Vacuum Moulding (V-Process)

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Introduction

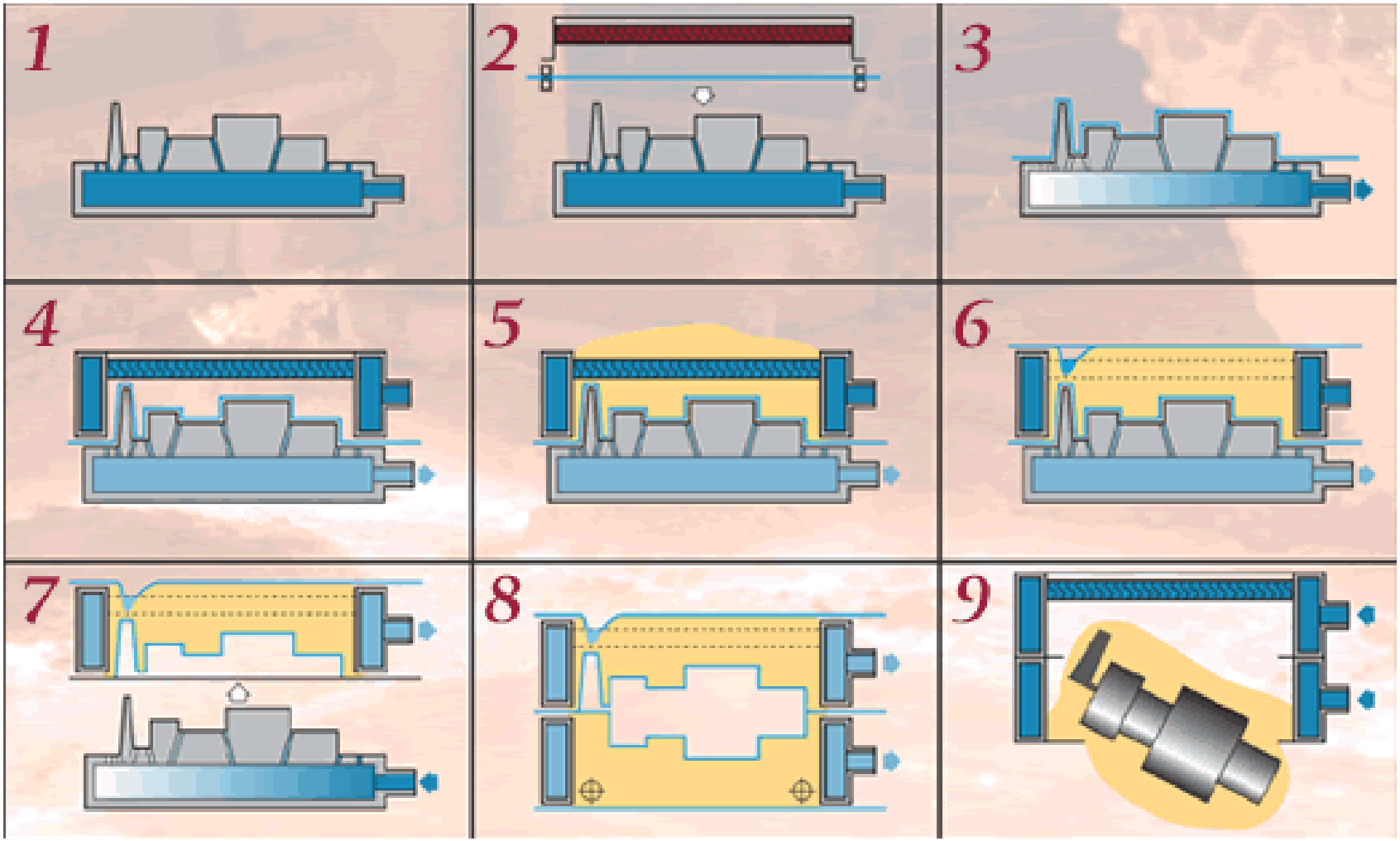
The vacuum moulding process, or V-process, is a sand moulding process in which no binders are used. Instead, the sand is positioned between two sheets of thin plastic and is held in place by the application of a vacuum. At the beginning of 1970's it was originally developed in Japan for the production of castings with high surface-area-to-volume ratios, the process is now licensed for use worldwide, and it has been successfully used to cast all metals that are normally cast in conventional green sand mould mixes.

In the V-process, the sand mass is shaped and framed by a polymeric film; By reducing the pressure inside the mould, the sand mass is compacted and the mould is formed. After the molten metal has been poured and solidified, the mould pressure is balanced to normal pressure and the casting parts are immediately separated from the sand without any action.

Process stages

Plates carrying the pattern halves are placed on a carrier box, which is hollow and connected with the vacuum assembly. The pattern is the same as the traditional pattern, except for the many thin channels (holes) drilled from the box cavity to the pattern surface. The polymeric film coated on the pattern with vacuum suction is covered with refractory mould paint.

This film, which is in contact with the sand surface very tightly with the vacuum suction applied to the sand, which is filled to the flask. The film does not burn when it meets the molten metal, but melts and evaporates immediately, this steam moves towards the depths of the mould and forms a stable sand surface layer.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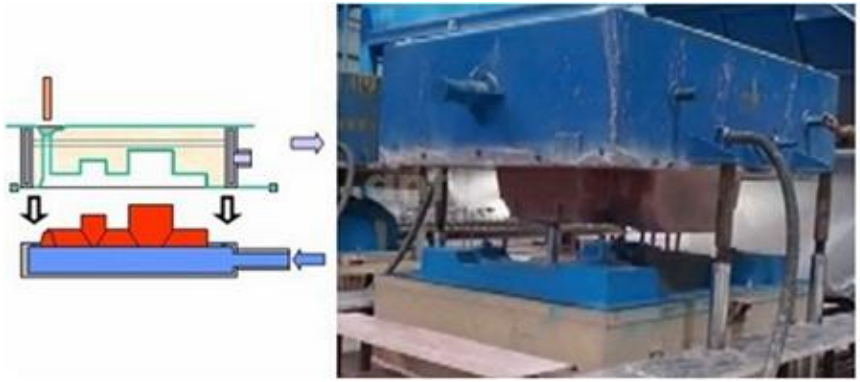
Commonly used film material is ethylene vinyl acetate (EVA). There is a film stretching mechanism on the pattern and a film heater on it. During the process, the film is heated with a gas or electric heater for a few minutes. The softened 0.05-0.1 mm thick film is approached to the pattern surface. 0.5 bar vacuum is applied to the transport box. With the effect of the air sucked through the thin channels, the film adheres tightly to the pattern.

The flask is filled with extremely dry and binder-free sand (silica, zircon, etc.) and vibration is applied. Runner and pouring basin are created on the upper surface of the mould and excess sand is removed away. The upper surface of the sand is covered with a film that exceeds the flask dimensions and the sand is compressed with 0.5 bar vacuum.

As long as vacuum is applied, the sand in the mould is constantly kept in mass. When the vacuum applied to the pattern box is removed, the polymeric film shaped by taking the shape of the pattern is easily removed from the pattern with the moulding box.

Cope and drag are created in the same way and combined. If necessary, cores prepared by any of the known methods can be placed in the mould. The vacuum application continues until the liquid metal poured into the mould solidifies. The vacuum is then released and the part is removed. Very little cleaning is required for the castings.



Properties of V-Process

- High dimensional precision is achieved in the castings produced as a result of the fact that the mould does not need to be loosened when removing the pattern, and every part of the mould has equal and unchangeable hardness.
- Since the moulding sand contains no moisture and binders and the mould is kept under negative pressure throughout the whole casting process, much finer sand can be used without reducing the permeability; As a result, the casting surface is very smooth. There is no moisture and binder in the mould as well as air circulation. Therefore, the heat output during the solidification of the casting occurs through radiation.

- The slow cooling and low solidification rate in the V-process can also be an advantage and a disadvantage. For example, despite the advantage that thin-section cast irons can be cast without carbide formation, slow cooling causes the formation of a coarse-grained structure and slows down the process in mass production. While slow cooling is beneficial for feeding in steel casting, it can be harmful for segregation.
- In the V-process, molten metal can travel much faster than green sand moulds due to the very low friction in the film-coated mould cavity.

- In the V-process, the pattern is easily separated from the mould without any mould degradation and sand spillage by the presence of plastic film and continuous vacuum application. This allows to kept the pattern taper (draft) very low or even zero. Holes with less depth can be created in the mould without using cores. Patterns do not have to be made of metal, plaster or wooden patterns can be used.
- In the V-process, the flaskes (cope and drag) are filled with gravitational effect and a very slight vibration of the pattern plate. Moulding sand has an infinitive life and is added only as much as dust loss. Since the knock out of the mould after casting is very simple, shake-type machines are generally not required. After casting, before the next moulding, the sand should be cooled below 40 °C.

- The V-process can be used for casting all known cast irons, steels, special alloy steels and non-ferrous metals and alloys. However, this method requires different vacuum devices than vacuum systems used in various sectors of the industry, and a special mechanism is also required to heat and soften the polymeric film, whereas most of the pre-casting and post-casting devices are not required in sand processes. There is no limit to the section thickness of the component that can be cast; part size can vary from very small pieces to pieces up to 12 tons.

Video links

- https://www.youtube.com/watch?v=0XK4i8w1Brk
- https://www.youtube.com/watch?v=XFhkEu84fZM
- https://www.youtube.com/watch?v=FNzJl6_QYiU
- https://www.youtube.com/watch?v=xMOCzg4bJWU