

COUNTER PRESURE DIE CASTING – GENERAL DESCRIPTION

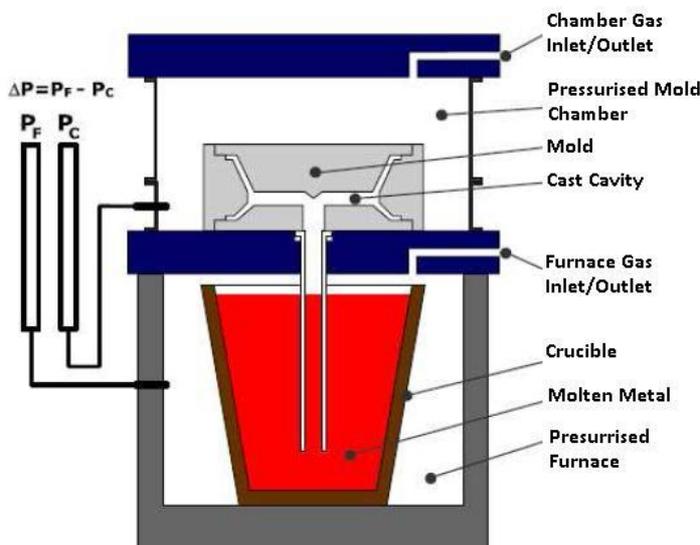
The gas counter-pressure casting (CPC) method has been developed by the Bulgarian scientists Academician Angel Balevski and Corresponding Member of the Bulgarian Academy of Sciences Ivan Dimov. Operating the gas pressure during the casting process significantly extend the casting capabilities in the production of aluminum alloys parts considerably improving mechanical, physical and service properties.

The main advantage of this method consists in the precise regulation of the pressure of the technological gas as the third thermodynamic parameter for control of the casting process especially regarding the structure of the castings. These special features of the method determined its fast progress in research, design and technological respect.

Technology

The machines for gas counterpressure casting consist of two chambers – one for the melted metal and one for the casting mould.

The main difference from the other methods is that when filling the mould the rising metal faces the gas pressure applied beforehand in the mould.

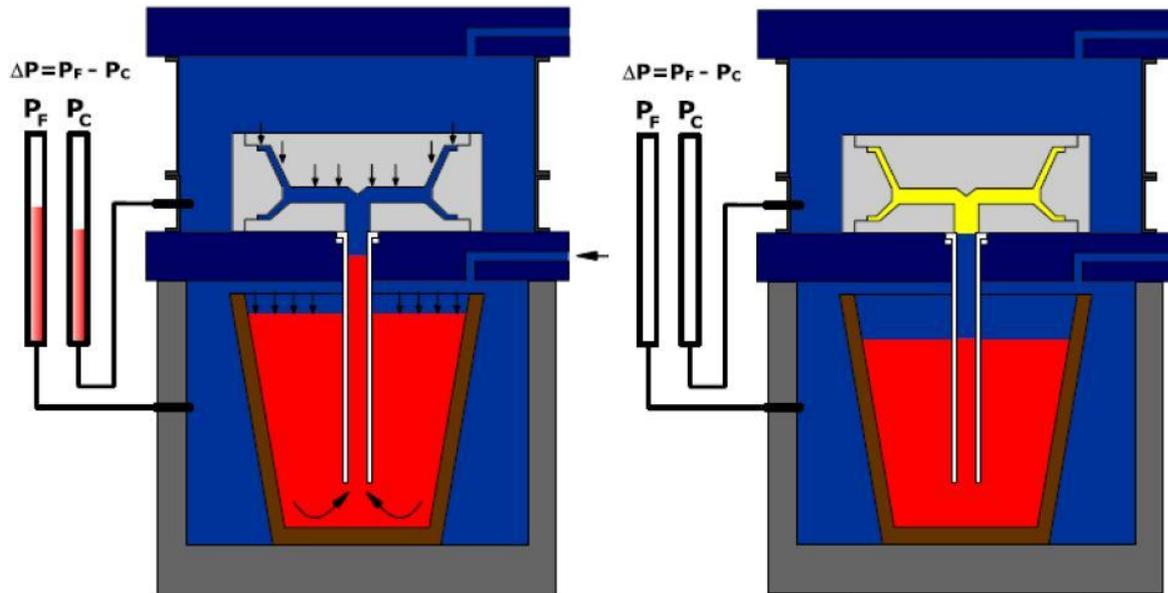


Counter Pressure Casting (CPC) uses a similar mold positioning and sealed furnace like low pressure and vacuum low pressure processes. With CPC, the casting cavity is placed entirely inside a pressure chamber.

Upon closure of the casting cavity, the casting chamber and furnace chamber are pressurized with equal pressures. The pressure in the casting chamber is slowly exhausted while the pressure in the casting furnace is increased. This allows metal to rise in the filling tubes and into the casting cavity at a controlled and tranquil rate, under a countering pressure. Multiple cavities and multiple fill tubes can be used.

Solidification is controlled directionally via sequenced cooling, just as the pressure filling and intensification is monitored to give maximum feeding in shrinkage-prone regions of the casting. The pressure is maintained upon the metal bath and casting until solidification is complete and then the pressure is released.

When the casting can be handled without damage, they are extracted from the machine. The process stages can be seen below:



Main Advantages

- The acting “counter pressure” suppresses the release of the gases present in the melt keeping them in a dissolved state thus eliminating the gas porosity in the casting.
- The solidification of the metal in the die cavity proceeds, being under the action of the gas pressure in the die housing and that of the melt pressure at the die inlet. That significantly:
 - Improves the conditions for melt infiltration and efficient feeding of the casting and prevent the formation of the associated with shrinkage of the metal defects like macro porosity and cavities.
 - Improves conditions to eliminate or reduce “natural” micro porosity, result of better infiltration of the melt between arising crystallites and plastic micro deformation them in the process of crystallization.
 - Prolong time of contact between die and solidifying metal in die cavity before creation the shrink gap increase the depth of fine macro structure result of longer intensive heat transfer to die. That increase the mechanical properties of the cast material and combined with above advantages improve structural strength of the casting.
- An integral structure can be obtained even in thick sections in the upper part of castings without the use of risers. If, however, small risers are used in some cases, they work under the same gas pressure, their efficiency being increased many times. That makes the yield of usable castings from the metal poured very high.
- Since the whole casting process takes place in closed vessels, the counter-pressure casting technology provides much better working conditions and minimizes air pollution as well and protective gases could be used with success.
- The precision control of creating Pressure Differential permit:

- Precise control of the rate of casting and filling the die. Rate of casting does not depend on the pressure acting on the melt.
- Precise control of the mould filling time. Accurate proportioning of the mechanical energy of the flowing melt required filling the mould without turbulence and breaking the melt free surface. Increasing the pressure difference in the end of the die filling in order to obtain a better reproduction.
- Casting in sand moulds and in permanent moulds with sand cores without any danger of their destruction, regardless of the applied working pressure.
- Realization of directional solidification by suitable changes in the mould filling speed.

Possibilities

The counter-pressure casting method offers new possibilities for development of the casting technologies. The following special features describe the main points of this method:

- The casting rate depends not on the pressure exerted upon the melt but on the difference between pressure and counter pressure;
- The casting rate, in contrast to other methods, can be controlled precisely and regulated in a large range by changing of the pressures;
- The appropriate casting rate and heat removal provide possibilities for oriented crystallization to run under the action of higher pressure. In this case the counter pressure is used as infiltrating pressure decreasing considerably the porosity in the castings;
- The high gas counter pressure that acts in the pores of the sand molds balances the pressure exercised by the melt on the mold walls. Due to this in gas counter pressure casting any known in the casting practice molds and cores can be used (metal, sand, combined, shell, etc.)

Application

- big-size parts
- parts with complex combination of thin and thick sections
- castings subjected to high dynamic and cyclic loads, in particular parts for vacuum technology
- parts subjected to high temperatures;
- car-building and transport machines;
- hydraulic and pneumatics;
- electronic and electrical industry;
- airplane building;
- replacing parts produced by other methods: forging, stamping and welding. In this case considerable savings of metal, labor and investments in big-size sophisticated equipment are achieved.

Benefits

Gas counter pressure casting reveals new possibilities for control and monitoring of the processes during shape and structure formation of aluminum castings. Moreover, products of improved mechanical, physical and operational properties are achieved. In the conditions of higher pressure the castings solidify faster and this provides higher productivity compared to the other casting methods.

The CNC control of the whole casting process ensures the high quality of the products, possibility for quick adjustment and readjustment of the equipment, elimination of the human factor during the production process and possibility for visual control and electronic transfer of the technical data.

The counter-pressure casting method increases the plasticity 2-3 times and the strength and hardness with 20 –30 % at the same time.

This results in a high reserve of operating strength of the parts, which is extremely important in the airplane-building industry. The production of such important parts is being done by special casting machines.