Shell Mould Casting

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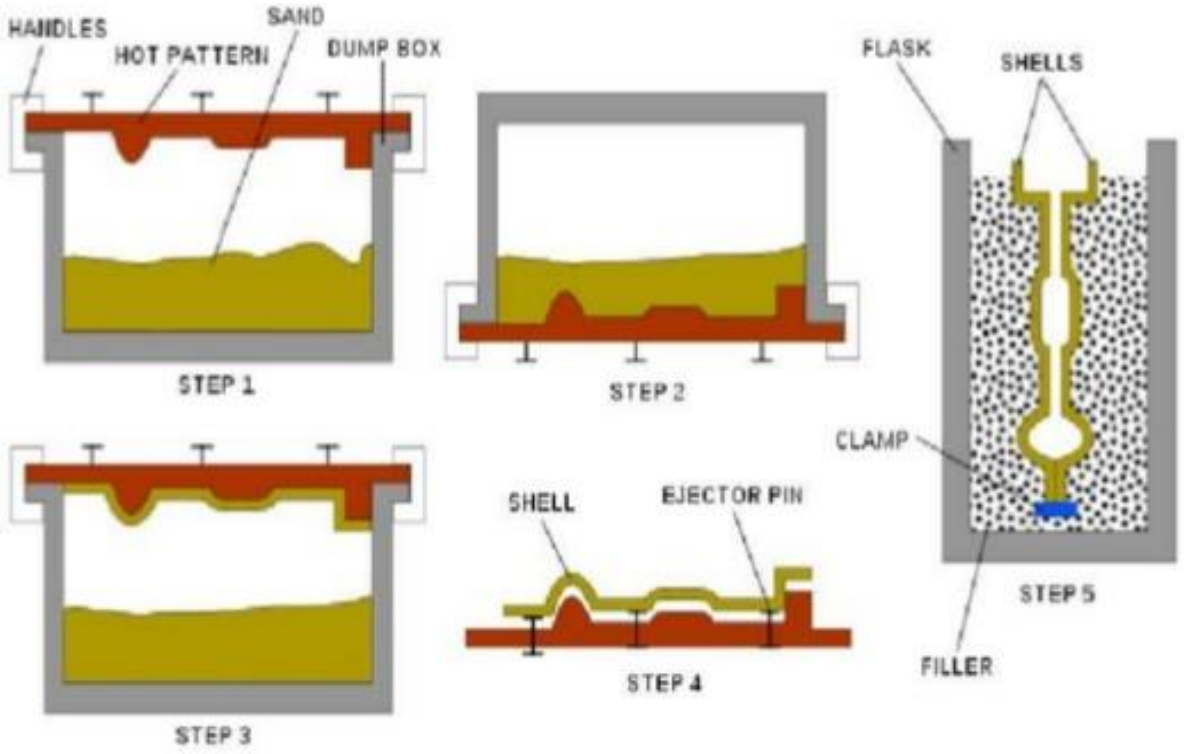
Introduction

Shell mould casting, also known as the Croning method (C-Process), is a moulding method patented by German engineer Johannes Carl Adolf Croning before the Second World War. After the Second World War, the method continued to develop with the additions made by C. W. Fitko to increase the flowability of the sand and then the hot coating of the sand with resin in the 1950s. The method is also widely used in core making. Cores produced by this method are frequently used in other casting methods.

In shell moulding, a mixture of sand and thermosetting binder is filled around the heated metal pattern. When the mixture is heated, the resin hardens while the sand grains stick together to form the shell that forms one half of the mould. After the shell hardens, separates from the pattern and cores are placed, the lower and upper halves are brought together. A special sealing press and mould adhesive are used for this process. Afterwards, the moulds are sent to the casting by being supported with sand within a flask or on a suitable sand bed.

SHELL-MOULDING PROCESS



Parts and components of ferrous and non-ferrous alloys from a few hundred grams to several hundred kilograms can be cast by this method. The main advantages and disadvantages of shell mould casting can be listed as follows:

Advantages

- Tighter dimensional allowances than sand casting
- High manufacturing speed
- Very good surface quality
- Less machining and cleaning costs
- Sufficient permeability even in fine sands
- Easy to transport due to the lightness of the mould
- Less space requirement
- Less sand consumption

Disadvantages

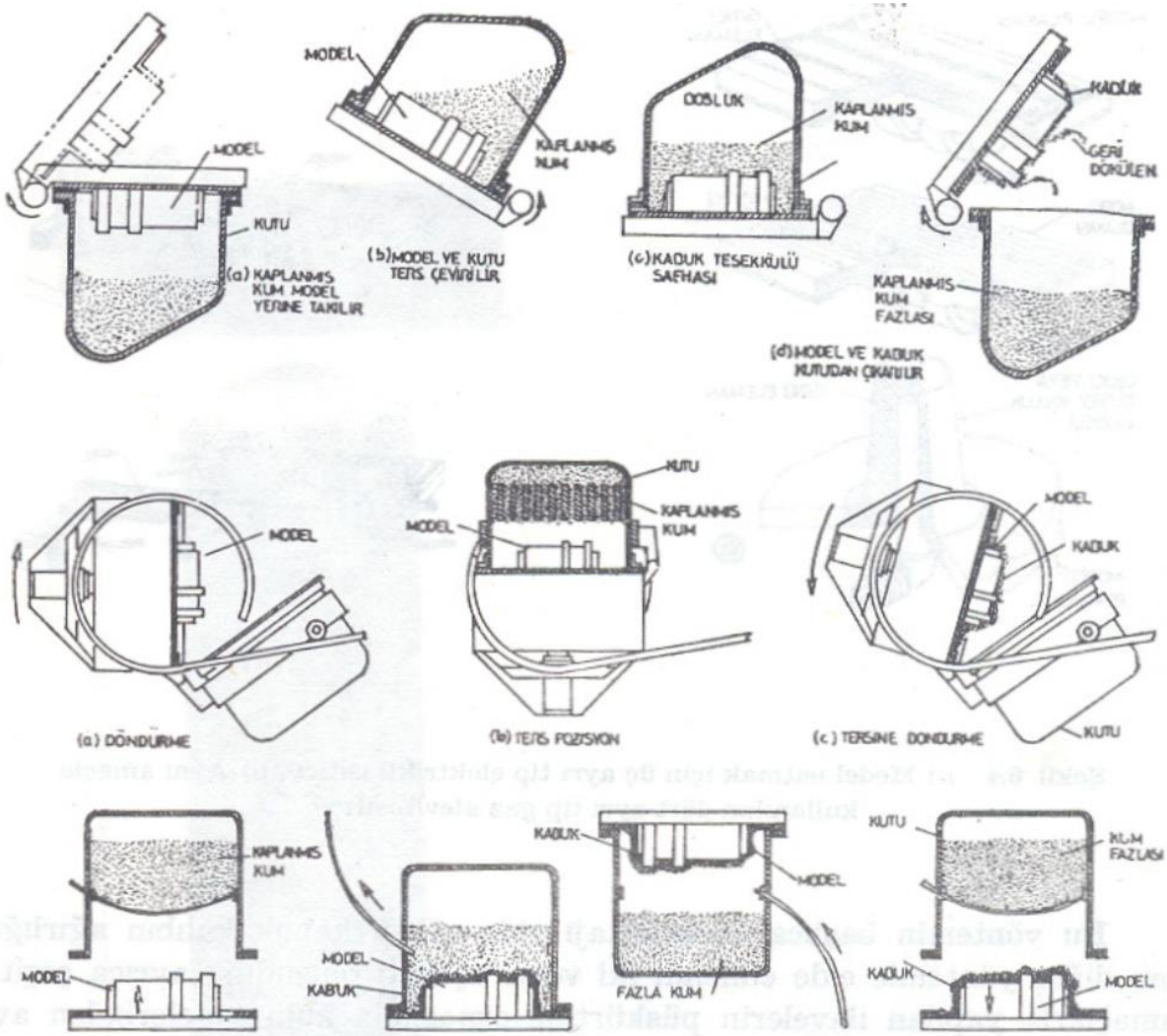
- High metal pattern cost
- Limited maximum mould size and weight
- Relatively high cost of moulding material
- Partial limitation caused by the creation of feeding and runner with the pattern
- Possibility of casting defects such as porosity
- Need more machinery and equipment
- The process is hot and gives off a bad odor to somebody.

Process stages

Mould and core making with shell moulding method is carried out on machines. Machines and working details differ according to the degree of automation. There are five main stages of mould and core making with this method, regardless of the degree and type of automation of the machine.

1. The sand-resin mixture is poured on a heated (~ 230 °C) metal pattern by any method (electric or gas burner). The resin in contact with the pattern melts, allowing the mixture to adhere to the pattern, and a shell is formed.
2. When the desired shell thickness is achieved, flip the pattern over and pour excess sand back into the container.

3. Final hardening of the shell on the pattern is completed in an oven (~ 400 ° C).
4. After the hardening is completed, the shell is removed from the pattern.
5. In the last step, the two parts of the shell mould are joined together with an adhesive and the mould is made ready for casting.



Şekil 6.3 Kabuk teşkilinde kullanılan üç değişik sistem.[1]
(1. sistemin en büyük dezavantajı şekilde belirtildiği gibi geri dökülmelerin ve boşlukların oluşudur).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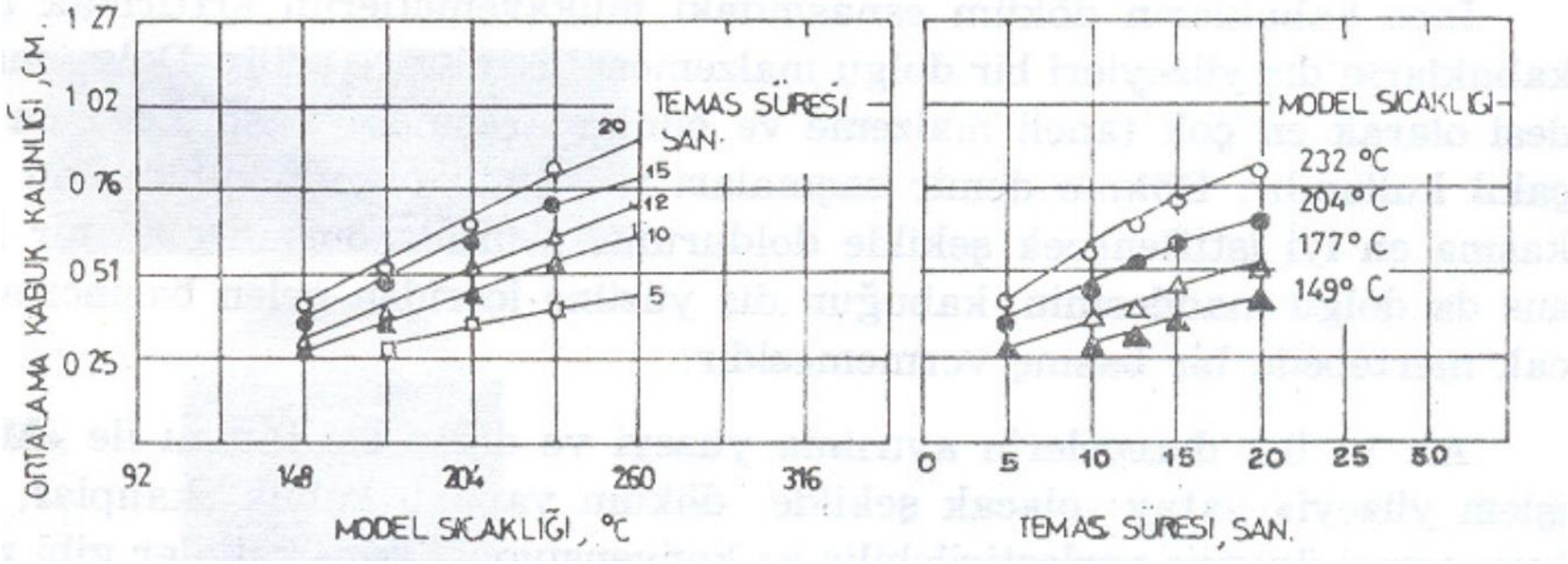
The shell thickness varies as a function of the pattern temperature and the time the sand-resin mixture has been in contact with the pattern. As can be seen in the figure, lower model temperatures and short contact times create thin shell thickness.



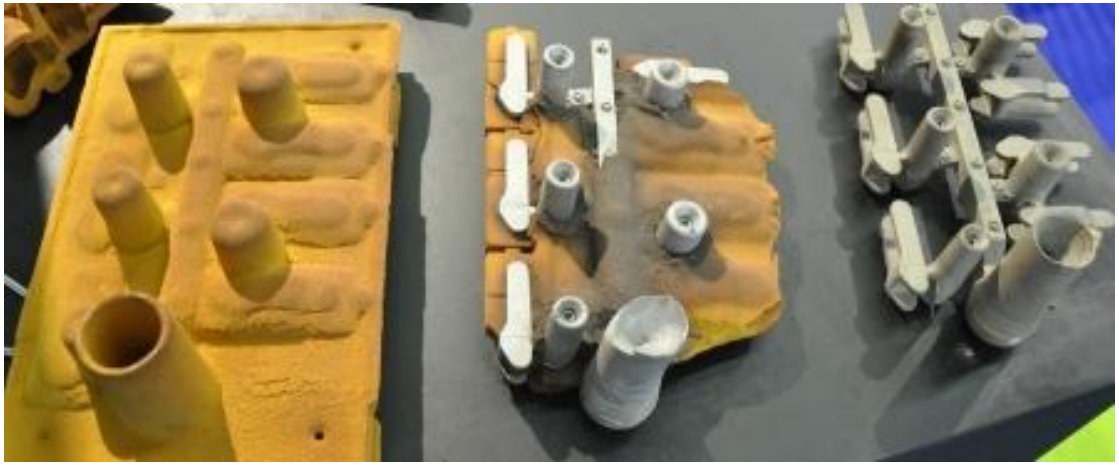
The shell thickness required for any application varies depending on the casting temperature and the shape and section thickness of the cast part. It is clear that as the casting temperature increases, a thicker shell will be needed. Likewise, a thick shell is required for thick-section castings. The thinnest shell suitable for the purpose can only be found in a few trials.

In shell moulding, overheating of the shell should be avoided. Overheating is manifested by premature cracking after liquid metal pouring into shell moulds. The bonds in the shell can burn before the solidification of the liquid metal is complete. Overheated shell moulds are black and dark brown.

On the other hand, incomplete firing causes small and large gas porosity in cast parts. The strength of these types of moulds is also less than required and their colour is light yellow. Properly heated shells are dark yellow or light brown in colour and this is usually achieved after 30-40 seconds of firing.

Preparation of sand and resin mixture

Shell moulding mixture consists of a fine, dry sand, for example silica or zircon, with 2–7% of a solid thermosetting resin binder. The resins commonly used are phenol novolaks containing hexamine as a hardener: these are designed to set permanently by cross-linking after a brief softening stage. Resins of low nitrogen content were also developed to counter specific surface defects. Also stearete additions are used as lubricant in moulding mixtures. The binder may be present as a powder mixed with the base sand, but precoated sands are usually preferred for their cleanliness, uniformity and economy in resin consumption. Sand and powder resin mixing can cause agglomeration. Resins were developed for either hot or solvent (cold) coating of the sand grains at the foundry, but commercially precoated sands also find wide application.



Video links

- https://www.youtube.com/watch?v=44R2IbzTvt4
- https://www.youtube.com/watch?v=VV17WRyY_uQ
- https://www.youtube.com/watch?v=UnJZy_0MGrw
- https://www.youtube.com/watch?v=nz_TBlO3vQ4
- https://www.youtube.com/watch?v=IOtLkPa93nk
- https://www.youtube.com/watch?v=NR2m3z7JFLU