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REVIEW PAPER ON STANDARD ATMOSPHRER

PRINCE CHAUHAN [1], Deepak Dhalla[2], Siddharth Jain[3], Somya Pal[4] [1]

Undergraduate Scholar, Department of Aerospace Engineering, School of Engineering & Technology, IIMT University, [2]Aharada Education, [3]Assistant Professor, Department of Aerospace Engineering, School of Engineering & Technology, IIMT University, [4]Head of Department, Department of Aerospace Engineering, School of Engineering & Technology

Abstract:

The Standard Atmosphere serves as a reference model for Atmospheric Conditions. It provides a standardized framework for aerospace engineering calculations and simulations. While the Earth's atmosphere is dynamic and varies with location and time, the standard Atmosphere simplifies these complexities.

The Standard Atmosphere includes average values for key atmospheric properties such as pressure, temperature, and density, which are function of altitude. This standardized model enables aerospace engineers to make consistent calculations and predictions.

INTRODUCTION:

Aerospace vehicles can be divided into two basic categories, atmospheric vehicles such as airplanes and helicopters, which always fly within the sensible atmosphere, and space vehicles such as satellites, the Apollo lunar vehicle, and deep-space probes, which operate outside the sensible atmosphere. However, space vehicles do encounter the earth's atmosphere during their blastoffs from the earth's surface and again during their reentries and recoveries after completion of their missions. if the vehicle is planetary probe, then it may encounter the atmosphere of Mars, Jupiter, Venus, etc. Therefore, during the design and performance of any aerospace vehicle, the properties of the atmosphere must be taken into account.

NOMENCLATURE:

h= altitude (m or ft)

g = acceleration of gravity (m/sec2)

p = pressure (N/m2 or kPa)

R = real gas constant for air ,287m2/

T = temperature (°C or°F)

ρ = density(kg\m3)

a = speed of sound (m/sec)

IMPORTANT STANDARTD FORM:

ICAO = International civil aviation organization

NAA = National Aviation Authority

ISA = International Standard Atmosphere

MSL= Mean Sea Level

ASL = Above Sea Level

PA = Pressure Altitude

FAA=Federal Aviation Administration

DGCA= Directorate General of civil Aviation

Altitude in the Standard Atmosphere:

Altitude is the vertical distance above a reference point, often measured in feet or meter above the sea level (ASL). Understanding altitude is vital for aerospace engineering, as it influences an aircraft's Performance, including take-off, climb, cruise, and descent.

Hydrostatic Equation:

The hydrostatic equation is a fundamental principle in fluid dynamics, including the study of the Earth's atmosphere. It describes how the pressure of a fluid (in this case, air) changes with altitude. The hydrostatic equation states that the rate of change of pressure with respect to altitude is proportional to the density of the fluid.

Mathematically, it can be expressed as:

$$\frac{dP}{dh} = \rho g$$

where:

$\frac{dP}{dh}$ = Pressure gradient

ρ = density of fluid

g = acceleration due to gravity

The hydrostatic equation helps us understand how pressure decreases with increasing altitude. It is a foundational concept for calculating pressure altitude.

Pressure altitude:

Pressure altitude is a critical parameter in aviation, as it affects aircraft performance.

It is defined as the altitude in the standard atmosphere corresponding to a specific atmospheric pressure. To calculate pressure altitude, we determine the altitude in the standard atmosphere where the pressure matches the observed pressure at a given location.

Temperature Altitude:

Temperature altitude is another important concept in aviation. It represents the altitude in the standard atmosphere corresponding to a specific temperature. Temperature altitude helps determine aircraft performance and engine power settings.

In the standard atmosphere, temperature decreases with altitude. however, this decrease is not linear but follows a specific temperature lapse rate. The standard temperature lapse is approximately 6.5 ℃ per

kilometer. Understanding temperature altitude allows pilots and engineers to anticipate temperature-related changes in aircraft behavior.

Geopotential Altitude:

Geopotential altitude is a specialized altitude reference used in aerospace engineering. It takes into account the variation of Earth's gravitational acceleration with altitude. Geopotential altitude is measured from the Earth's surface to a given geopotential height.

Density altitude:

Density altitude is a critical parameter for aircraft performance calculation. It represents the altitude in the standard atmosphere where the air density matches the observed air density at a specific location. Density altitude is essential for understanding how variation in temperature and pressure affects aircraft performance.

Standard atmospheric condition:

The standard atmosphere is typically defined by a set of conditions at sea level, which serves as a reference point for aerospace calculations. These standard values are as follows:

-Pressure: At sea level, the standard atmospheric pressure is 101.3 kilopascals(kpa) or 29.92 inches of mercury (in Hg).

-Temperature: At sea level, the standard temperature is 15°C or 59°F.

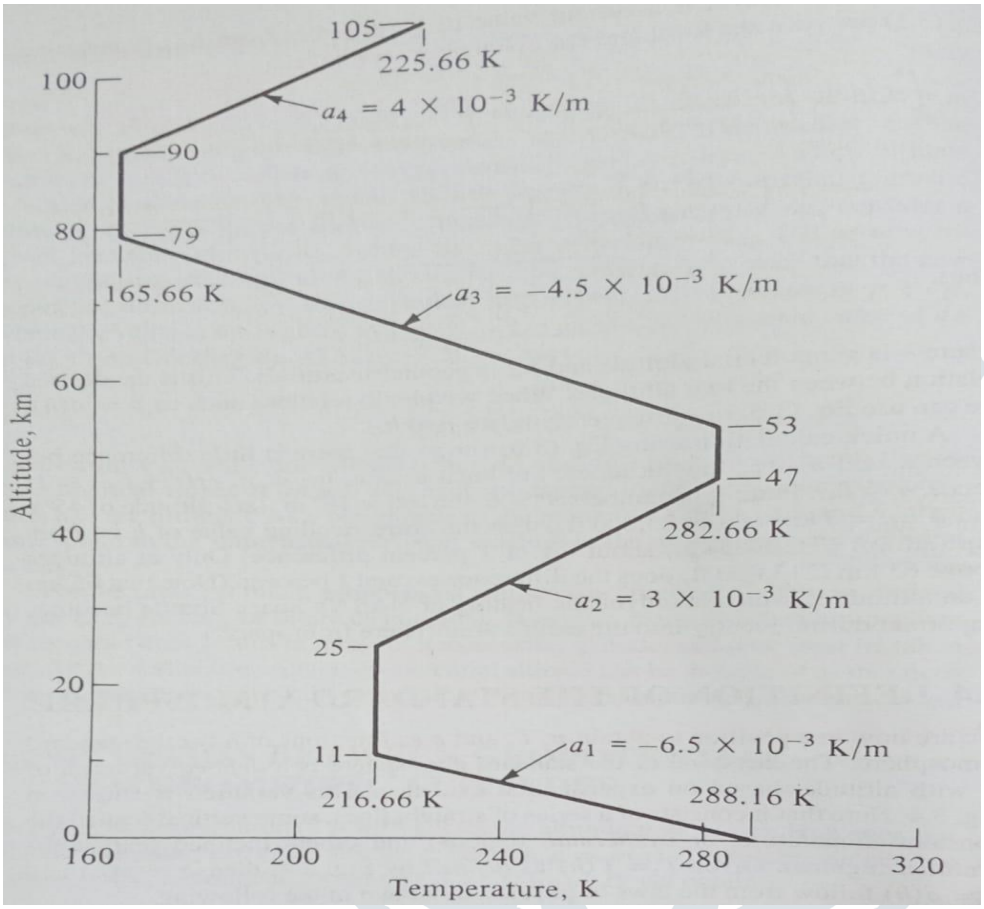
-Density: At sea level, the standard air density is approximately 1.225(Kg/m^3)

Temperature variation or distribution in standard atmosphere:

In the standard atmosphere, temperature exhibits a characteristic variation with altitude. understanding this variation is crucial for aircraft design and performance analysis. The standard atmosphere defines a specific temperature profile, which is as follows.

1. Troposphere (0 to 11 kilometers): In the lowermost layer of the atmosphere, knows as the troposphere, temperature decreases with increasing altitude.
2. Stratosphere (11 to 30 kilometers): In the stratosphere, temperature increases with altitude. This temperature inversion due to the presence of ozone.

3. Mesosphere (30 to 50 kilometers): Beyond the stratosphere, temperature decreases with altitude once again.
4. Thermosphere (50 to 400 kilometers): In the thermosphere, the temperature increases with increase in altitude.
5. Exosphere (above the 400 kilometers):



Some important formulas:

1. For find the Temperature at different altitude:

$$T = T1 + a\,(h - h1)$$

2. Pressure, Density In the isothermal regions:

$$\frac{p}{p1} = \frac{\rho}{\rho 1} = e^{-[g/(RT)](h-h1)}$$

3. Pressure, Density In the gradient region:

$$\frac{p}{p1} = (T/T1)^{-g0/(aR)}$$

$$\frac{\rho}{\rho 1} = (T/T1)^{-\{\left[\left(\frac{g}{aR}\right)\right]+1\}}$$

4. Lapse rate for the gradient layers.

$$\frac{T - T1}{h - h1} = \frac{dT}{dh} = a$$

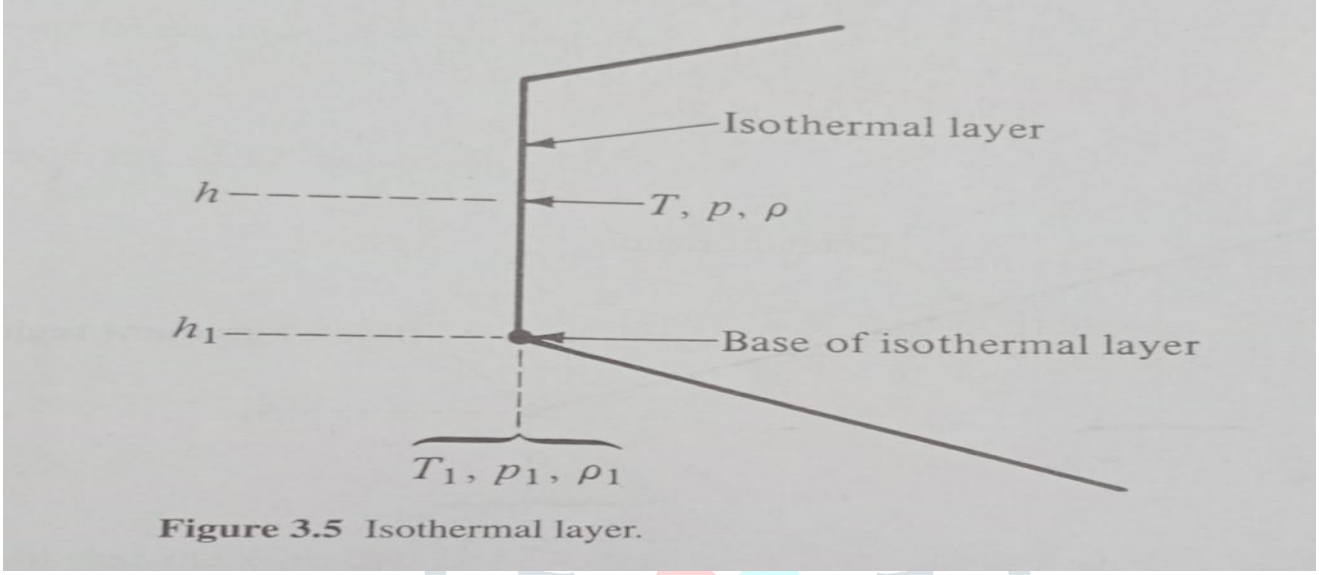


Figure 3.5 Isothermal layer.

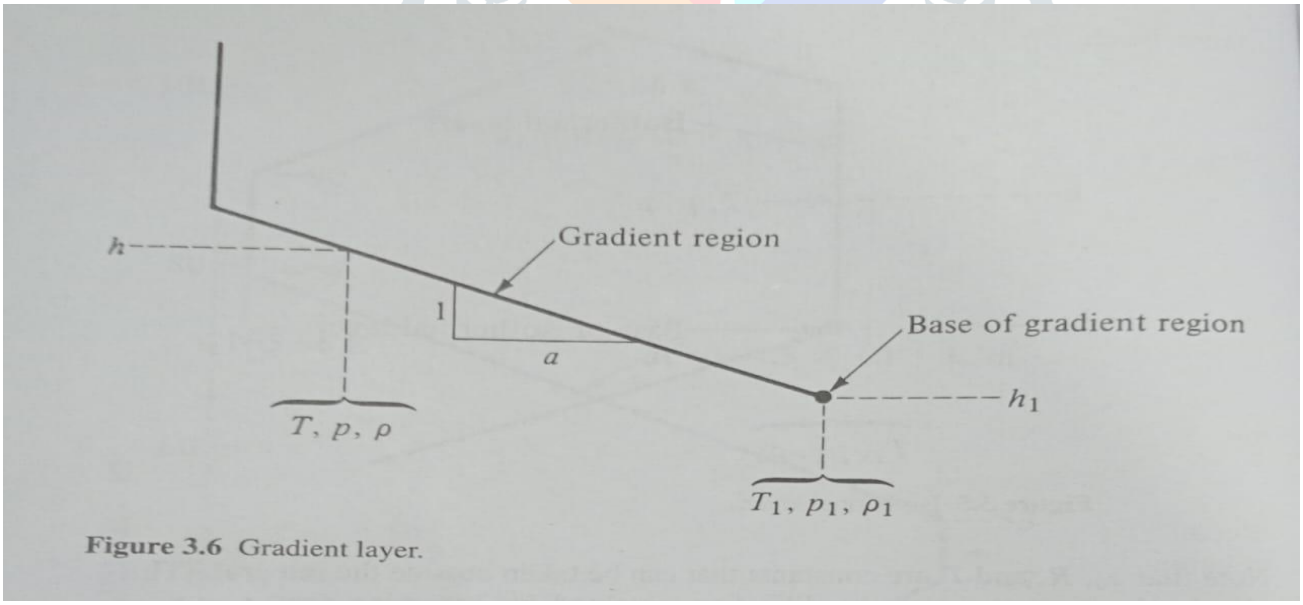


Figure 3.6 Gradient layer.

Conclusion:

In Conclusion, the study of the standard atmosphere and altitude relations is fundamental to aerospace engineering and flight mechanics. The standard Atmosphere provides a standardized framework for understanding and predicting atmosphere behavior with altitude. Concepts such as pressure altitude,

temperature altitude, geopotential altitude, and density altitude are crucial for aircraft design performance analysis, and advancement of aerospace technology.

Mastery of these concepts allows aerospace engineers, pilots, and researchers to make informed decisions, optimize aircraft performance, and ensure the safety and efficiency of aerospace vehicles in a variety of atmospheric conditions.

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