

Vacuum Moulding (V-Process)

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Introduction

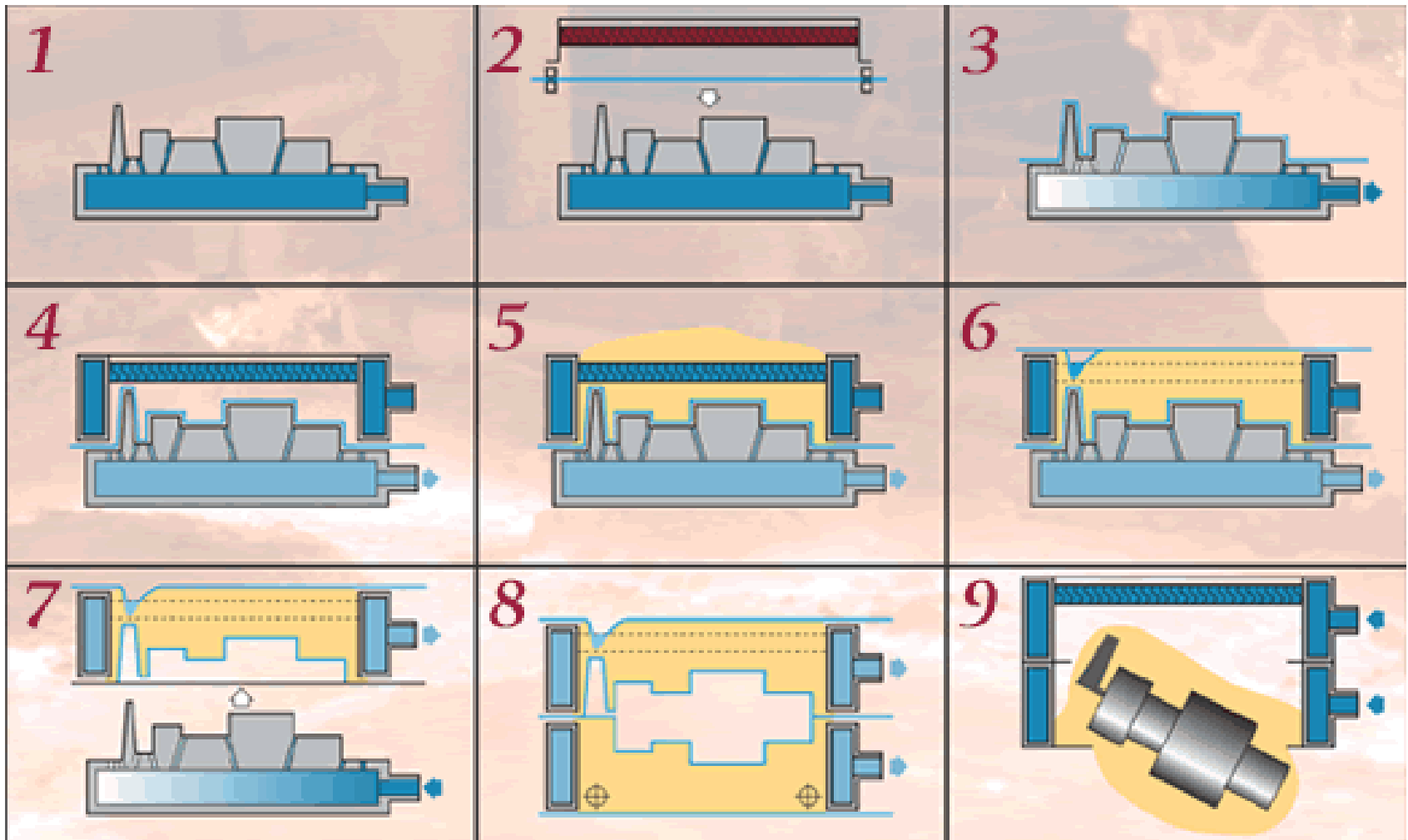
The vacuum moulding process, or V-process, is a sand moulding process in which no binders are used. Instead, the sand is positioned between two sheets of thin plastic and is held in place by the application of a vacuum. At the beginning of 1970's it was originally developed in Japan for the production 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

The plates holding the pattern halves are positioned on a carrier box, which is micro-perforated and connected to the vacuum system. The pattern itself is similar to a traditional pattern but features numerous thin channels (holes) drilled from the box cavity to the pattern surface. A polymeric film, adhered to the pattern via vacuum suction, is then coated with refractory paint.

When the flask is filled with sand, the vacuum suction ensures that the film remains tightly in contact with the sand surface. Upon contact with molten metal, the film does not burn but instead melts and rapidly evaporates, therefore forming a stable sand surface layer.

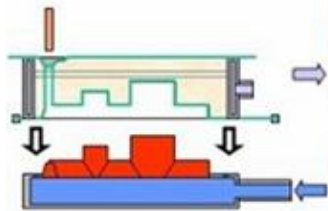


Ethylene vinyl acetate (EVA) is the most commonly used film material. The pattern is equipped with a film stretching mechanism and a film heater. During the process, the film is heated for a few minutes using either a gas or electric heater. Once softened, the 0.05–0.1 mm thick film is brought close to the pattern surface. A 0.5 bar vacuum is then applied to the transport box, causing the air to be drawn through the thin channels, which ensures the film adheres tightly to the pattern.

The flask is then filled with dry, binder-free sand—such as silica or zircon—and subjected to vibration to achieve uniform compaction. A runner and pouring basin are formed on the upper surface of the mold, and any excess sand is removed. The top surface of the sand is then covered with a film extending beyond the flask dimensions, and the sand is compacted under a 0.5 bar vacuum.

As long as the vacuum is applied, the sand within the mold remains compact and stable. Once the vacuum applied to the pattern box is released, the polymeric film—having conformed to the pattern's shape—can be easily separated from the pattern and transferred to the mould half.

Both the cope and drag are formed using the same method and then assembled. If needed, cores produced by any conventional technique can be placed inside the mold. The vacuum applied to the cope and drag remains active until the molten metal poured into the mold has fully solidified. Once solidification is complete, the vacuum is released, allowing for easy removal of the casting. Minimal cleaning is required for the final cast part.



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 section of the mould has even 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 dissipation during the solidification of the casting mostly 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 keep the pattern taper (draft) very low or even zero. Holes with less depth (mild cavities) 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 flasks (cope and drag) are filled with gravitational effect and only slight vibration. Moulding sand has an infinite life with this technique. Since the knock out of the mould after casting is very simple, shake-out machines are generally not required. After the casting, the sand should be cooled below 40 °C.

- The V-process can be used for casting all known cast irons, 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>