Electromagnetic Train

DESIGN DOCUMENT

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1 Introduction

1.1 PROJECT STATEMENT

The project is about electromagnetic train. We are building a track using a 18 AWG bare copper wire and build a train using a AA battery or a AAA battery and some N25 Neodymium magnets. We need to compare which battery has the highest speed to finish the track.

1.2 PURPOSE

The purpose of this project is to compare which batteries have the faster speed. We need to understand the principle behind of the electromagnetic train. The important of the project is to understand the Lorentz Force applied.

1.3 GOALS

Our goals for the project are to build a demo of the project before Spring Break 2017 and build the actual model before Spring 2017. Now we have built the demo of the project and we got an idea how to build the actual project after the break. The picture shown below is the output for the demo project.

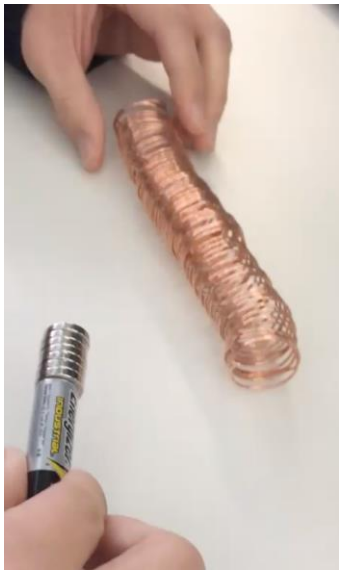


Figure 1: Demo for the Project

2 Deliverables

We need something that we could turn the copper wire into coil shape.

Wooden stick:

1. eco-friendly

2. round shape

3. bigger than the side of the magnets

3 Design

Include any/all possible methods of approach to solving the problem. Discuss what you have done so far. What have you tried/implemented/tested etc. We want to know what you have done.

3.1 SYSTEM SPECIFICATIONS

Building a working electromagnetic train.

3.1.1 Non-functional

Magnetic fields generated by contacting magnets on both end of the battery will for magnetic fields where the field is divergent. Thus, it will form a force exerting on the magnets which push the battery and thus causing the "train" to moves.

3.1.2 Functional

The "train" which is formed by two magnets attaching on both ends of the battery will moves the train through the tracks until the battery is depleted.

3.1.3 Standards

Our project is not considered unethical as it will not bring harms to both society and environment.

3.2 PROPOSED DESIGN/METHOD

Our project involves building an electromagnetic train, we are to design our train in such a way that it can gives us the highest velocity in an efficient manner. To do so, we have ordered the raw materials required to build the train including copper wires, rechargeable batteries and N52 Neodymium magnets. The reason why we use rechargeable batteries instead of an ordinary battery is because this project will deplete a lot of battery in the process, thus it is more efficient to invest on rechargeable batteries. Besides that, we uses N52 Neodymium magnets, which is the strongest magnet available commercially. This is because the stronger the magnets, the higher the velocity the train will travel.

Besides that, we have ordered two sizes of magnets, one which will fit a AA battery, which has a diameter of 5/8 inch, while the other will fit a AAA battery, which diameter is ½ inch. This is so that we will have a variety which we get to choose. Our hypothesis is that the train with a AA battery will have a higher velocity while the AAA battery could perform a stepper curve when going through a tight curve in the track.

3.3 DESIGN ANALYSIS

We have built a 1 meter long track which fits a AA battery train and tested it out. The train travels successfully as expected. But its speed gradually decreases when it travels for a certain period of time. This shows signs that the battery is gradually depleted and it needs to be charged again to regain its original velocity. In the future, we would increase or decrease the distance between coils to find the optimum width which will create the highest velocity for the electromagnetic train.

4 Testing/Development

4.1 INTERFACE SPECIFICATIONS

Our project involves several hardware such as copper wires, rechargeable batteries and N52 Neodymium magnets as mentioned above.

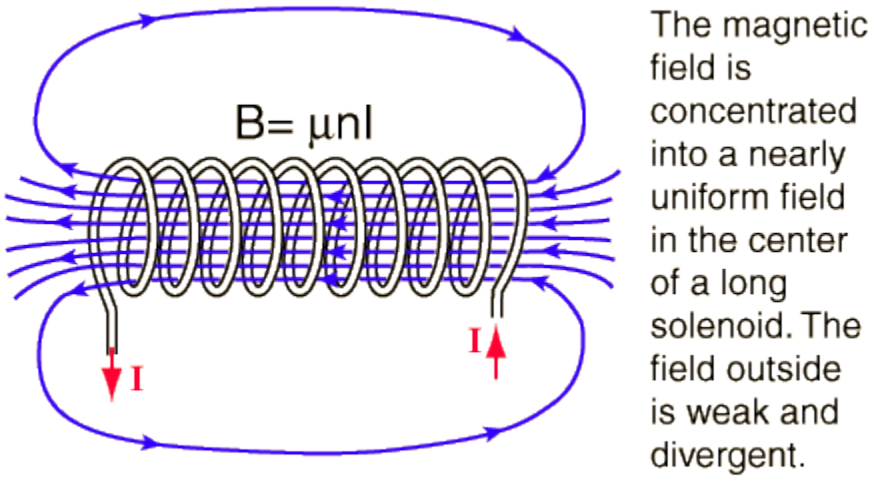
4.2 HARDWARE/SOFTWARE

- Copper wires- used to build and act as a track for the electromagnetic train.
- N52 neodymium Magnets- used to form magnetic fields and create force to push the "train".
- Battery- used to form magnetic fields and create force to push the "train".

5 Results

So far, we have just recently completed a miniature model of our project and have conducted some experiments on it. We have purely based our attention upon making the model and haven't had the physics behind it worked out yet. However, we do have some ideas about what we are doing after learning it through some videos we looked through. We mainly experimented on three things: How the number of magnets used relate to the speed of the train, and how the position of magnets affect the movement of the train.

For the varying number of magnets and relation to speed, we have had mixed results. This is because the model was too small and we could not accurately gauge the exact time travelled within the short rail. However, we did note that generally, the more magnets we had, the faster it travelled. Using 1 or 2 magnets would make it move slowly, but using 5 on each end would make the train run past the track almost instantaneously. Increasing the number of magnets would make them work as one and increase the magnetic flux density, which in turn, increases the force exerted upon the train as per Lenz's Law.



Figurative representation of Faraday's Law

As for the relation of position of magnets and the mobility of the train, we have found out that we need the poles facing outwards of the battery to be the same. Otherwise, the battery would vibrate, heat up, and drain quickly. If we put the magnets in the same direction, the magnetic fields shown above would show that the magnetic flux would be in the same direction, and opposing force would take place. Thus, the battery stays in motion and drains because of the connection between the positive and negative poles. Direction-wise, the train moves according to the Right-Hand rule, where the thumb is the magnetic field line and the other fingers are the current direction. If we invert the poles, the train moves in the opposite direction.

6 Conclusions

In a nutshell, we have finished our miniature model of the project and are planning to build a full scaled one and put it through various tests. We had limited options for experiments due to the short length of our scaled model. We have also done some self-study on the topic and are planning to compile our findings. We have figured out a way to build the rails and are planning to finish it by the end of this month too. The next phase would be to find scholarly articles on the topic so that we can fully understand the physics behind it and would be able to give a thorough report about it. All in all, we plan to have a full explanation of the electromagnetic train by the end of this year while having the working physical model of the project by the end of this semester.

7 References

http://physics.stackexchange.com/questions/150033/how-does-this-simple-electric-train-work

8 Appendices

Currently there are no appendices for this project.