Automotive Applications for Magnetic Materials

Introduction

The magnet is one of many products that modern society takes for granted.
Ask any person today what does a magnet look like? Their reply is usually “red and horseshoe shaped”, this opinion stemming from TV cartoons and from remembered basic school magnetic lessons. In reality, the truth is that magnets are not usually painted red and are anything but horseshoe shaped!

Magnets today are used in a vast array of products from Fridge magnets to Dentistry and from Loudspeakers to Space research. New applications for magnetic materials grow exponentially every few years.

This is certainly true in the Automotive sector. The modern Automotive market demands an increasing degree of sophistication in both the control and comfort of its products. Today’s cars have electric motors for door mirror positioning, window lift, seat positioning, and engine cooling fans. In addition Air Conditioning, ABS and anti-skid, multi speaker radio and CD systems are today not just encountered in prestige products but are fitted as standard on most models. The average modern car contains upwards of two hundred magnets covering all these applications.

In future, Drive by wire, Electrical steering, Braking systems, Climate control, and Headlight positioning, coupled with the planned move to adopt higher voltages in automotive electrics will ensure the dramatic growth trend in Automotive magnetic material usage continues.

Current Applications

Most current applications fall into five broad categories: -

1) **Motor Applications**
2) **Sensing Applications**
3) **Actuators**
4) **Instrumentation**
5) **Loudspeakers**

1.Motor Applications

Typical common applications include

Power steering motors
Starter motors
Alternators
Engine Cooling fans
Windscreen Wipers

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Washer pumps
Fuel pumps
Antenna lift
Window actuation
Heat and Air conditioning motors
Seating position motors
Sunroof motors
ABS pumps
Engine water pumps
Headlight positioning – *Must be used to control the beam height of Gas Discharge Headlamps but could be linked to steering to point in the chosen direction.*

2.Sensing Applications

These include

ABS and anti skid systems
Headlight position
Steering
Road Speed
Inertia sensing (Crash/Airbag)
Throttle
Engine speed (Crankshaft)
Remote locking/unlocking
Tyre pressure sensing
Alarm and security

3.Actuators
Anti skid
Suspension (both active and self leveling)
Throttle
Airbag

4.Instrumentation

Dashboard instruments - *including speed, engine speed, temperature, oil pressure etc.*

5. Loudspeakers

Sound systems
Navigation and information systems
Anti noise system – *currently being used in commercial aviation but could make the transition to Automotive usage in the near future*
Car Alarm Sounders.

Materials Changes

The two materials historically used in Automotive applications are Alnico & Sintered Ferrite.
Alnico (alloys of **Al**-uminium **Ni**-ckel and **Co**-balt) was traditionally used in sensing and instrument applications, but escalating costs of Cobalt mean that other materials are more commonly used today.

Sintered Ferrite arcs are used in DC motors and are therefore probably the commonest material currently in use in Automotive applications. Specific motor grades are available which are able to offer high resistance to highly demagnetizing forces at start up, thus retaining maximum magnetic strength.

Higher strength materials such as Samarium Cobalt alloys have been available for many years, but their high price has precluded their use in all but the most extreme applications. The major development in the past few years has been the availability of cheaper Neodymium Iron Boron magnetic material (NdFeB) both in sintered and bonded types. Although in the last few years of a patent licence, NdFeB can offer competitive pricing. NdFeB can offer up to ten times the magnetic performance of Sintered Ferrite, therefore allowing miniaturization of components with higher efficiencies.

The two drawbacks of NdFeB of temperature stability and corrosion have now been successfully dealt with. The alloying of trace quantities of additional metals to the NdFeB mix has allowed the production of materials able to handle 200°C and at the same time offering increased resistance to corrosion. Plating or coating after production offers maximum corrosion resistance in the most extreme of applications.

Over the past few years there has been much development in Injection or compression moulded magnetic materials offering easy manufacturing of complex shapes and magnetic pole configurations to net shape, without additional machining. In the past, injected Ferrite was successfully developed and today is in common usage. However it is the manufacture of bonded NdFeB that offers the exciting mix of higher performance coupled with lower weight that is expected to be commonly adopted by the Automotive industry in the future.

Today bonded and injected NdFeB grades are available with high resistance to start up demagnetization forces, allowing the material to easily replace Sintered Ferrite Arc segments in motors. This is probably the largest application sector in the Automotive market, and bonded NdFeB could offer both significant weight saving (and/or miniaturization), coupled to higher performance.

The Future

The Magnetic material industry will continue to develop new grades and materials to specifically suit the Automotive industry. This will allow the industry to meet the increasing pressure from manufacturers to design more efficient, lower weight high performance components. As we enter the 21st century we can expect the total number of magnets per car to at least double if not treble in the next few years.

Although I have mentioned the proposed change of voltage from 12 to 42 Volts, this change will have the single biggest impact for many years on the use of magnetic materials in Automotive components. It is expected that the prestige manufacturers will begin to offer this improvement by the end of 2002 early 2003. The change would allow the use of combined starter-generators, saving the weight of one of the bulkiest components and providing a much more efficient starting system. The increased voltage will also allow full electric steering to replace the current heavy hydraulic system of assisted rams and engine driven hydraulic pumps.

The 42 Volt system also offers great advantages in networking the controls of the car and the extra performance will allow further multiple engine measurements to be carried out to improve combustion, improve fuel efficiency and reduce emissions. This will mean totally new types of sensor probably utilizing the latest magnetic materials such as multi pole bonded or injection molded Ferrite or NdFeB.

Another exciting new Automotive application is the influence of a magnetic field in the combustion chamber of petrol engines. The magnetic aligning of the fuel charge molecules in the combustion chamber has been known to produce positive effects for many years. Some of the largest companies in the industry have researched this phenomenon over many years, but it is only with the emergence of low cost sintered NdFeB that the magnetic field can be produced effectively.

In short, the future for magnetic materials for Automotive applications shows great potential, with considerable growth forecast. The magnetic material industry has to keep up with the Automotive industry’s considerable technical demands for the future with both new material and applications. Component manufacturers should take care when selecting magnetic material suppliers and chose partners that can not only offer good quality at competitive pricing, but also offer strong technical and application backup.