Air Density and Density Altitude - Demystified

Gary White

From Physics of an Ideal Gas

- P*V = n*Rg*T
- where: P = pressure
  V = volume
  n = number of moles
  Rg = universal gas constant
  T = temperature
- Density is mass per unit Volume, or
- D = m / V

Physics (cont.)

- Note that:
  - $m = n * M$
  - where: m = mass
    n = number of moles
    M = molar mass

- Solving for the Molecular formation of dry air ($R = Rg / M$)

$$D = \frac{P}{R * T}$$

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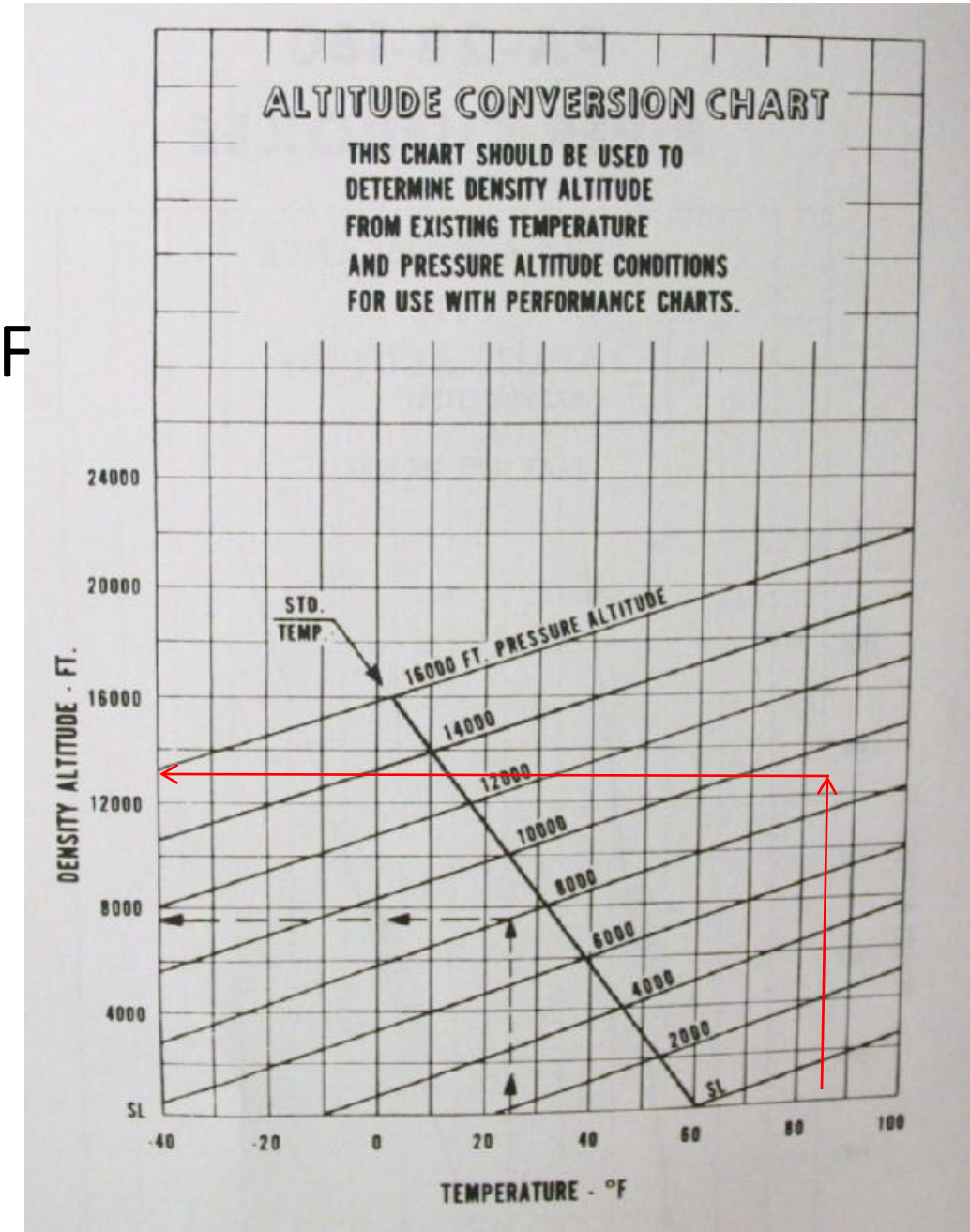
- Indicates Density Follows Pressure and is Inverse to Temperature
- Typically We Speak of Air Density as its Theoretical Altitude (Density Altitude)
- Think of it as its Altitude You Would Need to Either Go To In Order to Have That Air Pressure for That Air Density
- Normally it is Charted, or Obtained from an E6B

Density Altitude

- Recall Our Leadville Example, 9,934', T = 85F
- Chart Shows ~13,800'
- But What About Dew Point?



Does Dew Point Effect Density Altitude?

- Density of Moist Air is Less than that of Dry Air; Hence, Density Altitude Increases
- As Temp - Dewpoint Spread Decreases, Effect is More Pronounced
- E.g., http://www.pilotfriend.com/calcs/calculators/density.htm
- If Dewpoint is 80 deg F, then Density Altitude = 14,286’

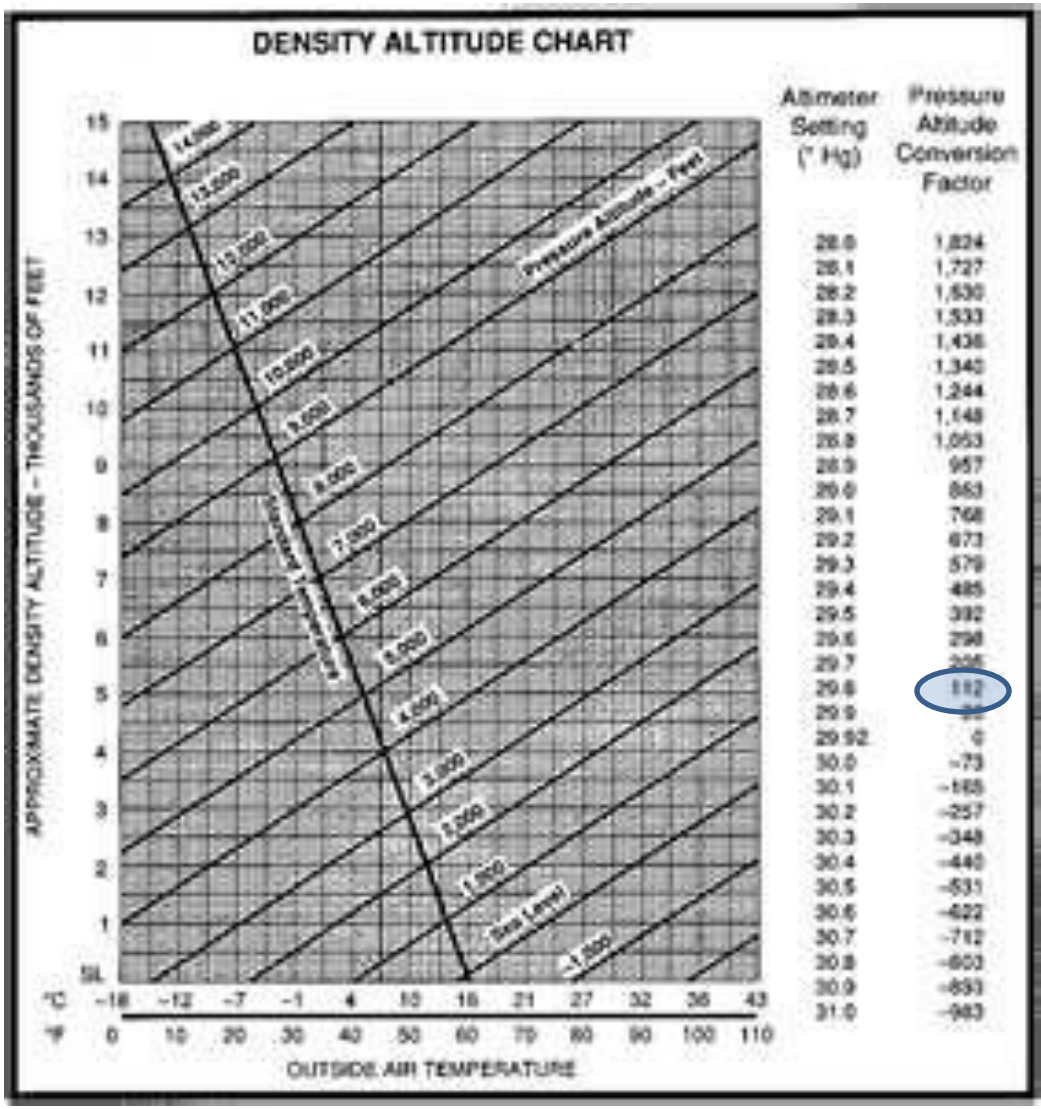
Does Pressure Effect Density Altitude?

- Computations So Far Has Been at Standard Pressure
- As Pressure Decreases, Density of Air Decreases
- E.g., In Previous Example for Leadville, We Obtained Density Altitude of 13,800’ With an Assumed Pressure Reading of 29.92” Hg for Very Dry Air

Pressure Affects Density Altitude

- Recall $D = \frac{P}{R * T}$

- Assume Pressure Altitude = 29.8” Hg
- Correct for Non-Standard Pressure By Adding 112’ for 13,912’



Summary

- Low Atmospheric Pressure, High Temperature, High Moisture (Small Dewpoint Spread) All Cause an Increase in Density Altitude
- Pressure Altitude and Density Altitude are only Equal at Standard Temperature
- As Density Altitude Increases, Engine, Propeller, and Aerodynamic Lift Decrease

Density Altitude

- Major Impact on Aircraft Performance
- Landing Distance
- Takeoff Distance
- Rate of Climb

A different definition for
Density Altitude

The Altitude the Airplane Thinks it is at and Performs in Accordance With