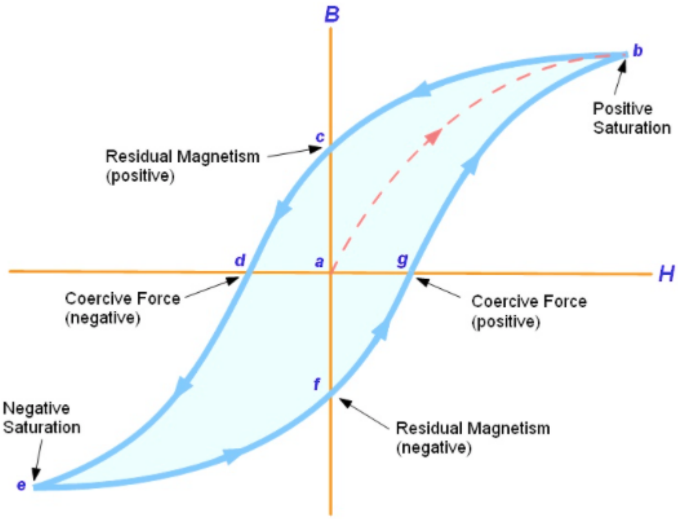
Basic Information about Magnets

- BH Characteristics

When tested experimentally, a ferromagnetic material such as iron will produce a curve similar to that shown above. Firstly, notice that here is an upper/lower limit to the magnetic flux density which may be achieved, which occurs at positive or negative saturation, respectively. This is related to the crystalline structure of the iron, where each crystal has its own – initially random – magnetic orientation. Increasing the magnetic field strength in either direction causes more and more magnetic 'domains' to align with the external magnetic field, but once almost all of the domains have aligned themselves, then little further increase in magnetic flux density is possible. The ferromagnetic material is said to be saturated.



A second key observation is that the curve demonstrates magnetic *hysteresis* or 'lag' as the sample is alternatively magnetized in the positive and negative directions. When initially magnetized, the curve follows points *a*–*b* on the graph, but on reducing *H* to zero, some residual magnetism remains (point *c* - also known as the *remanent flux density*). In order to fully demagnetize the specimen, it is necessary to apply a negative magnetic field strength (point *d* - called the *coercive force*). Making *H* increasingly negative leads to negative saturation (point *e*). If *H* is reduced back to zero, point *f* is reached (negative residual magnetism). As *H* becomes positive, the flux density reduces to zero (point *g*) and then becomes positive, finally returning back to point *b* (positive saturation), after which the cycle *b*–*g* repeats.

The area enclosed by the B-H curve (shaded light blue above) is proportional to the energy loss as the ferromagnetic material is magnetized with varying polarity by connection to an alternating (AC) power supply. This energy loss is undesirable and causes unwanted heating of the material. In general, harder ferromagnetic materials have higher hysteresis losses, since more energy is required to realign the magnetic domains. Steel, to which a small proportion of *silicon* has been added, is commonly used for applications such as transformer cores and motor rotors, due to its lower hysteresis loss. For smaller applications, such as inductor cores, passive filters, miniature transformers and antennas, then *ferrite* (a ceramic-like combination of metallic oxides including ferric oxide) is a popular choice.