AIRCRAFT INSTRUMENTS -EAS

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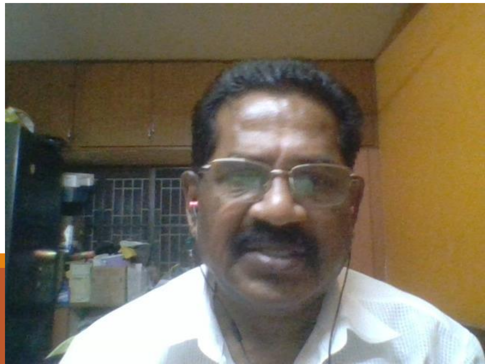
Types of Air Speed

- Indicated Air Speed (IAS)
- Calibrated Air Speed (CAS)
- True Air Speed (TAS)
- Equivalent Air Speed (EAS)
- Mach number
- Ground Speed (GS)

Pitot tube

To measure the IAS, aircraft are fitted with a sensor called a Pitot tube. The Pitot tube is a tube that is exposed to the airflow and can measure the **total pressure** exerted on the aircraft.



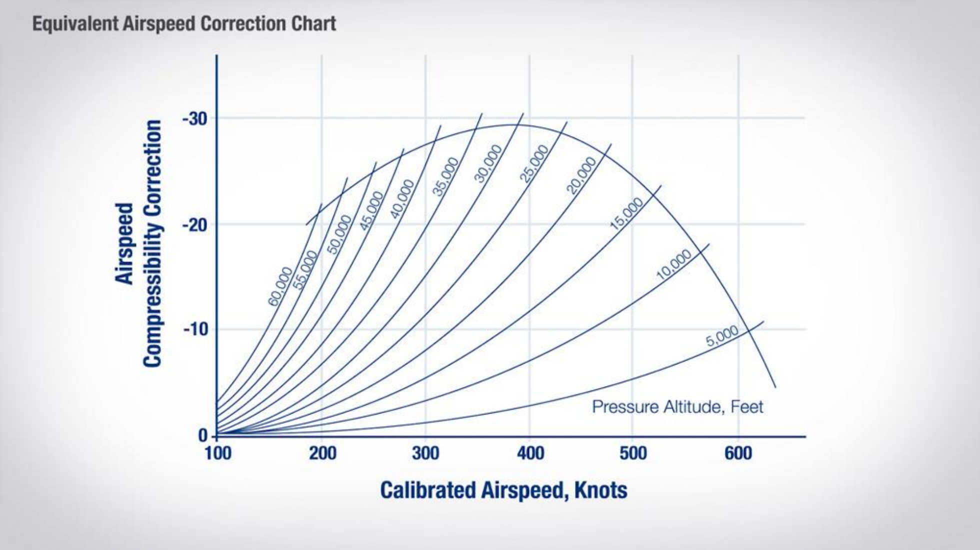
EQUIVALENT AIRSPEED (EAS):

Equivalent Airspeed (EAS): The Core Concept

- EAS represents the airspeed at sea level, under standard atmospheric conditions, that would produce the same dynamic pressure as the actual speed and altitude of the aircraft.
- In simpler terms, it's the airspeed a pitot tube with no compressibility errors would display at that altitude.
- EAS is crucial for determining various aircraft performance parameters, including:
  - Control effectiveness
  - Stalling speed
  - Engine performance limitations

The Challenge of Air Compressibility

- As aircraft reach higher speeds and altitudes, air molecules become compressed due to a phenomenon called compressibility.
- This compression affects how air interacts with the pitot tube, causing Calibrated Airspeed (CAS) to underestimate the actual dynamic pressure and, consequently, TAS.
- EAS bridges this gap by incorporating a correction for compressibility, providing a more accurate representation of airspeed for performance calculations

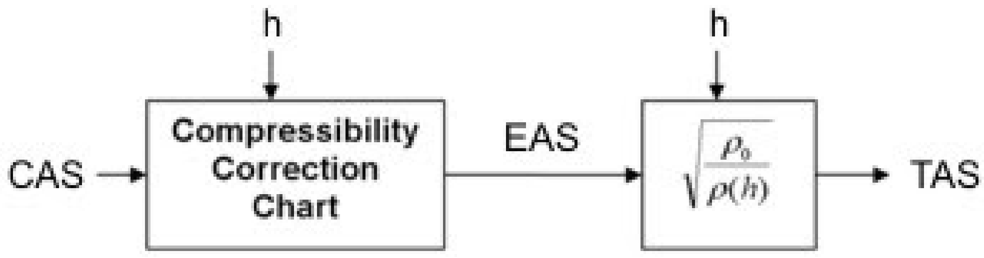


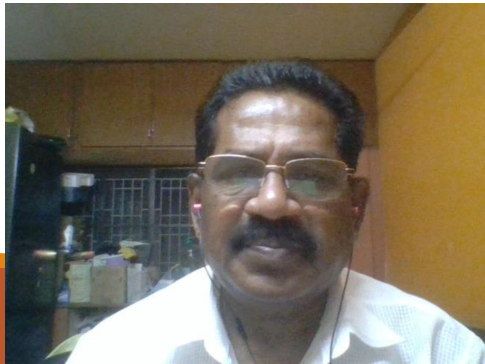
EAS vs. Calibrated Airspeed (CAS): Understanding the Difference

- Calibrated Airspeed (CAS) corrects for instrument position error but doesn't account for air compressibility effects.

- At high speeds and altitudes, CAS readings become less accurate due to compressibility. This can lead to underestimating stall speed and exceeding safe engine limitations based on CAS alone.

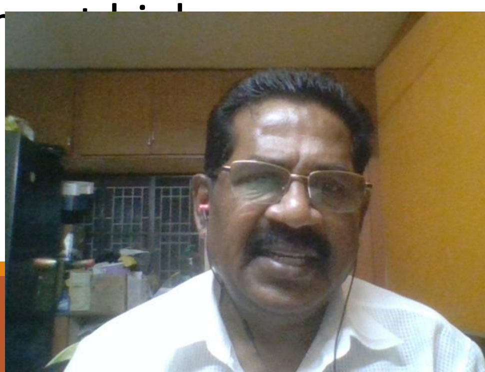
- EAS incorporates a correction for compressibility, providing a more accurate representation of airspeed for critical performance calculations





The Importance of EAS for High-Performance Flight

- **Maintaining Control Effectiveness**
  - At high speeds, air compressibility can reduce the effectiveness of control surfaces like ailerons and rudders.
  - CAS readings alone might not accurately reflect this decrease in control effectiveness.
  - EAS provides a more accurate representation of how air behaves around the control surfaces, allowing pilots to adjust their control inputs accordingly.
  - This ensures the aircraft responds as expected and maintains smooth handlin[illegible] speeds.



Preventing Stalls with EAS

- **Stalling Speed and EAS :**
  - Stalling speed is the minimum airspeed required to maintain enough lift to keep the aircraft airborne.
  - Stalling speed is affected by air density, which changes with altitude.
  - EAS helps determine the adjusted stalling speed for different flight conditions, preventing stalls

$$q_c = P\left[\left(1 + 0.2M^2\right)^{7/2} - 1\right]$$

$$M = \sqrt{5\left[\left(\frac{q_c}{P} + 1\right)^{2/7} - 1\right]}$$

$$EAS = a_0 M \sqrt{\frac{P}{P_0}}$$

$$CAS = a_0 \sqrt{5\left[\left(\frac{q_c}{P_0} + 1\right)^{2/7} - 1\right]}$$

q_c: *Impact Pressure*

M: Mach number

P: Static Pressure

P_0: Static Sea Level Pressure (IS

a_0: Sonic Speed at Sea Level ISA

Safe Engine Operation and EAS

- **Engine Performance Limitations and EAS**
  - Modern jet engines have limitations on maximum power output at different altitudes and speeds.
  - These limitations are often based on Equivalent Airspeed (EAS) to account for compressibility effects.
  - Exceeding engine limitations based on CAS alone can lead to engine damage.