

## Permanent Magnet Materials

### Basic Technical Questions

#### *What is a permanent magnet ?*

As the name suggests it is a magnet that exhibits magnetism without the provision of any electrical windings (unlike “soft magnetics” made by other MMG companies)

#### *What types of material are there ?*

There are a great many different materials, these are the main commercial materials in order of power or strength: -

<b>ALNICO</b>	ALuminium NICKel and COBalt alloys.	<i>Medium cost</i>
<b>Ferrite</b>	Usually Strontium Ferrite but could be Barium Ferrite	<i>Lowest cost</i>
<b>Samarium Cobalt (SmCo)–</b>	A first generation rare earth magnet	<i>Tends to be expensive</i>
<b>Neodymium Iron Boron</b>	(Neo or NdFeB) A second-generation rare earth magnet	<i>Between Alnico and SmCo in cost</i>

#### *What is meant by Anisotropic and Isotropic magnets?*

Anisotropic magnets have the magnetic axis determined at the pressing stage of manufacture. Once this has been carried out the axis cannot be changed. Isotropic magnets have no preferred axis and can be magnetized in any direction.

[Isotropic magnets will always exhibit lower magnetic performance when compared to Anisotropic].

## *How is a magnet's magnetic performance measured?*

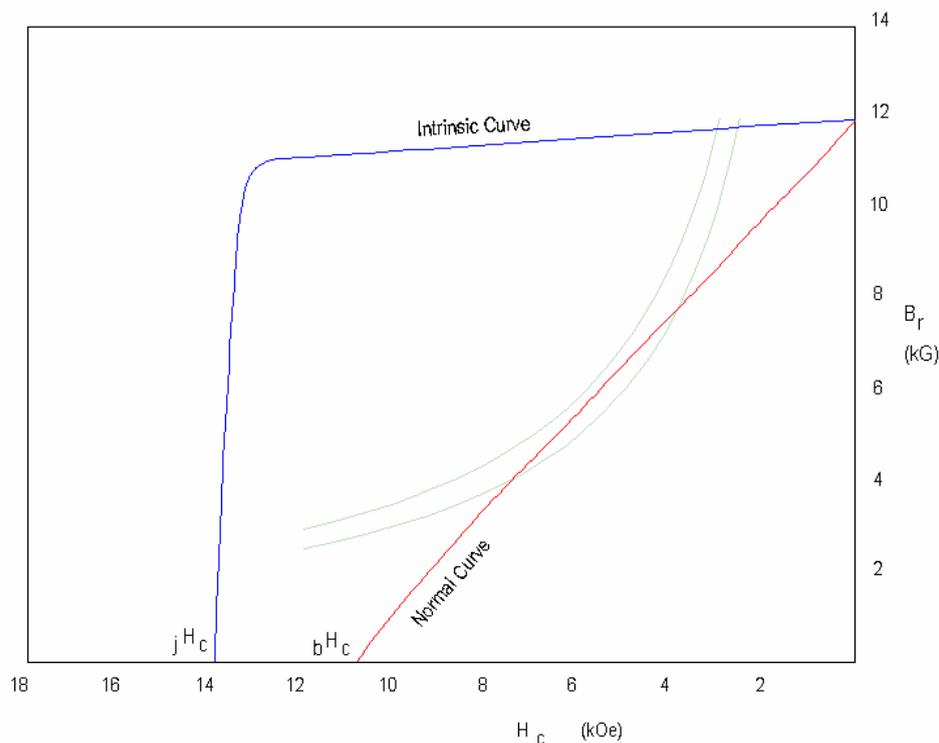
### 1. Flux or Gaussmeter

Using a Hall effect probe - a measurement of magnetic flux density in a given position.  
*This is not usually quoted by suppliers or users.*

### 2. Demagnetization Curve

This is the absolute performance of any magnetic material and will be found in all manufacturers data or in the MPPA or DIN standards.

Second Quadrant Demagnetisation Curve for NdFeB grade N33H.



#### Main points are:

1. Remanance ( $B_r$ ) measured in Gauss or Tesla – In this case 12kG

2. Coercivity ( $bH_c$  – Normal Coercivity,  $jH_c$  – Intrinsic Coercivity) measured in Oersteds or  $kA/m^2$  In this case:  $bH_c = 10.8$  kOe

$jH_c = 14$  kOe

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Normal coercivity is the applied field required to reduce the external field generated by the magnet to zero.

Intrinsic coercivity is the applied field required to fully demagnetize the material.

3. **BHmax** – maximum energy stored within the magnet – *measured in MGOe or kJ/m<sup>3</sup>*  
In this case 33MGO

A simple way to remember the Demag curve points

*Think of it as a ski slope !*

- The top of the hill is Remanence (Br)
- The bottom of the hill is Coercivity (bHc or jHc)
- Where the sharp drop starts is the BHmax.

Some material comparisons

Material	Br kG	BHc kOe	jHc kOe	BHmax MGOe	Comments
ALNICO 5	12.6	0.65	0.63	5.4	
FERRITE C8	3.7	3.0	3.25	3.3	
SmCo 2:17	10.3	7.5	12.0	24	7 times stronger than Ferrite C8
NdFeB N35	12.1	11.4	12.0	35	Over 10 times stronger than Ferrite C8