What Happens When Your Pitot Tube Ices Over?

By Boldmethod | 12/07/2023 | Previous | Next

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Instrument failures may be one of the toughest parts of training, and they can quickly spark confusion if they happen when you're in the clouds.

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Now that it's getting colder, airspeed failures are a very real possibility, especially if you inadvertently enter icing conditions. What can happen, and how will your airspeed indicator react?

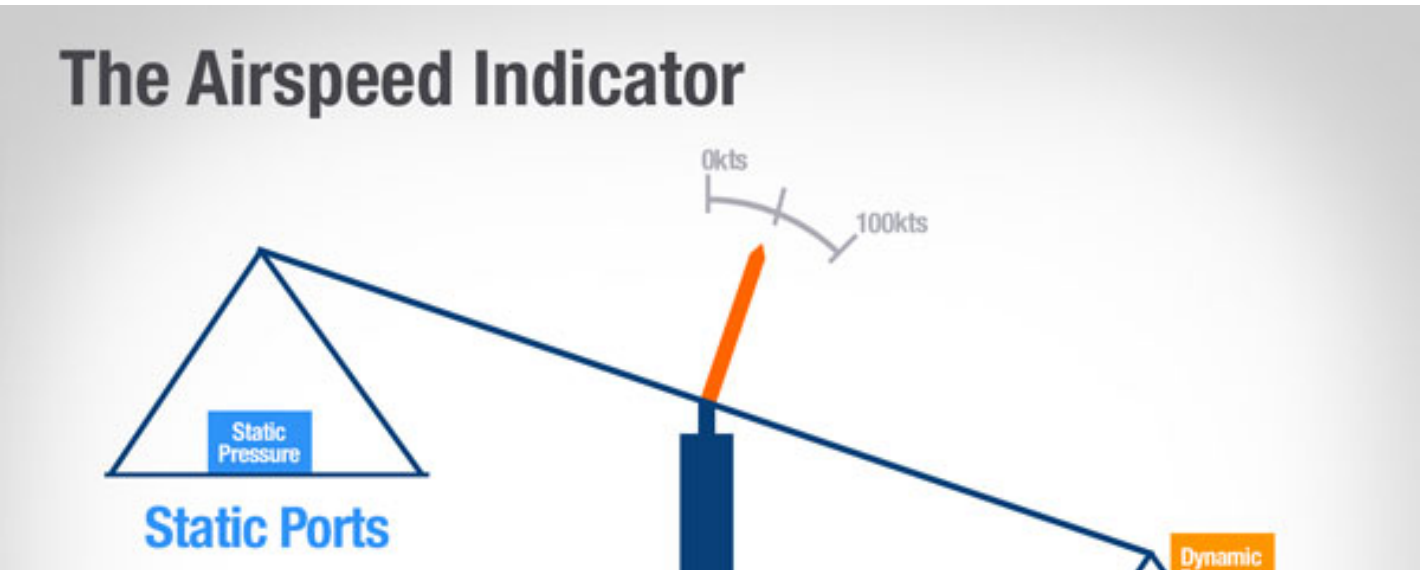
How Your Airspeed Indicator Works

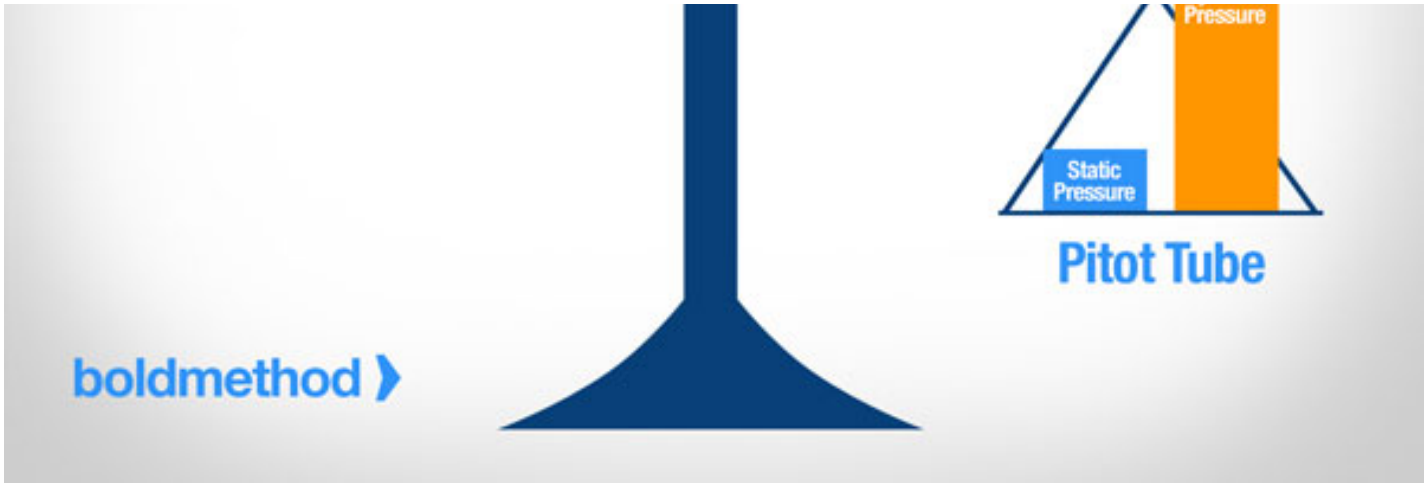
Before you can understand the failures, you need to understand how an airspeed indicator works. It's an incredibly simple instrument, and round-dial and glass-panel systems both use the same principles.

Your airspeed indicator measures dynamic pressure. That's the pressure caused by your movement through the air. However, you can't measure dynamic pressure directly, because static pressure is always in the mix as well.

Your pitot tube measures "ram pressure," which is a combination of dynamic and static pressure. If you're parked on the ramp, your ram pressure only includes the static component. As you start to move forward, ram pressure includes both static and dynamic pressure.

Your airspeed indicator is really a scale, which compares the static pressure from your static ports to ram pressure (static + dynamic) from your pitot tube. The two static pressures cancel each other out, and you're left with dynamic pressure. Dynamic pressure translates into your airspeed.





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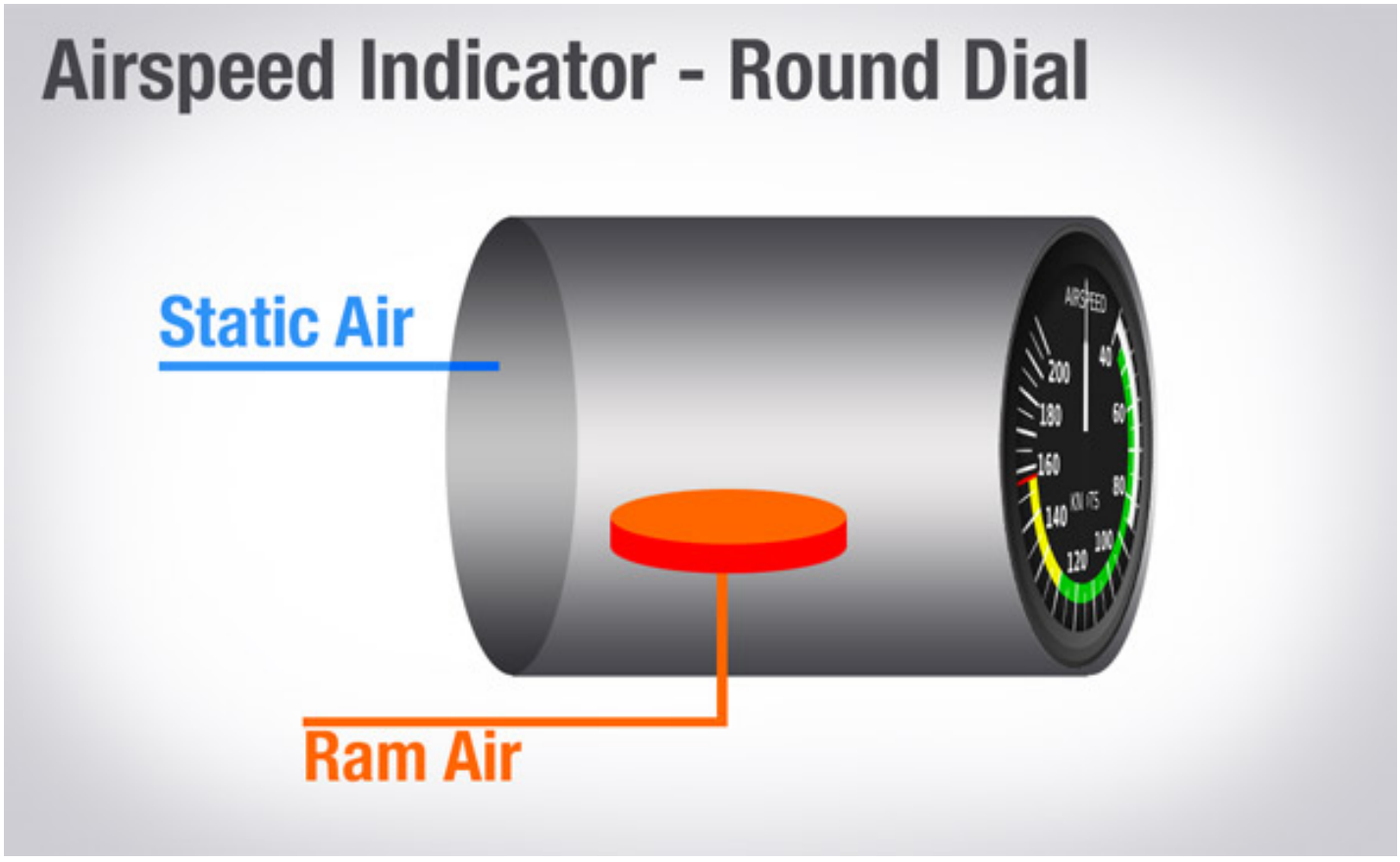
The traditional round-dial instrument uses an aneroid wafer filled with ram pressure, inside a case filled with static pressure.



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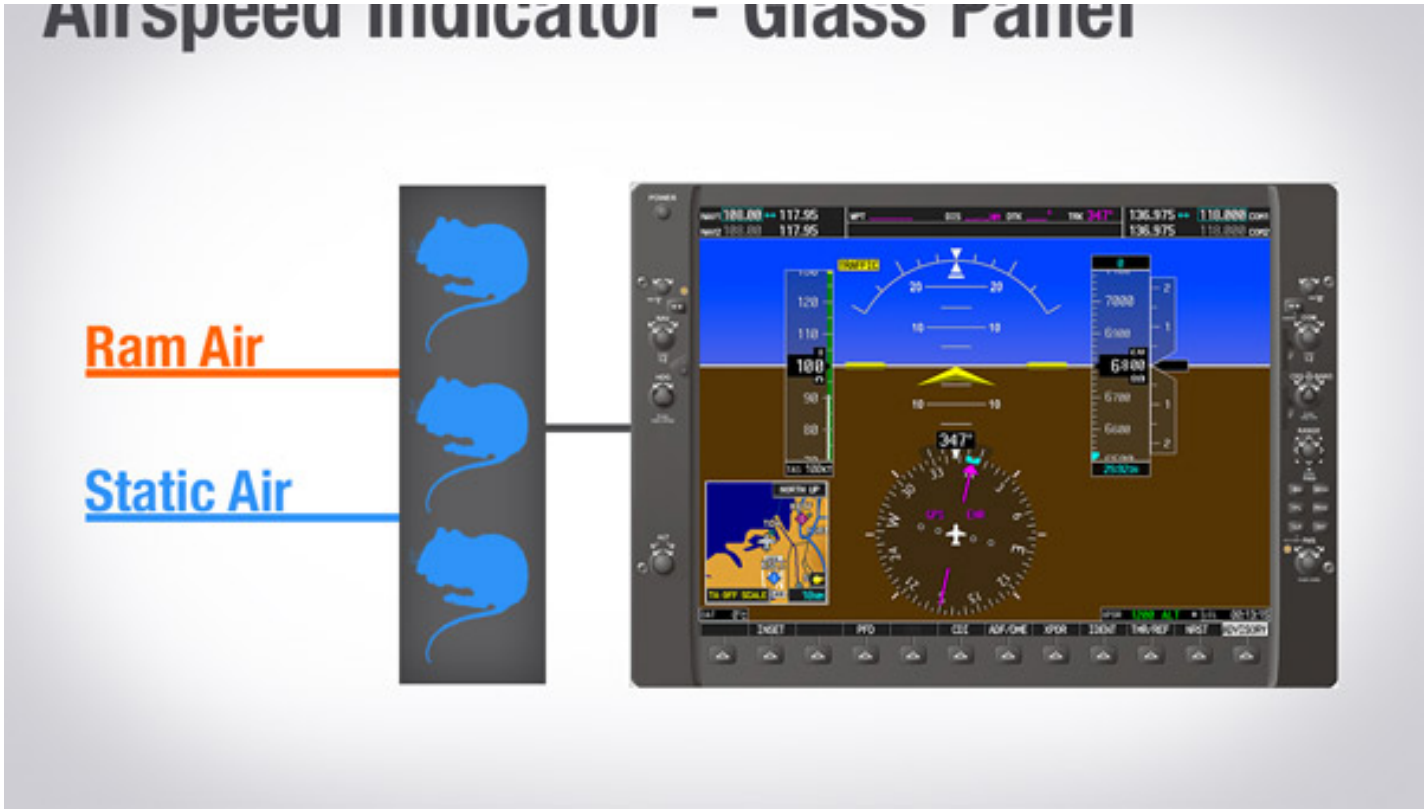
Glass-panel systems use digital sensors, which compare the ram and static air to indicate your airspeed.



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Either way, they both compare static to ram pressure.

The Failures

When your airspeed indicator fails, it's usually caused by a clogged pitot tube or static ports. In each case, your airspeed indicator may freeze, drop to zero, or gradually change.

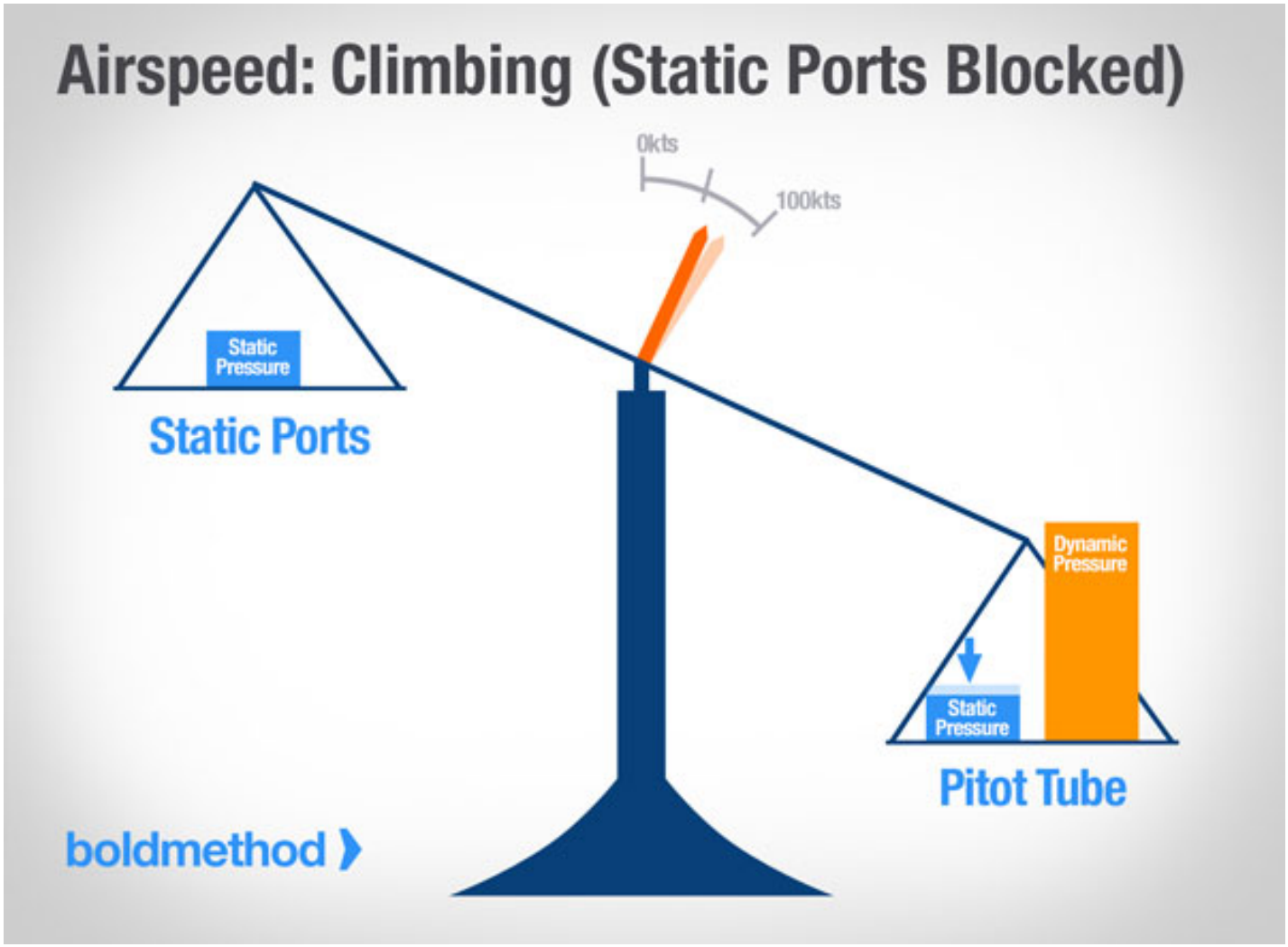
You can figure out what happens by thinking about how the static and ram pressures change on each side.

Scenario 1: Your Static Ports Clog And Your Pitot Tube Is Open

This could happen if your static ports ice over. Your airspeed indicator receives accurate ram pressure, but it compares the ram pressure to the trapped, and unchanging, static pressure.

As long as the barometric pressure doesn't change, and you stay at the same altitude,

your airspeed indicator indicates correctly. However, things get wonky if you climb or descend.



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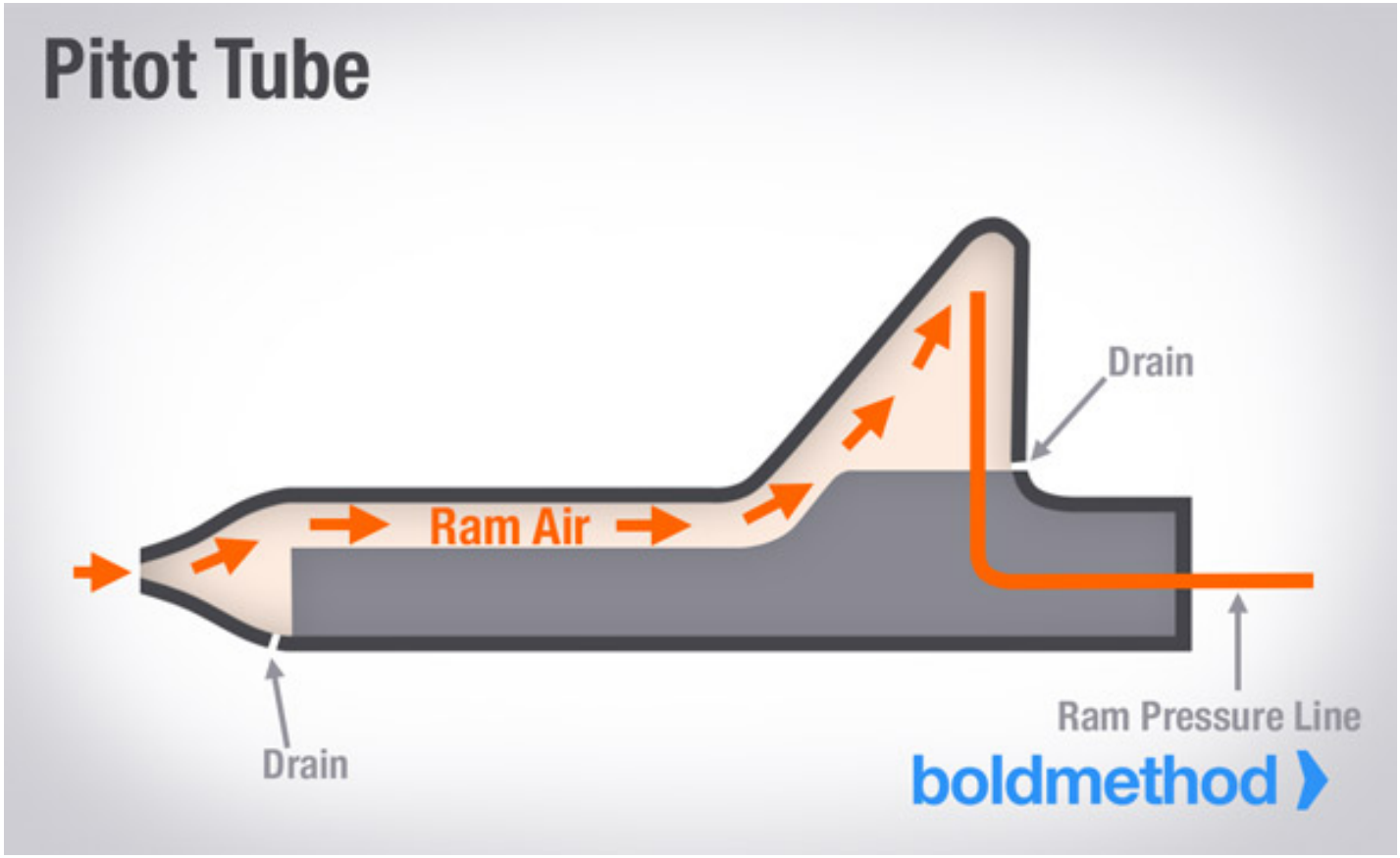
If you climb at a constant airspeed, your ram pressure's static component decreases. Since your static ports are clogged, they have too much static pressure. They're stuck at a lower altitude. The difference between ram and static pressure is smaller, and your indicated airspeed decreases. *Now you're flying faster than your indicated airspeed.* The opposite is true if you descend.

Scenario 2: Your Pitot Tube Clogs, And Your Static Ports Are Open

What happens if your pitot tube ices over, but your static ports remain open? There are actually a couple of different scenarios to consider, depending on what parts of the tube

ice over.



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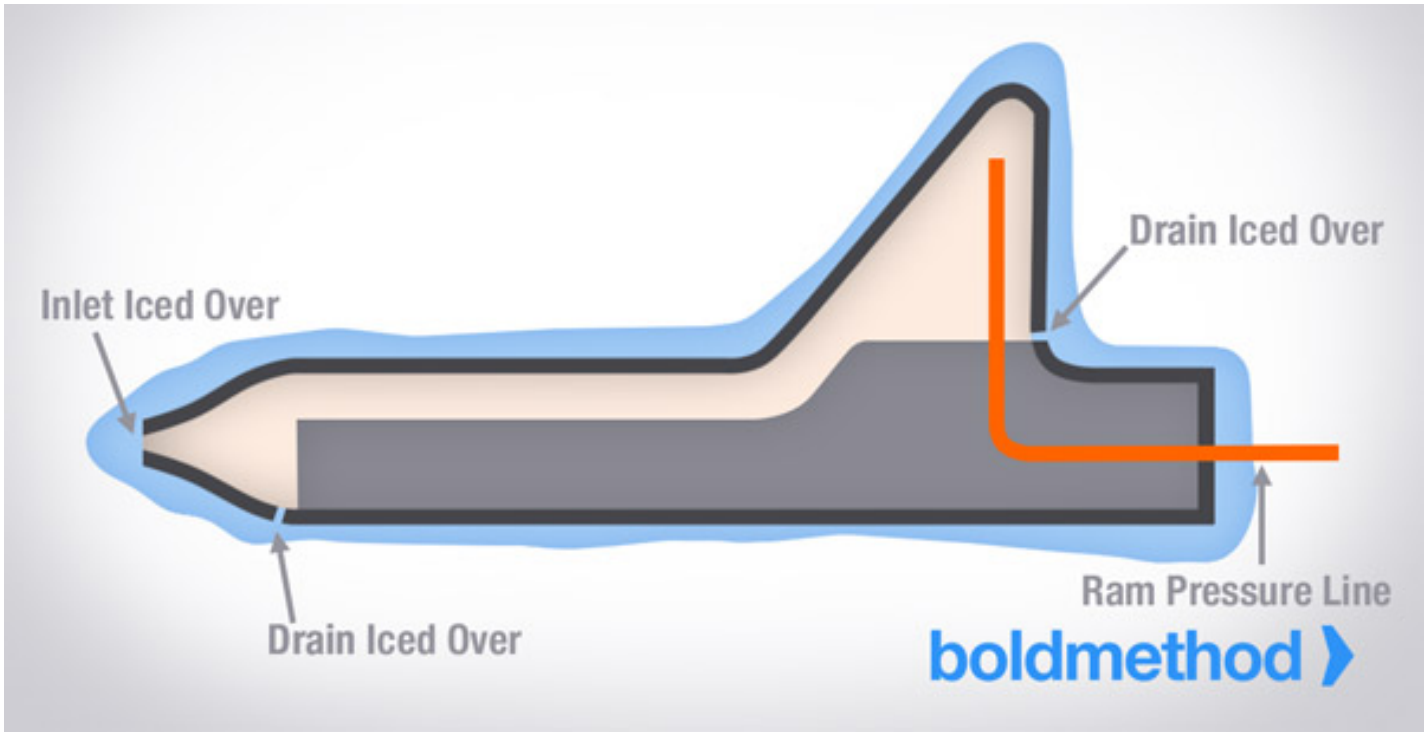
In the pitot tube above, ram air enters through the front of the tube, flows to the back of the chamber, and flows through plumbing to your airspeed indicator.

The pitot tube also has drain holes. If water enters the front of the tube or condenses inside the ram air chamber, it can drain out.

Many pitot tubes also include a static port. But, on most IFR certified aircraft, separate static ports on either side of your fuselage measure static pressure. They're more accurate, and the static port on your pitot tube is left unconnected.

What Happens If The Entire Pitot Tube Ices Over, And The Static Ports Remain Open?



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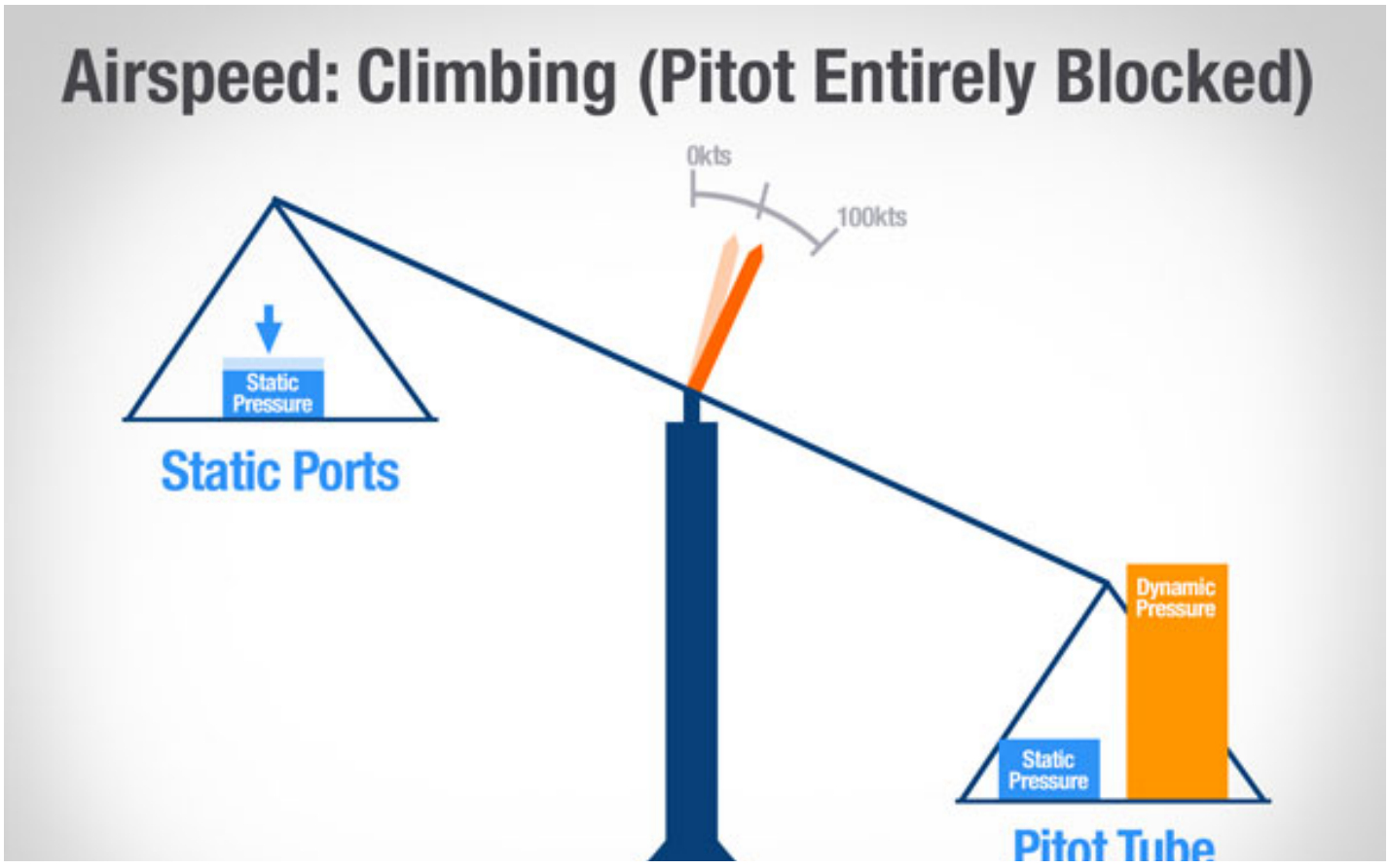
In this case, the ram pressure is trapped. As long as you stay at the same altitude, your airspeed freezes as well.



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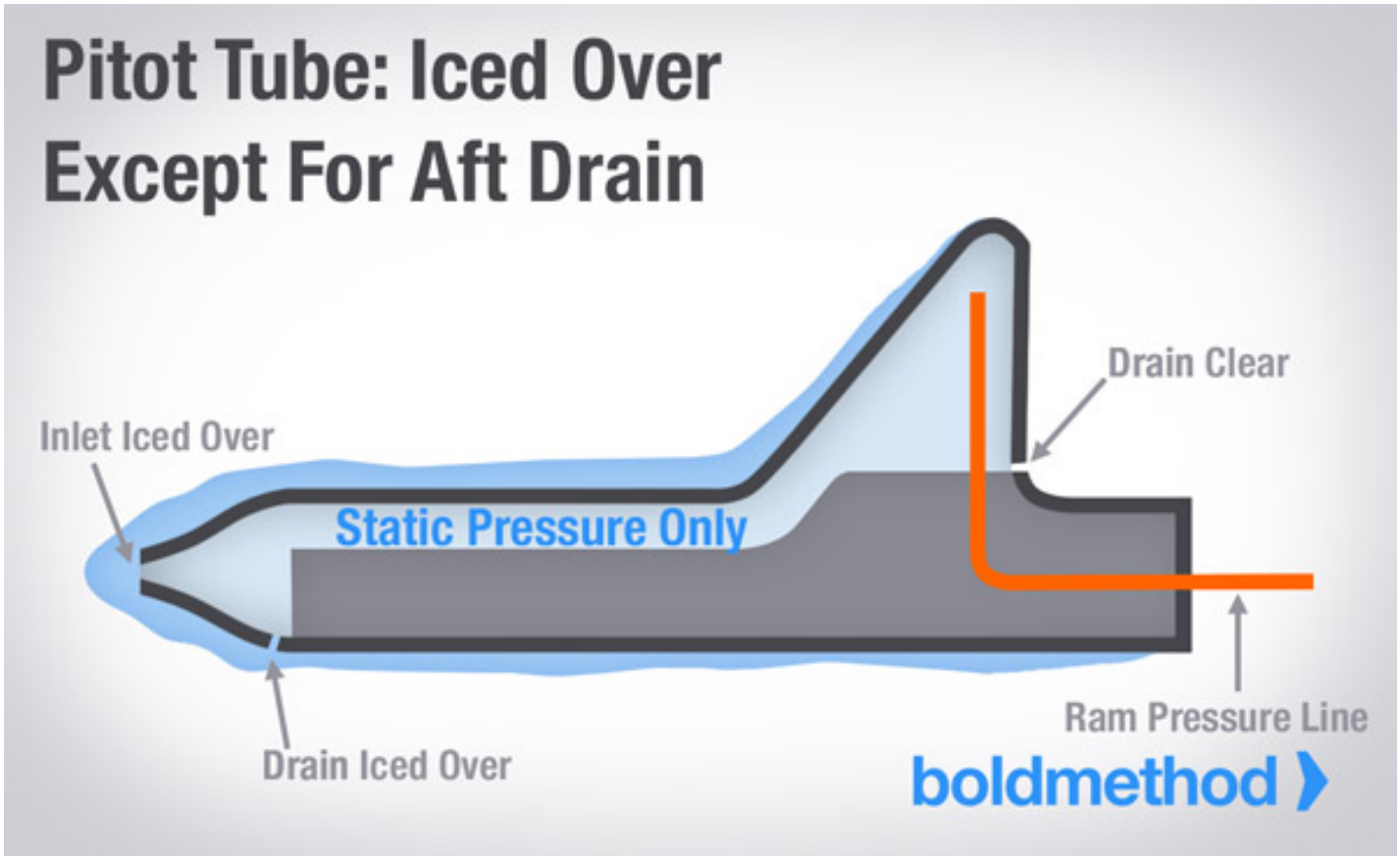
What happens if you climb? Since your static ports are still open, the static pressure will start to decrease. The trapped static pressure in the pitot tube is now greater than the actual static pressure, and your airspeed indicator starts to speed up. *You're now flying slower than your indicated airspeed.*. The opposite happens if you descend.

What Happens If The Ram Air Inlet Ices Over, But The Drains And Static Ports Remain Open?



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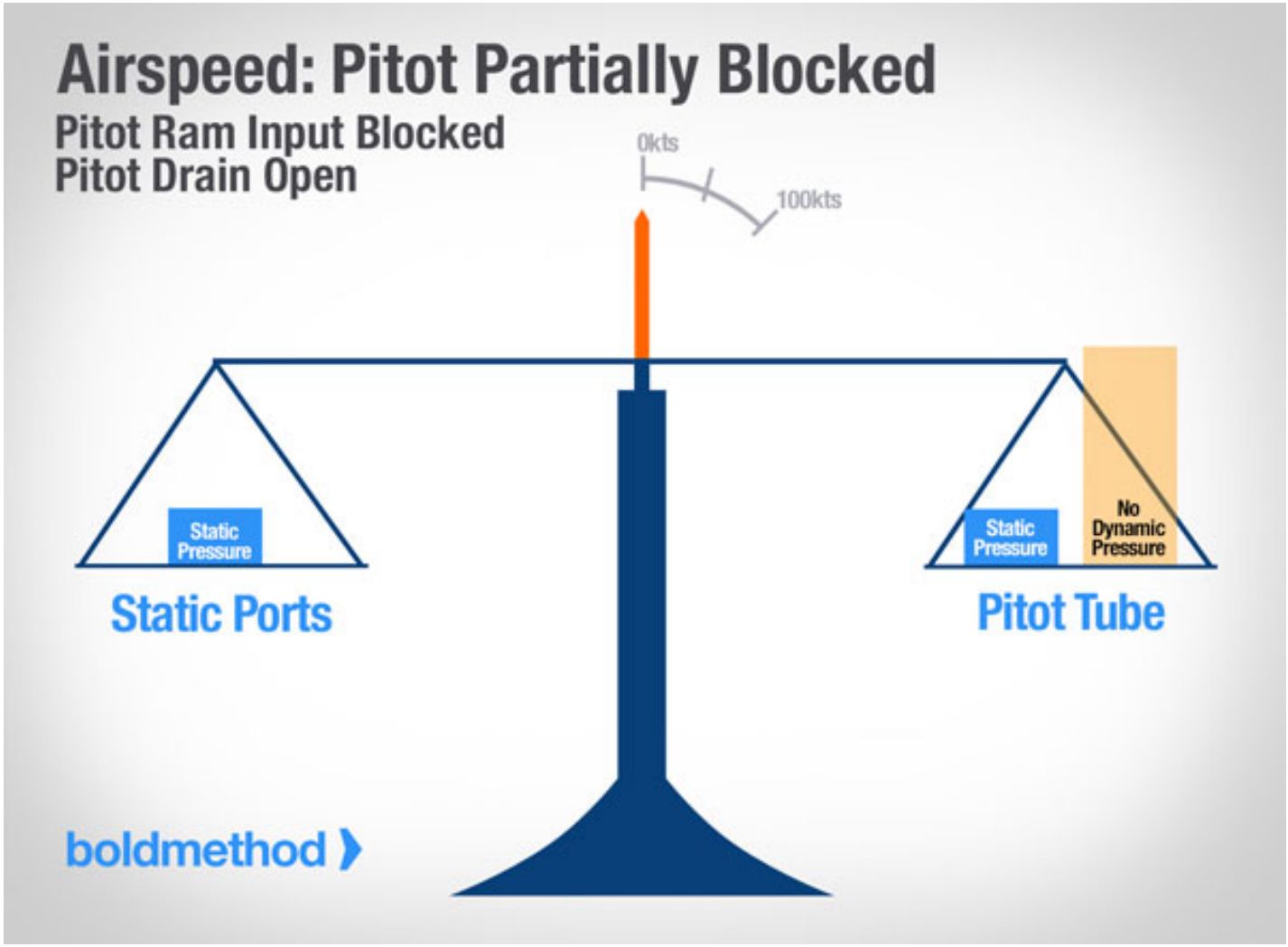
In this situation, the pitot tube becomes a relatively inaccurate static port.

Your airspeed indicator is now comparing inaccurate static pressure to accurate static pressure, and would read nearly zero. It may read slightly below zero, or slightly above

zero, depending on the drain hole's position.



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What Happens If The Pitot Tube And Static Ports Completely Ice Over?

This one is easy: all of the pressure is trapped, and your airspeed indicator freezes. Whether you climb or descend, speed up or slow down, your airspeed won't change.

Keeping Your Ports Clear

Icing isn't the only way to clog a pitot tube or static port, but it's a common one, especially this time of year. Using pitot heat is a great plan, but unless your airplane is certified for flight into known icing, your static ports are probably unheated and vulnerable. Staying out of freezing moisture unless your plane is certified for flight into

icing conditions is your best bet.

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Dick Campbell

Pitot tube completely frozen over is what killed the Air France out of Brazil, and a cargo jet (727?) out of New England. As both aircraft climbed, their indicated airspeed showed very high and they stalled trying to slow down.

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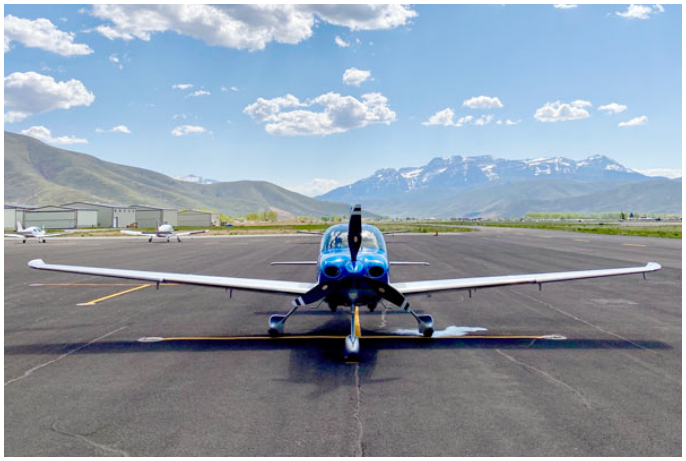

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