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P4_6 The Pot Noodle Proposal

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Abstract

It is claimed in the popular sitcom *The Big Bang Theory* that it is possible to heat up a pot of instant noodles with the laser that they have in a laboratory. This paper investigates the validity of the claim, and finds that although the laser can transfer enough energy for it to be possible, it would also destroy the container, thus rendering it pointless.

Introduction

The sitcom *The Big Bang Theory* has claimed in its script that it takes approximately two seconds to heat up a pot of instant noodles with a laser in a university laboratory [1]. It also states which kind of laser it is (an oxygen iodine laser) and its power output (500kW). This paper will investigate whether two seconds is a good estimation, and if such a feat is even possible.

Theory

An oxygen iodine laser produces an infrared beam by chemically reacting a combination of chlorine, iodine, hydrogen peroxide and potassium hydroxide, and is used mostly for industrial or military purposes [2]. It is capable of having a power output in the order of 10^8 W, so the output of 500kW assumed in the sitcom is reasonable.

The usual method of preparing instant noodles is to pour boiling water into the pot that contains the dried noodles and wait approximately two minutes for the noodles to absorb the water. When the sitcom describes the "heating up" of the pot, it is assumed that cold (room temperature) water is put in the cup and heated by the laser to boiling point. It is also assumed that the laser is likely to be firing horizontally, and should not be moved from its position (since it is in a university laboratory so could be integral to someone's research).

To find the energy required to heat the water from room temperature to its boiling point we must use Eq. (1) [3]

$$Q = mC\Delta T, \tag{1}$$

where Q is the heat required, m is the mass of water in the pot, C is the specific heat capacity of water and ΔT is the temperature difference between boiling point and room temperature. The amount of time it takes to transfer this heat from the laser to the water can be calculated by

$$Q = \int P \cdot dt$$
$$\therefore \quad t = \frac{mC\Delta T}{P}. \tag{2}$$

(Note: the latent heat of water does not need to be included as the intention is not to evaporate the water, just heat it.) The power output of the laser is known, as is the temperature difference (assuming room temperature to be 20^{o}C and the boiling point of water to be 100^{o}C). The mass of water can be estimated using

$$m_{water} = \frac{V_{pot}\,\rho_{water}}{2} \tag{3}$$

(this is assuming that only half the pot is filled with water – the rest would be dried noodles). The volume of the pot can be estimated at 500ml, so approximating the density of water as 1000 kgm^{-3} [4] the mass of water that needs to be heated is 0.25 kg. Using this and the specific heat of water (4.187 $kJkg^{-1}K^{-1}$ [4]) the total time to heat the pot to boiling point is just 0.167 s. It is reasonable to assume that 500kW is the maximum possible output of the laser, not the regularly used output. Assuming the figure of 2s is correct, by rearranging the equations it can be calculated that the power output of the laser would have to be 41.9 kW.

Potential Issues

It is not enough to show that the power output of the laser is sufficient to heat the noodles; the infrared laser beam may damage the container so that it is not possible to consume the food afterwards. To see if this is the case, the energy needed to melt the container must be found. This can be calculated using

$$Q = Lm + mC\Delta T \qquad (4)$$

where *L* is the latent heat of the pot, and *m* is the mass of the pot being melted. The pot can be assumed to be made from high impact polystyrene (HIPS) [5] which has a latent heat of fusion of 71.4 $kJkg^{-1}$ [6] and specific heat capacity of 1.71 $kJkg^{-1}K^{-1}$ [7]. The melting point of HIPS is 85 ^oC [8], so ΔT is 65^{o}C.

The mass can be estimated using a modification of Eq. (3). The volume can be estimated by taking the thickness of the container (~1mm) and the surface area of the container that the beam is in contact with (using a circle with radius 2cm, that's 1.2×10^{-3} m^2 – the divergence of the beam is neglected at such short distances). This gives a volume of around $10^{-6}m^3$ and with the density of HIPS being 1030 kgm^{-3} [9] the mass of HIPS being melted can be calculated to be 1.20g.

Using Eq. (4) and a modification of Eq. (2), the time taken for the laser to melt the container is calculated to be 4.51×10^{-4} s (with a 500 kW output). This is much lower than the time to heat up the water inside, so a laser does not look like an effective way to heat up instant noodles.

Conclusion

It has been found that it is possible to use the energy from a 500 kW oxygen iodine laser to heat up the volume of water required for a pot of instant noodles; however, the heat transfer process is very ineffective since it melts the container long before it heats the water. It is therefore concluded that this would not be a possible situation in reality.

References

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