Techniques de fabrication conventionnelles et avancées

Master 1 : Construction Mécanique

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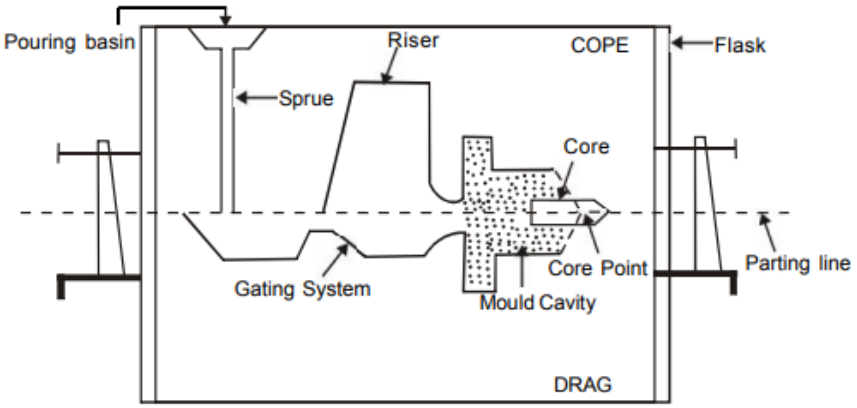
PROCESSUS DE FONDERIE / COULÉE

L'art de la fonderie (du latin « fundere », signifiant « fusion et coulée ») est très ancien dans l'histoire de l'humanité, puisqu'il est utilisé depuis 3000 av. J.-C., lorsque des pointes de flèches en bronze étaient coulées dans des moules en argile à face ouverte. La fonderie (ou simplement la coulée) est basée sur la propriété du liquide de prendre la forme du récipient qui le contient. Le processus de fonderie implique la coulée de métal fondu dans un moule, qui est une cavité formée dans un matériau de moulage tel que le sable. La cavité du moule ressemble exactement en forme et en taille au produit à fabriquer. Après la coulée, le métal fondu est autorisé à se solidifier, prenant ainsi la forme de la cavité du moule, et le produit ainsi obtenu est appelé une pièce moulée.

FOUNDRY PROCESS / CASTING

Flask	A moulding flask is one which holds the sand mould intact. Depending on the position of the flask in the mould structure, it is referred to as drag, cope and cheek. It is generally made up of wood for temporary use or of metal for long term use.
Drag	Lower moulding flask.
Cope	Upper moulding flask.
Cheek	Intermediate moulding flask used in three piece moulding.
Parting line	This is the dividing line between the two moulding flasks that makes up the sand mould.
Core	It is used for making hollow cavities in castings.
Pouring basin	A small funnel shaped cavity at the top of the mould into which the molten metal is poured.
Sprue	The passage through which the molten metal from the pouring basin reaches the mould cavity.
Runner	The passage ways in the parting plane through which molten metal flow is requlated before they reach the mould cavity.
Gate	The actual entry point through which molten metal enters mould cavity.
Chaplet	Chaplets are used to support cores inside the mould cavity to take care of its own weight and overcome the metallostatic forces.
Chill	Chills are metallic objects which are placed in the moulds to increase the rate of cooling of castings to provide uniform or desired cooling rate.
Riser	It is the reservoir of molten metal provided in the casting so that hot metal can flow back into the mould cavity when there is a reduction in volume of metal due to solidification.

Un moule en sable est illustré dans la Fig. 1.2.



FOUNDRY PROCESS / CASTING

As a production process, casting is usually carried out in a foundry. A foundry is a factory equipped for making molds, melting and handling metal in molten form, performing the casting process, and cleaning the finished casting. The workers who perform the casting operations in these factories are called foundry men.

Metal casting process begins by creating a mold, which is the 'reverse' shape of the part we need. The mould is made from a refractory material, for example, sand. The metal is heated in an oven until it melts, and the molten metal is poured into the mould cavity. The liquid takes the shape of cavity, which is the shape of the part. It is cooled until it solidifies. Finally, the solidified metal part is removed from the mould.

A large number of metal components in designs we use every day are made by casting.

The reasons for this include:

(a) Casting can produce very complex geometry parts with internal cavities and hollow

sections

(b) It can be used to make small (few hundred grams) to very large size parts (thousands of

kilograms)

(c) It is economical, with very little wastage: the extra metal in each casting is re-melted and

re-used

(d) Cast metal is isotropic – it has the same physical/mechanical properties along any direction

Typical metal cast parts

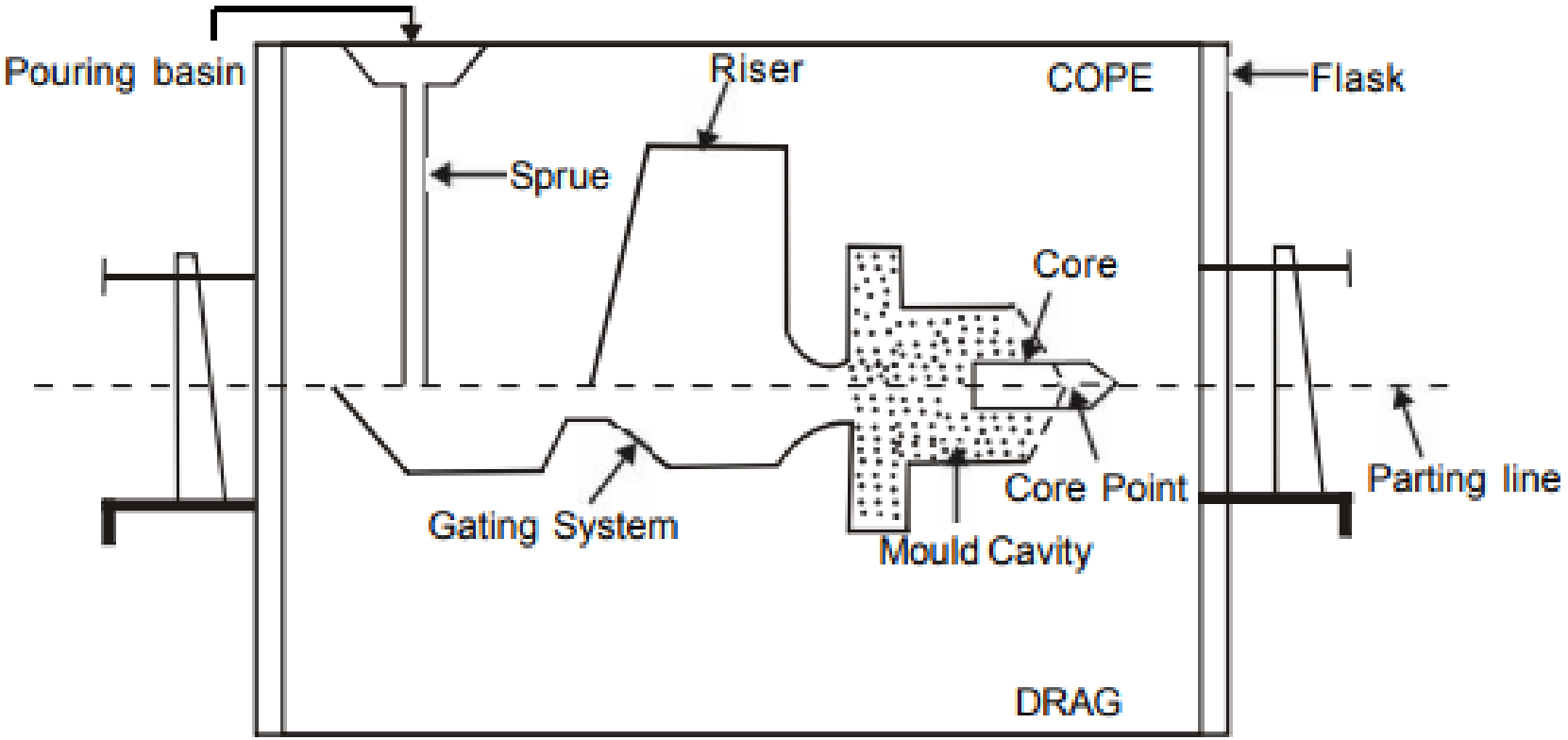
Process	Advantages	Disadvantages	Examples
Sand	Wide range of metals, sizes, shapes, low cost	poor finish, wide tolerance	engine blocks, cylinder heads
Shell mold	better accuracy, finish, higher production rate	limited part size	connecting rods, gear housings
Expendable pattern	Wide range of metals, sizes, shapes	patterns have low strength	cylinder heads, brake components
Plaster mold	complex shapes, good surface finish	non-ferrous metals, low production rate	prototypes of mechanical parts
Ceramic mold	complex shapes, high accuracy, good finish	small sizes	impellers, injection mold tooling
Investment	complex shapes, excellent finish	small parts, expensive	jewellery
Permanent mold	good finish, low porosity, high production rate	Costly mold, simpler shapes only	gears, gear housings
Die	Excellent dimensional accuracy, high production rate	costly dies, small parts, non-ferrous metals	precision gears, camera bodies, car wheels
Centrifugal	Large cylindrical parts, good quality	Expensive, limited shapes	pipes, boilers, flywheels

Table summarizes different types of castings, their advantages, disadvantages and examples.

Sand Casting

Sand casting uses natural or synthetic sand (lake sand) which is mostly refractory material called silica (SiO_2). The sand grains must be small enough so that it can be packed densely; however, the grains must be large enough to allow gasses formed during the metal pouring to escape through the pores. Larger sized molds use green sand (mixture of sand, clay and some water). Sand can be re-used, and excess metal poured is cut-off and re-used also.

Components of typical sand molds



- The mold is made of two parts, the top half is called the cope, and bottom part is the drag.
- The liquid flows into the gap between the two parts, called the mold cavity. The geometry of the cavity is created by the use of a wooden shape, called the pattern. The shape of the patterns is (almost) identical to the shape of the part we need to make.
- A funnel shaped cavity; the top of the funnel is the pouring cup; the pipe-shaped neck of the funnel is the sprue– the liquid metal is poured into the pouring cup, and flows down the sprue.
- The runners are the horizontal hollow channels that connect the bottom of the sprue to the mould cavity. The region where any runner joins with the cavity is called the gate.

CASTING PROCESSES

Casting processes divide into two broad categories, according to type of mold used:
expendable-mold casting and permanent-mold casting.

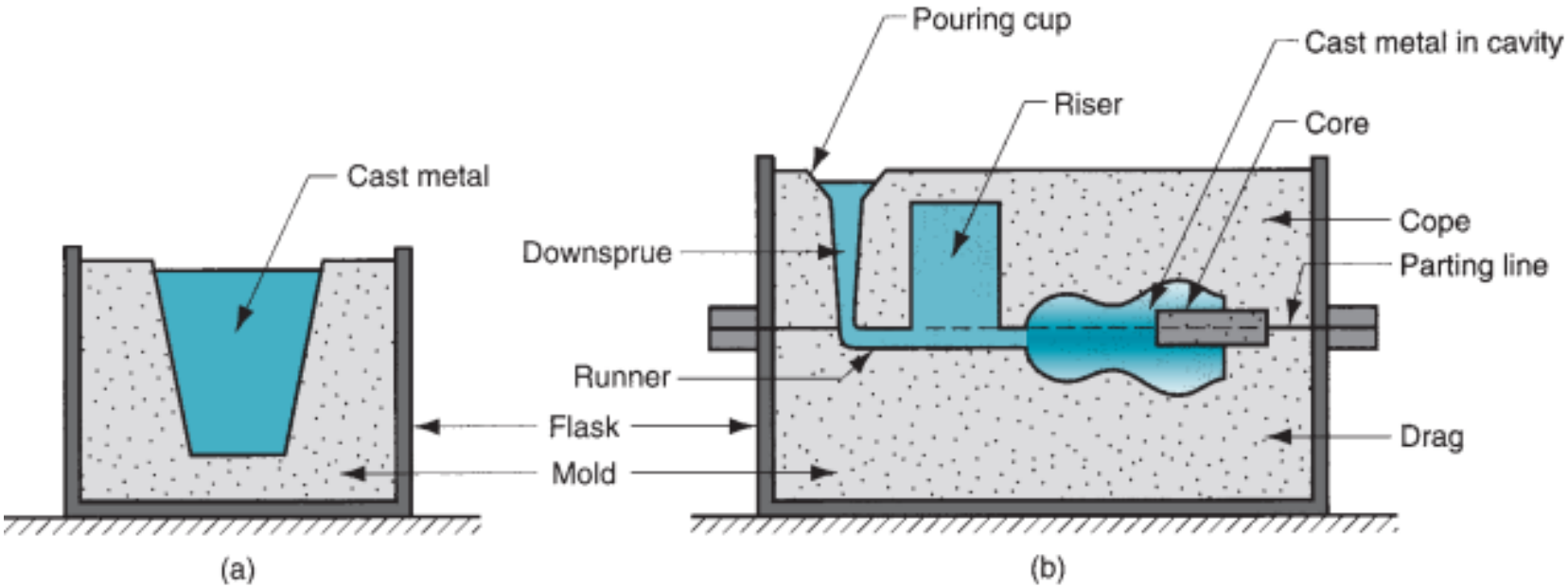


FIGURE 10.2 Two forms of mold: (a) open mold, simply a container in the shape of the desired part; and (b) closed mold, in which the mold geometry is more complex and requires a gating system (passageway) leading into the cavity.