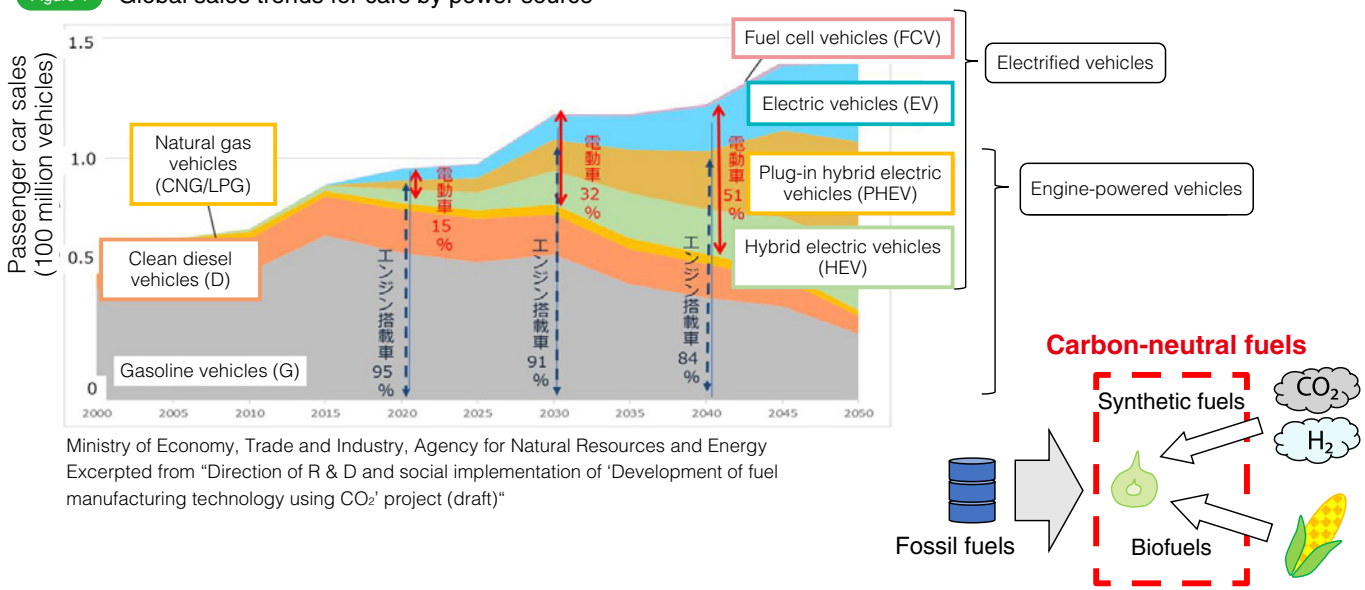
Electric Pump That Works with Carbon Neutral Fuels

1. Overview of the Invention

As shown in Figure 1, the electrification of cars is progressing towards a carbon-neutral society in 2050. Even for engine-powered vehicles, it is expected that there will be a shift toward carbon-neutral fuels, such as synthetic fuels produced by synthesizing CO_2 (carbon dioxide) and H_2 (hydrogen) from fossil fuels, and biofuels that utilize the energy of living organisms. Hybrid electric vehicles (HEV) and plug-in hybrid electric vehicles (PHEV) are expected to account for a large portion of the market.

Figure 1 Global sales trends for cars by power source

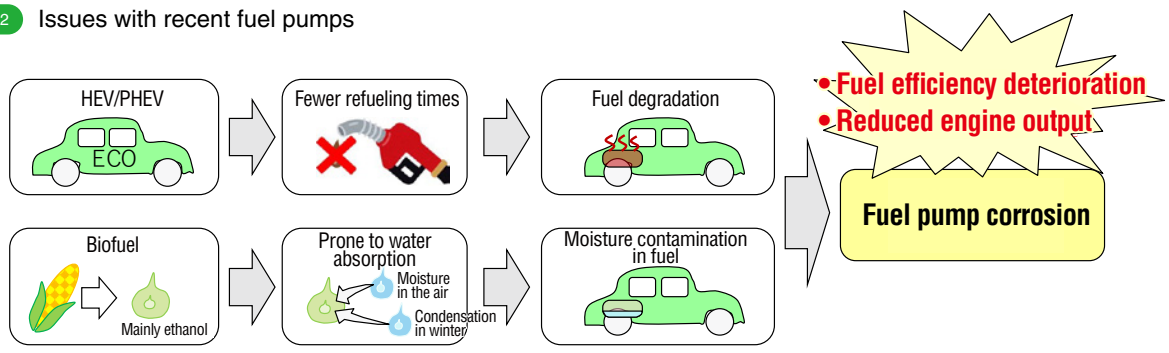


Ministry of Economy, Trade and Industry, Agency for Natural Resources and Energy
Excerpted from "Direction of R & D and social implementation of 'Development of fuel manufacturing technology using CO_2' project (draft)"

In engine-powered vehicles, including HEV and PHEV, fuel pumps are installed to pump fuel from the tank to the engine. As HEV/PHEV and carbon-neutral fuels become more common, fuel pumps need to be able to handle fuel degradation caused by HEV/PHEV, as shown in Figure 2, and moisture contamination caused by biofuel.

As fuel pump corrosion progresses, the fuel pump motor's efficiency decreases, which may result in insufficient fuel supply to the engine. This can lead to poor fuel efficiency and decreased engine output.

Figure 2 Issues with recent fuel pumps



Brushless motor-type fuel pumps consume less power. The most difficult part of their structure to protect against corrosion is the magnet shown in Figure 3.

Neodymium magnets, commonly used in motors, are susceptible to corrosion because iron is their main component. Figure 4 shows ferrite magnets, which are corrosion-resistant. However, they are hard and brittle, making them difficult to attach to the rotor. Additionally, their magnetic force is weaker than neodymium magnets', which significantly decreases motor performance due to the expansion of the clearance between the magnet and the motor core.

Figure 3 Fuel pump cross section

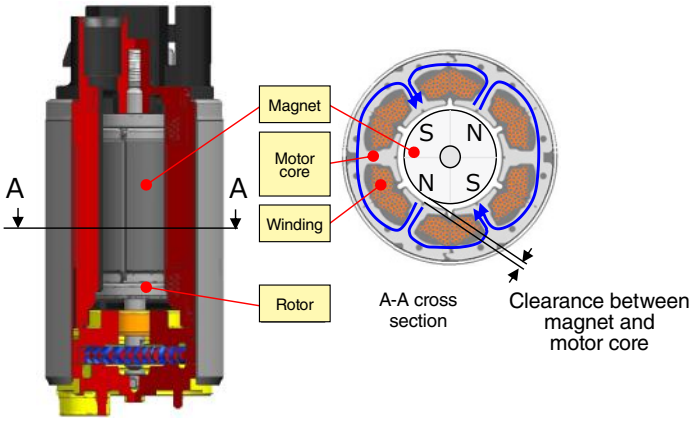
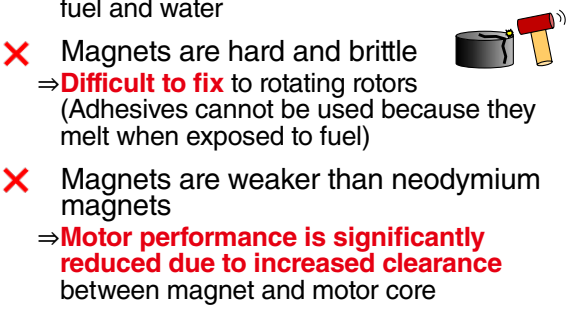


Figure 4 Advantages and disadvantages of ferrite magnets



2. Issues with Conventional Inventions and Development Needs

In conventional inventions, such as those represented by Japanese Unexamined Patent Application Publication No. Hei 6-205572, a small-diameter portion is provided in the magnet. A claw for the elastic member joint portion is attached to this small-diameter portion to hold the magnet in place.

However, this configuration has issues described on the right when doing stable fixation under different conditions.

◆ The elastic member is made of soft material: The claws of the joint portion may deform during the assembly process, or there may be insufficient magnet holding force against centrifugal force during motor rotation. → This may cause the magnet to move, requiring an increase in clearance.

◆ The elastic member is made of hard material: Large press-fit allowance of the elastic member. → There is a possibility that the brittle magnet may break during assembly.

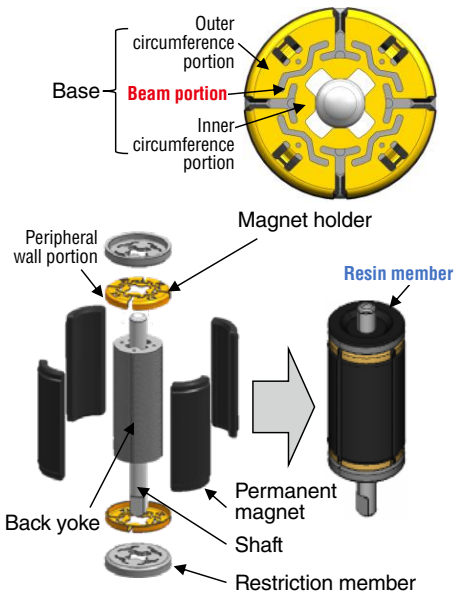
3. Features of the Invention, etc.

The present invention solves the problems of conventional inventions by fixing magnets to the rotor using the method shown in Figure 5.

Configuration (a): Deform the beam portion of the magnet holder and hold the permanent magnet in place with radial biasing force

Configuration (b): Seal the through hole with a resin member. Secure the magnet holder so that it does not move due to centrifugal force when the rotor rotate

Figure 5 Magnet fixing method



Because ferrite magnets are brittle, we designed the magnet holder with a deformable beam section to make it more elastic. This allows the peripheral wall portion to hold the magnet in place without applying force during assembly. After assembly, we sealed the beam section with a resin member in the through hole to prevent further deformation.

The above-mentioned fixing method enables stable assembly even when press-fitting conditions vary during assembly, eliminating the need to increase clearance for corrosion or movement of the magnet.

Consequently, it is possible to achieve high motor efficiency equivalent to that of a motor using neodymium magnets, as well as corrosion resistance of the magnet. (See Figures 6 and 7)

The present invention may generate the following secondary effects:
(1) It eliminates the need for surface treatment and other corrosion prevention measures in fuels containing acidic components or moisture. This reduces the environmental load of waste liquid treatment, etc. (2) It does not use rare earth elements such as neodymium, which are concentrated in specific countries, thereby alleviating supply concerns.

The brushless motor-type fuel pump incorporating the present invention is the world's first fuel pump to comply with standards (without requiring a special surface treatment) for different fuel environments in a carbon-neutral society. Mass production began in 2017, helping to bring about a carbon-neutral society.

Figure 6 Motor efficiency comparison

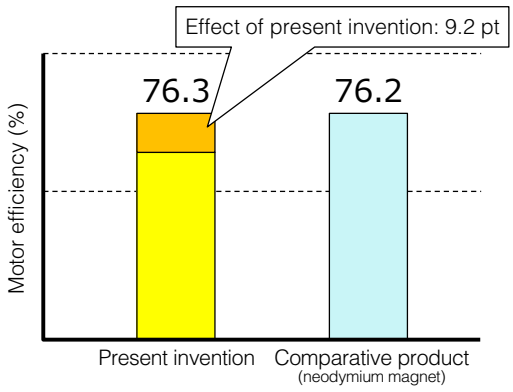
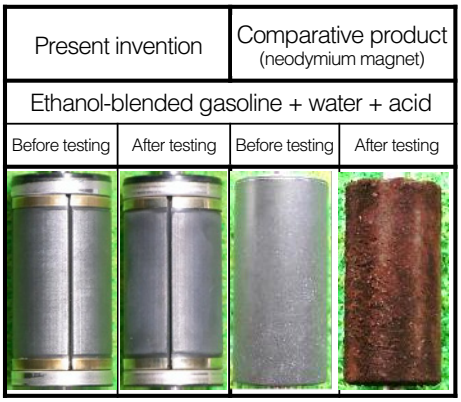


Figure 7 Corrosion comparison results



Award-Winning Achievements

FY2022
Aichi Invention Commendation:
Aichi Invention Award (Aichi Prefecture Invention Association, a General Incorporated Association)
Chubu Region Invention Commendation: Invention Encouragement Award (Japan Institute of Invention and Innovation, a Public Interest Incorporated Association)
FY2024
Chubu Science and Technology Center Commendation:
Promotion Prize (presented by the Public Foundation of Chubu Science and Technology Center, a Public Interest Incorporated Association)