

USES:

- TIG is most commonly used to weld thin sections of stainless steel and non-ferrous metals such as aluminum, magnesium, andcopper alloys. The process grants the operator greater control over the weld than competing processes such as shielded metal arc welding and gas metal arc welding, allowing for stronger, higher quality welds.

APPLICATIONS:

- While the aerospace industry is one of the primary users of gas tungsten arc welding, the process is used in a number of other areas. Many industries use TIG for welding thin workpieces, especially nonferrous metals.
- It is used extensively in the manufacture of space vehicles, and is also frequently employed to weld small-diameter, thin-wall tubing such as those used in the bicycle industry. In addition, TIG is often used in piping of various sizes.

POWER SUPPLY:

- The electrode used in TIG is made of tungsten or a tungsten alloy, because tungsten has the highest melting temperature among pure metals, at 3,422 °C (6,192 °F). As a result, the electrode is not consumed during welding, though some erosion (called burn-off) can occur. Electrodes can have either a clean finish or a ground finish—clean finish electrodes have been chemically cleaned, while ground finish electrodes have been ground to a uniform size and have a polished surface, making them optimal for heat conduction.

FIG:6.8:TIG Welding Equipments

TUNGSTEN WELDING:

- 2% Thoriated Tungsten – RED

Generally used for DC negative or straight polarity applications, this is the most common type of electrode used today. Provides excellent resistance from weld pool contamination, easier arc starting capabilities and a more stable arc. Contains 2% weight of thorium oxide (ThO2). Most common metals used for include: Carbon and Stainless Steel, Nickel Alloys, and Titanium.

- Pure Tungsten - GREEN

Used for AC welding applications. provide good arc stability. Typically the least expensive tungsten, but is more suitable to weld contamination than thoriated and lanthanated. Contains a minimum of 99.5% weight tungsten with no other alloys. Most common metals used for include: Aluminum and Magnesium Alloys (AC).

- 2% Ceriated Tungsten -
  Orange Used for AC or DC welding applications. An excellent alternative to Thoriated tungsten especially in low amperage welding. Takes approximately 10% less current to initiate arc and has a very stable arc. Not a radioactive material and tends to last longer . Contains 2% weight of Cerium Oxide (CeO2). Most common metals used for include: Carbon and Stainless Steels, Nickel Alloys and Titanium.

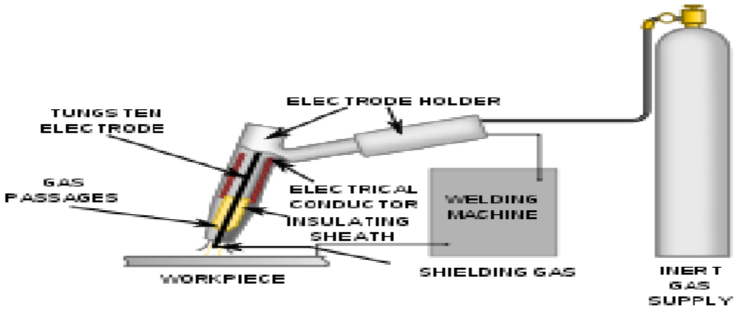


FIG:6.9:TIG Welding arrangement

6.5.2.3.SMAW WELDING

SMAW:

- This is one the arc welding processes that is commonly used in construction/fabrication processes. It is also known with several names such as; MMA or MMAW, flux shielded arc welding or informally known as stick welding.
- The electrode used in his process is consumable (a rod covered with flux).
- The flux burns to form the protective layer/cover for the weld.
- The current type used in this process can either be AC or DC depending on the design of the weld which will be stated in the WPS.
- Because of the versatility and simplicity of this process, it is most generally and widely used across the world, it is mostly used for repair and maintenance in the heavy steel industry.

WORKING PRINCIPLE:

- Current flows in through the cables (ground cable and the hot cable) from the power source (AC/DC) which the circuit is completed when the electrode tip comes in contact with the surface of the work piece as will be seen in the diagram that will be displayed in later slide.
- The heat is simply generated at the meeting point between the electrode an d the work pieces (arc).
- The heat input can however be calculated using the formula $H=[(60EI)/(1000S)]$ Kj/in
- Shielded metal-arc welding with the transformer welding machine depends upon this fundamental fact: that when one side of the welding circuit is

attached to a piece of steel, a welding electrode connected to the other side and the two brought into contact, an arc will be established.

- If the arc is properly controlled, the metal from the electrode will pass through the arc and be deposited on the steel. When the electrode is moved along the steel at the correct speed, the metal will deposit in a uniform layer called a bead.
- The arc is started by bringing the tip of the electrode into contact with the base metal (work piece) by a very light touch, hence this arc is maintained by keeping the electrode at a relatively close distance from the base metal. This arc length is usually 3mm - 4mm.
- Melting of the base metal and the core wire of the electrode take place to form the weld pool. However, in some cases an external filler rod could be where large weld deposit is required.
- The flux/coating of the electrode melts away to form the shielding layer (slag) that protects the weld pool from atmospheric contaminations as it solidifies. This slag are later chipped off to reveal the actual weld.
- The penetration depth of the weld could either be a full penetration or partial penetration (also referred to as incomplete penetration).
- Incomplete penetration in most cases are considered as defect but could be a requirement as stated in the WPS base on the service condition of the welded joint.
- Below is a detail diagram that describes the operation of SMAW process.

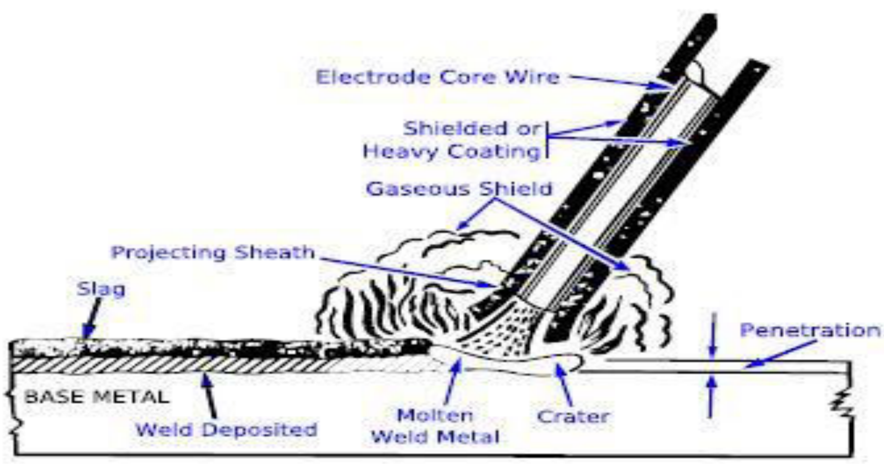


FIG:6.10: SMAW Welding

SOME FACTS ABOUT SMAW:

- SMAW is considered as one of the least efficient welding process because the operator’s factor of chipping away slag and changing of worn-out electrodes during the process.
- Actual welding technique utilized depends n the electrode, composition of the work piece, and the position of the joint to be welded.
- The choice of electrode and welding position also determines the speed of the weld.

EQUIPMENTS USED IN SMAW WELDING:

- Power source or power supply (AC or DC)
- Cables (ground cable and ht cable)
- Electrode holder also known as welding tong
- Welding table (for workshop)
- Clamps
- Electrodes

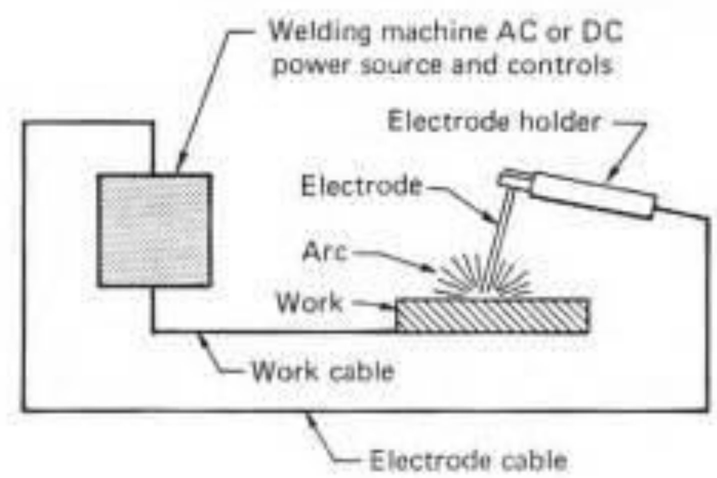


FIG:6.11.SMAW Arrangement

6.6.HEAT TREATMENT

What is heat treatment?

Heat treatment is the heating and cooling of metals to change their physical and mechanical properties, without letting it change its shape. Heat treatment could be said to be a method for strengthening materials but could also be used to alter some mechanical properties such as improving formability, machining, etc. The most common application is metallurgical but heat treatment can also be used in manufacture of glass, aluminium, steel and many more materials. The process of heat treatment involves the use of heating or cooling, usually to extreme temperatures to achieve the wanted result. It is very important manufacturing processes that can not only help manufacturing process but can also improve product, its performance, and its characteristics in many ways.

FIG:6.12:Heat treatment

6.6.1.TYPES OF HEAT TREATMENT:

6.6.1.1.Hardening

Hardening involves heating of steel, keeping it at an appropriate temperature until all pearlite is transformed into austenite, and then quenching it rapidly in water or oil. The temperature at which austentizing rapidly takes place depends upon the carbon content in the steel used. The heating time should be increased ensuring that the core will also be fully transformed into austenite. The microstructure of a hardened steel part is ferrite, martensite, or cementite.

6.6.1.2.Tempering

Tempering involves heating steel that has been quenched and hardened for an adequate period of time so that the metal can be equilibrated. The hardness and strength obtained depend upon the temperature at which tempering is carried out. Higher temperatures will result into high ductility, but low strength and hardness. Low tempering temperatures will produce low ductility, but high strength and hardness. In practice, appropriate tempering temperatures are selected that will produce the desired level of hardness and strength. This operation is performed on all carbon steels that have been hardened, in order to reduce their brittleness, so that they can be used effectively in desired applications.

6.6.1.3.Annealing

Annealing involves treating steel up to a high temperature, and then cooling it very slowly to room temperature, so that the resulting microstructure will possess high ductility and toughness, but low hardness. Annealing is performed by heating a component to the appropriate temperature, soaking it at that temperature, and then shutting off the furnace while the piece is in it. Steel is annealed before being processed by cold forming, to reduce the requirements of load and energy, and to enable the metal to undergo large strains without failure.

6.6.1.4Normalizing

. Normalizing involves heating steel, and then keeping it at that temperature for a period of time, and then cooling it in air. The resulting microstructure is a mixture of ferrite and cementite which has a higher strength and hardness, but lower ductility. Normalizing is performed on structures and structural components that will be subjected to machining, because it improves the machinability of carbon steels

6.6.1.5.Carburization

It is a heat treatment process in which steel or iron is heated to a temperature, below the melting point, in the presence of a liquid, solid, or gaseous material which decomposes so as to release carbon when heated to the temperature used. The outer case or surface will have higher carbon content than the primary material. When the steel or iron is rapidly cooled by quenching, the higher carbon content on the outer surface becomes hard, while the core remains tough and soft.

6.6.1.6.Surface Hardening

In many engineering applications, it is necessary to have the surface of the component hard enough to resist wear and erosion, while maintaining ductility and toughness, to withstand impact and shock loading. This can be achieved by local austentitizing and quenching, and diffusion of hardening elements like carbon or nitrogen into the surface. Processes involved for this purpose are known as flame hardening, induction hardening, nitriding and carbonitriding.

6.6.2.EFFECTS OF HEAT TREATMENT:

Effects of Heat treatment

Annealing & Normalizing	Hardening or Quenching		
Furnace Cooling	Air Cooling	Oil Quenching	Water Quenching
← Softer, less strong	Harder and stronger →		
← More ductile	More brittle →		
← Less internal stress	More internal stress →		
← Less distortion, cracking	More distortion, cracking →		

FIG:6.13:Effects of heat treatment

6.7.INSPECTION

6.7.1.VISUAL INSPECTION:

Visual inspection is based on the use of the human eye to identify surface defects, improper filling and moulding errors. Casting defects that can be detected via visual inspection include sand holes, excessively rough surface, surface shrinkage, blowholes, misruns, cold shuts, and surface dross or slag.

6.7.2.DIMENSIONAL INSPECTION:

Dimensional inspection is carried out to make sure that the castings produced have the overall dimensions including allowances for machining. It may e sometimes necessary to break a part of the casting to take measurements of inside dimensions.

FIG:6.14:Dimensional analysis

6.7.3.PROCEDURE FOR INSPECTION:

- ❖ After the knock out do the visual inspection.
- ❖ Ensure that heat:no strip is available and the same transferred to the casting.
- ❖ Check the lettering details are properly formed in the casting .
- ❖ Check the lettering details are properly formed in the casting and ensure no major defects are available on the casting.
- ❖ Note down initial rejection in daily rejection at wise format if the casting is not meeting the quality requirement and put red mark on the casting and casting has to e placed in scrap area after raising rejection advice ,otherwise allow for further processing.
- ❖ Confirm the heat treatment carried out as per word instruction number and proper records are maintained.
- ❖ Do physical testing as well as chemical analysis as per and internal specification .

- ❖ Record all the data in chemical ,physical register .prepare test certificate for the source.
- ❖ Do the visual inspection .
- ❖ Do the dimensional inspection as per the general quality assurance plan and as per customer drag.
- ❖ Do MPI for all casting as per the general quality assurance plan and record details in MPI register and mark defects by yellow paint.
- ❖ Do re-MPI after repair till it get accepted.
- ❖ Do DPI as general quality assurance plan or as per work order.
- ❖ Do ultrasonic test as per general quality assurance as plan or as per work order.
- ❖ Ensure the welding defect repair as per work instruction number.
- ❖ Re-inspect rectified area and ensure that all rectification was done.
- ❖ Record the inspection data in respective formats.
- ❖ If casting is acceptable in all mean raise dispatch advice and forward to sales planning.

6.7.4.DEFECTS IN CASTING

A properly designed casting, a properly prepared mould and correctly malted metal should result in a defect free casting. However, if proper control is not exercised in the foundry sometimes it is too expensive - a variety of defects may result in a casting.

These defects may be the result of:

(a) improper pattern design,

(b) improper mould and core construction,

(c) improper melting practice,

(d) improper pouring practice and

(e) Because of moulding and core making materials.

(f) Improper gating system

(g) Improper metal composition

(h) Inadequate melting temp and rate of pouring

6.7.4.1.SURFACE DEFECTS:

Due to design and quality of sand molds and general cause is poor ramming.

BLOW: - Blow is relatively large cavity produced by gases

Which displace molten metal form

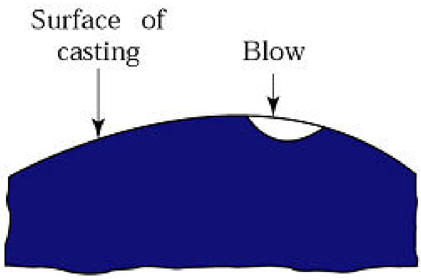


FIG:6.15: Blow in casting(defect)

SCAR:

Due to improper permeability or venting. A scare is a shallow blow. It generally occurs on flat surf; whereas a blow occurs on a Convex casting surface. A blister is a shallow blow like a scar with thin layer of metal covering it.

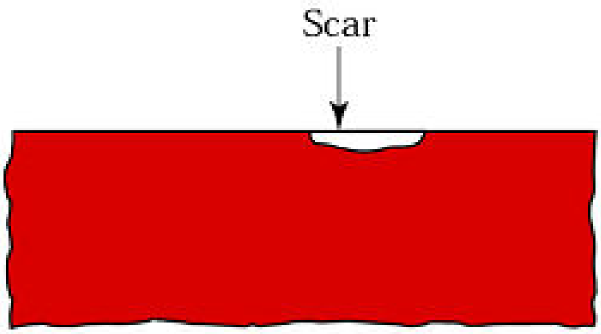


FIG:6.16:Scar

SCAB: -

This defect occurs when a portion of the face of a mould lifts or breaks down and the recess thus made is filled by metal. When the metal is poured into the cavity, gas may be disengaged with such violence as to break up the sand which is then washed away and the resulting cavity filled with metal. The reasons can be: - to fine sand, low permeability of sand, high moisture content of sand and uneven moulds ramming

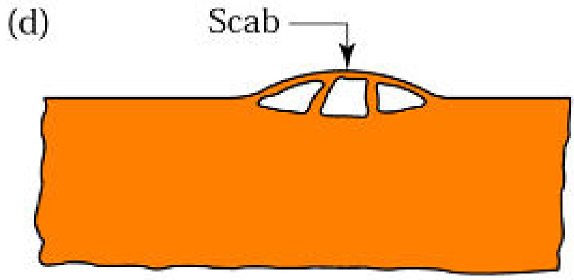


FIG:6.17:SCAB

DROP: -

Drop or crush in a mould is an irregularly shaped projection on the cope surface of a casting. This defect is caused by the break-away of a part of mould sand as a result of weak packing of the mould, low strength of the molding sand, malfunctioning of molding equipment, strong jolts and strikes at the flask when assembling the mould.

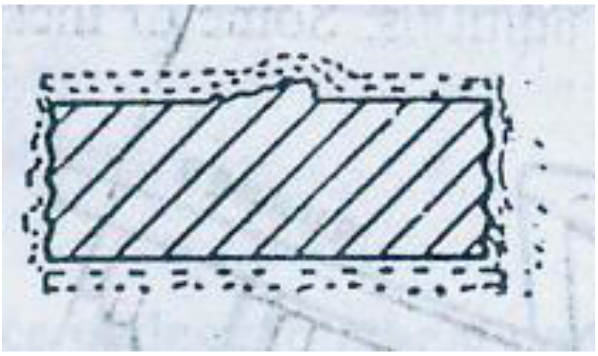


FIG:6.18:Drop

BUCKEL: -

A buckle is a long, fairly shallow, broad, vee depression that occurs in the surface of flat castings. It extends in a fairly straight line across the entire flat surface

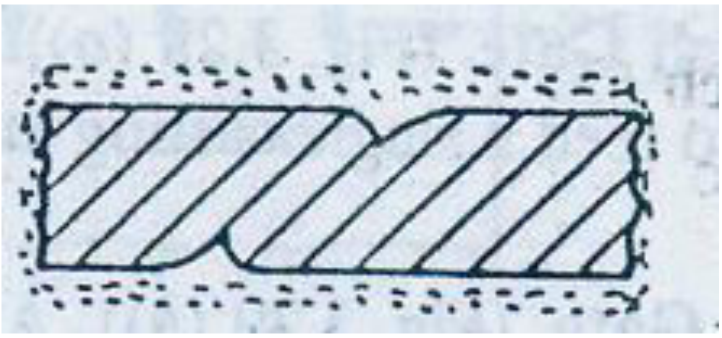


FIG:6.19:Buckel

6.7.4.2.INTERNAL DEFECTS:

PIN HOLES: -

Pin holes are small gas holes either at the surface or just below the surface. When these are present, they occur in large numbers and are fairly uniformly dispersed over the surface.

FIG:6.20:Pin holes

WASH: -

A cut or wash is a low; projection on the drag face of a casting that extends along the surface, decreasing in height as it extends from one side of the casting to the other end. It usually occurs with bottom gating castings in which the moulding sand has insufficient hot strength, and when too much metal is made to flow through one gate into the mould cavity.

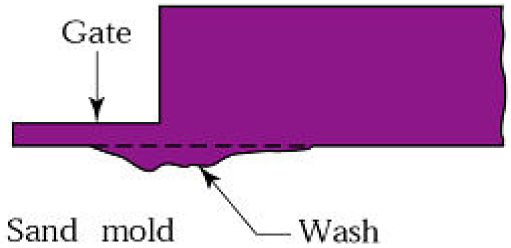


FIG:6.21:Wash

RAT TAIL: -

A rat tail is a long, shallow, angular depression in the surface of a flat rating and resembles a buckle, except that, it is not shaped like a broad vee. The reasons for this defect are the same for buckle.

HOT TEAR: -

Hot tears are hot cracks which appear in the form of irregular crevices with a dark oxidized fracture surface. They arise when the solidifying met does not have sufficient strength to resist tensile forces produced during solidification.

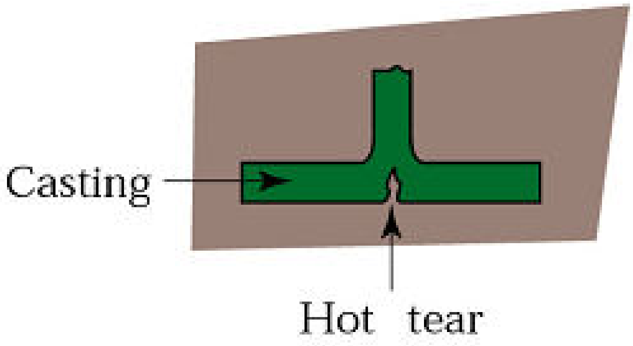


FIG:6.22:Hot tear

SHRINKAGE: -

A shrinkage cavity is a depression or an internal void in a casting that results from the volume contraction that occurs during solidification.

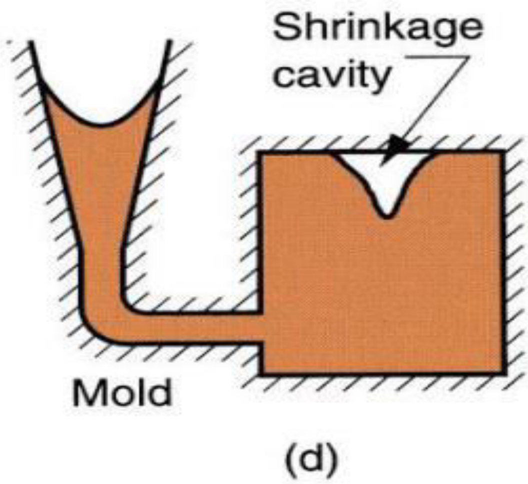


FIG:6.23;Shrinkage

SWELL: -

A swell is a slight, smooth bulge usually found on vertical faces of casting resulting from liquid metal pressure. It may be due to low strength of mould because of too high a water content or when the mould is not rammed sufficiently

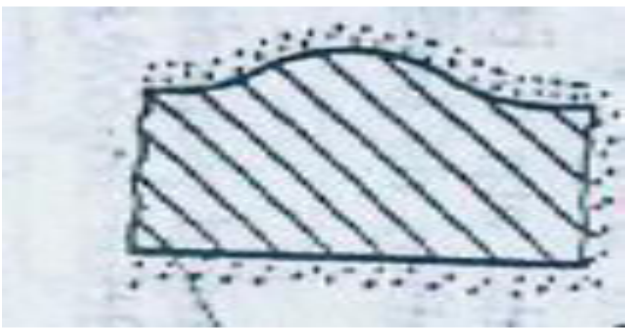


FIG:6.24:SWELL

SHIFT : -

Mould shift refers to a defect caused by a sidewise displacement of the mould cope relative to the drag, the result of which is a step in the cast product at the parting line. Core shift is similar to mould shift, but it is the core that is displaced, and (he dis-placement is usually vertical. Core shift and mould shift are caused by buoyancy of the molten metal.

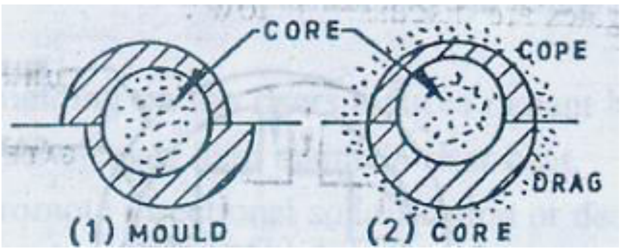


FIG:6.25:Shift

6.8.NON-DESTRUCTIVE TESTING

In order to evaluate the component without causing damage is the principle of Non Destructive Testing (NDT), Non Destructive Inspection (NDI), Non Destructive Evaluation (NDE).

It is a highly valuable technique that can save both money and time in product evaluation, trouble shooting.

It is very difficult to weld or mold a solid object that has the risk of breaking in service, so testing at manufacture and during use is often essential. During the process of casting a metal object, for example, the metal may shrink as it cools, and crack or introduce voids inside the structure. During their service lives, many industrial components need regular nondestructive tests to detect damage that may be difficult or expensive to find by everyday methods.

NON-DESTRUCTIVE TESTING:

Nondestructive testing (NDT) is the process of inspecting, testing, or evaluating materials, components or assemblies for discontinuities, or differences in characteristics without destroying the serviceability of the part or system. In other words, when the inspection or test is completed the part can still be used.

6.8.1.TYPES OF NDT:

- LIQUID PENETRATION TESTING (LPT)
- MAGNETIC PARTICLE TESTING (MPT)
- ULTRASONIC TESTING (UT)
- RADIOGRAPHY TESTING (RT)

6.8.1.1LIQUID-PRNETRATION TEST:

Liquid Penetration Testing (LPT), also called Dye Penetration Inspection (DPI) and Penetration Testing (PT), is widely used to detect surface defects in castings, forging, welding, material cracks, porosities and possible fatigue failure areas.The material is cleaned and then coated with a visible or fluorescent dye solution. Technicians remove the excess solution after waiting for a specified time (Dwell Time) than he/she applies a developer to the material. The developer acts like a blotter, pulling the dye solutions out of the imperfections due to the Capillary action.

Visible dyes will show a sharp contrast between penetration and developer making the “bleedout” easy to see. Fluorescent dyes are viewed with an ultraviolet lamp, which makes the "bleedout" fluoresce brightly reveling any material imperfections.

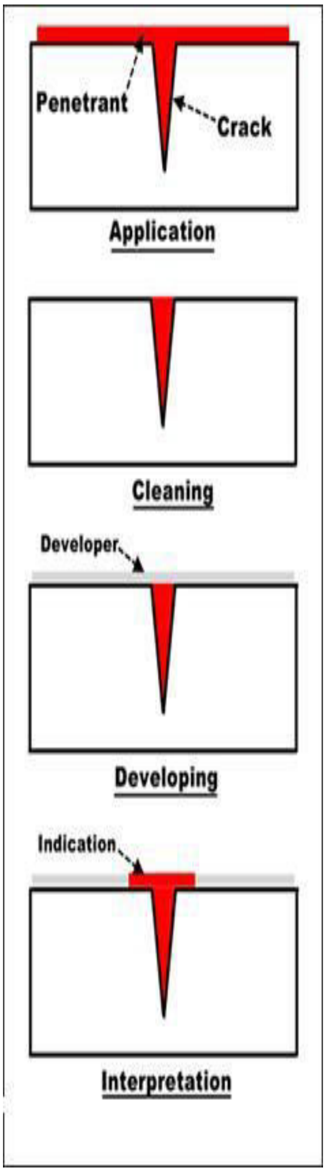


FIG:6.26:Test analysis

6.8.1.2.MAGNETIC PARTICLE TESING:

Magnetic particle Inspection (MPI) is a non destructive testing (NDT) process for detecting surface and slightly sub-surface discontinuities in ferromagnetic materials such as iron, nickel, cobalt, and some of their alloys. The process puts a magnetic field into the part. The piece can be magnetized by direct or indirect magnetization.

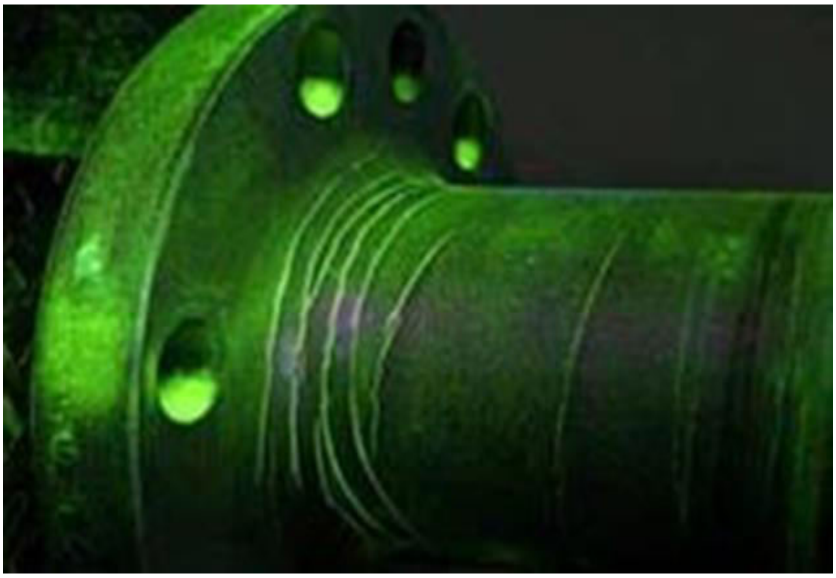


FIG:6.27:MPI Test(florescent powder)

The first step in a magnetic particle inspection is to magnetize the component that is to be inspected. If any defects on or near the surface are present, the defects will create a leakage field. After the component has been magnetized, iron particles, either in a dry or wet suspended form, are applied to the surface of the magnetized part. The particles will be attracted and cluster at the flux leakage fields, thus forming a visible indication that the inspector can detect.

The inspection medium shall consist of finely divided Ferro- Magnetic particles, which may be suspended in a suitable liquid medium (wet method) or used in dry powder form (dry method).

In dry method, dry particles are used for examination of large forgings and castings. The powder is sprinkled over the surface by using a powder blower operated at low-pressure. The air stream shall be so controlled that it does not disturb or remove lightly held powder patterns

In wet method the inspection medium may be flowed, sprayed or brushed over the surface of the specimen under inspection or may be immersed in an agitated bath of inspection medium.

In the wet method,

- The basic principle is to magnetize the ferro-magnetic work piece.
- The magnetic field lines run parallel to the surface of the work piece.
- The magnetic field lines must be perpendicular or at certain angle to the defect, if not there wont be any leakage and the defect will remain undetected.
- As the magnetic field lines run horizontally across the surface, the cracks or defects which are vertical are detected well.
- To inspect the work piece completely we need to change the direction (circular magnetic field) of the magnetic field by which the defects in horizontal direction are detected.

6.8.1.3.ULTRASONIC TEST:

Ultrasonic testing (UT) is a type of non-destructive testing techniques based on the propagation of ultrasonic waves in the object or material tested. In most common UT applications, very short ultrasonic pulse-waves with center frequencies ranging from 0.1-15 MHz, and occasionally up to 50 MHz, are transmitted into materials to detect internal flaws or to characterize materials.

FIG:6.28:Ultrasonic test

The conversion of electrical pulses to mechanical vibrations and the conversion of returned mechanical vibrations back into electrical energy is the basis for ultrasonic testing. The active element is the transducer as it converts the electrical energy to mechanical vibrations, and vice versa. This phenomena is known as piezoelectric effect.

In ultrasonic testing, ultrasound transducer connected to a diagnostic machine is passed over the object being inspected. The transducer is typically separated from the test object by a couplant (such as oil) or by water, as in immersion testing.

Ultrasound waves are generated by piezo-electric effect transducer, which convert electric oscillation into mechanical vibration and vice-versa.

As the wave travels through the material, it may get reflected, refracted, scattered or transmitted depending up on the condition within in the material. From defective location, the wave get reflected or attenuated.

The signals are picked up by the transducer and recorded for display as time pulse-height pattern on a Cathode Ray Tube (CRT) screen. Spacing between pulses and height of pulses are interpreted in terms of relative location size of the flaw in material.

6.8.1.4.RADIOGRAPHY TEST:

- Radiographic Testing (RT), or industrial radiography, is a nondestructive testing (NDT) method of inspecting materials for hidden flaws by using the ability of short wavelength electromagnetic radiation (high energy photons) to penetrate various materials.
- Either an X-ray machine or a radioactive source (Ir-192, Co-60, or in rare cases Cs-137) can be used as a source of photons This can see very different things from X-rays, because neutrons can pass with ease through lead and steel but are stopped by plastics, water and oils.
- X-ray tube consists of a glass bulb under vacuum, enclosing an anode and a cathode. The cathode comprise a filament which when brought to incandescence by a current of few amperes emits electrons. Under the effect of electrical tension set between the anode and cathode, these electrons from the cathode are attracted to anode.
- This stream of electrons is concentrated in a beam by a cylinder or a focusing cup. The anti-cathode is a strip of metal with high melting point seceded into the anode at the place where it is struck by the beam electrons. It is by impinging on the anti-cathode that the fast moving electrons give X-rays.

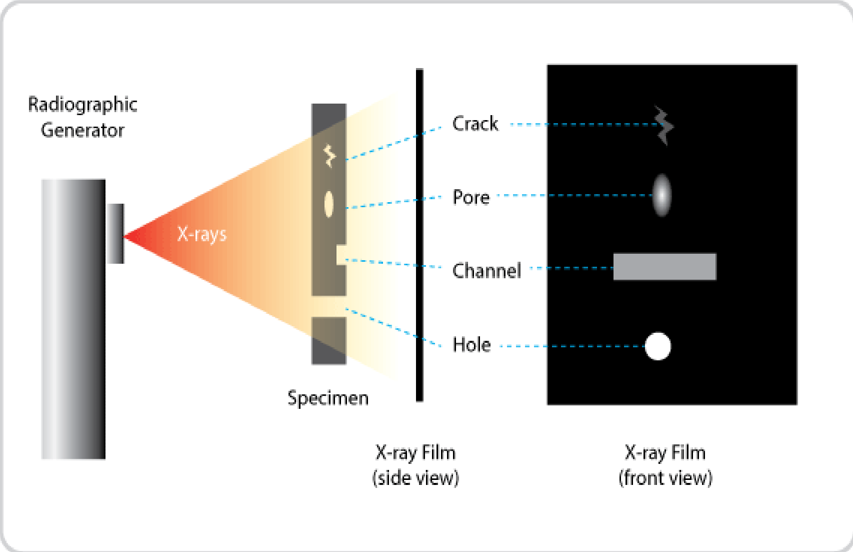


Fig:6.29:Radiography test

IMAGE QUALITY INDICATOR:

- Image quality indicators also called Penetrameters, are the devices to judge the quality of a radiograph. This is measured in terms of radiographic sensitivity. Smaller the numerical value of radiographic sensitivity better is the radiographic quality.

➢ Types of Penetrameters:

- Plate Type: This consists of a plate of uniform thickness in which three drilled holes of diameters equal to 1T, 2T, 4T are made (T is thickness of the plate).
- Wire Type: These are sets of up to six wires in one Penetrameters. The wires are made of steel or Aluminum or of a material similar to that of the object under inspection.

NATURE OF DEVELOPER:

Radiographic developers are aqueous solutions containing four major components, which react with silver bromide, when exposed films are immersed in them.

The developing agent, The accelerator the preservative

These substances when dissolved in alkaline solution can distinguish between the exposed and the unexposed crystals of silver bromide and can reduce the exposed silver bromide to metallic silver.

Three commonly used developing agents are:

1.Methol

2. Hydroquinone

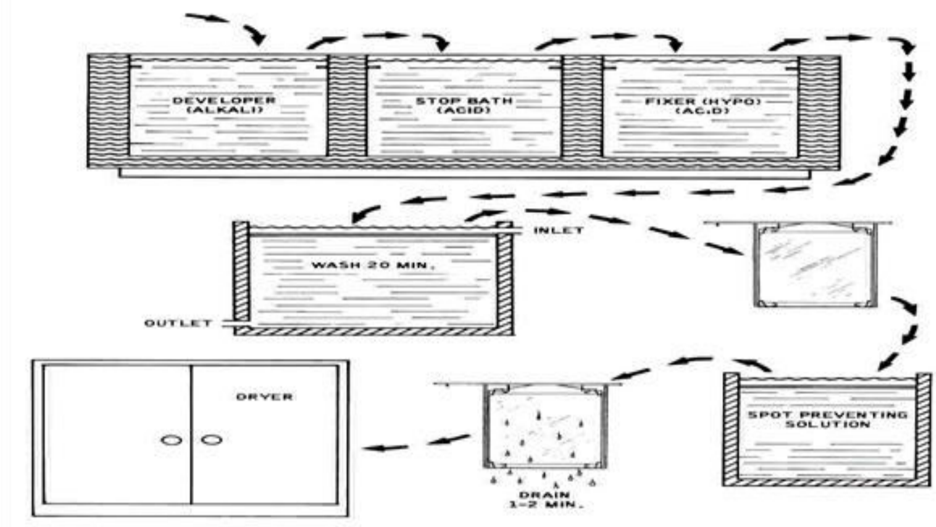


FIG:6.30:Film developing process of radiography

6.8.2.NDT TEST SELECTION:

NDT TECHNIQUE	NATURE OF DEFECT
Liquid penetrant testing	Surface and sub-surface defects
Magnetic particle testing.	Surface and slightly sub-surface defects in ferromagnetic materials.
Ultrasonic testing	Sub-surface and interstitial defects.
Radiography testing.	Surface and sub-surface defects

TABEL:6.1: NDT-NATURE OF DEFECT

CHAPTER 7

MAINTENANCE DEPARTMENT

Maintenance is work that is carried out to preserve an asset (such as a roof or a heating boiler), in order to enable its continued use and function, above a minimum acceptable level of performance, over its design service life, without unforeseen renewal or major repair activities.

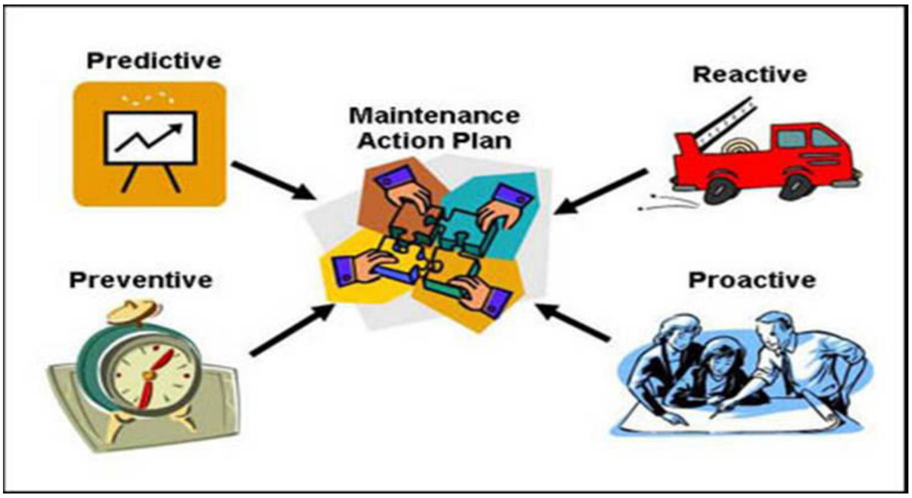


FIG 7.1 Maintenance

7.1.Reasons for Maintenance:

Maintenance serves to protect the owners' real estate investment in a number of ways

- **Physical Integrity**

To keep the assets in good working order so as to minimize disruptions and downtimes.

- **Risk Management**

To keep the assets in a state of good repair for the owners' health and safety.

- **Aesthetic Preservation**

To keep the assets from deteriorating in appearance and becoming unsightly.

- **Responsible Stewardship**

To ensure that the assets achieve their full potential service life.

- **Duty of Care**

To satisfy a legislated duty that is owed to owners, occupants and guest on the property.

- **Duty to Mitigate**

To prevent unnecessary damage to assets that may result in their premature failure.

7.2.Types of Maintenance:

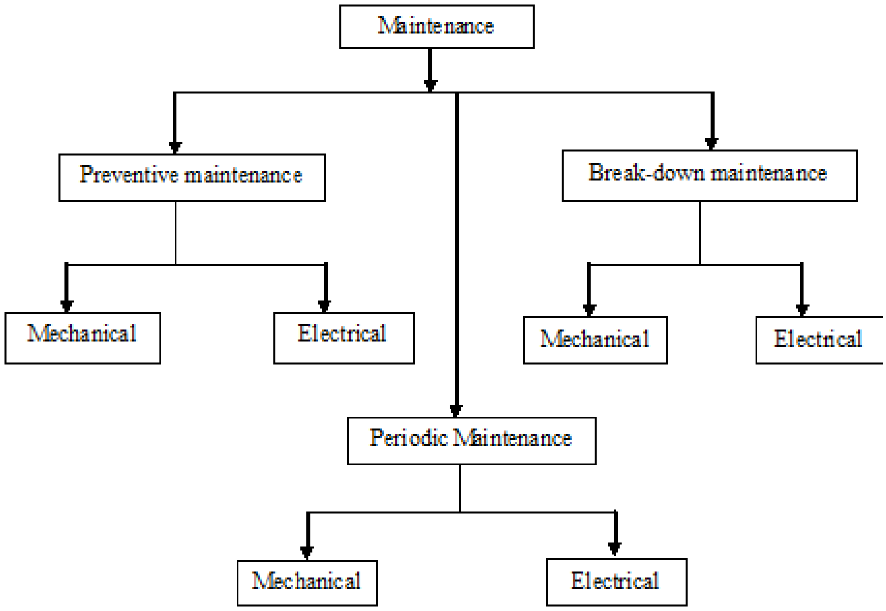


FIG 7.2 Types of maintenance

- Breakdown maintenance
- Preventive maintenance
    1. Periodic maintenance (Time based maintenance - TBM)
    2. Predictive maintenance
        I. Condition Monitoring
- Corrective maintenance

7.2.1.Break Down Maintenance

It means that people waits until equipment fails and repair it. Such a thing could be used when the equipment failure does not significantly affect the operation or production or generate any significant loss other than repair cost.

ADVANTAGES:

- Lower start up cost
- Limited personal requirement
- Reduced maintenance cost
- Potentially increased margins

DISADVANTAGES:

- ➢ Unpredictability
- ➢ Equipment not maximised
- ➢ Indirect cost

7.2.2.Preventive maintenance

It is a daily maintenance (cleaning, inspection, oiling and re-tightening), design to retain the healthy condition of equipment and prevent failure through the prevention of deterioration, periodic inspection or equipment condition diagnosis, to measure deterioration. It is further divided into periodic maintenance and predictive maintenance. Just like human life is extended by preventive medicine, the equipment service life can be prolonged by doing preventive maintenance.

ADVANTAGES:

- ➢ Overall cost effective.
- ➢ Flexibility can allow for adjustment of schedule to accommodate other work.
- ➢ Increased equipment life.
- ➢ Saved energy cost resulting from equipment running from pick efficiency.
- ➢ Reduced equipment or process failure.
- ➢ Over all saving between 12 to 18%.

DISADVANTAGES:

- ➢ Catastrophic failure still a risk.
- ➢ Labour intensive.
- ➢ Performance of maintenance based on schedule not required.
- ➢ Risk of damage when conducting unneeded maintenance.
- ➢ Saving not readily visible without a base line.

7.2.2.1.Periodic maintenance

Time based maintenance consists of periodically inspecting, servicing and cleaning equipment and replacing parts to prevent sudden failure and process problems

7.2.2.2.Predictive maintenance

This is a method in which the service life of important part is predicted based on inspection or diagnosis, in order to use the parts to the limit of their service life. Compared to periodic maintenance, predictive maintenance is condition based maintenance. It manages trend values, by measuring and analysing data about deterioration.

7.2.2.2.1.Condition Monitoring

Condition monitoring is the process of determining the condition of machinery while in operation.

- The key to a successful condition monitoring programme includes:
    1. Knowing what to listen for
    2. How to interpret it
    3. When to put this knowledge to use
- Successfully using this programme enables the repair of problem components prior to failure.
- Condition monitoring not only helps plant personnel reduce the possibility of catastrophic failure, but also allows them to order parts in advance, schedule manpower, and plan other repairs during the downtime.

ADVANTAGES:

- Extend bearing service life.
- Maximise machine productivity.
- Minimise unscheduled downtime.
- Safely extend overhaul intervals.
- Improve repair time.
- Increased machine life.
- Improve product quality.
- Reduce product cost.
- Enhance product safety.

DISADVANTAGES:

- Monitoring equipment costs.
- Skilled personnel needed.
- Strong management commitment needed.
- A significant run-in time to collect machine histories and trends is usually needed.

7.2.3.Corrective maintenance

It improves equipment and its components so that preventive maintenance can be carried out reliably. Equipment with design weakness must be redesigned to improve reliability or improving maintainability.

ADVANTAGES:

- Lower short-term costs.
- Requires less staff since less work is being done.

DISADVANTAGES:

- Increased long-term costs due to unplanned equipment downtime.
- Possible secondary equipment or process damage.
- Prone to neglect of assets.

7.3.General classification of maintenance problems

- Mechanical Failure
- Thermal Failure
- Chemical Failure

7.3.1.General classification Maintenance problem:

Mechanical Failure

- Worn out bushes and bearings and other moving parts.
- Fatigue of machine members
- Creep of material at high temp
- Excessive forced vibration, misalignments etc

Thermal Failure

- Overheating of the component
- Lack of lubrication
- Inadequate of cooling
- Electrical insulation failure

Chemical Failure

- Highly corrosive fluids containing abrasive particles
- Failure of protective linings like glass , rubber etc.

7.4.Classification of maintenance problem based on time span

- ❖ Short Run Maintenance Problem
- ❖ Long Run Maintenance Problem

7.4.1.Classification maintenance problem based on time span:

- **Short run production problem**

Maintenance problem which are carried out in a sort period of time are known as short run production system. It may be hourly, daily ,weekly and monthly.

Example:-

Hourly- inspection of correct lubricant, level of coolant, sharpness of cutting tool.

Daily- cleaning of m/c, tightening of nuts, correct cooling, inspection of various indicators, minor adjustment of parts.

Weekly- Major adjustment, lubrication, tightening of parts.

Monthly- checking for insulation, corrosion, safety guards, checking of worn-out and distorted parts.

7.5.Maintenance Strategy :

- A maintenance strategy defines the rules for the sequence of planned maintenance work. It contains general scheduling information, and can therefore be assigned to as many maintenance task lists (PM task lists) and maintenance plans as required.

A maintenance strategy contains maintenance packages in which the following information is defined:

- The cycle in which the individual work should be performed (for example, every two months, every 3,106.86 miles, every 500 operating hours)
- Other data which affects scheduling.

7.6.MAINTENANCE PLANNING:

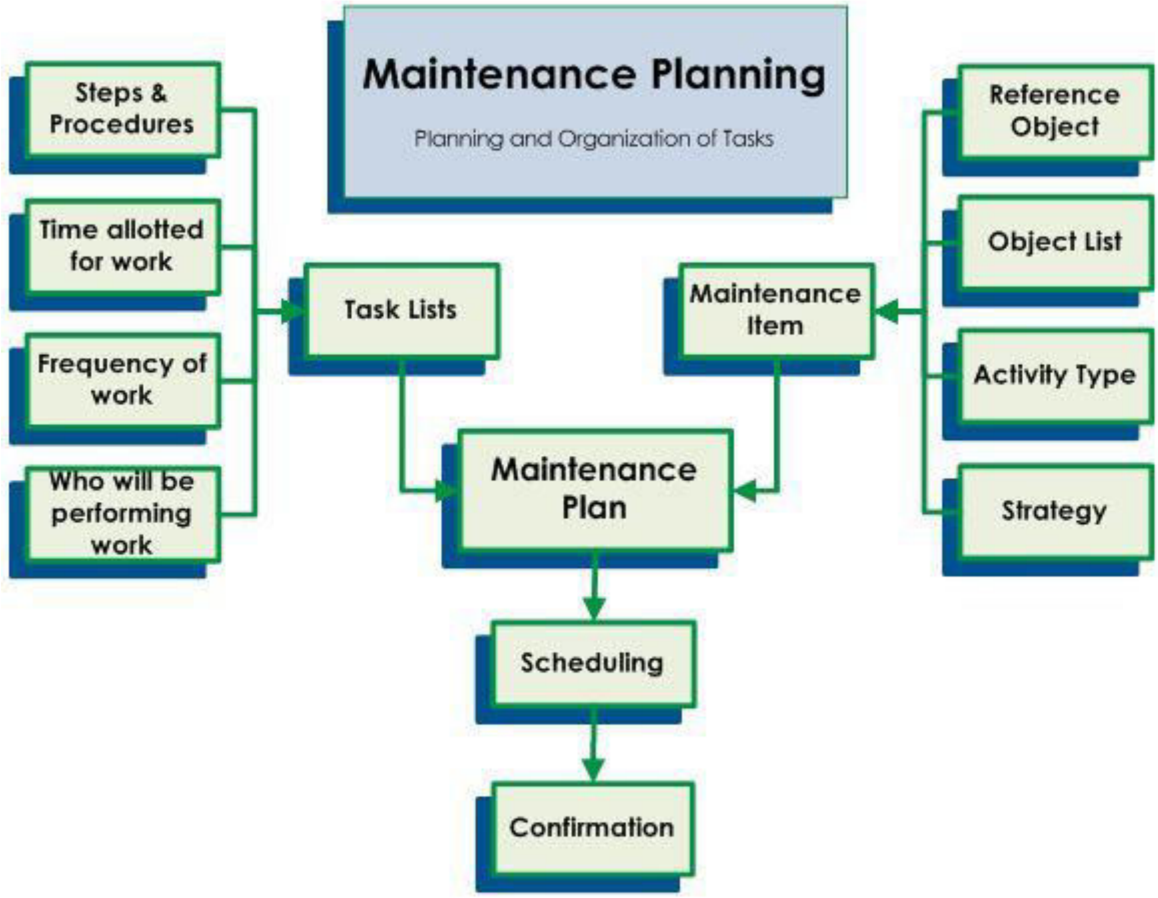


FIG 7.3 Maintenance planning

7.7.PIPLINE COLOUR CODES IN PEEKAY INDUSTRY:

PIPE-COLOUR	PRODUCTS
	Compressed-air
	Water
	Flammable fluid
	Combustible fluid
	Black sand
	White sand
	Fire quenching fluid
	Hydraulic oil
	Raw water
	Coolant oil
	Oxygen
	Argon

TABLE 7.1 Pipe line colour codes

CHAPTER 8

ROLLING MILL

8.1.Introduction:

Steel is a product of a large and technologically complex industry having strong forward and backward linkages in terms of material flows and income generation. TMT Bars are re rolled bars from Ingots/Billets. The finished product TMT bars are of Fe 415 & Fe 500 Grade steel bars. TMT bars have proven record in resisting loss of strength at high temperatures as experienced during fires. These bars are corrosion resistant. TMT Bars can be described as new-generation high strength steel having superior properties such as weld ability, strength, ductility and tensile strength, which meet the highest international quality standards.

8.2.Market:

The growth in construction activity and infrastructure projects in India has buoyed the demand for steel industry. There is a demand for steel products such has Thermo Mechanically Treated (TMT) Bars , Structural steel viz., angles, plates, channels, rounds etc.,

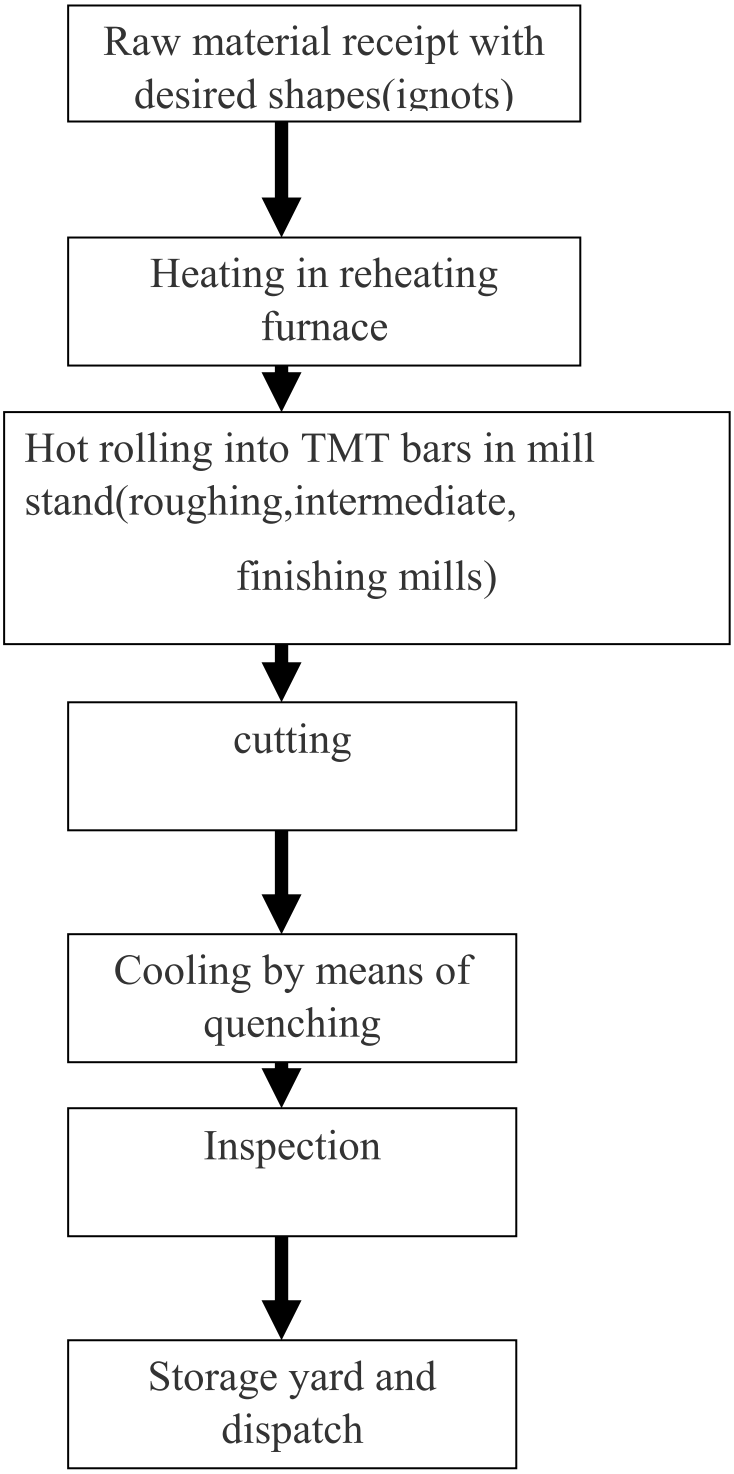
8.3.Raw Material:

The raw materials used in manufacturing of TMT Bars are Ingots and Billets which are manufactured from scrap and sponge iron.

FIG 8.1 Billet

8.4.Manufacturing Process

TMT (Thermo Mechanically Treated) Bar is a manufactured in a process in which the ribbed bar is heat-treated in three stages during the production process itself. The bar is rapidly cooled/ quenched in high pressure water jacket/spray system as it emerges from the finishing stand of the rolling mill. The process of manufacturing TMT Bars is explained in the following process flow diagram.



8.5.Technology:

The technology/Machinery required for Steel Melting Shop unit are: Melting Shop Machinery item like Induction Furnace, dies for casting and other misc. items etc Rolling Mill Electricals like Motors, drivers, pumps, electrical panels, cables, liquid starters and Transformer of 1500 KVA etc Rolling Mill Auxiliary equipments like EOT cranes, Air compressor, gas cutting machines and other Misc. auxiliary equipments etc.

FIG 8.2 Rolling of billets

8.6.CONTINUOUS CASTING:

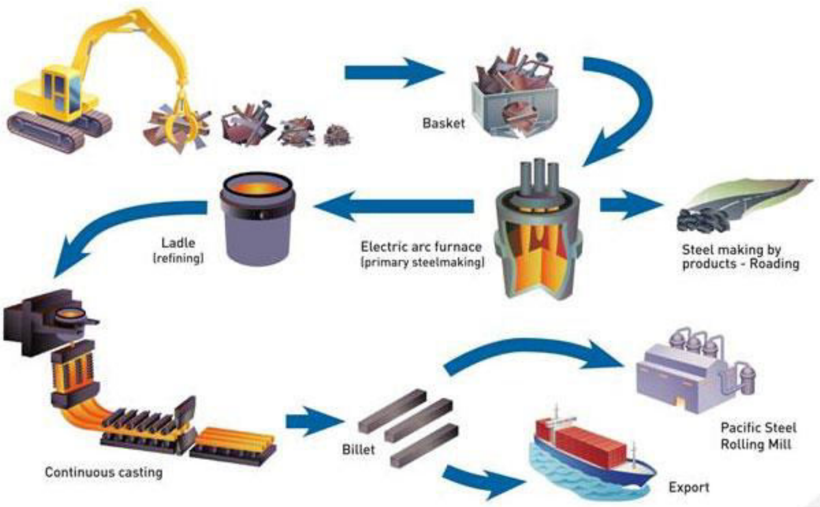


FIG 8.3 Continuous casting

Continuous casting is a process for producing intermediate semi-finished products which can then be subjected to rolling or other processes to form the finished product.

It can be used for several metals and alloys like Aluminium, Copper or steel.

The process involves liquefying the metal and forcing it through an open ended mould. As the metal progresses through the mould, the metal starts solidifying and emerges in a solid form.