



Engineering the correct Magnetic Level Indicator for your specific application

MAGNETS

Modern permanent magnets are made of special alloys that have been developed through research in order to create increasingly better high performance magnets. The most common families of magnet materials today are made out of Aluminum-Nickel-Cobalt (Alnico), Strontium-Iron (Ferrites, also known as Ceramics), Neodymium-Iron-Boron, and Samarium-Cobalt. (The Samarium-Cobalt and Neodymium-Iron-Boron families are collectively known as the Rare Earths).

As a manufacturer of Magnetic Level Indicators, we are occasionally surprised by the claims made by other manufacturers. We assure you the physical properties of existing magnetic materials are well known, and therefore we would like to take this opportunity to clarify our position on float magnets. As the MLI product we provide is engineered for a specific application, we take the same approach with magnets. There is no “magic” type of super magnet that is good for all applications. All types have strength and weaknesses. We encourage you to be wary of statements like “ We use rare earth magnets for all our applications”. Orion’s approach is to use the right magnet for the application. In some cases that would be Alnico, and in others it could be Samarium Cobalt.

Have a look at the attached chart, and you will see many of the popular magnet types available. While maximum temperature can vary from source to source, this chart represents typical characteristics. For many MLI applications Alnico 5 is a great choice. A large percentage of the mag gauges we sell, are installed at elevated temperatures. Alnico 5 is typically good to 1000°F, offering temperature characteristics better than any other permanent magnet. This allows us to confidently offer a five year warranty on floats using this magnet. Compare this with a neodymium 30 (rare earth) magnet with a maximum of only 175°F and you can see the range of trade off involved. In a small number of applications under limited circumstances we may use a rare earth magnets such as Samarium Cobalt. These high energy magnets offer higher flux fields for applications where you need to penetrate very thick pipe walls and heavy external insulation, and can accept the limited temperature capability and reduced life. In some of these rare earth magnet applications, our five year float warranty may need to be de-

rated. All MLIs use permanent magnets, but as you can see, under elevated process conditions some are more permanent than others. An area of caution to the use of Alnico magnets, are high magnetic fields from other sources that could start to demagnetize the magnet. However in MLI applications this causes other problems as well, so they are not applied in this type of application.

An additional advantage of Alnico, is that the material is easily magnetized after assembly and completion of the float. Rare Earth magnets on the other hand must usually be pre magnetized and have the potential to present issues when welding the float together.

Do not confuse a magnets Curie temperature with it's maximum temperature rating. Curie temperature is the point at which there is non-recoverable damage to the magnet i.e. you cannot re-magnetize it. Reduction in the magnetic field, and failure of the MLI occurs at temperatures much lower that the Curie point.

When evaluating magnets that will be used under process conditions in an MLI, it is important to understand, that more field strength is not necessarily better. Good engineering practice requires balancing the magnetic field strength for the application. For example, if too high a field strength is used, significant hysteresis can be observed due to additional friction between the float and chamber wall. This results in reduced float life, reduced buoyancy safety factor, and excessive attraction to the flag or shuttle magnet outside the bridle.

Perhaps excessive flux field strength (rare earth magnets used, where they are not needed) is just used to cover up other deficiencies in the design, such as a weak magnetostrictive transmitter that lacks sensitivity and needs an unusually high field strength to work.

We feel it is important for users of ORION mag gauges to understand that you do not have to know a thing about magnets to use our product. We have our engineers do all the work for you. However an increased technical understanding may help you see through some of that "marketing noise" out there.

For the more technical types please read on, and check out the many third party web sites (some are listed below) with helpful magnet information.

You may also contact Allen Shoemake, Orion's Engineering and Quality System Manager, at 1 866 556 7466, or email to ashoemake@orioninstruments.com, with any questions you might have on this subject.

<http://www.adams-magnetic.com/>

<http://www.dextermag.com>

<http://www.magnetapplications.com/USA/home.htm>

Courtesy of Adams Magnetics

Magnetic Properties

MATERIAL	Maximum Energy Product	Residual Flux Density Br Gauss	Coercive Force Hc Oersteds	Maximum Operating Temperature (C) / (F)	Temperature Coefficient % Loss/C
	BHmax				
Standard Energy Flexible 0.65	0.65	1600	1370	80/175	0.190
High Energy Flexible 1.1	1.1	2200	2000	80/175	0.190
High Energy Flexible 1.6	1.6	2650	2200	80/175	0.190
Ceramic 1	1.0	2300	1860	400/750	0.129
Ceramic 5	3.4	3950	2400	400/750	0.190
Ceramic 8	3.5	3900	2950	400/750	0.190
Sintered Alnico 2	1.7	7100	560	540/1000	0.015
Sintered Alnico 5	3.9	10900	620	540/1000	0.007
Sintered Alnico 8	4.0	7400	1500	540/1000	0.007
Cast Alnico 5	5.5	12800	640	540/1000	0.013
Cast Alnico 8	5.3	8200	1650	540/1000	0.013
Samarium Cobalt 18	18	8500	800	260/500	0.030-0.045
Samarium Cobalt 26	26	10500	9200	350/660	0.015-0.030
Samarium Cobalt 32	32	12000	11000	350/660	0.015-0.030
Neodymium 27	27	10500	10000	100/212	0.09-0.130
Neodymium 30	30	11400	10400	80/175	0.090-0.130
Neodymium 35	35	12000	11300	80/175	0.090-0.130
Neodymium 40	40	12900	12300	150/300	0.090-0.130
Neodymium 45	45	13700	13000	150/300	0.090-0.130

These are nominal values based on manufacturers' specifications. Actual values may vary based on geometry of material and the circuit in which it is used.

ALNICO

- **High saturation values**
- **Excellent thermal stability**
- **Good corrosion resistance**

Alnico is from the family of magnets that was the first to be developed, becoming commercially available in the early 1900's. The most common production method is by casting, although the powder metallurgy sintering process is particularly suitable for small and more complex parts. The limited resistance to demagnetization in the presence of high magnetic fields, and cost of the base alloy are considerations in its use. However, there are specific advantages which make it the ideal choice in certain critical applications.

The Curie Point is significantly higher than for all other permanent magnet materials enabling it to be used at elevated temperature. The losses in flux density when heated are both very low and predictable. It is also considered to have excellent corrosion protection.

RARE EARTH

- **High energy**
- **High coercive force**

The first of these alloys SmCo₅, was discovered in the 1960's and represented an enormous leap forward in available magnetic properties. This was followed in 1983 by the announcement of NdFeB which since that time has led to a doubling of the properties of the SmCo grades. The "rare earth" element is from the Lanthanide group and the description is a misnomer; both Samarium and Neodymium are much more prevalent in the earth's crust than for example Lead. The most common method of production is by the powder metallurgy process, with field alignment during pressing; the resulting compact will nearly always require machining to size.

Although NdFeB is lower cost and has a higher energy, there are many applications for SmCo due to improved temperature performance and corrosion resistance. Both are extremely difficult to demagnetize but handling and assembly can be problematic as they are both brittle and fragile making them susceptible to chipping and breakage.

SmCo exhibits good resistance to corrosion but for NdFeB, due to the high Iron content, it is recommended to coat the parts.

Magnet FAQ

How permanent is a magnet ?

If a magnet is stored away from power lines, other magnets, high temperatures, and other factors that adversely affect the magnet, it will retain its magnetism well beyond 100 years.

Will magnets lose their power over time?

Modern magnet materials do lose a very small fraction of their magnetism over time. For Samarium Cobalt materials, for example, this has been shown to be less than 1% over a period of ten years.

What might affect a magnet's strength?

The factors that can affect a magnet's strength are:

Heat

Radiation

Strong electrical currents in close proximity to the magnet

Other magnets in close proximity to the magnet

(Neo magnets will corrode in high humidity environments unless they have a protective coating.)

Shock and vibration do not affect modern magnet materials, unless sufficient to physically damage the material.