Operational Efficiency:

Making the Most of Your Fuel Dollars

by Matthew McDaniel

Feeling the sting at the avgas pump? Don't give up hope; there *are* ways to operate more fuel efficiently. If there is anything the airlines excel at, it is operating fuel efficient within the confines of the FARs and SOPs. I became accurately aware of this when I returned to airline flying in 2005. In the three-plus years I'd been away from airline operations, their commitment to fuel saving measures had expanded exponentially. As GA pilots, we can learn (or adapt) plenty from the airline industry's efficiency procedures.

Author's Note: *This article is intended only to present ideas to consider and get you thinking about better fuel management techniques. The PIC will always have the sole responsibility of operating their aircraft in the manner they deem safe and legal. Some procedures discussed may vary slightly in different models, vintage and equipped Cirrus aircraft. Mostly, I have used numbers consistent with a normally aspirated SR22, based upon averages I've experienced flying hundreds of them. Always consult your POH and performance charts for acceptable practices and procedures.*

Rich of Peak (ROP) versus Lean of Peak (LOP) Operations

I will not argue the virtues of ROP versus LOP operations. That is simply not the intent of this article. Whether you choose to fly ROP or LOP is a personal choice based upon one's training, comfort levels and aircraft limitations. The fact is, the ideas and considerations presented here can help you fly more efficiently whether you are a ROP zealot or a deacon in the church of LOP!

Pre-Flight

Fuel waste often starts before the aircraft ever moves. Consider these fuel saving tips.

Before engine start:

- During cold weather, pre-heat the engine (and cabin, if possible). This reduces the need to sit idling until the engine (and avionics) reach minimum temperatures.
- Get in, get situated and get everything in place.
- Acquire airport weather and departure clearance prior to engine start. Select BAT2 and Avionics Master ON, which will power the essential avionics (PFD, 430 #1, and A/P). The audio panel won't be powered, but the pilot can communicate via its fail-safe feature (the left seat's headset and PTT). In this configuration, obtain ATIS/AWOS and your clearance. Then, enter your detailed flight plan in 430 #1's FLP page and save it to the FLP catalog. By this time, the PFD will have completed its initialization and you can perform the pre-flight A/P test. Next, input your initial assigned HDG, ALT, desired Vertical Speed and the current BARO into the PFD (or EHSI and Alt Pre-Selector).
- Turn OFF the Avionics Master and proceed with your Before Engine Start Checklist. Note: Do not turn BAT2 Off, as that would cause you to lose everything you just placed into the PFD and force it to re-initialize when power is restored. Since BAT2 does not power the starter, the fact that you have drained it slightly does not affect your ability to start the aircraft.

Run-up and Taxi

You are ready to start the engine and should need minimum time before taxi and run-up. Remember, you saved your flight plan in 430 #1. Simply select and activate it from the FLP catalog.

- If you can do your run-up in your parking spot, do so. This prevents having to power up to leave the parking spot and then again to leave the run-up spot.
- After applying just enough power to get the aircraft rolling, use minimum power and only brake as necessary for steering control. This saves fuel, reduces brake wear, and keeps the brakes cooler and more effective, should you need them for an aborted takeoff.
- Lean the mixture for taxi. How much will vary with specific aircraft and density altitude, but rarely is it necessary to taxi with a full rich mixture. This also can help prevent spark plug fouling.

Runway Choice and Initial Climb

At controlled fields, GA pilots generally accept a controller's runway assignment without question. At uncontrolled fields, they often choose the runway closest to them (wind permitting). The airlines teach: An airplane burns far less fuel taxiing to the most distant runway, than it would if required to takeoff and climb opposite the desired direction of flight, then make a large turn to get on course.

- Don't hesitate to query ATC about your desire to utilize a runway that would permit you to takeoff in the general direction of your destination. You could even do this before engine start.
- When choosing a runway, prioritize:
  1. Wind, terrain and traffic
  2. The one which places you on course the quickest
  3. Shortest taxi distance
- If taking off opposite of the desired direction of flight, climb steeply. This will prevent you from flying a greater distance in the wrong direction and, thus, lessen the required backtracking. It also can result in a quicker clearance to turn on course, as ATC often needs you to reach a specific altitude before they can turn you.

Cruise Climb

The general rules of thumb still apply here:

- If climbing into a headwind, use a faster IAS and a shallower climb. This allows the headwind to have less negative affect on your groundspeed (percentage of speed wise) and gets you further downrange, while keeping you lower longer, often resulting in lighter headwinds at the lower altitudes.
- If climbing with a tailwind, use a slower IAS and a steeper climb. This allows the tailwind to have more positive affect on your groundspeed (percentage of speed wise) and gets you up into the presumably stronger tailwinds quicker.
- Fuel management during climb is another area of potentially large savings: SR22s have a placarded Fuel Flow versus Altitude chart. This chart applies to ROP climbing with full throttle. The information is right in front of you; use it! Don't hesitate to interpolate this chart, adjusting the mixture every 1,000 or 2,000 feet, rather than at the 4,000-feet increments depicted on the placard.
- If you are comfortable with it, and rate of climb is less important for your situation, you might consider climbing LOP. Generally, Cirrus pilots do this with wide-open-throttle (WOT) and the lowest mixture setting that keeps the engine smooth and its temperatures in the normal range. The mixture is leaned continually during the climb to keep pace with the thinning air as altitude is increased. All mechanical arguments aside, one cannot argue that WOT/LOP climbs use far less fuel than ROP climbs under the same conditions.

Cruise

Since cruise is generally the longest portion of any given flight, it is also the segment with the largest potential for fuel savings.

- As with climbing, LOP is always going to be far more fuel efficient than ROP. LOP will cost you speed, but will increase both range and endurance at comparable power settings. Generally when choosing LOP, you can count on about a 10 KTAS loss. Over the course of a three-hour leg, this means you will arrive only about 10 minutes later, but fuel savings could easily exceed 15 gallons.

- Using all available sources, evaluate the winds aloft, both forecast and reported. Careful wind planning is a commonly wasted opportunity to increase fuel efficiency. Use winds as one of your decision points for choosing cruising altitudes. Be aware of frontal boundaries and pressure systems that can change wind direction and speed as you progress along your route. When passing through such areas, it is often advantageous to change altitude to stay in the most favorable winds. If a higher altitude is required, you need to evaluate the gain versus the extra fuel burned while climbing.

- Consider true airspeed. As a rule of thumb, you will gain 2 KTAS and lose one inch MP (non-turbo) for each 1,000 feet of climb. So, flying higher is usually more fuel efficient only to a point. Eventually, your available power will be so low that you will no longer gain TAS as you climb. Generally speaking, you can count on a faster TAS in non-Turbo SR22s as you climb, until you reach the oxygen altitudes. Above that, close comparison of the conditions (winds, temps, etc.) and your performance charts is necessary to determine if anything can be gained by climbing even higher.

- Your route is also a consideration. GPS Direct is the shortest distance in ground miles, but when you factor in wind and perform a careful evaluation, sometimes you will discover GPS direct is *not* the shortest distance. A GPS Direct routing is not a straight line, but rather a great-circle route. That means the longer the route, the more your heading will change as you progress. Heading changes will generally mean a wind-component change as well. If that slows your GS (ground speed) along the way, you could actually end up flying more air-miles (miles flown through the air mass) than if you'd flown a similar, yet slightly longer, Victor airway routing that kept you on a more consistent heading.

  If this concept is a little confusing, let me give a realistic example to simplify it: *Assume an ~500 nm Cirrus flight, where an airway routing is 10 nm longer than a GPS Direct routing and the headwind difference is only 5 kts.*

  A Nautical Air Mile (NAM) =
  [Nautical Ground Mile (NGM) × TAS] / GS

  Example:

  Direct Route (GPS Direct):
  525 NGM, TAS=170 kts, GS=135 kts (35 kts headwind)
  [525 × 170] / 135 = 661.1 NAM

  Non-Direct Route (airways or fix-to-fix):
  535 NGM, TAS=170 kts, GS=140 kts (30 kts headwind)
  [535 × 170] / 140 = 649.6 NAM

[redacted]

As you can see, by flying the slightly *longer* airway routing, with only a five-knot wind difference, you'd actually fly 11.5 less air miles! The difference (fuel savings) is small, but small savings add up when applied consistently.

- If you have a headwind, it is more efficient to cruise a little faster. This results in a smaller percentage penalty and gives the wind less time to work against you. The stronger the headwind, the faster you should push into it. Conversely, it's better to cruise slightly slower with a tailwind. This results in a larger percentage bonus and gives the wind more time to push you along. When I say fly "slower" or "faster," I'm speaking about a relatively small airspeed range in Cirrus aircraft (rarely more than +/-20 kts). If you aren't sure, experiment using your fuel monitor. Change power and/or mixture settings, allow fuel flow and TAS to stabilize and note the change in ETE, ETA and Fuel at the Destination. Any of the suggestions above can be validated, in flight, by quickly "running the numbers" through various combinations of your 430 #2 (for reroute distances and courses), an E6B, a calculator and/or your on-board fuel computer(s). Of course, the POH charts can be very helpful too! Or you could use the same formula above to determine air miles versus ground miles.

Example 1: Assume you have a screaming tailwind on a 400 nm flight and want to extract the most advantage from it, so you decide to fly a slower TAS. Comparing your efficiency at high cruise speed (170 kts, LOP) versus a "slower for the tailwind" speed (say 160 kts, LOP):

170 TAS: [400 NGM × 170 kt TAS] / 220 kt GS (50 kt tailwind) = 309.1 NAM (Nautical Air Miles) and 1.8 hours flight time. LOP fuel burn would be around 14 gph at average altitude and conditions resulting in a total fuel burn of 25.2 gallons.

160 TAS: [400 NGM × 160 kt TAS] / 210 kt GS (50 kt tailwind) = 304.8 NAM and 1.9 hours flight time. LOP fuel burn would be around 12 gph at average altitude and conditions resulting in fuel burn of 22.8 gallons.

This example shows that by slowing down only 10 KTAS to take better advantage of the 50-knot tailwind, you will fly 4.3 *less* air miles, while arriving only six minutes later and saving roughly two-and-a-half gallons of fuel.

Example 2: Assume you have a brutal headwind on the same 400 nm flight and want to minimize its damage to efficiency and arrival time, so you decide to fly a faster TAS. Comparing your efficiency at an "economy" cruise speed (150 kts, LOP) versus a "faster into a headwind" speed (170 kts, LOP):

Flying at 150 TAS: [400 NGM × 150 kt TAS] / 100 kt GS (50 kt headwind) = 600.0 NAM and 4.0 hours flight time at 11.5 gph for a total of 46.0 gallons burned.

Flying at 170 TAS: [400 NGM × 170 kt TAS] / 120 kt GS (50 kt headwind) = 566.7 NAM (air miles) and 3.3 hours flight time at 14 gph for a total of 46.2 gallons used.

By flying 20 KTAS faster to minimize the 50-knot headwind, you will fly 33.3 *less* air miles, while arriving a whopping 36 minutes earlier. Yes, you'll burn 0.2 gallons more fuel in exchange for arriving over a half-hour earlier. The airlines would call this technique "preserving the schedule."

Descent

Economy descent principals are very similar to those discussed in the climb section.

- When cruising with a headwind, it's usually best to begin your descent earlier and at a slower rate. The early drop-down allows you to come down out of the headwind sooner. Since you're descending a greater distance from the destination, you'll need to use a slower rate. Coming down at 500 fpm allows you to pick up a little speed in the descent and to hold that speed increase for a longer period of time. Generally I suggest descending at the same power setting from cruise and allowing the manifold pressure to increase naturally.

To maintain the same relative mixture setting (whether ROP or LOP), set the engine monitor to Normalize just before beginning to come down. Throughout this phase, enrich the mixture just enough to maintain the previously established settings, as indicated by the Normalize Mode's baseline.

- When cruising with a tailwind, try to stay up in the strongest wind for as long as practical. Plan to delay the descent until 1,000 fpm, or more, is necessary (passenger comfort needs notwithstanding). It's usually my goal to stay high just long enough to allow a descent rate that is sufficient to give a good gravity-induced speed boost, but not so steep that I'd have to reduce power to prevent the IAS from exceeding any structural, turbulence or autopilot limits. If you achieve that goal, power changes are unnecessary and you can use the same Normalized Mixture technique discussed above.
- At some point you are going to reach an altitude where you'll need to make a power adjustment. If you plan it right, this should be as you're entering the VFR pattern or the initial segment of the IFR approach. In either case, that is the appropriate time to ensure a proper mixture setting for your density altitude and landing, always considering the possibility of a missed approach or go-around.
- Regardless of the descent strategy used, it can be made easier by utilizing the vertical navigation profile information in the Garmin 430s. On the VNAV page, input your desired altitude and distance from the airport, or other waypoint, input the target vertical speed and select the VNAV Messages ON. As you approach the selected descent rate, you'll get a message saying "Approaching VNAV Profile." Request a descent from ATC and match the 430's recommended Vertical Speed Required (VSR) to achieve your descent parameters.

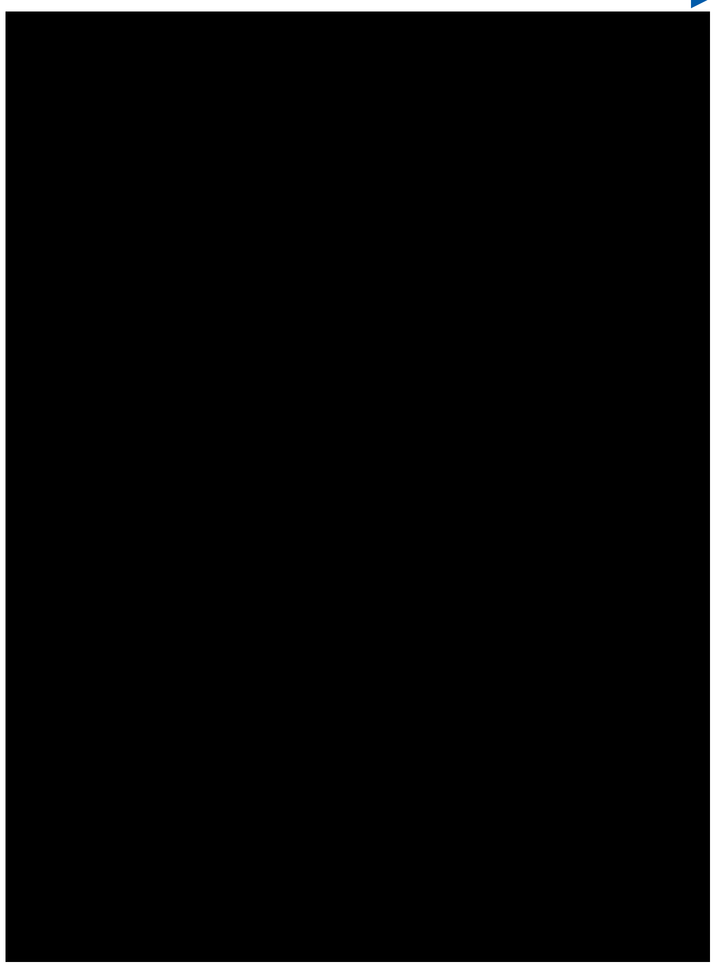
Instrument Approach and Landing

Because instrument approaches are so procedural and consistency is critical to safety, there are fewer opportunities to make major fuel-saving changes, but there are things well within standard operating procedures to consider.

- Don't configure (extend flaps) too early. It is important to do so for the final approach segment at the right time, but doing so too early will only require you to carry more power for longer to compensate for flap-drag. Plan to be on-speed with 50% flaps by 1-2 nm from the FAF (non-precision) or one-dot below the glideslope (precision).
- Generally, approaches with vertical guidance are going to be the most fuel efficient choices, because they allow a consistent power setting throughout the entire final approach segment. A non-precision approach, however, may require multiple power changes for step-down fixes.
- When flying approaches with the A/P, use GPSS whenever possible. Its ability to anticipate turns and roll out precisely on the next course is far more fuel efficient than overflying a fix and establishing on the next course via intercept and bracketing angles.
- As with departure, your choice of instrument approach and landing runway can be a fuel saver. ATC, wind and traffic flows permitting; choose the approach that allows the shortest transition from the en route to final approach course.
- Consider the landing runway and where you will land versus where you need to taxi. The shorter distance, the better. However, it's still more fuel efficient to taxi a long way than it is to overfly the airport, reverse course and fly back.
- If you are only using the approach to "get down through the clouds" while the airport is technically VFR, consider a downwind approach and a circle-to-land maneuver (which is basically just a traffic pattern when the weather is VFR). If a downwind approach is closely aligned with your en route course, it can be used as an efficient transition from cruise flight to the VFR traffic pattern and often lends itself well to an appropriate VFR pattern entry.

VFR Traffic Pattern Entry

Fuel waste in this phase of flight is due almost entirely to not briefing the en route course versus the airport layout and/or expected pattern entry. Use all the information the Cirrus puts at your fingertips to become familiar with the airport layout and how to safely, legally and efficiently enter the traffic pattern. As a CSIP, I often see Cirrus pilots ignore this simple task, become confused when they arrive at the field and are forced to circle, overfly, and make unnecessary turns to "get their bearings" before entering the pattern.



Post-Landing Taxi

As with your taxi out, you can lean the mixture for your taxi in. Ensure your Boost Pump is off, as it increases fuel flow. Select the shortest taxi route feasible and taxi at the lowest acceptable power setting. Again, avoid riding the brakes and try to resist that full-power-induced sharp turn that I often see Cirrus pilots using to squeeze into tight parking spaces.

Other Considerations

- *Weight:* Obviously, the heavier your aircraft is, the less fuel-efficient it will be. Inventory your plane's contents a few times a year and offload unnecessary weight. We all have little gadgets we like to have accessible, but try to be reasonable. They add weight, reduce payload and you burn fuel to carry them along. I know a couple of Cirrus owners that have a W&B for flying with the rear seats removed. This gives them a huge storage area when they want it and also lowers their airplane's empty weight.
- *Tankering Fuel:* There is the old axiom that there is nothing as useless as fuel left behind. As true as that might be, its costs fuel to carry fuel. Within reason, consider leaving fuel behind to lighten your aircraft. By all means, carry the fuel you need for the trip, the alternate and reserves, but do you really need full tanks for a 1.5-hour solo flight in VFR weather? It might be comforting to have it in the wings, but there is a price to be paid for using your Cirrus as a tanker plane.
- *Center of Gravity (C.G.) Location:* Aerodynamically speaking, the most efficient C.G. location is the aft limit of the envelope. This is because, the further aft it is, the less downforce the tail is required to generate to balance the aircraft in flight. Less tail downforce (negative lift) equals less drag, as lift (upward or downward) generates induced drag. Therefore, an aircraft flying with an aft C.G. produces less drag than an aircraft with a more forward one (all other things being equal). I am not suggesting that you fly around at the aft C.G. limit all the time, but when you load your aircraft, keep this principal in mind, especially for longer flights.
- *Autopilot Usage:* I won't admonish any pilot for choosing to hand fly and, thereby, keep their flying skills sharp. Having said that, even the sharpest pilot cannot hand fly for long periods of time as smoothly or efficiently as the autopilot can. Any way you slice it, every little course or heading deviation and altitude bobble costs fuel when added up over the course of a long flight. Using the autopilot can minimize that and, thus, improve fuel efficiency. As discussed in the "Instrument Approach and Landing" section, the A/P's GPSS mode will typically be the most fuel-efficient method.
- *Clean equals efficient*: Most Cirrus pilots realize their airplanes are rather sensitive to being dirty, flying in rain or (heaven forbid) collecting any ice. Blame this on the highly efficient laminar flow wing which is much more sensitive to disruptions of the smooth airflow across it. The further forward on the airfoil the disruption happens, the greater the loss of efficiency. In Cirrus aircraft, this can translate to TAS losses of 10-15 kts or even more. Collect any ice (even with TKS functioning) and you should be worried about a lot more than your fuel efficiency! There is no doubt whatsoever that you can absolutely improve the fuel efficiency of your Cirrus by keeping it clean and dry as much as possible, especially the leading edges of the wings.
- *Maintenance:* Nearly anything the pilot can control to improve efficiency can be quickly mitigated by an improperly maintained aircraft. The inefficiencies of mechanical neglect can add up quickly and exponentially. This includes the disuse of your aircraft, which can often be even worse than overuse in terms of causing mechanical issues. So, fly and fly often. It's good for your skills and your aircraft's systems.

In Conclusion

There is little doubt that some of the topics I've discussed might generate a few spirited discussions. LOP operations still have a stigma that many pilots (and mechanics) cannot shake; in spite of the supporting evidence. Some will say that many of my suggestions are too much trouble for too little reward. To that, I say, little rewards are cumulative. Tiny fuel savings in any given area *will* add up to large fuel savings over years of flying. And, just to clarify, I have not and will *never* endorse sacrificing safety, legality, consistent training, or overall prudence for the sake of fuel efficiency. Period.

During my aviation career, I cannot count the number of times I've heard pilots and mechanics say, "Fuel is cheap, engines are expensive." Maybe once upon a time that was true, but when I roll into a big city FBO and see Avgas for $7.00/gallon, I'm thinking that fuel's not so cheap anymore! COPA

[redacted]

About the Author: *Matthew McDaniel is a Master & Gold Seal CFII, ATP, MEI, AGI, IGI and CSIP. In 19 years of flying, he has logged over 10,000 total hours and more than 4,000 hours of instruction-given. As owner of Progressive Aviation Services, LLC* (www.progaviation.com), *he has specialized in Cirrus instruction since 2001. He's also an airline pilot, currently flying the Boeing 717, and holds four turbine aircraft type-ratings. Matt can be reached at:* matt@progaviation.com *or (414) 339-4990.*