Zach Blankenship

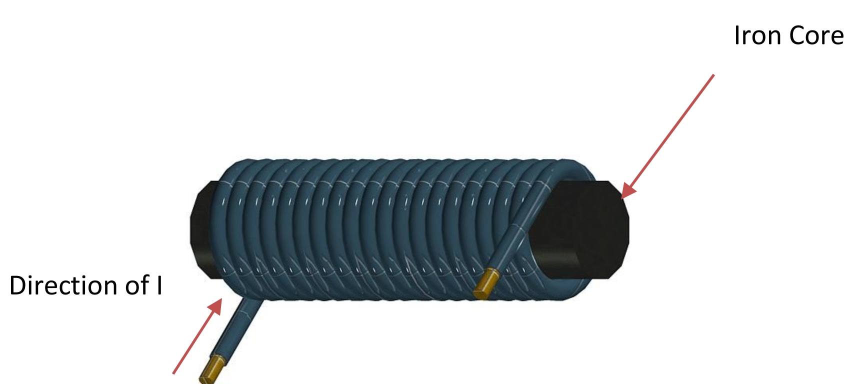
Cedric Horvath

20 April 2009

Electromagnet

Electromagnets are solenoids which have soft iron cores instead of an air core. They are hideously useful for many industrial tasks because they can be turned on and off with a switch and can hold immense amounts of weight. To build an electromagnet take an iron core and wrap it with as many turns of wire as possible insuring they are in the same direction and hook it up to a current.

The physics behind and electromagnet involve the magnetic field created by a solenoid and is then amplified by the iron core. Iron cores can amplify the magnetic field by up to 200 times the original solenoid's field. The solenoid generates a magnetic field by running a current through a wire that is wrapped around it. The current creates a field and because of the shape of a solenoid the field in the center of the solenoid will all be in the same direction. The magnetic field of a solenoid is given by the equation $B = n\mu_0 I$. Where n is the turns per unit length, μ_0 is permeability of free space constant and I is the current being run through the wire. For an electromagnet this field is then multiplied by a constant depending on the core composition.



Originally 3 electromagnets were built on steel bolts to test the affects of having larger wire wrapped around the bolt instead of more turns. The electromagnets were build using 30 gauge, 26 gauge and 22 gauge wire. The 30 gauge wire was originally expected to do the best because it maximized the turns per unit length, but in the end the 22 gauge wire was able to hold 234% more than the 30 gauge wire and 171% more than the 26 gauge wire. Based on this the real electromagnet was built using the 22 gauge wire. This electromagnet weighting 7lbs was able to hold 25 lbs (possibly more) at 7 amps with approximately 426 turns of wire and 24 cm.

In the lab the magnet was tested at 5 amps to be creating a .3T field. From this one can calculate the constant that the iron core is amplifying the field by.

$$B = n\mu_0 I(K) \qquad .3T = \frac{426}{.24m}(\mu_0)(5A)(K)$$

$$K = \frac{.3T}{\frac{426}{.24m}(\mu_0)(5A)} \qquad \text{K=26.899}$$

At 7 amps we can predict that the field generated will then be.

$$B = \frac{426}{.24}(\mu_0)(7A)(26.899)$$

$$B = .4199T$$

Source	1 9V	2 9V	3 A current	5A current	7A current
22 gauge electromagnet	89 washers	The 22 gauge bolt	7 lbs	13lbs Self+ 6lbs	25lb weight
30 gauge bolt	41 Washers	____________	____________	____________	____________
26 gauge bolt	56 Washers	____________	____________	____________	____________
22 gauge bolt	96 Washers	____________	____________	____________	____________

This table depicts the maximum weights tested successfully, but it is possible that more could be held depending on the shape and composition of the object.

To improve the electromagnet one could use a soft iron core instead of a steel core as this would amplify the field many times more. One could also use more current as current is very important to the overall operation of the electromagnet. Also more turns would have improved the magnetic field, but more turns does not out weight more current. This is caused by the massive resistance of the smaller wire, 30 gauge wire per 1000ft has a resistance of 103.2Ω compared to 16.14Ω per 1000ft in 22 gauge wire.

This project successfully gave insight into how to build a successful electromagnet through building smaller ones. Then a bigger electromagnet was constructed with this knowledge and was able to hold 25 lbs in lab.

Works Cited

Stewart, John and Gay Stewart. *UP II Fall 2008 Course Guide Part II: Magnetism*. Fayetteville: John and Gay Stewart, 20 April 2009.

"Wire Gauge and Current Limits." PowerStream. 20 Apr. 2009 <http://www.powerstream.com/Wire_Size.htm>.

Picture Taken from http://upload.wikimedia.org/wikipedia/commons/9/91/Simple_electromagnet.gif