KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY.

DEPARTMENT OF MATERIALS ENGINEERING
INDEGINOUS METAL CASTING.
MSE 257.
GROUP 8.
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ABSTRACT.

Metal casting is one of the most efficient and versatile manufacturing processes today – and with good reason. This technique, which involves pouring molten metal into a mold, is actually thousands of years.

Castings, or the metal pieces formed during the metal casting process, can vary in size from a few grams to thousands of pounds.

In this article, we'll break down everything you need to know about metal casting, including what is metal casting, the history of metal casting, and the various types of metal casting, tools employed and how the exploration of metal casting at the structural level underscores a profound interconnection between material science, engineering design, and manufacturing processes. This report also unveils the intricate microstructural features and mechanical properties that define the integrity and performance of cast metal components.

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CHAPTER ONE.

INTRODUCTION.

Metal casting is one of the most efficient and versatile manufacturing processes today – and with good reason. This technique, which involves pouring molten metal into a mold, is actually thousands of years old.
For the past 6,000 years, metal casting has been used to manufacture everything from swords and wedding bands to sprockets and screws. Today, metal casting is used to effectively make metal parts for a variety of industries.
Castings, or the metal pieces formed during the metal casting process, can vary in size from a few grams to thousands of pounds.

Fig. 1.1: image of metal casting.

BACKGROUND INFORMATION.

Metal casting is a manufacturing process that involves pouring molten metal into a mold to create a 3D metal piece. Once the metal and the mold have both cooled, the metal object is extracted, deburred, machined, and finished. Since the process involves a custom mold, metal casting can be used to create metal objects with a large variety of shapes and sizes.

MATERIALS NEEDED.

Casting materials for sand casting include metal, concrete, epoxy, plaster, and clay

TOOLS AND EQUIPMENT

SHOVEL: It is an iron Pan fitted with a wooden or metal handle. It is used in mixing and conditioning the sand manually and transferring it to the flask.
VENT WIRE: It is a thin Steel rod or wire carrying a pointed edge at one end and a wooden handle on the opposite side or a bent look at the other after ramming and striking of excess sand, it is used to make small holes called Vents through sand mold to allow the exit of gases and steam during casting.
TROWELS: Trowels are used for finishing flat surfaces and joints in mold. The common shapes of trowels are flat iron Pan attached with a wooden handle.
SLICKS: They are used for repairing and finishing the mold surfaces and edges after the pattern has been withdrawn. The commonly used slicks are heart, leaf, square, spoon and bead shaped.
LIFTERS/ CLEANERS: It's a finishing tool used for repairing and finishing the sand mold

after withdrawal of pattern. They are also used for removing loose sand from mold cavities.
DRAW SPIKE: It's a tapered steel rod having a Loop or ring at it's one end and other end is shaped. It's used to rap and draw patterns from mold.
DRAW SCREW AND RAPPING PLATE: Draw screws is a straight mild steel rod carrying a Loop at one end and other end is screw thread. They are used with a rapping plate for rapping and pulling out the pattern from the mold.
MALLET: it is similar to a hammer just made of wood used in carpentry workshop. In foundry work it's used to drive draw spike in the pattern and then rapping it.
CLAMP COTTER AND WEDGE: It is made of steel and is used for clamping the molding boxes firmly together during pouring.
CONTAINERS: The Common containers used in foundry work are the following, molding boxes, ladles, crucibles
Swab: It's a hemp fiber brush used for moistening the edges of sand mold which are in contact with the pattern surface. Before withdrawing the pattern, it is also used for coating liquid blanking on the mold faces in dry sand mold.

GAGGERS: It is a bent piece of wires and rods which are used for reinforcing the downward projecting boxes sand mass in the cope are known as gaggers.

BELLOW: A hand operated bellow is used to blow away the loose or unwanted sand from the surface and cavity of mold.

NAILS AND WIRE PIECES: They are used to reinforce thin projections of sand in the mould or cores made in two halves.

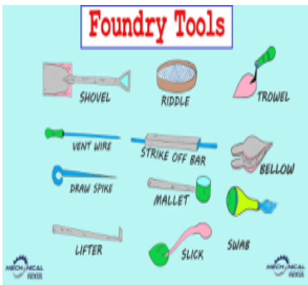
A shovel

A pouring container

A bunch of trowels

A bunch of Neils.

A mallet



List of foundry tools.

CHAPTER TWO.

PROCESSES INVOLVED IN SAND CASTING

The basic metal casting process involves creating a pattern and a mold, then pouring molten metal into the mold. You will then extract the solid metal casting and finish your piece. This process is customizable for deferent types of metal casting, along with shapes, sizes, and more.

Step 1 (Create the pattern) : Before you make your mold, you must create a pattern to determine the mold's shape. The pattern can be a 3- dimensional model of your final cast. It may be shaped in wax, sand, plastic, or even wood. Some casters use molds made of plaster or silicone, which are materials that could not withstand a molten metal cast, but allow the caster to mass create wax multiples to use in expendable mold casting.

Step 2 (make the mold) : After you have created a pattern, it is time to make your mold. As we mentioned above, you may choose to make a reusable mold, which is typically made from metal, or a single-use mold, which may be made from sand, plaster, or ceramic shell.

Step 3 (Choose the metallic alloy) : All metal castings are produced from either ferrous or non-ferrous alloys. Alloys are a mixture of elements that provide the best mechanical properties for the final cast's use. Ferrous alloys include steel, malleable iron, and gray iron. Non-ferrous alloys that are most commonly used in casting are aluminum, bronze, and copper

Step 4 (Melt the alloy) : Melting processes vary between alloys because each alloy will have a deferent melting temperature. Essentially, melting consists of placing the solid alloy in a crucible and heating it over an open flame or inside of a furnace.

Step 5 (pour into mold) : Pour the molten metal into the mold cavity. If it is a small casting, you may simply pour from the crucible where the metal was heated directly into the mold. A larger casting
may require a small team to support heating the metal inside of a
metal casting furnace.

Step 6 and 7
Remove the casting from the mold, file and polish your solid metal cast! This may involve cleaning your cast metal object, like scrubbing away excess mold material in water, breaking o! the casting gates with clippers for small objects, or even an angle grinder for large pieces.

SAND CASTING.

Sand casting is a manufacturing process in which molten metal is poured into a sand mold containing a hollow cavity of the desired shape. After a period, the casting cools and solidifies. The sand is then broken and shaken out.

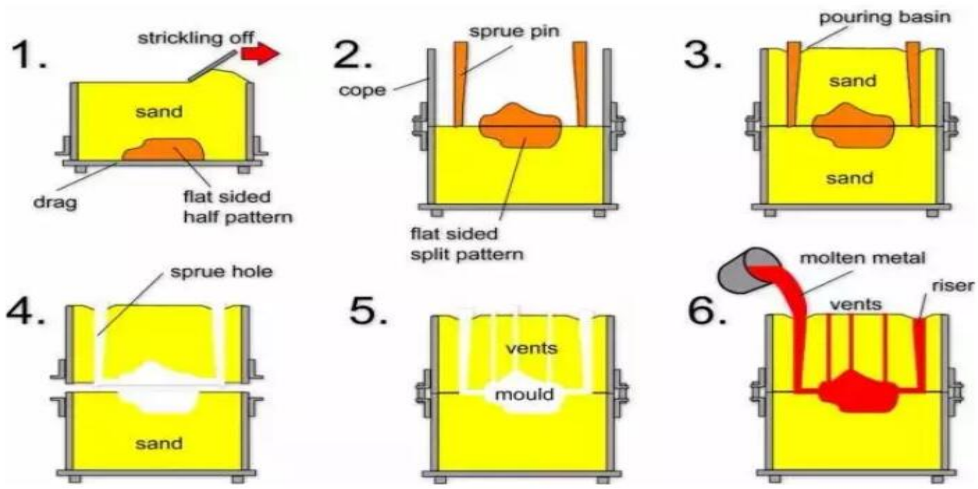


Fig. 2.1: image showing process involved in sand casting.

ADVANTAGES OF SAND CASTING

1. It is suitable for making blanks with complex shapes, especially with complex inner cavities;
2. Wide adaptability and low cost;
3. For some materials with poor plasticity, such as cast iron, sand casting is the only forming process for manufacturing its parts or blanks.

INVESTMENT (LOST WAX) CASTING.

Investment casting: usually refers to making a pattern from a fusible material, coating several layers of refractory material on the surface of the pattern to make a shell, and then melting the pattern to discharge the shell, so as to obtain a mold without a parting surface, which is roasted at high temperature The casting scheme that can be filled with sand after pouring. Often referred to as "lost wax casting".

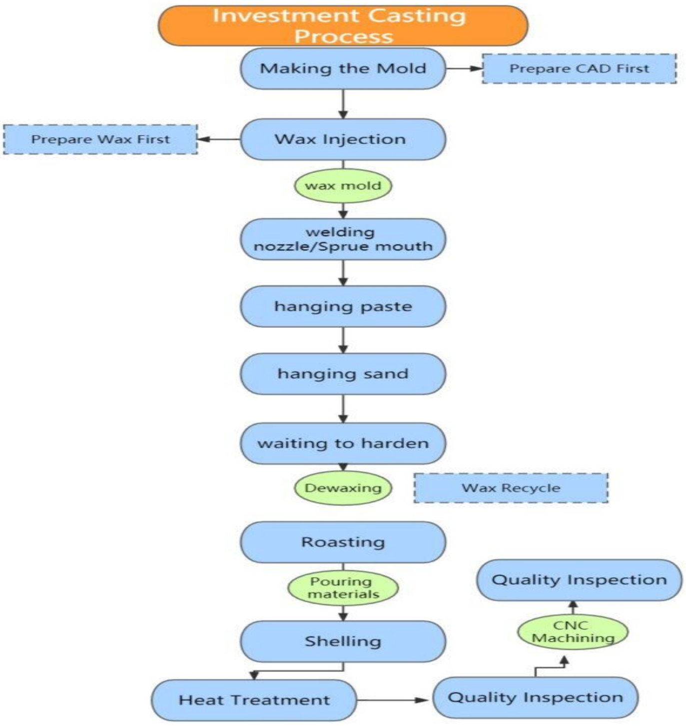


Fig. 2.21: image of process involved in investment casting process.

Advantages:

4. High dimensional accuracy and geometric accuracy
5. High surface roughness;
6. It can cast castings with complex shapes, and the casting alloys are not limited.

Casting microstructure and defects

Metal castings have very specific microstructures. When a liquid metal cools and begins to solidify in a mold, grains (crystals) of the metal start to form, both on the mold walls and in the bulk of the liquid metal. As the metal solidifies, it forms curious tree-like *dendrites* (from *dendron*: the Greek for tree). This structure is maintained after the casting is fully solidified, as can be seen from Figure 2.3, which shows a typical casting microstructure. (The image is created by polishing the surface of the metal, immersing it for a short while in a dilute acid and viewing it under an optical microscope.) In addition to the dendritic structure, there are two other common defects that can be found in a cast microstructure: particles of impurities known as *inclusions*, and *porosity* which is small holes in the casting.

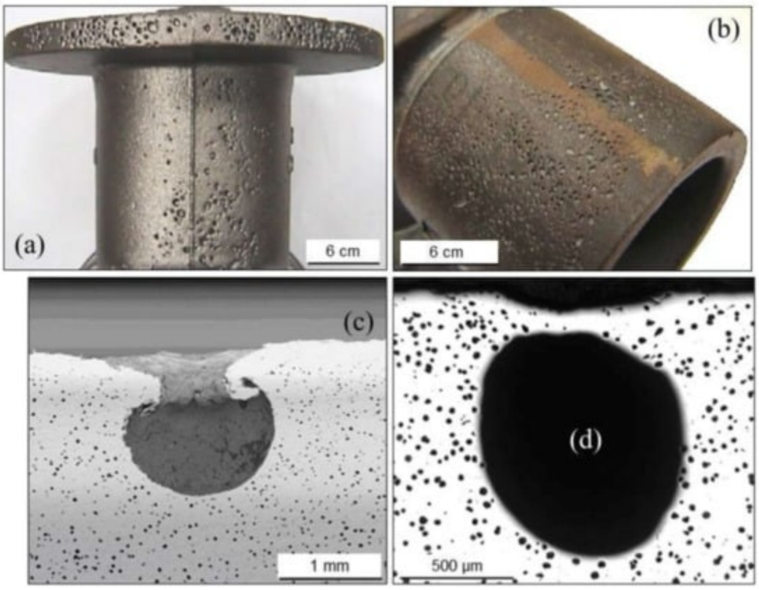


Figure 2.22 Pinholes found in the skin (**a**) and after machining (**b**). Deformed aspect of an open pinhole with irregular graphite and Mn-S layer in its internal surface after shot blasting (**c**). Internal pinhole close to the skin of the casting (**d**).

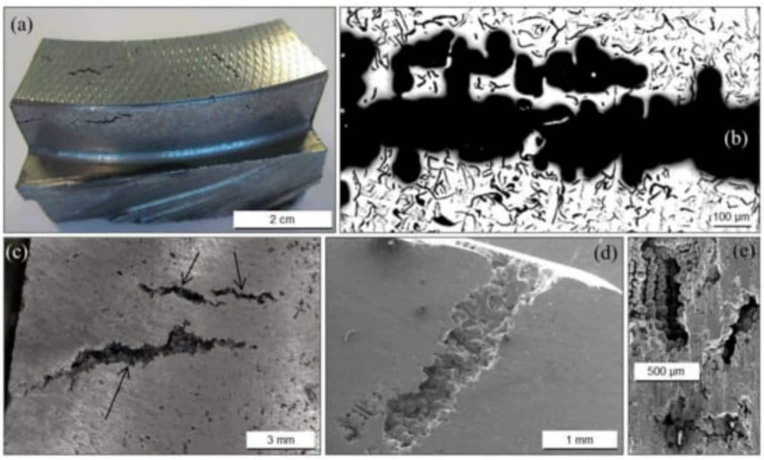
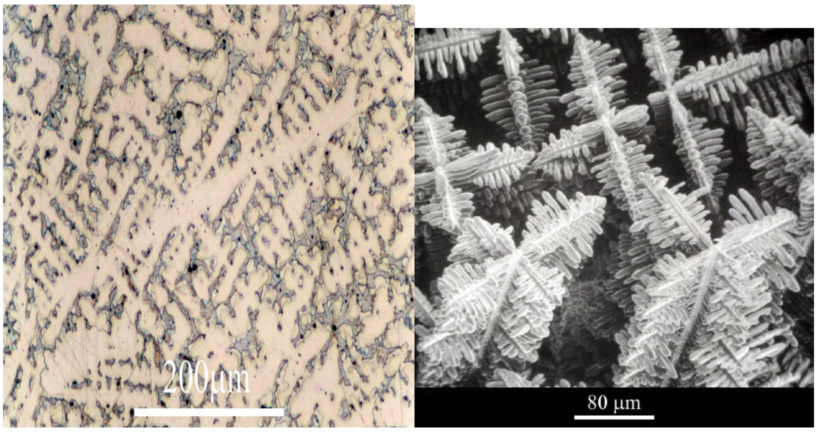


Figure 2.23 Fissures provoked by the precipitation of nitrogen gas during solidification: (**a**,**c**) fissures found after machining steps; (**b**) metallographic view of a defect present in a gray iron casting; (**d**,**e**) SEM views showing dendritic morphologies in the internal surfaces of the fissures.



Figures, 2.3 This micrograph (left), taken with a reflected light microscope, shows the appearance of dendrites of a copper-tin alloy when observed as a 2D section through the 3D structure. This micrograph (right) is an image of the 3D structure of dendrites in a cobalt-samarium-copper alloy, taken with a scanning electron microscope .

CONCLUSION.

In conclusion, the exploration of metal casting unveils a sophisticated interplay of scientific principles, engineering techniques, and material properties. Through meticulous investigation, we have elucidated the intricate processes involved in transforming raw materials into intricate metal objects, spanning a range of applications from industrial components to artistic creations.

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