Related topics

Induction, magnetic flux, coil, magnetic field strength, magnetic field of coils, remanence, coercive field strength.

Principle

A magnetic field is generated in a ring-shaped iron core by a continuous adjustable direct current applied to two coils. The field strength H and the flux density B are measured and the hysteresis recorded. The remanence and the coercive field strength of two different iron cores can be compared.

Equipment

2	Coil, 600 turns	06514-01
1	Iron core, U-shaped, solid	06491-00
1	Iron core, solid	06490-00
1	Iron core, U-shaped, laminated	06501-00
1	Iron core, short, laminated	06500-00
1	Commutator switch	06034-03
1	Power supply, universal	13500-93
1	Hall probe, tangent., prot. cap	13610-02
1	Barrel base -PHYWE-	02006-55
1	Right angle clamp -PHYWE-	02040-55
1	Support rod PHYWE, square, *l* = 150 mm	02025-55
2	Connecting cord, l = 250 mm, red	07360-01
1	Connecting cord, l = 250 mm, blue	07360-04
1	Connecting cord, l = 500 mm, red	07361-01
2	Connecting cord, l = 500 mm, blue	07361-04
1	Cobra4 Wireless Manager	12600-00
2	Cobra4 Wireless-Link	12601-00
1	Cobra4 Sensor-Unit Electricity	12644-00
1	Cobra4 Sensor-Unit Tesla	12652-00
1	Software Cobra4 - multi-user licence	14550-61

Additionally required

PC with USB interface, Windows XP or higher

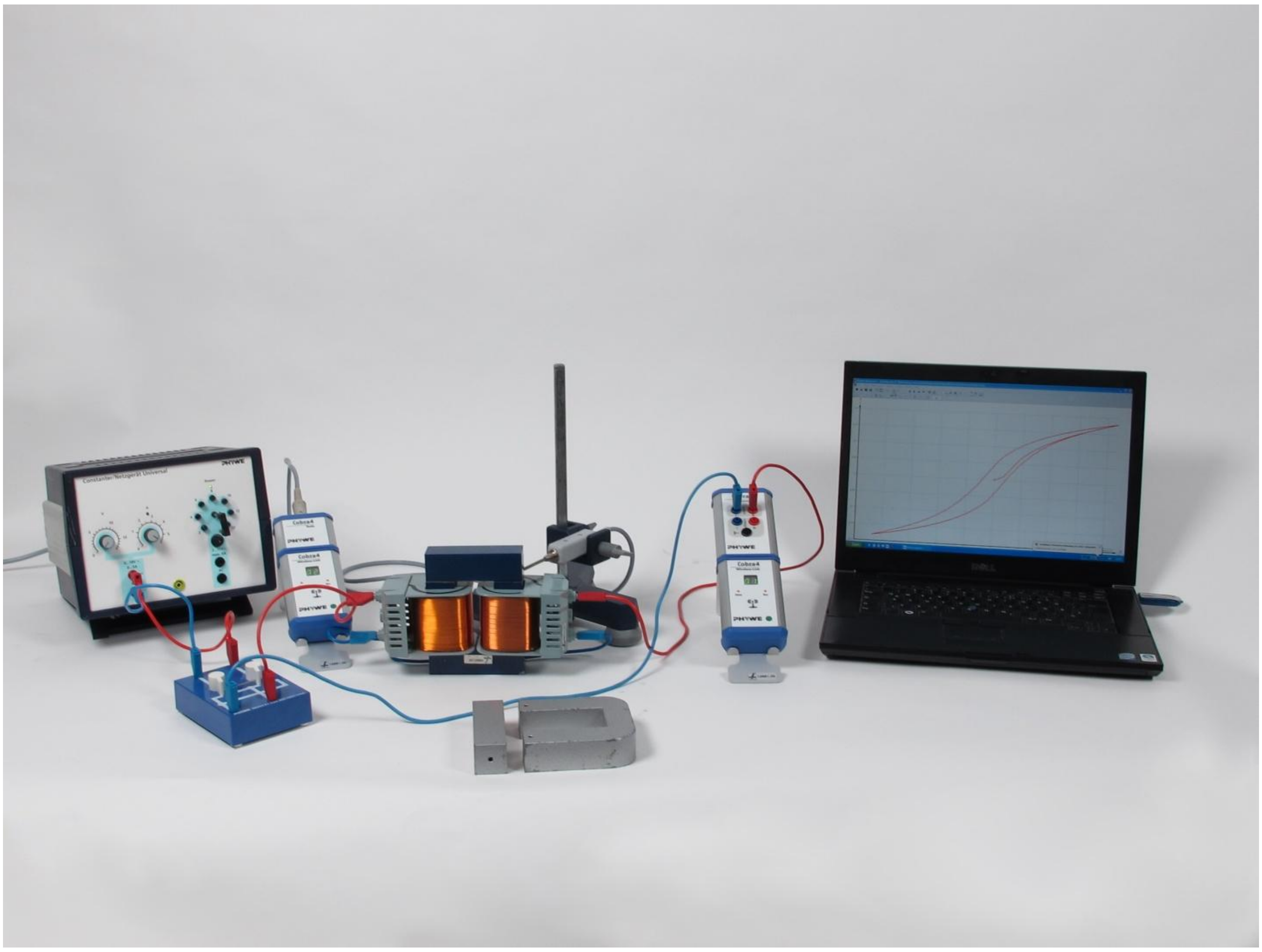

Fig. 1: Experimental set-up for the ferromagnetic hysteresis

Tasks

Record the hysteresis curve for a massive iron core and for a laminated one.

Set-up and Procedure

The experimental set-up is shown in Fig.1. Position the coil set-up far from the computer and from the Cobra device to avoid errors during the transfer of data due to interference by the strong magnetic fields. Put the Sensor-Unit Tesla on the first Wireless-Link, the Sensor-Unit Electricity to the second one and connect the voltage *U* which is measured across the resistor to the current input of the Sensor-Unit Electricity. Connect the cable of the Hall probe with the Sensor-Unit Tesla and attach the Hall probe under the yoke in such a manner that the sensor is located directly adjacent to the borehole for the positioning pin. The magnetic field of the coils should be reversed with the commutator switch only at a voltage of 0 V as otherwise voltage spikes are generated which can affect data transfer. The flux density B_0, measured by the hall probe, and the current I through the coils are recorded.

Load the experiment. (Experiment > Open experiment). All pre-settings that are necessary for the measurement are now carried out. If residual magnetism is present in the iron core, demagnetise the core as follows: Set the commutator switch in such a manner that an opposing field is generated. Briefly increase the voltage far enough for the flux density to assume a zero value; repeat a number of times. Set the current limiter on the power supply to 5 A.

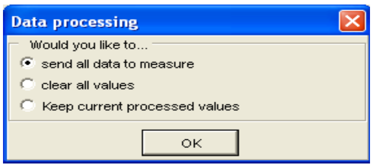

Fig. 2: Saving measurements.

After pressing the icon "Start measurement" ●, increase the voltage slowly and uniformly from zero upwards and decrease it to zero again. Using the commutator switch reverse the polarity of the voltage. Again increase and then decrease the voltage slowly and uniformly. Once again reverse the polarity of the voltage with the commutator switch and increase the voltage. Click on the ■ icon in the icon strip to end measurement and reset the voltage to 0 V. Transfer all measured data to "measure" and save the measured data by clicking on the menu prompts "File" and "Save measurement" (Fig 2). The recorded values are represented graphically as flux density as a function of field strength.

Now change the function of the calculated channel (right click on "Virtual devices"→"Setup"; mark the corresponding channel and click on "edit" (Fig. 3)) to "02I*2459" (Fig. 4). Save these settings, start a new measurement and repeat the experiment with the laminated iron core.

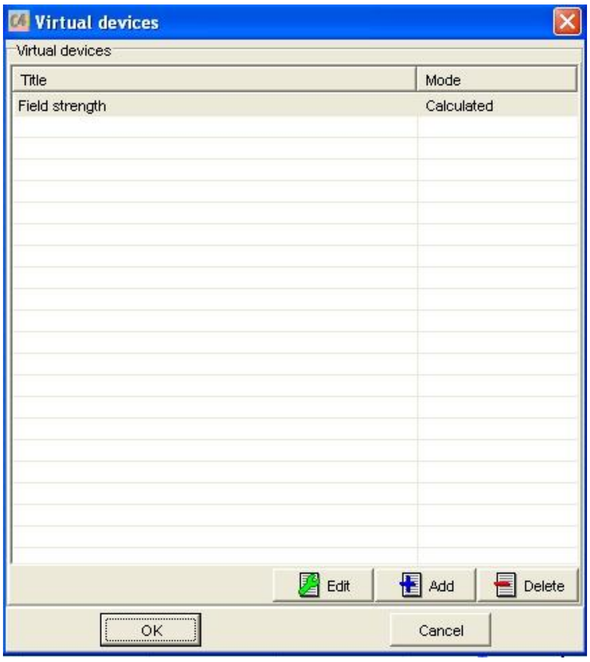

Fig. 3: Virtual device.

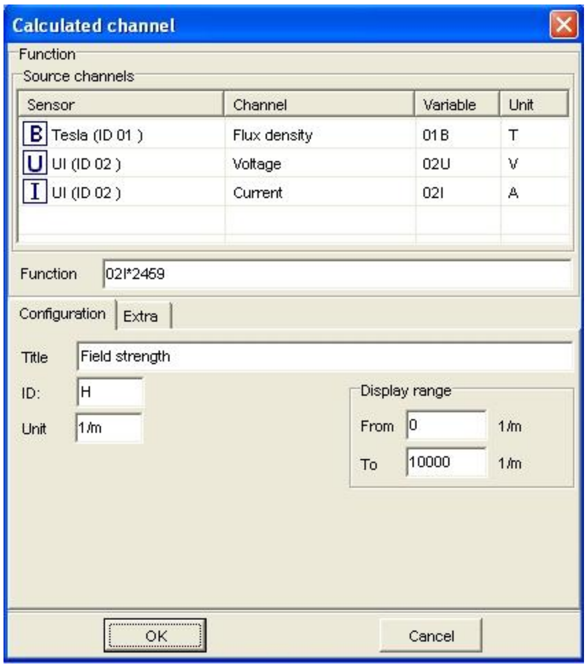

Fig. 4: Calculated channel.

Remarks

The flux density should not exceed 1000 mT because of the sensor.

Theory and evaluation

The field strength is calculated with the formula

$$H = I \cdot n/L$$

where H = field strength
n = number of turns in the coil (600 turns)
L = average field line lengh in the core.
(solid core: L = 232 mm laminated core: L = 244 mm)

The factor n/ L changes due to the different dimensions of the two iron cores as follows:

Solid iron core: n/ L = 2586 in 1/m
Laminated iron core: n/ L = 2459 in 1/m

The calculation of the field strength is combined with a change of the x-axis in the visualisation.
The factor in the mathematical ”Operation” depends on the used iron core and is equal to n/ L.

Now, the coercive field strength and the remanence can be extracted from the hysteresis. Therefore, use the ”zoom” function in the region of the intersection of the axes and then choose ”survey” to obtain the points of intersection of the x and y-axis with aid of the cursor lines, which can be freely moved and shifted. A comparison of Figs. 5 and 6 shows that the remanence and coercive field strength are substantially greater in a solid iron core than in a laminated one.

Typical values for this experimental set-up are:

iron core:	massive	laminated
coercive field strength:	436 A/m	80 A/m
remanence:	143 mT	41 mT

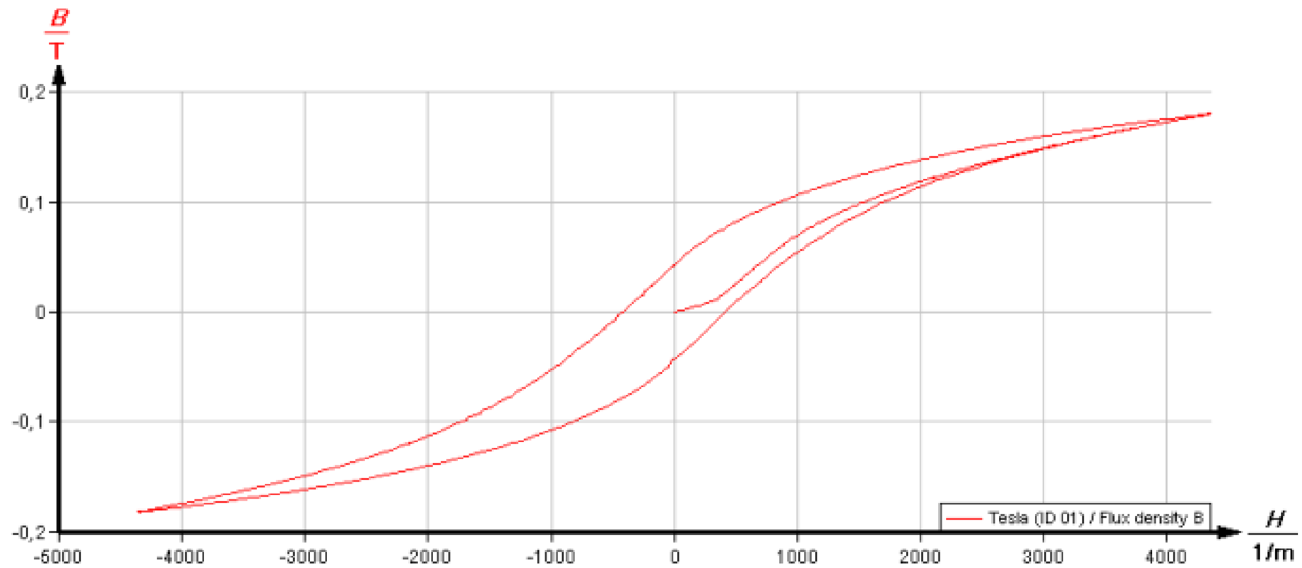

Fig. 5: Hysteresis of a massive iron core.

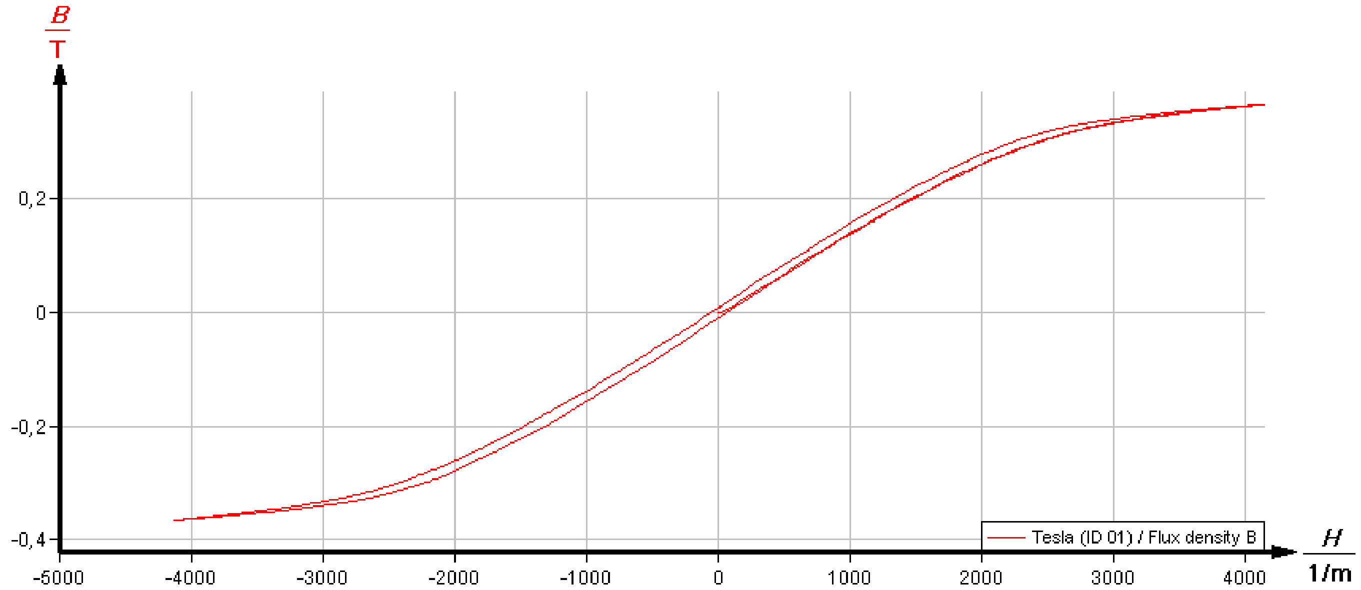

Fig. 6: Hysteresis of a laminated iron core.