**PAESTA Podcast Series  --  You Asked, We Answered!**

**Episode 16  --  What is the Mpemba effect?**

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You asked, we answered. What is the mpemba effect? Let’s first start out with who and how this discovery was made.

Erasto Mpemba is the one who discovered the mpemba effect. Erasto is a Tanzanian high school student, that is famous for the Mpemba effect [3]. Mpemba’s observations confirmed some of history’s most revered thinkers, such as Aristotle, Rene Descartes and Francis Bacon, they all believed that hot water froze faster than cold water [2].

This was all observed through Erasto’s experiment that he discovered the Mpemba effect. Here is how Mpemba discovered this effect.

It all started out with an experiment in his classroom. Most of the students in the room would create a mixture of ice cream. And one day a student arrived late to class and saw other students mixtures were already boiling. The students allowed their mixture to cool after it was boiling hot. After it had cooled down, they would all rush to the refrigerator for a space in the fridge. Another classmate arrived late as well and saw Mpemba boiling his milk and the other student quickly made his mixture with milk and sugar and poured it on to an ice tray without boiling it, so he wouldn’t miss his chance to having a spot in the fridge [2].

After Mpemba saw this, he decided to risk ruining the fridge by putting hot milk into it. As they tried to allow the ice cream to form, the went back an hour later to check on their product and found out that Mpemba’s tray of milk had frozen into ice cream, while his classmates mixture was still only a thick liquid, not yet frozen. Since his discovery, he talked to the professor Dr. Osborne from Dar es Salaam University and the professor performed the same experiment with different materials and came up with similar results as Mpemba [2]. It then made it to modern history, known at the Mpemba effect.

However, what causes hot water to freeze faster than cold water? Well,

evaporation is the strongest candidate to explain the Mpemba effect. As hot water is placed in an open container, the water begins to cool, and the overall mass decreases as some of the water evaporates [3].

Another idea that leads to hot water freezing faster than cold is because of convective heat transfer.  When a liquid is heated, it can form convection currents that rapidly bring the hot liquid to the surface, where the heat is lost by evaporation. Professor Osborne noted that this convection will keep the top of the liquid hotter than the bottom, even when the temperature matches an initially cold liquid that doesn’t possess this convection cooling.  This results in a faster rate of cooling that could, under the right circumstances, result in Mpemba’s observation [3].

Dissolved gas can also play a part in Mpemba’s effect, hot water can hold less dissolved gas than cold water, and large amounts of gas escape upon boiling.  So, the initially warmer water may have less dissolved gas than the initially cooler water.  It has been speculated that this changes the properties of the water in some way, perhaps making it easier to develop convection currents (and thus making it easier to cool), or decreasing the amount of heat required to freeze a unit mass of water, or changing the boiling point [1].

Scientist today are still figuring out the Mpemba effect and how it really works, this study of the Mpemba effect is still on going today, thank you for listening.

(*This audio file was recorded by Jailene Olmedo, undergraduate student at Penn State Brandywine, on April 9, 2016)*

**Works Cited**

[1] Jeng, M. (1998, November). Can hot water freeze faster than cold water? Retrieved February 22, 2016, from http://math.ucr.edu/home/baez/physics/General/hot\_water.html

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[2] Staff, L. S. (2012, September 10). Does Hot Water Freeze Faster Than Cold Water? Retrieved February 25, 2016, from http://www.livescience.com/32128-does-hot-water-freeze-faster-than-cold-water.html