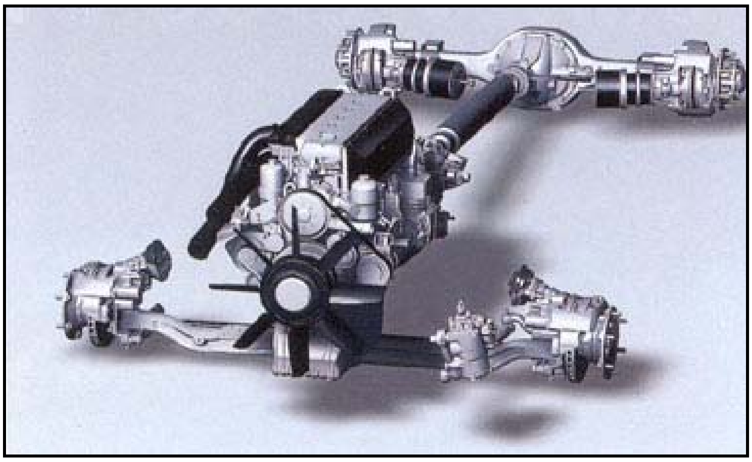
Applications – Power train – Introduction

The term power train refers to the group of components that generate power and deliver it to the driving wheels. It includes the energy generating engine, the clutch, the transmission, the various drive shafts and the differential. The driveline is the portion of a vehicle after the transmission which changes depending on whether the vehicle is front-wheel drive, rear-wheel drive, or four-wheel drive.



Power train of an automobile

Most of the aluminium which is supplied today to the automotive market is used in the power train. On average, the power train of the cars produced in Europe contains about 80 kg aluminium. This corresponds to 55-60% of the average total aluminium content of the automobiles produced in Europe. For cars produced in North America and in Southeast Asia, the proportion of the aluminium applications in the power train is with 65-70% even higher.

The majority of the aluminium power train components are cast parts (80-85%), produced by different casting technologies. The applied casting alloys typically have an alloy concentration of up to 20%, mostly silicon, magnesium and copper. Many aluminium casting alloys are produced from recycled aluminium, i.e. post-consumer aluminium scrap, often from end-of-life vehicles. The share of the power train components produced from wrought alloys is relatively small (approx. 10% rolled, approx. 5% extruded and about 1% forged aluminium).

In different power train applications, aluminium is the material of choice and has reached complete market penetration. For example, aluminium has displaced copper or brass as the preferred heat exchanger material more than 50 years ago and is today the exclusively used material for these applications. Aluminium is also practically the only material used for pistons. For cylinder heads, transmission housings and many ancillary aggregates, full market penetration is approaching very fast. Lately, engine blocks have been the largest driver of aluminium growth, first for gasoline engines, but now for diesel engines too.

The significant growth of the aluminium share in the engine occurred mainly at the expense of cast iron. However further growth potential in the power train is limited. In fact, there are applications where other lightweight solutions are starting to replace aluminium castings. Today the main material competitors for aluminium in power train applications are high performance plastics, which offer the possibility of a cost efficient part fabrication in areas not subjected to high temperature impacts, and cast magnesium solutions. In the future, the absolute volume of aluminium used in power train components (engine, transmission and driveline parts) may decline due a gradual shift to smaller and more fuel efficient vehicles using smaller power train components.

More detailed descriptions of aluminium applications in power train components are presented in the following subchapters:

- Pistons
- Engine blocks
- Cylinder liners
- Cylinder heads
- Fuel system
- Heat shields
- Heat exchangers
- Miscellaneous engine components
- Transmission and driveline.

Future developments

As the automotive industry strives to reduce emissions and radically improve fuel efficiency, the power train is the most important component sector for development. Today the choices for OEMs are bewildering in technology terms as each underlying power train option continues development at a pace. These developments clearly influence the selection of the materials applied in the power train of future passenger cars and thus have a strong impact on the overall application of aluminium in the automotive market.

The conventional internal combustion (IC) engine will continue to dominate the market at least in the near and medium terms. But apart from continuous effort to improve the efficiency of gasoline and diesel IC engines - which invariably increase the material requirements with respect to mechanical and thermal loads - different types of alternative fuels (natural gas, biofuels, hydrogen) are being introduced. Except for the fuel delivery components, most internal combustion engines that are designed for gasoline use can run on natural gas or liquefied petroleum gases (e.g. propane) without major modifications. Large diesels can run with air mixed with gases and a pilot diesel fuel ignition injection. Liquid and gaseous biofuels, such as ethanol and biodiesel, can also be used. Some engines with appropriate modifications can also run on hydrogen gas.

In addition, battery-driven electric vehicles (plug-in versions or with fuel cells) are coming increasingly on the market. Of special interest are hybrid vehicles with two or more power sources in the drive train. Current hybrids use both an internal combustion (IC) engine and a battery/electric drive system to improve fuel consumption, emission, and performance. Hybrids are classified by the division of power between sources; two sources may operate in parallel to accelerate the vehicle, or the vehicle may be primarily driven by one source with the other only engaged during acceleration.

This added complexity moves the industry away from long standing power train development trends and forces a much more expansive approach to future power train strategies. It also adds new or additional material requirements. However, lightweighting will continue to be an important driver for new developments and with continuing alloy and product development efforts, aluminium will defend or even increase its share in power train applications also in future.