

HIGH ALTITUDE ENGINE OPERATION PROCEDURES **(Especially for "flatlanders" visiting the High Country the first time)**

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MYTHBUSTER: Aggressive leaning at higher cruise altitudes will not harm your engine...It is impossible to run your engine "too lean" when cruising above 7000' density altitude, provided cylinder head temperatures all stay at 380° F. or below and oil temperature stays under 210° F.

MYTHBUSTER: Operating your engine "under square" (i.e., RPM/100 below the manifold pressure setting in inches) will not harm your engine. For example, there is nothing wrong with setting the prop to 2000 while the manifold pressure is set to 23" in order to decrease the noise level.

Before leaving for the High Country (non-turbocharged aircraft):

1. If your aircraft's POH and/or checklist says "Mixture: Rich" for landing or takeoff, cross out the word "Rich" and change it to "Set": We do not use full-rich mixtures in the High Country (except perhaps at the lowest-elevation airports on the coldest days)
2. Learn to use the attached Density Altitude chart.
3. In your local area, bring your DA chart and go flying.
4. Climb to a density altitude that you've calculated is equal to 7000' for your given outside air temp that day.
5. With the throttle full forward, lean the mixture until you obtain maximum power on the RPM or MP gauge (as applicable to your plane's power instrumentation).
6. Memorize the position of the mixture control at this "full power" point: This is close enough to the position you will use for takeoff and landing at most airports in the high country. (Typically, this means the mixture control will be *at least 1"* aft of full forward...if it's not, your engine may need adjustment.)
7. Pitch up to your airplane's normal after-takeoff climb speed and note your airplane's climb rate.

During cruise to the High Country (all aircraft):

1. Unless you have a fuel-injected engine and digital multi-cylinder EGT (exhaust gas temperature) gauge and you previously learned how to run it lean-of-peak, you can ignore the EGT gauge: It varies for each engine and cylinder installation and therefore for each airplane...there is no "correct" EGT setting.
2. Instead, for maximum fuel efficiency (and to prevent spark plug fouling), THE IDEAL MIXTURE SETTING (at any altitude, including those you fly at back home) is the one where:
 - (a) The engine is run as lean as possible (min. fuel flow) without the engine stumbling or running rough. (Note, if you have a fuel-injected engine, it's possible that you could lean it beyond the "stumbling" point and it will start to run smooth again: This is "lean-of-peak" operation. You won't know if your engine can do it until you experiment); and
 - (b) All of the engine's cylinder's head temperatures (CHT's) stay below 380° F.; and
 - (c) The oil temperature stays below 210° F.
3. If you don't have a CHT gauge, you may need to run your engine slightly richer than you would than if you had a CHT gauge simply because you just won't know how hot the cylinders are running. In that case, keeping oil temperature below 190° F. is advisable, and you may want to consider leaving the cowl flaps partially open, as well.
4. If you have a single-cylinder CHT gauge, you won't know if it is reporting the temperature of your hottest cylinder, so you should consider operating with mixture settings that keep that single cylinder head temp readout below 370° F, instead of 380.
5. Every time you change altitude or power setting, you must also change the mixture.

Once you arrive in the High Country (non-turbocharged aircraft):

1. In the traffic pattern, set the mixture control to the pre-determined "best power" setting you memorized back home (most likely about 1" aft of full-forward).
2. After landing, and once off the runway with the power at normal taxi setting, lean the mixture further; you want to taxi (and idle) with the engine running at its maximum lean setting in order to prevent spark

plug fowling. This will be the setting where the engine runs fine at taxi power, but starts to stumble as soon as the throttle is advanced.

3. During the runup before takeoff, lean the mixture until you achieve the maximum available power on your RPM or MP gauge. Compare it to the best-power takeoff mixture setting you memorized during your test flight back home....they should be very close.
4. During the takeoff roll, after advancing the throttle to takeoff power, you can lean the mixture slightly more and note if the MP or RPM increases even further.

Once you arrive in the High Country (turbocharged aircraft):

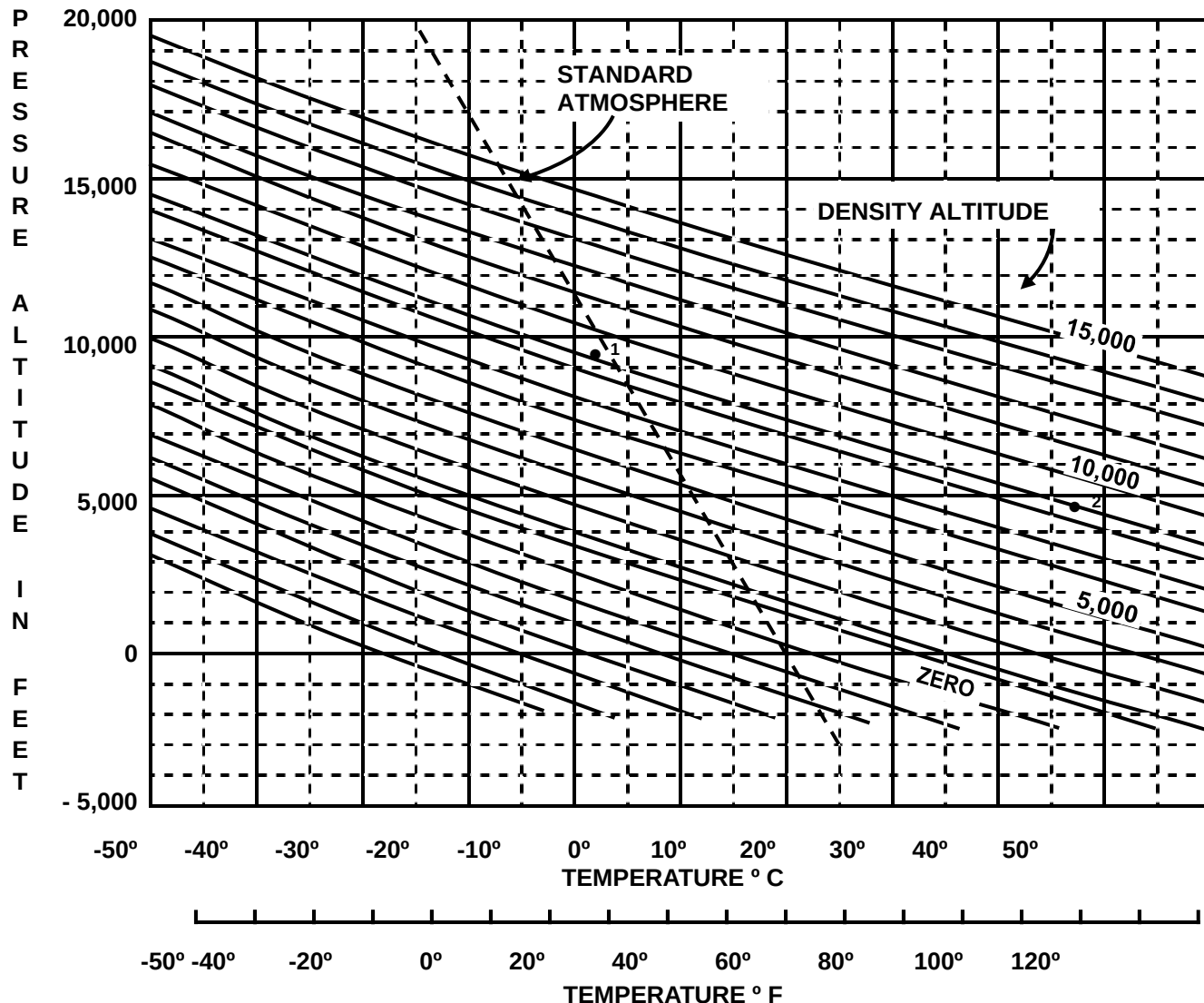
1. On descent, reduce power slowly to prevent cylinder shock cooling; the old rule-of-thumb is 1" of manifold pressure every minute. (This has lately become controversial... some pilots claim shock-cooling cylinders by aggressive power reductions is a myth.)
2. For descent and landing, it's perfectly fine to lean the mixture to the maximum lean (min. fuel flow) setting, provided the engine runs smoothly and temperatures stay within range: 1" aft is usually a fine setting for approach and landing in a turbocharged engine...just remember to set it to full forward if you need to go around.
3. After landing, and once off the runway with the power at normal taxi setting, lean the mixture further; you want to taxi (and idle) with the engine running at its maximum lean setting in order to prevent spark plug fowling. This will be the setting where the engine runs fine at taxi power, but starts to stumble as soon as the throttle is advanced.
4. Always use FULL RICH (maximum fuel) for cooling during takeoff and go-arounds
5. After takeoff, you can start to lean after reaching about 1000' AGL provided cylinder and oil temperatures remain under 380 and 210, respectively.

QUESTIONS? COMMENTS?

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DENSITY ALTITUDE GRAPH



INSTRUCTIONS: Set the aircraft's altimeter at 29.92 inches. The altimeter will indicate pressure altitude. Read the outside air temperature. Enter the graph at the pressure altitude value and move horizontally to the temperature value. Read the density altitude by following the sloping line to where it intersects the standard atmosphere line.

Example # 1:

Density altitude in flight: Pressure altitude is 9,500 feet and the temperature is -8 degrees C. Find 9,500 feet on the left of the chart and move to -8 degrees C. Density altitude is 9,000 feet. See dot on the chart that is labeled # 1.

Example # 2:

Density altitude for takeoff: Pressure altitude is 4,950 feet and the temperature is 97 degrees F. Enter the graph at 4,950 feet and move across to 97 degrees F. Density altitude is 8,100 feet. See dot on the chart that is labeled # 2.