IARJSET

ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.066 ⁝⁝ Peer-reviewed / Refereed journal ⁝⁝ Vol. 10, Issue 10, October 2023

DOI: 10.17148/IARJSET.2023.101009

Heating of a Fluid by Suspended Particles under Influence of Gravity

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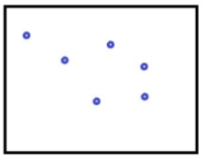
Abstract: A fluid that has got suspended particles in an isothermal system, heats the fluid under the influence of gravity. As the suspended particles fall, the friction with the fluid molecules heats up the fluid.

Keywords: Specific heat capacity, Universal gravitational constant, isothermal system, heat.

I. INTRODUCTION



The above figure shows an isothermal box containing some particles. The box is somewhere in the space under the influence of gravity.

As it is an isothermal process the work done on the floating particles by gravity is equal to the amount of heat gained by the system.

$$Q = w \qquad \ldots (1)$$

Here Q is the heat and w is the work.

Now the work done is,

$$w = Fs \qquad \ldots (2)$$

Where F is the force and s is the distance travelled by the particles.

(All other forces due to heat and other parameters are not taken under consideration as they does not affect the Gravitational force).

$$F = V\rho g \qquad \ldots (3)$$

V is the volume of the fluid displaced by the particle and g is the acceleration due to gravity at that point in space.

$$w = V\rho g s \qquad \ldots (4)$$

As shown before work done on the system is equal to the heat gained.
And expression for heat is.

$$Q = mC\Delta T \qquad \ldots (5)$$

Where m is the mass of the fluid that is being heated, C is the specific heat constant and ΔT is the change in temperature.

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On combining equation (4) and (5), we get

$$V\rho g s = mC\Delta T \quad \ldots (6)$$

Solving for ΔT

$$\Delta T = \frac{V\rho g s}{mC} \quad \ldots (7)$$

Acceleration due to gravity can be written as,

$$g = \frac{MG}{r^2} \quad \ldots (8)$$

From Newton's law of gravitation.

Here M is the mass of the body that is attracting the fluid and G is the universal gravitational constant and r is the distance between the two bodies taken from centre.
Hence,

$$\Delta T = \frac{GMV\rho s}{mCr^2} \quad \ldots (9)$$

II. CONCLUSION

This consideration may be necessary in certain cases. Say a rocket landing on Earth with particles mixed in the fuel. We know to what extent it would heat up the fuel on its landing. Or say a person descends from sky, blood may heat up due to certain suspended molecules in the blood.

REFERENCES

[1]. Britannica, The Editors of Encyclopaedia. "Newton's law of gravitation". Encyclopedia Britannica, 15 Aug. 2023, https://www.britannica.com/science/Newtons-law-of-gravitation. Accessed 4 November 2023.
[2]. Drake, Gordon W.F.. "thermodynamics". Encyclopedia Britannica, 27 Oct. 2023, https://www.britannica.com/science/thermodynamics. Accessed 4 November 2023.
[3]. Britannica, The Editors of Encyclopaedia. "density". Encyclopedia Britannica, 4 Jul. 2023, https://www.britannica.com/science/density. Accessed 4 November 2023.