Equivalent airspeed

Equivalent airspeed (**EAS**) is calibrated airspeed (CAS) corrected for the compressibility of air at a non-trivial Mach number. It is also the airspeed at sea level in the International Standard Atmosphere at which the dynamic pressure is the same as the dynamic pressure at the true airspeed (TAS) and altitude at which the aircraft is flying.[1][2] In low-speed flight, it is the speed which would be shown by an airspeed indicator with zero error.[3] It is useful for predicting aircraft handling, aerodynamic loads, stalling etc.

$$EAS = TAS \times \sqrt{\frac{\rho}{\rho_0}}$$

where:

ρ is actual air density.

ρ_0 is standard sea level density (1.225 kg/m^3 or 0.00237 slug/ft^3).

EAS is a function of dynamic pressure.

$$EAS = \sqrt{\frac{2q}{\rho_0}}$$

where:

q is dynamic pressure $q = \frac{1}{2}\rho v^2$,

EAS can also be obtained from the aircraft Mach number and static pressure.

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

where:

a_0 is 1,225 km/h (661.45 kn), the standard speed of sound at 15 °C

M is Mach number

P is static pressure

P_0 is standard sea level pressure (1013.25 hPa)

Combining the above with the expression for Mach number gives EAS as a function of impact pressure and static pressure (valid for subsonic flow):

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

where:

q_c is impact pressure.

At standard sea level, EAS is the same as calibrated airspeed (CAS) and true airspeed (TAS). At any other altitude, EAS may be obtained from CAS by correcting for compressibility error.

The following simplified formula allows calculation of CAS from EAS:

$$CAS = EAS \times \left[1 + \frac{1}{8}(1-\delta)M^2 + \frac{3}{640}(1 - 10\delta + 9\delta^2)M^4\right]$$

where:

pressure ratio: $\delta = \frac{P}{P_0}$

CAS and EAS are airspeeds and can be measured in knots, km/h, mph or any other appropriate unit.

The above formula is accurate within 1% up to Mach 1.2 and useful with acceptable error up to Mach 1.5. The 4th order Mach term can be neglected for speeds below Mach 0.85.

Contents

See also

- Acronyms and abbreviations in avionics
- ICAO recommendations on use of the International System of Units
- Calibrated airspeed
- Flight instruments
- Global Positioning System
- Indicated airspeed
- Position error
- True airspeed

References

1. Clancy, L.J. (1975), *Aerodynamics*, Section 3.8, Pitman Publishing Limited, London. ISBN 0-273-01120-0
2. Anderson, John D. (2007), *Fundamentals of Aerodynamics*, p.215 (4th edition), McGraw-Hill, New York USA. ISBN 978-0-07-295046-5
3. Houghton, E.L. and Carpenter, P.W. (1993), *Aerodynamics for Engineering Students*, Section 2.3.3, Butterworth-Heinemann, Oxford UK. ISBN 0-340-54847-9

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- Anderson, John D. (2007), *Fundamentals of Aerodynamics*, Section 3.4 (4th edition), McGraw-Hill, New York USA. ISBN 978-0-07-295046-5
- Gracey, William (1980), "Measurement of Aircraft Speed and Altitude" (http://www.dtic.mil/dtic/tr/fulltext/u2/a280006.pdf) (11 MB), NASA Reference Publication 1046.

External links

- Equivalent airspeed calculator (https://www.fxsolver.com/browse/formulas/Equivalent+airspeed)