Belousov–Zhabotinsky Reaction: Effects of Magnetic Field Variations.

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Abstract: The Belousov-Zhabotinsky (BZ) reaction is a classical oscillatory reaction that is the subject of many studies. One of its applications is to model other oscillatory processes, such as circadian rhythm. More often than not, experiments done on people are impractical, thus requiring simulations or modeling to enlighten the world on the unknown. A study of the effects of magnetic fields on the BZ reaction is presented. Magnetic fields create a huge impact on our lives, so much so that without them we may not function properly. It is not practical to expose people to diverse magnetic environments, such as outer-space, since an assay that assesses this requires multiple readings as well as the ability to allow another person to do it. Therefore, the Belousov-Zhabotinsky reaction, a Helmholtz coil, petri dishes, and a timer were used to provide clues as to how magnetic fields affect oscillating reactions. Our results indicate that the BZ reaction is a good model to replicate oscillatory biological reactions. Furthermore, the experimental conclusion is that reactions exposed to strong magnetic fields will oscillate slower than those exposed to weak magnetic fields.

Keywords: *oscillatory reactions, Belousov-Zhabotinsky reaction, magnetic field effect.*

Introduction

Since the 1950's the Belousov–Zhabotinsky reaction, otherwise known as BZ, has been employed as a model to study biological related oscillating reactions.[1] One factor that plays a part in possible changes in biological reactions, such as birds migrating or when a person falls asleep, involves the magnetic field created by the earth's core. Inversely, the lack of a magnetic field also causes differences in the biological clock. Places without magnetic fields or a large difference in the strengths of magnetic fields include outer space and other planets in the galaxy. Due to the fact that testing on people or even animals is deemed unethical or not practical, the Belousov-Zhabotinsky reaction provides the perfect solution. With this oscillating reaction and a Helmholtz coil, different magnetic fields can be tested on this particular solution thereby allowing a simulation of a living being traveling in space.

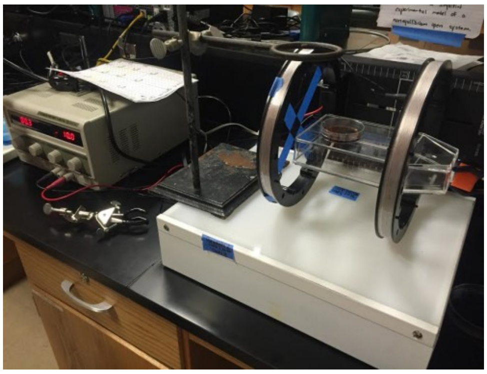
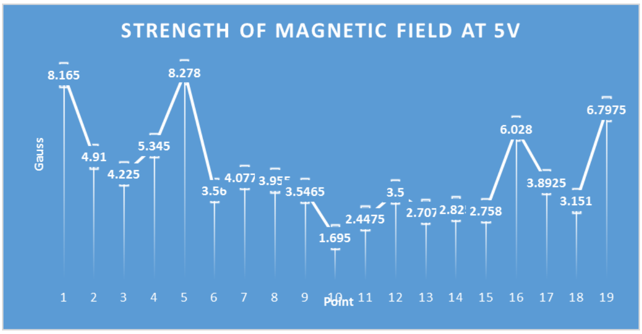


Fig. 1: DC power supply which is connected to the Helmholtz coil. A petri dish is placed on top of a suspended flask to ensure that the solution is directly in the most uniform area.

Methods and Results

The environment to which this experiment takes place in must have minimal interference. Once familiar with the BZ reaction, the solution can be portioned in order to minimize waste. The apparatus should then contain a Helmholtz coil attached to a DC power supply. Quickly after the solution is mixed, it is placed in to a small petri dish and suspended directly in the middle of the Helmholtz coil in order to insure magnetic field uniformity within the mixture. From this point all chemical wave fronts are recorded for the duration of the reaction.



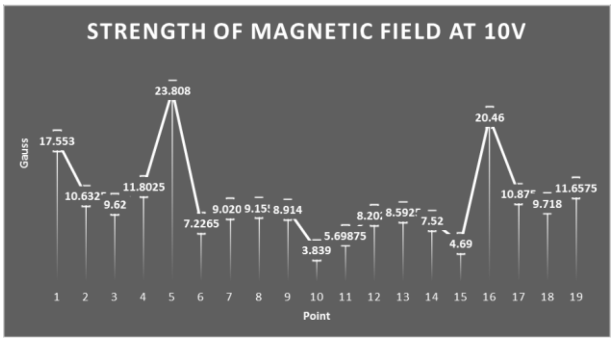


Fig. 2: The graphs are representations of the information obtained from using a sensor connected to an interface as an average. The measurements were taken along the horizontal axis.

Although the Helmholtz coil creates an almost uniform magnetic field, the horizontal axis was measured in order to find the most consistent area. This allowed the proper positioning of the petri dish and ultimately ensuring that the solution had little to no interference. This was accomplished by using graphing paper suspended within the Helmholtz coil and a sensor connected to an interface which measured the magnetic field in Gauss.

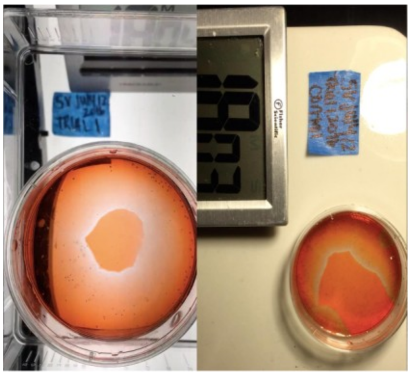


Fig. 3: ***From left to right: Side by side comparisons during a 5 volt trial where the left is the assay and the right is the control. The picture on the left shows an acceleration of the oscillating process of the BZ reaction***.

Fig. 4: ***From left to right: Side by side comparisons during a 10 volt trial where the left is the assay and the right is the control. The picture on the left shows a deceleration of the oscillating process of the BZ reaction***.

Conclusions

Considering that the magnetic field on Earth ranges roughly from 0.25 to 0.65 Gauss, the data from this experiment suggests that reactions exposed to high magnetic fields will oscillate slower than those exposed to lower magnetic fields. The varying magnetic fields affect the iron diffusion in the chemical wave. The research done here with the Belousov-Zhabotinsky reaction is vital to understanding how changes in magnetic fields effect the oscillating reactions within living organism, which could be extrapolated to the potential colonization of other planets.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgments

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References and Notes

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