Air speed

Airspeed is the speed of an aircraft relative to the air

The measurement and indication of airspeed is normally accomplished on board an aircraft by an airspeed indicator (ASI) connected to a pitot-static system.

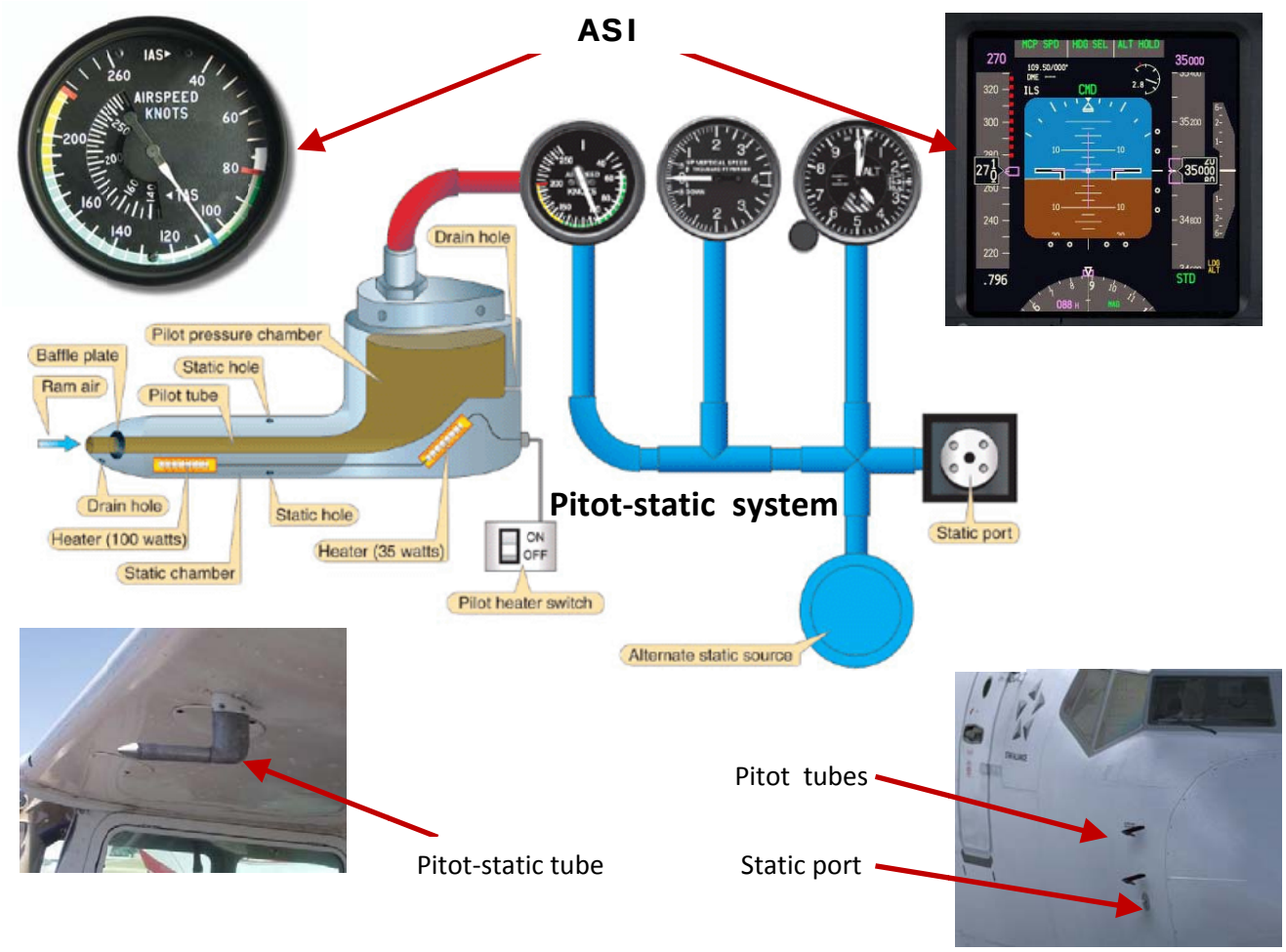

figure 1

The pitot-static system comprises one or more Pitot probes (or tubes) facing the on-coming air flow to measure pitot pressure (also called stagnation, total or ram pressure) and one or more static ports to measure the static pressure in the air flow. These two pressures are compared by the ASI to give an IAS reading.

Indicated airspeed (IAS)

Indicated airspeed (IAS) is the airspeed indicator reading (ASIR) uncorrected for instrument, position, and other errors.

Simply said: it is the airspeed indicated on the instrument.

The IAS (also referred to as KIAS: Knots indicated airspeed) is the safety speed for handling the aircraft.

Stall speeds, gear and flaps limitation speeds, holding speeds and approach speeds are indicated airspeeds.

TAKE-OFF :
V1 = take-off decision speed (or critical speed). Before V1, the pilot can abort take-off. After V1, the pilot MUST take off.
VR = take-off rotation speed at which the pilot gently pulls the flight controls to rise the nose and take off.
V2 = take-off safety speed to be reached before passing 35 ft above runway altitude.

CRUISE :
Va = Maneuvering speed, max speed at which flight controls can be fully maneuvered.
Vno = Normal Operation speed, max cruise speed.
Vne = Never Exceed speed.
Vmo = Maximum Operating speed (KIAS).
Mmo = Maximum Operating Speed (Mach).

APPROACH AND LANDING :
Vfe = Maximum speed with Flaps Extended.
Vlo = Maximum speed for Landing gear Operations (retraction and extension).
Vle = Maximum speed when Landing gear Extended.
Vs = Stalling speed (at max weight).
Vso = Stalling speed with gear and flaps Out (at max weight).
Vref = Reference speed (or landing speed) = 1.3 x Vso (Vref also known as Vat).

APPROACH REGULATION :
Minimum clean speed = minimum speed with gear/flaps/slats up and airbrakes in, usually about 1.5 x Vso.
Minimum approach speed = Vref (see above), 1.3 x Vso.

True airspeed (TAS)

True airspeed (**TAS**) of an aircraft is the speed of the aircraft relative to the airmass in which it is flying. True airspeed is important information for accurate navigation of an aircraft.

Note: when you file your flighplan: FILL IN YOUR TAS...not your IAS!

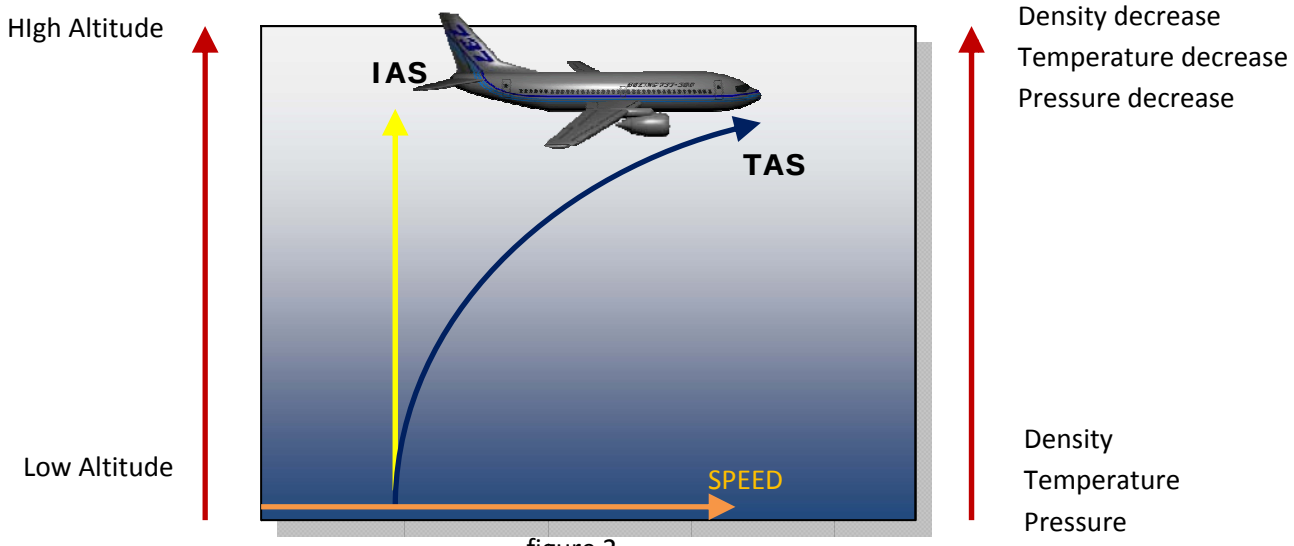

figure 2

The higher you fly, the less denser the air will be. This will result in less drag/friction which will make the aircraft fly faster with the same IAS setting. Climbing higher and higher will eventually result in an decrease of thrust because the engines need oxygen for the combustion. Not enough oxygen will eventually cause engine flameout. For that reason each aircraft has a Flight ceiling and an optimum flight level calculated by the FMC (flight management computer) to fly as economical as possible.

The calculation of TAS depends on the density, pressure, temperature and IAS. It can be roughly estimated by correcting the IAS by 2% for every 1000ft you climb

$$TAS = IAS + (0{,}02 * IAS * \frac{Altitude}{1000})$$

for example:

$$TAS = 270 + (0{,}02 * 270 * \frac{35000}{1000})$$

TAS = 459 knots

figure 3

Ground speed (GS)

The Groundspeed (GS) is the True airspeed (TAS) corrected with the wind speed and represents the speed of an aircraft relative to the ground

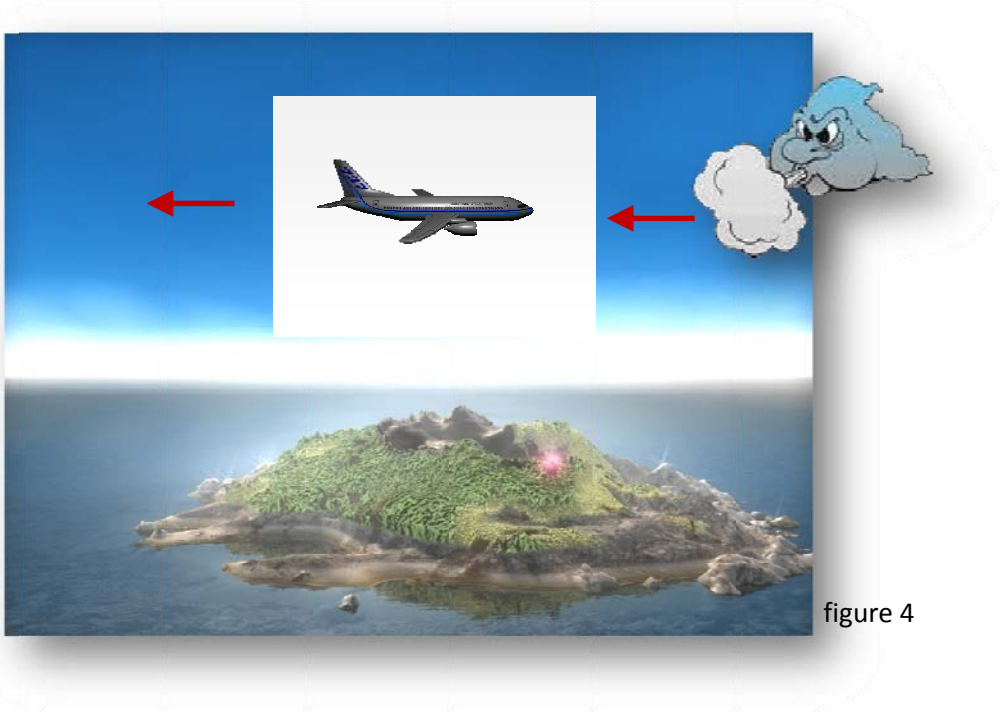

figure 4

Imagine your aircraft is flying inside a big "box" of air with a certain density which gives you the True airspeed. The " box" of air is also being moved by winds which may result in a tail wind (which makes you go faster), a head wind (which makes you go slower) or a cross wind (which makes you drift off-course).

GS = TAS+/- wind correction

In the MFD of figure 4 we see a perfect headwind of 25 knots.

The TAS is 457

The Groundspeed = 457 - 25 = 433

well...almost ☺

The MFD presents whole numbers only

figure 5

Note: You need your GS to calculate your estimated time of arrival (ETA) over a certain point

For instance: your groundspeed was 433 and let's say we have 72nm to go before we reach CVO at FL350.
This will take us : (72/433)* 60 = approx. 10 minutes

Mach number (M)

The Mach number is the True airspeed relative to the speed of sound

$$M = \frac{TAS}{C}$$

Note: MACH numbers are normally used above Flight level 250 !

For the mathematicians, I will give you an example to show you that we can calculate an estimate which will be pretty close to what our MFD would say.

But before we start you need to know a few extra rules:

1: calculations are based on the ICAO standard temperature of 15°C and standard ICAO pressure altitude of 1013 HPa.

2: For every 1000ft you climb...the temperature will drop with 1,98 °C (for a quick estimate...use 2)

3: The speed of sound depends on several factors..but in order to not make it too complex...it can be estimated by temperature only according to :

$$C = 20 * \sqrt{273 + T}$$

We are flying at FL 350 with a KIAS of 270 knots. We already calculated our TAS of 459 knots

Our standard ground temperature is 15°C and for every 1000ft we climb the temperature drops with 1,98°....so...the temperature at FL 350 = 15 - 35*1,98 = -54,3 °C

The Speed of sound C at FL 350 will then be: 20 * SQRT (273 - 54,3) = 295.8 m/s

The only thing to do is to convert the TAS from knots = nm/h into m/s

where 1nm/h = 1,85 km/h = 0,5138 m/s

So finally we have:

TAS = 235,9 m/s

C = 295,8 m/s

which makes the MACH number M = 235,9 / 295,8 = **0.797** wow...that's pretty close

figure 6

So now you know a bit more about speeds and their differences.

I'm sure you have come to realize that various speeds have their effect on performance, flight time and fuel planning.

If we fly from Cairo to Hurgada, which is a geographically distance of 235**nm** (**nautical miles**), the total distance flown can be much longer because of the climb, cruise and descent and the weather conditions (do we have head winds or tail winds??).

The total distance flown is now called the [**nam**]...**nautical air miles**.

more about speeds

check http://academy.ivao.aero