The manufacturing of sand cores

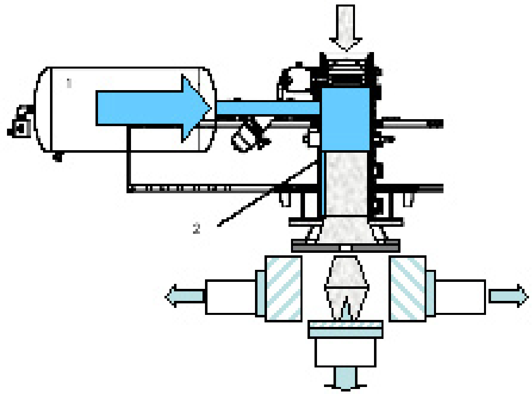
The manufacturing of iron, steel and non-ferrous castings is achieved using a variety of casting process designs, and most of these involve the use of sand cores which form the internal shape of the casting. A good quality casting requires a good quality core. Dimensional stability, uniform density, strength, hardness and permeability are some of the characteristics that need to be controlled. A good core must have sufficient strength and hardness to be handled and to resist during the pouring of liquid metal. Sufficient permeability is also necessary for the escape of gases generated during the casting process. The different manufacturing processes and some of the issues related to core production will be discussed here.

Suspension arm sand core.
Courtesy of Teksid

Sand core blowing processes

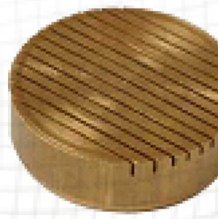
The manufacturing of sand cores is commonly made using chemically bonded sands in several distinct stages. First sand grains are coated with a binder or resin. The coated sand is then placed in the sand magazine of the core shooting machine. The release of a high pressured air cartridge "blows" the sand from the sand magazine into the blowing plate and shooting nozzles to fill a core box at high speed. The shooting process only takes a fraction a second depending on the core size. Finally, a catalyst or hardening gas is passed through the core box to harden and cure the sand.

Core blowing processes are classified depending on the type of binder and gas used. In the Cold Box process, in production since the 70s, phenolic ure-



Schematic representation of a core blowing machine.
Courtesy of Laempe

thane binders are used together with amine which acts as a catalyst during the gassing stage. In the Betaset and Novanol processes, respectively methyl formate and CO_2 react chemically with the alkaline phenolic binder to obtain the core hardening. Other types of core blowing processes exist. Most notably, the Hot Box process in which the drying of the binder provides the necessary core hardening. In this case, heat is used to evaporate the water from specific binder resins removing the need for gassing and reducing the use of hazardous chemicals.



To allow for the air or gas to escape during the blowing and gassing stages, air vents are necessary and need to be positioned at various locations inside the core box. Finally ejector pins are necessary to extract the sand core from the core box. Ejector pins (as well as core box parting lines) often provide additional air venting.

Factors affecting core blowing

Several parameters can influence the core shooting and gassing processes. These parameters include:

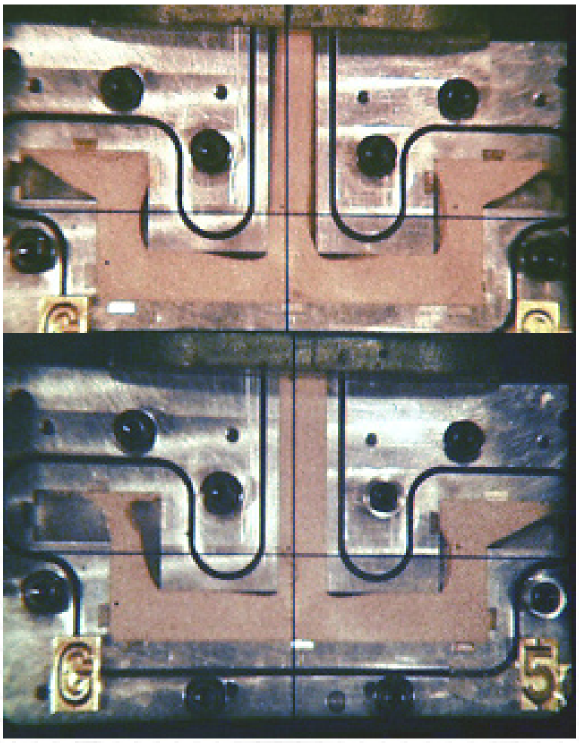
- shape of the core,
- size and position of shooting nozzles,
- shooting pressure,
- type of sand and resin,
- gassing pressure,
- position and size of air vents.

The sand grain size and resin type have an influence on the "flowability" of the sand, on the strength

CASTING E-TIP 24

and hardness obtained during the gassing and finally on the core permeability. A finer sand will give a lower permeability.

The shooting pressure will influence the blowing time, the sand flow inside the core box, the sand compaction and density, and to some extend the permeability. Typical blowing pressures used industrially range from 3 to 7 bars. Gassing pressures are much lower and the gassing process itself will last several seconds.



Sand blowing experiments conducted at CTIF showing the influence of the venting with all vents opened (top) and left vents closed (bottom).

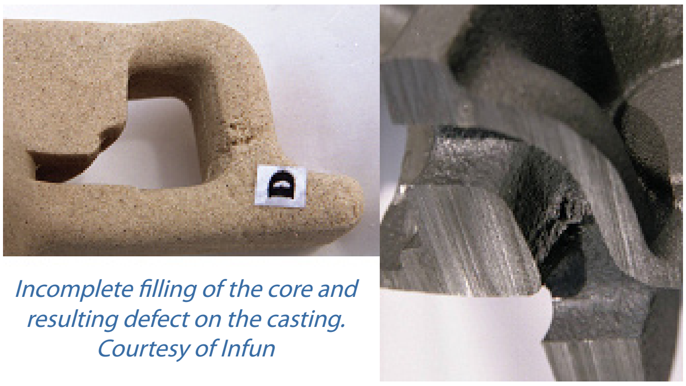
The position and size of the air vents will influence the sand and gas flow inside the core box. The total venting area can be estimated from the blowing tubes dimensions. Their positioning is however largely based on experience but, in general, should be located at the extremities of the core and evenly distributed around the core. Optimal venting conditions can be different during shooting and gassing stages and it is therefore necessary to find a compromise. Improper venting can cause incomplete filling, poor sand compaction or inefficient gassing.

Core quality control

Various measurement techniques can be used to check the quality of the cores:

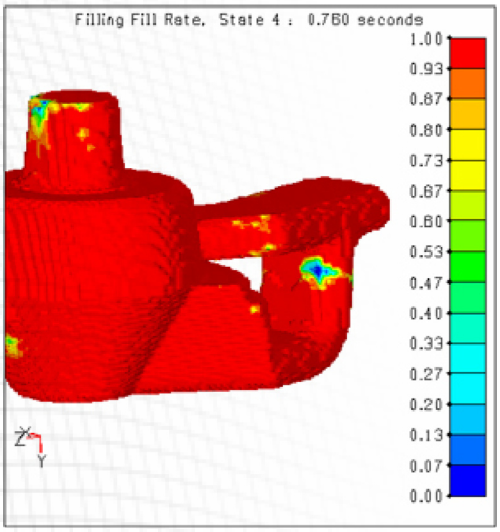
- visual inspection,
- local density measurements,
- total core weight,
- scratch hardness test,
- permeability measurement.

These core production quality controls are necessary to ensure, in fine, the casting quality. In the example below, incomplete filling (or poor compaction) is obtained in one location of an axle core. This core manufacturing defect is responsible for the veining and metal penetration observed on the casting itself. Adding or moving additional air vents in that precise location would solve the problem.



Incomplete filling of the core and resulting defect on the casting. Courtesy of Infun

The interaction of various parameters and process conditions makes the core manufacturing a very complex process. Recently, core blowing simulation models were introduced for sand shooting and also gassing. With process simulation, a better understanding of these interactions can be obtained and the lengthy trial and error development phase significantly reduced, similarly to what happened in the 90s with casting process simulation.



Core blowing simulation results showing unfilled and poorly compacted areas in the axle core .

(simulation performed with PAM-QUIKCAST)