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# P3_2 Pumpkin power

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**Abstract**

We found that if every person on Earth lit a pumpkin with a tealight on Halloween, 77000 t of carbon dioxide would be released which is 0.022 percent of the average carbon dioxide emission of the UK in 2019. This leads to a annual net flux increase of carbon of about 160 $\mathrm{GtCyr}^{-1}$. Each pumpkin produces 41 W of power which results in 310 billion W for every pumpkin.

## Introduction

Carving a pumpkin with a scary face and placing a candle inside of it is a Halloween tradition that many people participate in every year. This paper investigates how much carbon dioxide and how much power would be produced if every person on Earth lit a candle this year and how this would increase the annual net flux of carbon dioxide in the atmosphere.

## Theory

We will assume that the tealights start with a mass of 17 g, [10] and that after 5 hours completely burns. We assume every candle undergoes complete combustion, so the maximum amount of carbon dioxide is produced.

When a candle completely burns, an average of 10 g, [3] of carbon dioxide is released. If we take the population of Earth in 2019 to be 7.673 billion, [2], then using Eq. (1) we can work out an estimate for the amount of carbon dioxide released if every person lit a pumpkin.

$$\Delta D = P_e C \tag{1}$$

Where $\Delta D$ is the total amount of carbon dioxide produced (in kg), $P_e$ is the population of Earth and $C$ is the carbon dioxide produced per pumpkin.

In order to work out the power each tealight produces when it burns, we first need to work out the energy transferred using (2).

$$E = mJ \tag{2}$$

Where $E$ is the energy transferred, $m$ is the mass of candle burnt and $J$ is joules per gram, which is 43,000, [8]. We assume that the tealight has a mass of 17 g and all of the tealight burns so the mass of candle burnt will be 17 g.

In order to work out the power produced by a single tealight we use Eq. (3)

$$P = E/t \tag{3}$$

where $P$ is the power, $E$ is energy transferred and $t$ is time for candle to burn. The time it takes on average for a tealight to completely burn is 3-5 hours, [9]. The upper bound of 5 hours is used for the calculations. The upper bound is used to ensure that the power is calculated is for if all the candles fully burn. We use Eq. (3) and multiply it by how many pumpkins will be lit, which is 7.673 billion to work out the total power produced.

Take the concentration of carbon in the atmosphere in 2019 as 410 ppm, [7].The amount of carbon dioxide found in Eq. (1) is converted in ppm and taken as the increase in carbon dioxide in the atmosphere for the following year (i.e is added to 410 ppm). Using Eq. (4) and dividing by the time (in this case one year), we can work out the annual increase of the net flux of carbon in the atmosphere.

$$m_{carbon} = x \times (w_{carbon}/w_{air}) \times m_{air} \quad (4)$$

where $m_{carbon}$ is the mass of carbon in the atmosphere; $x$ is the concentration of carbon dioxide the following year minus the concentration of carbon dioxide in 2019; $w_{air}$ is the molecular weight of air, 28.9 g/mol [4]; $w_{carbon}$ is the molecular weight of carbon, 12.0 g/mol, [5]; and $m_{air}$ is the mass of the atmosphere $5.1\times 10^{18}$ kg [6].

**Results**

The results show that if every human lit a pumpkin then $76.73 \times 10^6$ kg of carbon dioxide would be released. Carbon dioxide emission is usually measured in tonnes hence 76730 t is released. The power produced per pumpkin was found to be 40.61 W which results in a total of 312 billion W for the power produced by the pumpkins altogether. The concentration of carbon in the atmosphere if everyone lit a pumpkin was found to be 486.73 ppm, which then leads to a annual net flux increase of carbon of about 160 $\mathrm{GtCyr}^{-1}$

**Discussion and conclusion**

The average emission of carbon dioxide in the UK in 2019 was 351.5 million tonnes, [1]. The amount produced if every pumpkin was lit is 0.022 percent of the emission in the UK in 2019. Data from 2019 is used as during the year 2020 the lock downs due to COVID-19 may have impacted the carbon dioxide emission.

In conclusion if every person on Earth lit a pumpkin with a tealight for Halloween, it would produce 310 billion W of power and 77000 t of carbon dioxide would be released and leads to a annual net flux increase of carbon of about 160 $\mathrm{GtCyr}^{-1}$.

**References**


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