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P5_4 Martian Tripods In All Their Nuclear Glory

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Abstract

In the terrifying 2005 movie adaption of the famous H. G. Wells "The War of the Worlds", the Martians use machines of mass destruction in the form of giant three-legged walkers with powerful heat rays to vaporise humans. In this paper we calculate how much uranium-235 would produce enough energy from nuclear fission, to not only vaporise a human but also cause human extinction. We found that 0.0363 g of U^{235} is required to completely vaporise a 78 kg human, and 2.37×10^5 kg of U^{235} to completely eradicate humanity. We found that one tripod would have to undergo nuclear fission for 1145.2 years to produce enough energy for global extinction.

Introduction

The War of the Worlds Martian tripods use heat-rays to transfer energy from the power source (in this case taken to be nuclear fission) to their desired targets. To find the mass of U^{235} required, we first need the energy value to vaporise the human body down to its constituent molecules. This is done by assuming the human body is made of three components (bone, tissue and water) and finding the dissociation energy for each. The dissociation energy for bone is calculated to be 8.98×10^4 kJ [1] and the dissociation energy for water and tissue is calculated to be 2.79×10^6 kJ and 1.13×10^5 kJ respectively [2]. Therefore, the amount of energy required to vaporise a 78kg human is 2.99×10^6 kJ or 1.86×10^{28} eV. But for complete instantaneous vaporisation to occur this energy must be applied evenly in a short amount of time. Because of this we assumed the Martians heat-ray applies this energy evenly and quickly with no energy loss, which is shown in the film with each human taking less than one second to be vaporised.

Theory

Using the total dissociation energy, we calculated how much U^{235} would be needed for one human. U^{235} produces approximately 200 MeV per nucleus during fission [3]. Therefore, we first calculated the number of nuclei needed for this process using equation (1).

$$N = \frac{E}{200 \times 10^6} \tag{1}$$

Where E is the total dissociation energy 1.86×10^{28} eV and 200×10^6 eV is the energy per nuclei.

The mass of U^{235} can now be calculated using equation (2).

$$M = \frac{235N}{6.02 \times 10^{23}} \tag{2}$$

Where 235 g/mol is the mass of Uranium per mole and 6.02×10^{23} $nuclei/mol$ is Avogadro's number.

This result can be applied to a variety of different events which occurred in the film. The first event we look into is the introduction scene of

the tripods where the heat-rays are continuously active for 63 s. The tripod has 2 heat-rays active at this time and if we assume one heat-ray supplies 2.99×10^6 kJ of energy every second then we can combine equation (1) and (2) and enter the above characteristics to find the amount of U^{235} required for this scene, forming equation (3).

$$M = \frac{235 \cdot 2E}{6.02 \times 10^{23} \cdot 200 \times 10^6} t \qquad (3)$$

Where 2E is the energy of both heat-rays 3.72×10^{28} eV and t is the time of activation in s.

The next event we looked into was the event of global extinction in 2005. In 2005 the world population was 6,541,907,027 [4], therefore using the result for a single 78kg human and assuming the entire population averages at 78kg we can calculate the amount of U^{235} required for extinction. We then calculated how long it would take to generate this energy through the fission process, assuming that each tripod has the same amount of thermal energy of one Chernobyl reactor, producing 3.2×10^9 W [5].

Results

Equation (1) calculated that 9.3×10^{19} *nuclei* is required per human. Using the answer from Equation (1), Equation (2) calculates that 0.0363 g of U^{235} must be used to vaporize a human. For the induction scene, Equation (3) calculated that 4.574 g of U^{235} is required for 63 seconds of activation, meaning on average the tripod consumes 4.256 g every minute while active. Therefore the tripod will consume 6.126 kg in a day, this is 1.95 times greater then your typical 3000 MW thermal reactor [6]. For global extinction the tripod would consume at least 2.37×10^8 g or 2.37×10^5 kg of U^{235} with a total energy requirement of 1.956×10^{19} J. Therefore by dividing the power by energy we found it would take one tripod at least 1146 years to generate enough energy for global extinction.

Conclusion

We calculated that to completely vaporise a 78 kg human with the energy from nuclear fission, the tripod must use at least 0.0363 g of U^{235} assuming that the energy is distributed evenly and within 1 second. The tripod would then consume $4.574g$ of U^{235} in the opening scene of the film and to complete its goal for global extinction, it would consume 2.37×10^5 kg of U^{235}. Therefore the tripod's nuclear reactor must of been active for 1146 years to produce and store all that energy. This means the martians could have buried their war machines during the early medieval era.

References

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