MAKING OF DIE CASTING TOOL

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ABSTRACT

This paper describes one of the ways for the making of the pressure die casting process for motor rotar . This paper is to maintain the closest tolerances, reduced all machining and can make the process the optimum choice for small volume production as well. Die casting is a Metal casting process that is characterized by forcing molten metal under high pressure into a mold cavity. The mold cavity is created using two hardened tool steel dies which have been machined into shape and work similarly to an injection mould during the process. Most die castings are made from non-ferrous metals, specifically zinc, copper, aluminium, magnesium, lead, pewter and tin based alloys. Depending on the type of metal being cast, a hot- or cold-chamber machine is used.The main die casting alloys are: zinc, aluminium, magnesium, copper, lead, and tin; although uncommon, ferrous die casting is also possible. Specific die casting alloys include: ZAMAK; zinc aluminium. The Aluminum Association (AA) standards: AA 380, AA 384, AA 386, AA 390; and AZ91D magnesium. Maximum weight limits for aluminium, brass, magnesium, and zinc castings are approximately 70 pounds (32 kg), 10 lb (4.5 kg), 44 lb (20 kg), and 75 lb (34 kg), respectively. The most important material properties for the dies are thermal shock resistance and softening at elevated temperature; other important properties include hardenability, machinability, heat checking resistance, weldability, availability (especially for larger dies), and cost. The longevity of a die is directly dependent on the temperature of the molten metal and the cycle time. The dies used in die casting are usually made out of hardened tool steels, because cast iron cannot withstand the high pressures involved, therefore the dies are very expensive, resulting in high start-up costs. Metals that are cast at higher temperatures require dies made from higher alloy steels.

Keyword: - *Die casting 1, motor rotors2, mold cavity3, aluminum4, thermal shock resistanc5.*

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1. Die Construction

Two dies are used in die casting; one is called the "cover die half" and the other the "ejector die half". Where they meet is called the parting line. The cover die contains the shot hole (for cold-chamber machines), which allows the molten metal to flow into the dies; this feature matches up with the shot chamber in the cold-chamber machines. The ejector die contains the ejector pins and usually the runner, which is the path from the shot hole to the mold cavity. The cover die is secured to the stationary, or front, platen of the casting machine, while the ejector die is attached to the movable platen. The mold cavity is cut into two cavity inserts, which are separate pieces that can be replaced relatively easily and bolt into the die halves. The dies are designed so that the finished casting will slide off the cover half of the die and stay in the ejector half as the dies are opened. This assures that the casting will be ejected every cycle because the ejector half contains the ejector pins to push the casting out of that die half. The ejector pins are driven by an ejector pin plate, which accurately drives all of the pins at the same time and with the same force, so that the casting is not damaged. The ejector pin plate also retracts the pins after ejecting the casting to prepare for the next shot. There must be enough ejector pins to keep the overall force on each pin low, because the casting is still hot and can be damaged by excessive force. Other die components include cores and slides. Cores are components that usually produce holes or opening, but they can be used to create other details as well. There are three types of cores: fixed, movable, and loose. Fixed cores are ones that are oriented parallel to the pull direction of the dies (i.e. the direction the dies open), therefore they are fixed. Other features in the dies include water-cooling passages and vents along the parting lines. These vents are usually wide and thin (approximately 0.13 mm or 0.005 in) so that when the molten metal starts filling them the metal quickly solidifies and minimizes scrap. No risers are used because the high pressure ensures a continuous feed of metal from the gate. The most important material properties for the dies are thermal shock resistance and softening at elevated temperature; other important properties include hardenability, machinability, heat checking resistance, weldability, availability (especially for larger dies), and cost. The longevity of a die is directly dependent on the temperature of the molten metal and the cycle time. The dies used in die casting are usually made out of hardened tool steels, because cast iron cannot withstand the high pressures involved, therefore the dies are very expensive, resulting in high start-up costs. Metals that are cast at higher temperatures require dies made from higher alloy steels.

Table -1 : Die and component material and hardness for various cast metals

Die component	Material	Hardness
Cavity inserts	H13	42–48 HRC
Cores	H13	44–48 HRC
Core pins	DIN 1.2367 prehard	37–40 HRC
Ejector pins	H13	46–50 HR
Plunger shot sleeve	DIN 1.2367	42–48 HRC
Nozzle	H13	46–50 HR
Holder block	4140 prehard	~300 HB

Table -2 : Typical die temperatures and life for various cast materials

ALUMINIUM	
Maximum die life [number of cycles]	100,000
Die temperature [C° (F°)]	288 (550)
Casting temperature [C° (F°)]	660 (1220)

2.Process

The following are the four steps in traditional die casting, also known as high-*pressure die casting*, these are also the basis for any of the die casting variations: die preparation, filling, ejection, and shakeout. The dies are prepared by spraying the mold cavity with lubricant. The lubricant both helps control the temperature of the die and it also assists in the removal of the casting. The dies are then closed and molten metal is injected into the dies under high pressure; between 10 and 175 megapascals (1,500 and 25,400 psi). Once the mold cavity is filled, the pressure is maintained until the casting solidifies. The dies are then opened and the shot (shots are different from castings because there can be multiple cavities in a die, yielding multiple castings per shot) is ejected by the ejector pins.

2.1 Lubricants

Oil in water is the best, because when the lubricant is applied the water cools the die surface by evaporating while depositing the oil, which helps release the shot. A common mixture for this type of lubricants is thirty parts water to one part oil, however in extreme cases a ratio of 100:1 is used.

2.2Pore-free

When no porosity is allowed in a cast part then the pore-free casting process is used. It is identical to the standard process except oxygen is injected into the die before each shot to purge any air from the mold cavity. This causes small dispersed oxides to form when the molten metal fills the die, which virtually eliminates gas porosity. An added advantage to this is greater strength. Unlike standard die castings, these castings can be heat treated and welded. This process can be performed on aluminium, zinc, and lead alloys.

2.3 Cooling curves for aluminium

Cooling curves are important in controlling the quality of a casting. The most important part of the cooling curve is the cooling rate which affects the microstructure and properties. Generally speaking, an area of the casting which is cooled quickly will have a fine grain structure and an area which cools slowly will have a coarse grain structure. Below is an example cooling curve of a pure metal or Aluminium.

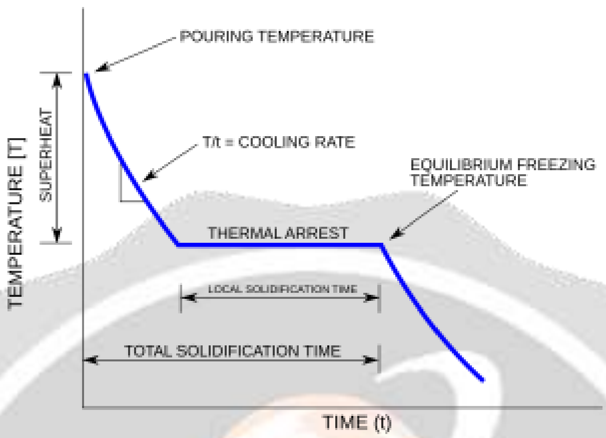

Chart 1: Cooling curves for aluminium

2.4Shrinkage

The shrinkage of the liquid is rarely a problem because more material is flowing into the mold behind it. Solidification shrinkage occurs because metals are less dense as a liquid than a solid, so during solidification the metal density dramatically increases. Patternmaker's shrinkage refers to the shrinkage that occurs when the material is cooled from the solidification temperature to room temperature, which occurs due to thermal contraction.

Table -3: Solidification shrinkage of various metals

METAL	PERCENTAGE
Aluminium	6.6
Zinc	3.7or6.5
Low carbon steel	2.5-3.0
High carbon steel	4.0

Table -4: Typical patternmaker's shrinkage of aluminiun metal

Metal	Percentage	in/ft
Aluminium	1.0-1.3	$\frac{1}{8}$–$\frac{5}{32}$

Table5: Material selection

Description	Material
Front Die	Tool steel
Core Length Cup	OHNS
Back Die	Tool steel
Die Plate	Grade material-en24

3.Working principle

During the cold-chamber die casting process, the molten charge (more material than is required to fill the casting) is ladled from the crucible into a shot sleeve, where a hydraulically operated plunger pushes the metal into the die. The extra material is used to force additional metal into the die cavity to supplement the shrinkage that takes place during solidification. The principle components of a cold-chamber die casting machine are shown below. Injection pressures over 10,000 psi or 70,000 KPa can be obtained from this type of machine.Thus the component –motor rotor made of aluminium is obtained.

Figure1:Die casting tool

Figure2:Die casting tool working in machine

4. CONCLUSIONS

In this work a die was designed based on factors to be considered in the critical dimensions and filling analysis is used to determine the size, location and to ensure a complete and balanced filling of the part while designing for proper runner system. Such exact and light parts are one of the premises for the electric motor and automobile industry.Parts with a lightweight design and exact products directly influence the energyconsumption of the users and are satisfied. In this work a die was designed based on factors to be considered in the critical dimensions and filling analysis is used to determine the size, location and to ensure a complete and balanced filling of the part while designing for proper runner system

5. REFERENCES

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BIOGRAPHIES

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