Chapter 1
Role of Altitude in the Design of Aerospace Vehicles

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ABSTRACT

The atmosphere is the layer of gases surrounding the Earth and retained under its gravity. The atmosphere of our planet is made up of blankets of air that contain numerous gases such as oxygen, nitrogen, carbon dioxide, and others. Earth's atmosphere can be differentiated into five regions based on their physical properties such as temperature and pressure. Troposphere, stratosphere, mesosphere, ionosphere or thermosphere, and exosphere are these zones. The atmosphere provides the platform for these aerospace vehicles, which have taken off from Earth to operate at different altitudes. To investigate and understand the performance of flight tests, wind tunnel tests, and the design of aerospace vehicles or any other flying objects, there is a need for standard values to evaluate the parameters of the airplane or any other objects influenced by aerodynamic forces. Finally, the purpose of this chapter is to help the reader understand what the standard atmosphere is and how it can be utilized to analyze aeronautical vehicles.

DOI: 10.4018/978-1-6684-4230-2.ch001

INTRODUCTION

Just can't see anything aerospace vehicles such as Airplanes, rockets, and Missiles through our naked eye unless there is no atmosphere in our mother earth. These gases exist in nature in the atmosphere and vary at different altitudes as well as the different locations on the earth. Different gas molecules present in the atmosphere influence the variation of the atmosphere's features. As a result, the physical properties of the earth's atmosphere vary depending on altitude, it will vary with the variation of altitudes as well as the location of the earth. Earth's atmosphere is not just only a platform for aerospace vehicles, but it also provides free energy resources such as oxygen to fuel the aerospace vehicles to operate in the earth's atmosphere. Furthermore, there is no clear dividing line between these regions and each region eventually combines with its neighbors. These regions are differentiated and demarcated at different altitude levels based on the physical properties calculated by using the hydrostatic equation (Anderson & Bowden, 2005).

In this chapter, we'll go over everything in detail, how these physical properties are calculated, how these regions are defined and they can be used to understand the properties with a variation of altitude through graphical image representation. Aerospace vehicles such as aircraft, rockets, and missiles cannot fly unless there is no atmosphere on the earth or any planet. The vehicles operated using the atmosphere may be categorized into two: atmospheric vehicles, such as planes and helicopters, are one example, parachutes, etc., which always operate within a sensible atmosphere i.e., within the stratosphere region and it will not move beyond a particular altitude because beyond this region there will be the absence of required gas properties, which is necessary for atmospheric vehicles and another one is space vehicles such as satellites, interplanetary probe, exo-planet space probe, re-entry vehicles tend to operate outside the sensible atmosphere and it can be obey operated any altitude level. As these aerospace vehicles are encountering the atmosphere during their mission, they might be influenced by the atmospheric properties. As a result, the features of the atmosphere must be considered (Jaganraj et al., 2015).

The atmosphere of the Earth is not a static system; it is constantly changing. Physical qualities of the atmosphere, such as pressure and temperature, are affected by altitude. Location (longitude and latitude), time of day, weather, and perhaps even solar sunspot activity are all factors to consider. To design and investigate the performance of these aerospace vehicles operated through our earth's atmosphere. Variations in these physical features of the environment must be taken into consideration as a precondition. Without knowledge of these physical properties, it is impossible to design and flight aerospace vehicles. The determinants of these properties are temperature, pressure, and density. These physical properties are used to calculate the various parameters of aerospace vehicles such as aerodynamic forces, gravitational forces, airspeed, etc. The gravitational forces and aerodynamic forces encountered and experienced by aerospace vehicles vary with their altitudes. This is the fact that because of atmospheric properties viz; pressure, density, and temperature also change with altitudes. It implies that these forces are strong functions of atmospheric properties. For this purpose, these standard values are agreed upon through international agreement and named as International Standard Atmosphere (ISA) (Anderson & Bowden, 2005).

International Standard Atmosphere (ISA) refers to an imaginary set of values assigned to the physical properties of the atmosphere at different altitude levels through an international agreement under the International Civil Aviation Organization (ICAO). Though these agreement numbers don't represent actual conditions at any particular time, they can act as a guideline. It is vital to study the standard atmosphere, which helps us to plan and design perfect aerospace vehicles such as aircraft, Rocket, Missiles, etc.,