MAGNETIC MATERIALS

All material shows some magnetic effects. In many substances the effects are so weak thatthe materials are often considered to be non magnetic.

A vacuum is the truly nonmagnetic medium.

DIAMAGNETIC:

In diamagnetic materials magnetic effects are weak. Atoms in which the small magnetic fields produced by the motion of the electrons in their orbit and those produced by the electron spin combine to produce a net field of zero.The fields produced by the electron motion itself in the absence of any external magnetic field.

This material as one in which the permanent magnetic moment m_0 of each atom is zero.Such a material is termed diamagnetic.

PARAMAGNETIC:

In paramagnetic materials the magnetic moments of adjacent atoms align in opposite directions so that the net magnetic moment of a specimen is nil even in the presence ofapplied field.

FERROMAGNETIC:

In ferromagnetic substance the magnetic moments of adjacent atoms are also aligned opposite, but the moments are not equal, so there is a net magnetic moment.

It is less than in ferromagnetic materials.The ferrites have a low electrical conductivity, which makes them useful in the cores of acinductors and transformers.

Since induced currents are less and ohmic losses are reduced. There are a number of elements that are attracted by magnets, commonly referred to as ‘magnetic’. These are the same materials that can be magnetised to create permanent magnets, Here you can see a list of magnetic elements and minerals:

Magnetic materials are categorised as magnetically hard, or magnetically soft materials. Magnetically soft materials are easily magnetised but the induced magnetism is usually temporary. For example, if you rub a permanent magnet along a nail, or a screwdriver, the nail or screwdriver will become temporarily magnetised and will emit their own weak magnetic field. This is because a large number of their iron atoms are temporarily aligned in the same direction by the external magnetic field.

Like magnetically soft materials, magnetically hard materials can be magnetised by a strong external magnetic field, such as those generated by an electromagnet. The difference being that magnetically hard materials will remain magnetised indefinitely, unless they are demagnetised by an opposing magnetic field, raised above their curie temperature or allowed to corrode. Magnetically hard materials are used to create permanent magnets made from alloys generally consisting of varying amounts of iron, aluminium, nickel, cobalt and rare earth elements samarium, dysprosium and neodymium. The strongest permanent magnets are known as neodymium magnets and are made from an alloy of neodymium, iron and boron. Permanent magnets are difficult to magnetise as unlike magnetically soft materials their atomic magnetic domains aren't easily aligned but once they are aligned, they remain so indefinitely.

Because all materials have a different atomic structure different materials react differently when placed in a magnetic field. In its simplest form, the magnetic behaviour of a material is determined by its number of unpaired electrons in each atom. In the atoms of most elements electrons exist in pairs with each electron spinning in a different direction causing them to cancel out each other's magnetic field, therefore no net magnetic field exists. However, some materials have unpaired electrons which will generate a net magnetic field and therefore have a greater reaction to an external magnetic field. Most materials are classified either as ferromagnetic, diamagnetic or paramagnetic.

Ferromagnetic materials have some unpaired electrons in their atoms and therefore generate a net magnetic field, albeit a very weak one. This is because the individual atoms or groups of atoms, known as magnetic domains, are randomly aligned cancelling each other out. When an external magnetic field is applied to the ferromagnetic material the individual domains are forced into alignment which they maintain once the external field is removed therefore maintaining their magnetism, known as remanence. Iron, nickel and cobalt are all ferromagnetic materials.

Diamagnetic materials repel any externally applied magnetic field. This occurs because their magnetic domains realign to oppose an externally applied magnetic field when influenced by a magnetic field. All materials show some diamagnetic properties, however, in most materials the effect is extremely weak and unnoticed. All the electrons within the atoms of diamagnetic materials are paired, therefore they do not generate their own net magnetic field. Most elements in the periodic table are diamagnetic.

Paramagnetic materials have a small susceptibility to magnetic fields meaning that they are slightly attracted by a magnetic field. However, unlike ferromagnetic materials they do not maintain their magnetic properties once the external magnetic field is removed. Most elements are paramagnetic, however, because their attractive

force is many thousands of times weaker than ferromagnetic material they are also generally considered as ‘non-magnetic.

Neodymium magnets are the strongest magnets available and therefore have a high power to volume and weight ratio. Because they are so strong it also means they have a relatively low cost per unit of strength (Maximum Energy Product, MGOe). They have an incredibly high resistance to being demagnetised but generally have low maximum operating temperatures compared to other materials and are susceptible to corrosion if their coating is damaged.

Other grades of neodymium magnet, including special high maximum operating temperature grades are available. For more information regarding the properties of grades not mentioned above, please refer to our neodymium magnet grades.