Magnet Technology Compact

Current Applications and Technologies with Permanent Magnets

01/2024

Chip trap magnets in transmissions

Chip trap magnets have been used successfully in oil pans and oil drain plugs in cars for decades. Traditionally, AlNiCo[1] alloys and sintered hard ferrites have been used for this. For years, Magnetfabrik Bonn has been supplying plastic-bonded magnets for this purpose. Plastic-bonded magnets have weaker fields due to their material, but their ability to capture debris is higher since, due to the surface and lattice-like geometry of the component, the ferromagnetic debris is held securely for the entire service life of the part.

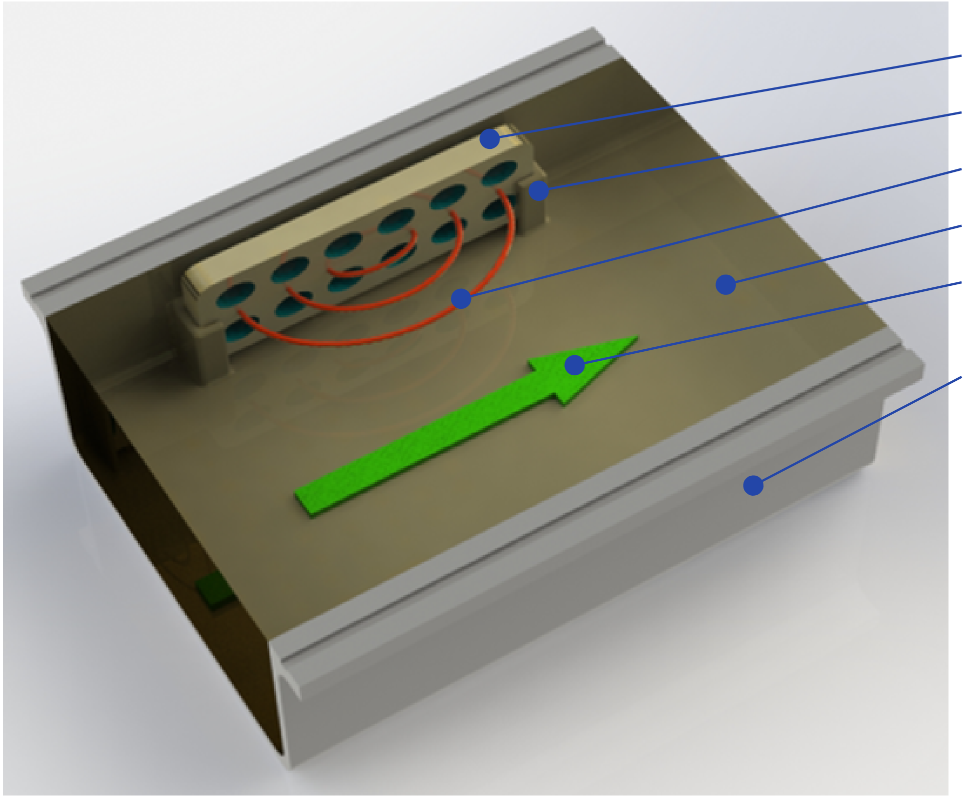

Figure 1: How an oil pan chip trap magnet works

1 Aluminium-nickel-cobalt

Magnetfabrik Bonn GmbH
Dorotheenstraße 215 • 53119 Bonn • Deutschland
Telefon +49 228 72905-0
verkauf@magnetfabrik.de • www.magnetfabrik.de

Even the earliest permanent magnet applications made use of the forces between magnets and iron particles. For decades, magnets have been used in the form of separation magnets or magnetic separators to remove iron parts from liquids or loose solid masses. One logical development of this filter technology was to protect machines using separators which remove iron chips from flushing liquids and lubrication oils.

Chip trap magnets work in a similar way and are becoming an effective method for removing metallic contaminants with a size of up to 30 µm which form due to transmission wear, for example. The capture performance of these magnetic components in comparison with conventional solutions mentioned above can be multiplied by a magnetic grid structure which is tailored to this application.

Magnetfabrik Bonn invented plastic-bonded permanent magnets for applications of this kind and has successfully positioned itself as a designer and producer of complex chip trap magnet shapes. Affordable, cost-effective solutions using polymer-bonded hard ferrite magnets are used to replace traditional sintered ferrite plates and AlNiCo designs.

Details:

Figure 1 shows a functional example of how the product works. A cut-out of a plastic container for a lubricating medium can be seen with a chip trap magnet attached it. In this application, the medium flows past the chip trap magnet in the direction indicated by the arrow. The chip trap magnet permanently filters out and captures the ferromagnetic particles which flow past it. This solution offers better cost-effectiveness and performance than sintered magnets. Our objective is to work with customers to optimise the design and realisation of the capture performance and assembly requirements of such applications. Plastic-bonded magnets can be used successfully for decades if treated properly. We've now supplied more than one billion magnets in the automotive industry; customer satisfaction is overwhelming.

Figure 2 shows the commonly used types of chip trap magnets. While the plastic-bonded magnet can be given an open-pore structure, somewhat like a sponge, it is more cost-effective to retain a block shape for the sintered magnet for production reasons and for the sake of its stability. Magnetfabrik Bonn favours the use of plastic-bonded permanent magnets, since they have a whole range of advantages. A comparison of the two types illustrates this:

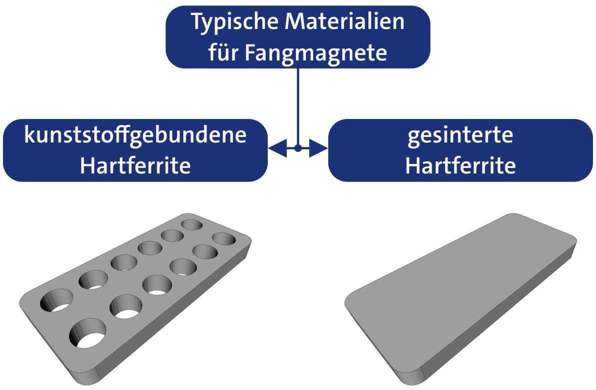

Figure 2: Magnets from two different material classes

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verkauf@magnetfabrik.de • www.magnetfabrik.de

In comparison with plastic-bonded magnets, **sintered hard ferrite magnets** are generally more brittle. This means that they are more prone to damage during transport, installation and other handling (low mechanical resilience). In addition, material-related cracks and chipping can be expected on sintered magnets. As a result, the scrap rate during production and finishing is higher. There is also a risk of an increased degree of contamination (chipping of the magnet itself, production residue from the sintering process), which can cause problems during finishing and cause the cleanliness requirements of the automotive industry to not be met. For geometries more complex than a closed, rectangular magnet, post-processing is required after sintering, and some geometries are not technically achievable at all. Moreover, the process is such that the tolerances are large without post-processing work, and significantly smaller tolerances can be achieved with plastic-bonded chip trap magnets. – To sum up: Sintered magnets are not ideal for automated processing.

Due to their plastic content, plastic-bonded chip trap magnets have a weaker magnetic field and therefore a reduced magnetic force to act upon magnetic contaminants. Despite this, their capture performance in liquids is significantly higher. This has been demonstrated in a large number of experiments using different shapes by measuring the weight of the retained debris following a dwell time in a contaminated oil flow. Particularly over longer periods of time, the capture performance is more than double that of sintered magnets of the same size. Two effects explain this:

First, it is not the absolute value of the particle retention force which is relevant; rather, it is its interaction with the flushing force in the flowing medium which counts. The surface properties of the magnet and lattice-like structure with open pockets mean that the debris to be filtered is retained optimally just like dirt in the open pores of a sponge and is no longer exposed to the force of the flowing medium. Further, the microscopic surface structure of the magnet flushes the particles into the collection chambers rather than away from the magnet. This is why not all chip trap magnets are the same. Behind each development is an optimisation which can only partially be illustrated by a detailed drawing (see Figure 3).

Second, the holding force results not only from the field strength but also from the spatial variation of the field. Extremely high fields and field gradients arise on mechanical edges, meaning that the absolute holding force here locally exceeds that of a block-shaped sintered magnet, too.

If you compare sintered magnets with injection-moulded plastic-bonded magnets, the density difference of commonly used material blends alone offers a weight saving of around 30% for the same volume. In addition, the part volume is reduced by the collection pockets. This results in a cost-effective saving on material and an improved energy and carbon footprint. The injection moulding process allows plastic-bonded chip trap magnets with complex geometries to be produced at a high process capability level with a fault rate of zero. Thanks to the pockets, the trapped iron particles are captured and held in place better. Practically any desired geometry can be produced, allowing the magnets to be adjusted to suit commonly used fixation methods so that they can be installed in a more cost-effective manner. In addition, the injection moulding process enables smaller tolerances without post-processing work. Due to the plastic matrix, the component is more ductile and has a higher mechanical resilience than a sintered magnet. Moreover, the magnet will not chip or burst, causing contamination and preventing further processing. These advantages make handling and processing options easier and more versatile. A closed process without post-processing work allows high cleanliness standards to be reached (in order to meet typical cleanliness requirements of the automotive industry). In existing processes, Magnetfabrik Bonn achieves a scrap rate of 0 ppm.

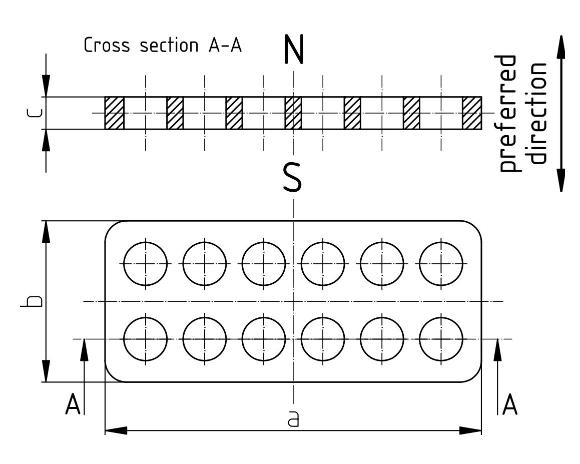
Plastic-bonded hard ferrites	Sintered hard ferrites
Versatile geometries	Only simple geometric shapes are possible
Low material requirement	High material requirement
Scrap rate ≈ 0 ppm	High scrap rate
Low degree of contamination	High degree of contamination
Lower weight	Higher weight
No cracks or chipping	Typical material-related chipping
Ductile magnet due to plastic matrix	Low mechanical strength, brittle
Small tolerances without post-processing	Large tolerances or need for expensive grinding for production reasons

Table 1: Comparison of material classes

Our know-how in this area results from many years of experience in the production and use of these plastic-bonded chip trap magnets.

Table 1 provides a list of the advantages of plastic-bonded hard ferrite magnets in comparison with sintered magnets.

Figure 3 illustrates how our plastic-bonded chip trap magnets can look in principle. See the table for common installation dimensions. Generally speaking, our magnets are magnetised in the preferential direction and have holes or cut-outs. We are able to provide samples on request and after consultation.



Variant	a	b	c
1	55 mm	22 mm	3 mm
2	65 mm	13 mm	3 mm

Figure 3: Geometry and dimensions of available prototypes

We'd be happy to work with you to develop your perfect magnet solution.

Reaching our goals together! Set us your challenge!

magnetfabrik bonn

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