Heat-resistant and Non-combustible Magnesium Alloy

Development of engine members using the casting technique of heat-resistant and non-combustible magnesium alloy

In order to achieve higher fuel-efficiency and lower vibration and noise in automobiles, we developed magnesium alloy members having heat-resistance and abrasion-resistance that are usable as engine parts, without using costly materials such as rare earths.

- Challenges
  - Since most of pistons are made of aluminum alloy and the shapes are already optimized, there is no room to reduce weights.
  - To solve friction and seizing problems, tinning and alumite treatment are applied depending on the site and heat load.

- Features
  - Light-weight, high attenuation capacity and low friction coefficient.
  - Higher heat resistance compared with traditional casting alloy (AZ91).
  - Stable supply with low cost due to the recycling technique and no use of rare earths.

We established the production and recycling techniques of heat-resistant casting members using magnesium alloy.

- Development of heat-resistant alloy
  - Hardness: 118HV / Elevated temperature tensile strength: 130MPa (250°C)
  - The hardness of 118HV was achieved by adding silicon to non-combustible magnesium alloy. Also, we established the inclusion control method by calculating the allowable defect size to fulfill the tensile strength of 130MPa.

- Establishment of inclusion control method
  - Thermal fatigue strength: 63MPa (250°C) / No defect at stress concentration point
  - We established the casting method by calculating the allowable defect size to fulfill fatigue strength 63MPa (250°C) at stress concentration point, by evaluating solidified structures through observation and instrumental analysis and by examining the simulation analysis and prototypes.

- Establishment of recycling technique
  - Recycled material use rate is 60%
  - We achieved 60% of recycled materials use rate by applying quality control standards that include oxide inclusion ratio estimated by oxygen analysis, and metal impurities of recycled materials.

- Shape optimization design
  - Reductions of weight, vibration and noise were verified.
  - In the evaluation using actual equipment, the high strength of alloy in high-temperature range was verified. Reductions of weight, vibration and noise were verified and consistent with the theory.
Non-combustible Magnesium Alloy

Features of non-combustible magnesium alloy

Traditional images of magnesium alloy, easy to flammable at low ignition temperature, is now overturned.

- **Lightest**
  - Lightest among practical alloys with a specific gravity of 1.8, about 2/3 of aluminum alloy and 1/4 of steel.

- **Vibration absorption (attenuation capacity)**
  - Having the largest vibration absorption (attenuation capacity) among practical metals, vibration and noise can be successfully reduced.
  - Attenuation capacity: 267 times of Al (in case of pure Mg)

- **Specific strength & Specific rigidity**
  - Possible to produce lighter-weight products for the same specification due to its higher specific strength/rigidity compared with aluminum alloy and steel.

- **Cutting performance**
  - As its cutting resistance is about 1/2 of aluminum alloy and 1/5 of mild steel, reduction of process time and extension of tools lifetime are possible.

- **Non-combustible magnesium alloy products**
  - Ingot
  - Billets for extrusion processing
  - Sand casting
  - Metal mold casting
  - Die-casting

- **Applications of non-combustible magnesium alloy**
  - As a structural material: Interior member of high-speed trains
  - Magnesium air battery (negative-electrode material)

Seeds development by National Institute of Advanced Industrial Science and Technology (Patented)
- Patent-3116806 “Production of calcium-containing magnesium alloy casting”
- Patent-3030338 “Production of high strength Non-combustible magnesium alloy”

Technical transfer
Tobata Seisakusho Co., Ltd.

Taking advantage of its light-weight and high specific strength/rigidity, it is in practical use as a shelf support.

Magnesium air battery has not been realized because of problems including the short lifetime due to self-discharge (a reaction not by battery reaction), ignition risks and high costs. In this project, we are working for the production technique of alloy with high-efficiency and ignition-inhibition features realizing thinner plate thickness and lower costs.