Aluminium die castings in automobiles

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SYNOPSIS

Great advances have made in the last twenty years in the development of aluminium die castings. Advances in the size of die casting machines, casting know-how, die materials, improved alloys and the increasing recognition of the die cast aluminium as a structural material have accelerated the use of aluminium die castings so much so that they now represent more than 30 per cent of the total aluminium castings produced in the world. In the automobile industry the use of aluminium die cast alloys is increasing at a fast rate to replace the heavy cast iron parts. Small parts are being followed by large structural parts such as transmission cases, torque converter housings and clutch housings. In this paper the great potentiality of applicability of aluminium die casting alloys in Indian automobile industry has been dealt with.

ADVANCES made during the last 25 years in the die casting process have played a very important role in the growing use of aluminium for its inherent ability to produce complex parts at a higher speed and at a lower cost than any other metal. Improvements in the sizes of machines, casting know-how, die materials and improved alloys have accelerated the use of aluminium die castings to the point that today they represent more than 40 per cent of the total aluminium castings produced in the world.

The automobile manufacturers have been one of the leaders in recognising the adaptability of aluminium. As the industry searched for weight reduction and lower costs, aluminium die castings provided the ideal combination.

Automotive applications

The most imprtant factor in favour of aluminium and aluminium alloys is their low specific gravity. This coupled with the desirable mechanical properties of aluminium alloys is responsible for the low average weight achieved. For example, grey cast iron with a specific gravity of 7·8 stands clearly at a disadvantage when compared with aluminium alloys with a specific gravity of 2·6 to 3·0. Cast iron parts are, therefore, being gradually substituted by aluminium die castings at an increasing rate over the past twenty years. Quite a number of smaller engines and transmission components have been produced as die castings in Indian Standard alloys A2M and A6M (equivalent to British alloys LM2M and LM6M respectively). Electric lighting equipment such as head lamp, reflector, bezel ring, generator castings and cooling fans are all gravity die castings in Indian standard alloy A4 (British alloy LM4).

Small parts are being followed by large structural parts such as transmission cases, torque convertor housings and clutch housings. Oil pumper bodies, rocker arms, rocker arm brackets, water pumps, timing chain cover, valve covers, crank cases, carburetors and many other parts in die cast aluminium are available in passenger cars and trucks.

The die casting process in aluminium has been able to combine several parts into one casting thereby achieving production economies. For example, in the automatic transmission, the transmission case, rear extension, front covers and several valve bodies were produced initially as separate parts. By a process evolution it has now become possible to combine the several valve bodies into one valve body and then to combine the valve body and servo-cylinders with the cases and finally to incorporate the covers and extensions. These accomplishments could be achieved by developments in die casting machines, higher locking force, higher injection processes and thereby higher quality die castings.

Clutch and torque convertor housings made of die casting aluminium have been introduced in advanced countries as early as 1950. This has increased the amount of aluminium used per car to 12 kg (in 1953) and in 1963 the average reached to about 30 kg of which 18 kg or nearly 60 per cent was in the form of die castings. These die castings were specified for the mechanical or structural parts. The remainder of the aluminium was used for pistons, brake drums, mouldings and other ornamental parts.

In Europe, Italy achieved the 30 kg per car figure in 1956. France was also very close to it in 1960 and Germany has been slightly ahead of these figures.

Recent trends for bigger automotive castings

The attention of the automotive industry has for considerable time been focussed on developments in the

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advanced countries for large pressure die castings. Although in early 60s a British motor manufacturer produced the first clutch housing in LM2M, one-piece clutch housings, gear boxes are now common.

While advantages of aluminium for engine blocks have long been recognised by automotive engineers, the cost of a block produced in sand or a semi-permanent mould could not compete with that of a cast iron block. Although to begin with, the size and the quality of aluminium casting was limited by the lack of technical knowledge, production experience and size of die casting machines, further improvements in the die casting techniques made the production of cylinder blocks a reality in 1955. The engine block was of wet sleeve design and weighed only 21 kg which was about 60 kg lighter than an equivalent grey iron block. This block was made for the Kaisers in United States. This was the heaviest die casting produced up to that time.

Subsequently die cast aluminium engine blocks were also made by American Motors and Chrysler Corporation. The general motors used this method to produce aluminium V-8 engine for Buick and Oldsmobile. There were many problems and prejudices to overcome in the design of a die cast block with dry sleeves. Corrosion was viewed as a serious problem in a water cooled engine. The higher co-efficient of expansion of aluminium compared to iron was expected to create problems specially in bearing clearance. Aluminium was considered neither strong nor rigid enough to withstand the pulsating stresses of the powerful engine and high compression ratios. Aluminium would not have the dampening effect of grey iron resulting in a noisy engine. Porosity was another problem and it was thought not possible to produce a leakproof engine block. The die casting industry might not be capable of producing engine blocks of acceptable quality in large quantities. All these fears had already been disproved by the high performance of relatively small engines but still these prejudices persisted.

Nevertheless, the design work continued. Compromises between die casting needs and traditional practices were achieved. Should cylinder walls be die cast? Should they be made of so and so alloy? Should they have pressed-in iron liners? Should iron liners be cast in place?

Answers to these questions and many others were found. Prototypes were made and tested. New casting machines were designed and built to handle engine block dies and the production of die casting engine blocks was started by American Motors for their passenger cars in 1961. Although today aluminium die cast engine blocks are not popular in passenger cars, the main reason being economics, it is expected that aluminium die cast blocks will soon replace cast iron blocks. This is bound to occur when the automotive engineers decide to go all out for aluminium and take complete advantages of the metal and the die cast process. Experimental door frames have also been made as a large die casting in aluminium alloy S12A.

Aluminium die castings in Indian automobile

The Indian automobile manufacturer although started a little late is also taking the advantage of the inherent qualities of aluminium die castings. Automobile components such as mounting block-steering unit, clamp ring steering units, gear box extension, gear box top cover extension, etc. are being made of the Indian Standard alloy A24M. Gear box and clutch housing, sealing block, rear bearing oil seal, packing for starter motor are some of the castings made out of LM21. Gear box, top cover, gear box extension and inlet manifold are also cast in the Indian standard alloy A4M.

Small components like door handles, headlamp and reflectors have also been die cast in aluminium.

Conclusion

In view of the vast potentialities of aluminium die castings in the Indian automobile, the Indian Standards Institution has recently decided to take up the preparation of a code of practice for the manufacture of aluminium die castings. The alloy compositions have already been standardized at the national level in IS : 617. It is expected that after this code is published, not only the automobile manufacturers but also the other engineering industries will take notice of this widely accepted material and use it to their advantage.