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P3_11 A Mincey Situation

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Abstract

With Christmas coming up, it is always a joy to see and spend time with your family. Although, sometimes they can really make your blood boil as you sit there trying to scoff mince pies and count Monopoly money. Speaking of mince pies and blood boiling, here we estimate the number of mince pies an individual would need to eat to make their blood boil to be around 19.5 mince pies, assuming 100% energy efficiency.

Introduction

The term ‘blood boiling’ is often used to describe making an individual very angry. Here, we explore how much energy would be needed to theoretically make someone’s blood boil and then discover how many mince pies they would need to consume for this to occur.

Method and Results

First, we need to find the energy needed to heat the blood from body temperature (37°C) [1] to the blood’s boiling point. This is around 100°C as blood plasma is over 90% water [2]. Here, we will assume the blood plasma is composed of 100% water and that 100% of the blood is plasma to simplify our calculations, thus the temperature change is 63°C. The mass of the blood in the body is around 10% of the total mass of a human, meaning a 70kg human will have 7kg of blood [3]. Finally, the specific heat capacity of water is 4200 Jkg⁻¹°C⁻¹ [4], and substituting these values into the equation below means this energy needed is 1.85x10⁶J.

$$Q = mc\Delta T, \quad (1)$$

where Q is the energy produced due to this temperature change, m is the mass of the blood, c is the specific heat capacity, and ΔT is the temperature change.

Now we need to find the energy required to vaporise the blood, and we can do this by using the latent heat of the vaporisation equation.

$$E = mL_v, \quad (2)$$

Where E is the energy, m is the mass of the blood, and L_v is the latent heat of vaporisation of water, 2260kJkg⁻¹ [5]. This means that the energy required to vaporise the blood is 1.58x10⁷J, and thus the total energy needed to make blood boil is 1.77 × 10⁷J.

Next, we need to calculate the number of mince pies that this energy is equivalent to. We can convert the number of calories of a mince pie to Joules by multiplying 217kcal [6] by 4.18 to get 908kJ of energy released per mince pie [7]. Dividing the energy needed by this value means 19.5 mince pies need to be consumed to make your blood boil.

Discussion and Conclusion

In reality, we would need to eat much more food to make our blood boil. One of the biggest flaws in this calculation is that we have assumed 100% energy efficiency, and this is simply not the case. There are many different processes in the human body needed to keep someone alive (homeostasis), including thermoregulation, where our body regulates temperature, maintaining it around 37°C. Not only does this mean we would need much more energy to heat our blood, but we would also be unlikely to raise our temperature through food consumption due to homeostasis and thermoregulation.

It is estimated that around 10% of a human's daily expenditure goes towards heating the body and thermoregulation [8]. This new information would mean that 10× more energy would be needed to heat blood to its boiling point - around 195 mince pies. However, this energy is used to keep the body at 37°C rather than heat the blood, as proteins begin to denature above this temperature and affect the body's functions. As such, the body expels this heat through the skin, which involves loss of heat through thermoregulatory processes, such as vasodilation and vasoconstriction.

In conclusion, consuming just 19.5 mince pies would theoretically be enough energy to make your blood boil. However, we have assumed that 100% of this energy is transferred to heating the blood. In reality, just 10% of our daily energy intake goes to thermoregulation, so we would need to consume 195 mince pies at once to reach this boiling threshold.

However, most of this energy is used to maintain our temperature rather than significantly increase this, so our body can function efficiently. As such, our body aims to remove this excess heat through various thermoregulatory processes, such as vasodilation and perspiration (sweating). Thus, while this process is incredibly unlikely to occur, we conclude that 195 mince pies could be enough to theoretically make your blood boil.

References

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