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P2_4 Heat Loss in the House of Commons

E J Watkinson, D Staab, M Walach, Z Rogerson

Department of Physics and Astronomy, University of Leicester, Leicester, LE1 7RH.

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Abstract

A simple static thermal equilibrium model was used to approximate the heat transfer through the House of Commons chamber to the outside surroundings. Comparison to the heat input from respiration of 650 MPs, found in a previous study, showed that heating is necessary once the outside temperature is 0.2 K below that of the chamber.

Introduction

The current economic climate has led to many people becoming more conscious of the rise in energy prices. In a previous study the authors found that a substantial amount of power (10.34 kW) is produced by MPs breathing [1]. It may be conceivable to utilise this power leading to lower parliamentary energy costs. In order to assess this, the outside temperature at which the rate of heat input, from the MPs, is equal to the rate of heat loss was found. An assumption for this is that the chamber should remain at a comfortable 20 °C.

Assumptions

A static thermal equilibrium model was developed to describe the heat transfer out of the chamber. It assumed that only conduction was present, and thus radiation and convection were neglected. Figure 1 shows the location of the House of Commons Chamber with respect to the rest of Westminster Palace and the outside, and was adapted from a scaled drawing [2]. The latter was analysed to estimate the dimensions of the Chamber: approximately 13.3m wide, 22.5 m long and 22 m high.

The chamber and the rest of the palace were assumed to be at a constant temperature of 20 °C, but the lobbies were taken as unheated. Hence conduction could only occur through the ceiling and outwards through the lobbies, (conduction through the floor was neglected).

Both the ceiling and walls are made partly of glass and oak panels; for simplicity, the ceiling is modelled as entirely glass, and the inner surface of the chamber walls as oak.

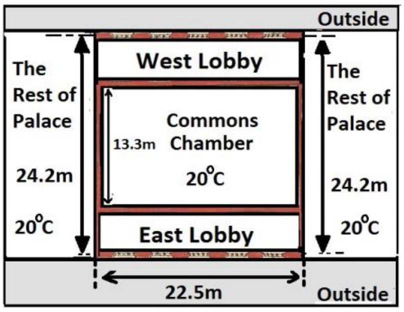

Figure 1: Schematic floor plan showing the location of the House of Commons Chamber. It has been adapted from [2].

Each of the side walls between the chamber and the lobby are around 0.75 m thick, this includes the thickness due to the oak panelling. Generally, glass and oak panels were assumed to be $5\text{x}10^{-3}$ m and $40\text{x}10^{-3}$ m thick respectively [3]. The outer walls of the lobbies are around 1.1 m thick including oak panelling (see Figure 2).

Each lobby has about half of its outer wall comprised of glass windows, and the other half of oak panel. The situation is simplified as having one lobby with a glass outer surface and the other as oak panelled (see Figure 2).

Heat Transfer

Three parallel heat conduction processes are present: two that act laterally through the lobbies and one that acts vertically through the ceiling. The thermal resistance, R, for each process is calculated using,

$$R = \frac{|\Delta x|}{kA}. \qquad (1)$$

Δx is the thickness of the material through which the conduction takes place, k is the thermal conductivity of the material and A is its cross-sectional area.

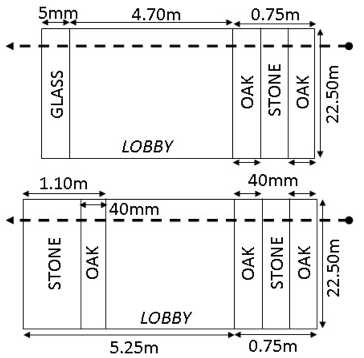

Figure 2: a schematic showing the dimensions of the modelled glass and oak lobbies. The heights of the walls and lobbies were taken as 22 m. The dotted line shows the heat transfer direction (from the inside to the outside).

Figure 3 is the thermal resistance diagram for the heat transfer out of the chamber. All thermal resistances are calculated using equation (1). Each branch represents one of the three parallel processes. All dimensions are found in Figure 2 or as above. The thermal conductivities (in units of W m^{-1} K^{-1}) of glass [4], oak panel [5], sheltered stone [6], exposed stone [6] and air [4] are taken as 0.8, 0.3, 1.46, 1.56 and 0.026 respectively.

Numerous materials are traversed in the lateral conduction processes (see Figure 3). The inner wall is assumed to be made of stone and has a thermal resistance $R_{shelt.stone}$. The oak panelling has a thermal resistance R_{oak}. $R_{air\ in\ glass\ lobby}$ and $R_{air\ in\ oak\ lobby}$ are the thermal resistances of the air gaps in either lobby. $R_{exp.\ stone}$ is the thermal resistance of exposed stone and $R_{glass\ wall}$ is the thermal resistance of the glass surface.

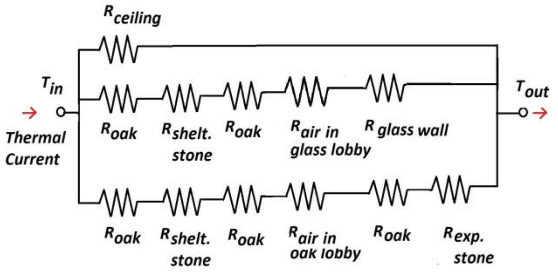

Figure 3: the thermal resistance diagram for the heat transfer out of the chamber.

The overall thermal resistance, R_{ov}, of the conduction through the chamber to the outside is calculated with reference to Figure 3, using the rules of combining parallel and thermal resistances (analogous to electrical resistance rules) and is found to be 2.1×10^{-5} K W^{-1}.

The temperature difference, ΔT, between the inside and outside of the chamber, which permits static thermal equillibrium is calculated using,

$$\Delta T = \frac{dQ}{dt} R_{ov}, \qquad (2)$$

where dQ/dt is the total power produced by the MP's breath [1]. It is found to be around 0.2 K. In conducting this analysis it is found that the glass ceiling is the primary cause for heat conduction out of the chamber.

Conclusion

For any but the smallest of ΔT values, the heat loss from the chamber becomes too large for the MPs' heat input to be used as a means of heating. However only the effects of respiration were considered and further work is needed to account for other methods of heat transfer from the MPs to the outside. In any case, to properly utilise this heat source and lower the Parliament's energy bills, the chamber would likely require better insulation.

References

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