Lightweight Automobile and Aluminum Alloy

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Abstract

Automobile aluminum alloy is the main way to reduce the weight of automobiles, which can effectively save energy and decrease the ring.

Keywords

Automotive industry; Lightweight; Aluminium alloy.

1. Introduction

In 2002, the global automobile output was 57.96 million, of which 37.37 million were cars, accounting for 64. 3%. The rapid development of the whole automobile industry puts forward new requirements to the material science, which drives the new development of the automobile material. Modern cars are developing in lightweight, intelligent and high-performance development, and new requirements for materials have been put forward. With the emergence and aggravation of the worldwide energy crisis, as an effective way to reduce the fuel consumption rate, the effective way to save energy is to reduce the weight of the car body, that is, to realize the light weight of the vehicle. Reduction of vehicle weight can be achieved by improving the structure of the vehicle or by using lightweight materials. The former has no great potential to dig, and the automotive industry is generally focused on the development of lightweight materials to solve this problem. Aluminum alloy has been widely used in automobile industry since 1970s. Aluminum alloy has been developing rapidly since it entered the automobile industry, and the amount of aluminum alloy has been increasing year by year. Automobile manufacturing industry has become the most important consumer of aluminum materials. At present, the average amount of aluminum used in cars in developed countries has reached 133kg, and the aluminization rate has reached 12. At present, the average amount of aluminum used in domestic automobiles is only 60kg, and the aluminization rate is less than 5%, which has great potential for development.

2. Advantages of Aluminium Alloying used in Automobile Industry

Theoretical calculation shows that proper reduction of vehicle weight can reduce fuel consumption by 37, load of suspension device by 18 and vibration intensity by 5. As a result, automotive companies have gradually adopted lightweight aluminum alloy materials to replace traditional steel structural materials.

Aluminum has a small specific gravity of only 2. 7 g / cm3 (light metal), roughly a third of that of steel. Aluminum alloy can be formed by adding some elements or elements to aluminum. Compared with pure aluminum, aluminum alloy can improve the comprehensive properties of materials such as strength, hardness, fatigue resistance and so on. The strength of some aluminum alloys is even higher than that of ordinary structural steels. Aluminum alloy and its processed materials have a series of excellent properties, such as low density, high specific strength and specific stiffness, good elasticity, good impact resistance, corrosion resistance, wear resistance, high conductivity, high thermal conductivity, easy surface coloring, Good processing formability and high recovery and regeneration.

Aluminum matrix composite is a new type of gold composite material which is widely used. The matrix of aluminum matrix composites is aluminum-silicon alloy. The commonly used reinforced fibers are ceramic fibers (alumina, aluminum silicate fiber), whiskers, particles and so on. At present, aluminum matrix composites are prepared by liquid phase process in automobile industry. Due to its excellent high temperature performance, excellent wear resistance and fatigue resistance, the composite material has been successfully used to manufacture automotive parts such as piston, cylinder sleeve, suspension arm, brake caliper, drive shaft, wheel, etc. In addition, some typical new aluminum alloy materials, such as powder metallurgy aluminum alloy, solid foam aluminum alloy, rapid solidification aluminum alloy and superplastic aluminum alloy, are playing more and more important roles in automobile industry.

The benefits brought by the increase in the amount of aluminum alloy in the automobile are mainly reflected in the following aspects:

2.1 Automobile lightweight

In order to reduce the weight of automobile, it is necessary to choose more lightweight materials, such as aluminum and aluminum alloy, magnesium and magnesium alloy, plastic and so on, on the premise of ensuring the performance of automobile. The price and safety of magnesium and magnesium alloys limit their use. Recycling of polymer plastics is a problem of environmental pollution. Aluminum and aluminum alloys are rich in resources, low cost, and the proportion of aluminum is only 1/3 of iron, light weight, high specific strength, good formability, corrosion resistance, And more than 80% of aluminum can be recycled and reused, so aluminum and aluminum alloys are widely used in automobile industry.

According to the American Aluminium Institute, every 0. 45 kg aluminum used in cars can reduce the weight of 1Kg. In theory, aluminum cars can lose about 40% of their weight compared to steel ones. For a 1300Kg heavy sedan, if the weight is reduced by 10 parts, the fuel consumption can be reduced by 8%.

The most classic use of aluminum alloy is the new Audi A2 ultra-light sedan introduced by German Audi Motor Company in 1999, which is the first all-aluminum car in the world to be produced in large quantities. The body uses an all-aluminum space frame body ASF (that is, the dashboard part is supported by a high-strength aluminum structure). The space frame consists of an extruded section of a vacuum die-casting joint, which is combined into a very light aluminum alloy body), the aluminum shell of the vehicle, the front top column to the baggage compartment, including the door handle, which is formed with aluminum. The quality of the car is reduced by more than 40% compared with the traditional steel body, only 895Kg, the fuel consumption is reduced to 3L, and the CW value reaches the world record 0.25.

2.2 The effect of saving energy and reducing consumption is obvious.

According to the data, 70% of the vehicle energy consumption is related to the vehicle weight. In one case, for every 1 kilogram of vehicle weight, 1 liter of gasoline can make the vehicle travel 0.011 km longer. In other words, cars can save 0. 7 kg of fuel per 10, 000 km. At present, each car in the United States has at least 100 tons of aluminum alloy and can lose 225 kilograms of weight. If a single car is used for only 10 years and its journey is 400000 kilometers, each car can save 6.3 tons of gasoline.

The body frame is made by extruding aluminum in the space frame technology. The body mass is almost 50% lighter than the traditional body, and the material utilization is very high. The quality of the aluminum welded body of the integrated-2010 car developed by Ford reduces the 450Kg (46%) compared with the steel welded structure body. Without reducing the performance of the vehicle, the engine power was reduced from 110kW to 59kW, and the fuel consumption was only 4.7 L / 100 km.

2.3 Reducing emissions is good for Environmental Protection

At present, more than 70% of the urban pollution comes from automobile exhaust gas. The higher the aluminization rate, the lighter the weight, the more obvious the fuel saving effect is, the less the exhaust gas emission is, and the less the environmental pollution is. It is estimated that if the U.S.

sedan weight is reduced by 25 percent, the fuel can be saved by 750000 barrels a day, and the annual CO 2 emissions can be reduced by 110 million tons, bringing huge energy saving and environmental protection effects.

2.4 Improve the structure rigidity of the body parts and the driving performance of the vehicle, extend the service life of the body

After lightweight, the quality performance (the ratio of vehicle quality to rigidity and bottom area) has been improved to some extent. According to OPEL, its aluminum body improves its quality and performance by 23 percent, the distortion rigidity by 74 percent, and its bending performance by 62 percent.

After reducing the weight of the car, the center of gravity of the body is reduced, the vehicle is more stable and comfortable, which has great benefits for acceleration and elasticity, and the noise of the rotating and vibrating parts can be reduced obviously at the same time. After the vehicle is lightweight, the mass is light, so the energy produced in the collision is small, which reduces the damage to the vehicle. During the impact, the properties of aluminum alloy and the structure of the body can fully absorb the energy generated during the impact, so it is safer. In addition, aluminum has a longer life than steel, thus prolonging the service life of cars.

2.5 Reduce manufacturing costs

The recovery rate of aluminum alloy is very high. At present, 80% of the aluminum alloy can be used in foreign countries, and more than 60% of the aluminum alloy materials used in automobile are recycled aluminum. The recovery of 1t aluminum alloy is more important than the new production of 1t aluminum alloy, and the energy consumption is 95% less than that of the new production, which can save a great deal of energy. The investment of equipment for aluminum alloy processing in automobile industry is much less than that of steel and iron. At the same time, aluminum extruded profile is the main part of automobile aluminum body frame, the solder joint is less, the working order is reduced, the assembly efficiency is improved, and the manufacturing cost is also reduced.

3. Application of aluminum alloy in automobiles

The earliest aluminum was used in cars by Indians, who in 1896 were the first to make crankcases from aluminum. In the early 20th century, aluminum was mainly used in the manufacture of luxury cars and racing cars, and cars with aluminum bodies began to appear, such as Henry Fordundefineds ModelT and the second. In the 1930 s, Ferrari 360 cars on the European racetrack were made of aluminum. During the second world war, the average amount of aluminium per car was only 5. 44 kg, increased to 35Kg in 1971, and the use of aluminium more than tripled in the last 10 years

3.1 Composition and Application of Aluminium Alloy Materials for Automobile

The aluminum alloy used in automobile can be divided into cast aluminum alloy and deformed aluminum alloy. Cast aluminum alloy is the most used in automobile, accounting for more than 80%, which is divided into gravity casting parts, low pressure castings and other special casting parts. Wrought aluminum alloy includes sheet metal, foil, extrusion material, forgings, etc. Although the varieties of industrial aluminum alloy materials are different in the world, they are generally the same. Its variety composition: casting about 80%, forgings account for 1 ~ 3, the rest are processed materials. In the American automobile industry, the deformed aluminum material accounts for a large proportion, reaching 36. 3%.

Casting aluminum alloy is mainly used for manufacturing engine cylinder block.Housing, rear axle housing, steering gear housing, transmission, valve train, engine.Oil pump, water pump, rocker cover, timing gear housing and other shell parts.Motive components and bumper, wheel, engine frame, brake caliper, cylinder.Non engine components such as brake discs.

Wrought aluminum alloy is mainly used for manufacturing body frame, door luggage.Box and body panels, bumpers, hood, wheel spokes, wheels
Cover, wheel outer cover, brake assembly shield,

noise elimination cover, anti lock brake.System, heat exchanger, seat, carriage floor and other structural parts and meters.Decorative pieces such as plates.

3.2 Application of Aluminum Alloy in main parts of Automobile

3.2.1 Body of car

The essence of automobile industry is the manufacture of automobile body, which accounts for almost 60% of the total investment of automobile manufacturing company. According to statistics, the weight of the car body accounts for about 30% of the total mass of the vehicle, so it is very important to reduce the weight of the vehicle body to reduce the weight of the whole vehicle. In the future, the increase of aluminum alloy materials for automobile body manufacturing will be the focus of the development of aluminum alloy in automobile industry. According to KGPundefineds estimate, by 2006, the total demand for aluminum alloys used in body manufacturing by the entire automotive industry worldwide will reach 2.05 million tons.

3.2.2 Hub

Aluminum alloy wheels first appeared in the 1920s, when sand casting was used. After decades of development, solid casting (gravity casting, low pressure casting), forging, aluminum sheet stamping or spinning, extrusion, semi-solid die forging and other manufacturing processes have been developed. The material can be made of wrought aluminum alloy or cast aluminum alloy. The weight effect of the aluminum alloy wheel used in the automobile is obvious. The aluminum alloy wheel used in the light vehicle is 30 ~ 40 lighter than the traditional steel wheel hub, and the medium vehicle can be 30% lighter than the traditional steel wheel hub. The wheel of integral sheet (6061 alloy) produced by Sentlain Tourr Company by split-spinning method reduces the weight of the wheel by up to 50%, and the spinning time is less than 90 seconds / second, and no assembly operation is required. Suitable for mass production. In addition, the compressive strength of aluminum alloy wheels with the same diameter is also improved.

With the increasing popularity of ABS installed in automobiles, the use of aluminum alloy wheels is becoming more and more popular in order to reduce the weight of non-suspension parts and the load of brake system. According to statistics, the utilization rate of aluminum alloy wheels on light vehicles has reached about 50%, and some countries have exceeded 60%.

Aluminum alloy wheels for cars can be roughly divided into integrated and combined two types. The integrated type can be produced by casting or forging. The suitable aluminum alloy is A356.2 or AC4C / H 5052, etc. The rim of the combined (two or three) hub is formed by plate, while the spoke is formed by sheet or forging. Suitable aluminum alloys are 5054-O, 5052-O and 6063-O.

3.2.3 Aluminum alloy heat exchange

Automobile heat exchanger is mainly used to reduce the engine temperature and adjust the ambient temperature of the vehicle. It includes radiator, inner cooler, oil cooler, heater core and air conditioning condenser, evaporator and so on. It requires good welding performance, molding property, corrosion resistance, high strength, high thermal conductivity and so on. American brazing technology without flux was invented in 1967 to solve the brazing problem of aluminum. The properties of aluminum alloy can meet these requirements, so it is widely used in hot interchanger of aluminum alloy. Aluminum radiator is more corrosion-resistant than copper radiator, so it has long service life, 20 ~ 30 lighter mass than copper radiator, high heat exchange efficiency of 12. The cost of processing the two materials is almost equal, but before. The price of the person is much lower than that of the latte.

Before 1940, aluminum alloy materials were used only as auxiliary materials for automobile heat exchangers. In 1990, the amount of aluminium used in automobile radiators and radiator cores reached 68,000 tons. At present, the popularization rate of aluminum alloy radiators on automobile in European countries has reached 100, 65 ~ 75 in America and 30 ~ 40 in Japan. Aluminum alloy heat exchangers have two forms, assembly type and welding type, the latter is superior to the former. The shape of heat exchanger is also changed from serpentine to thin-walled parallel manifold, Durant cup shape, single box shape and so on.

For aluminum materials of automobile aluminum alloy heat exchangers, Japan generally uses materials such as A3003, A6951 and A1050, while the United States tends to use materials such as AA3003, AA3004, AA5005 and AA5052. In addition, aluminum used in automobile heat exchangers in both countries has been specially protected. During the operation of aluminum heat exchanger, corrosion perforation caused by electrochemical corrosion and leakage of coolant from fluid tube often occur. Therefore, during non-high vacuum brazing, a small amount of Zn is added to the heat exchanger material to suppress the corrosion and perforation of the fluid pipe by reducing the natural electrode potential of the radiator, and in high vacuum brazing, Since almost all of Zn evaporates from the radiator during the heating brazing process, a small amount of elements such as Sn in are added to the heat exchanger material, and the anode action is sacrificed according to the corrosion theory. The radiator is used as sacrificial anode to improve the corrosion resistance of aluminum heat exchanger.

2.2.4 Engine

Engine cylinder head, piston, connecting rod, rocker arm and other parts have been following the development of the automotive industry needs, with aluminum alloy materials instead of black metal materials. Almost all modern automobile engine pistons are made of aluminum alloy. The main materials are eutectic aluminum-silicon alloy (AC8A in Japan, SAE321 in the United States, KS1275 MALH E124 in Germany). Gravity casting, liquid die forging, etc. Forging, etc., to make forming. As the main reciprocating parts, the piston reduces the weight by using aluminum alloy. The inertia force is reduced to reduce the counterweight of crankshaft, to increase engine power, to reduce engine vibration, and to reduce noise and fuel consumption.

In general, the engine accounts for about 18 percent of the total vehicle weight, and the engine cylinder block accounts for about 25 percent of the total engine weight. More and more automobile companies apply cast aluminum cylinder blocks. General Motors uses all-aluminum cylinder liners. French cars have a penetration rate of 100 aluminum cylinders and 45 aluminum cylinders. In 2003, Hyundai, South Korea, the United States, Delham Chrysler, Japan Mitsubishi three automobile companies jointly formed a world-class engine alliance, Based on the modern automobile engine, the project is based on a four-cylinder gasoline engine with a displacement of 1.8g / 2.0L, and develops and mass-produces a new type of aluminum engine with low fuel consumption, high power and high cutting edge. Production of 1.5 million aluminum engines a year by a Hyundai U.S. plant is expected to start in March, making it the worldundefineds largest engine base by output.

4. Peroration

The development of automobile industry is closely related to energy, environmental protection and safety. With the development of society and economy, the accumulation of material wealth and the enhancement of the national consciousness of environmental protection, we must objectively seek low energy consumption, low pollution, safety and comfort, good quality and low price. And these are inseparable from its closely linked material industry. After entering the 21st century, facing the severe challenge of the resource and environment, it is still the key to develop the automobile industry to continue to push the automobile lightweight to reduce the fuel consumption. Owing to the complex manufacturing process and high cost, magnesium alloys can not be used in large quantities in the automobile industry in the short term, while the recycling of polymer plastic materials has the problem of environmental pollution. Aluminum alloy has unparalleled advantages in cost, manufacturing technology, mechanical properties, sustainable development and other lightweight materials. Therefore, aluminum alloy will become the preferred lightweight material in automobile industry.

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