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OPERATING RECOMMENDATIONS

FOR

TIO-540-AE2A ENGINE
IN
PIPER AIRCRAFT MALIBU MIRAGE

SSP-400 Rev. 2 (01/09)

Operating Recommendations for TIO-540-AE2A Engine in Piper Aircraft Malibu Mirage

Lycoming Part Number: SSP-400

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OPERATING RECOMMENDATIONS
TIO-540-AE2A ENGINE

Introduction

The following has been prepared to provide new or current owners of The Piper Aircraft Malibu Mirage with some additional operating recommendations direct from the engine manufacturer, Lycoming Engines. These recommendations do not change the basic specifications or limits in the Pilot's Operating Handbook or Engine Owner's Manual. They are intended as a supplement to give owners recommended operating guidelines to obtain good aircraft and engine performance while maintaining a good service experience with the engine.

Piston aircraft engines are a unique breed of powerplant. Unlike their automotive cousins that spend their entire lives operating at 20% power or less, piston aircraft engines live almost continuously at 65% power and above. An automobile engine probably never reaches its full rated power in its entire lifetime. The aircraft engine does it every day on every takeoff roll. NASCAR race cars operate at high power for extended periods of time, up to 500 miles, after which they are disassembled and rebuilt. The aircraft engine is expected to run at high power for up to 2000 hours without an issue.

The Lycoming –540 engine is the strongest, most reliable six cylinder engine in General Aviation. No matter how rugged and durable, it is a mechanical device that still requires care in operation and maintenance to obtain the best service experience. Included with this information package are factory recommendations and tips toward improving the service life of your engine.

Break-In

Initial operation of the TIO-540-AE2A engine must be done with only Ashless Dispersant aviation oil. Lycoming approves multi-viscosity, 20W-40, 20W-50 or SAE 30, SAE40, or SAE 50 straight weight oils depending on ambient temperatures (Reference Lycoming Operator's Manual) and owner's preference. Operate the engine in accordance with the following general recommendations during the break-in period. There is no need to conduct any special break in operation for the –AE2A engine other than avoiding long periods of operation at low power (less than 65%) or prolonged idle. Engine break-in is normally completed within the first 50 hours time in service.

Normal Operation

Takeoff

The engine power setting for takeoff is 42 in. MAP, 2500 RPM, Full Rich Mixture. Observe the manifold pressure redline. It is not unusual to experience an overboost of up to 2 in. MAP with cold oil or on the first takeoff of the day. During cold conditions, the throttle movement rate can exceed the capability of the turbocharger controller to regulate manifold pressure. The overshoot condition can normally be prevented by interrupting the throttle advance momentarily several inches below rated manifold pressure. This allows the cold control system to catch up with the throttle movement. Maintain takeoff power until clear of obstacles then reduce power to 2500 RPM, 35 in. MAP, with climb speed of 125 KIAS, 32 gallons per hour fuel flow. Above 24,000 ft., reduce MAP to 34 in. or below. This slightly reduced power setting combined with higher climb speed provides better engine cooling with less loading.

Cruise Settings

Higher operating temperatures and pressures generally increase the wear rate of critical engine parts. Aircraft engines have operating limitations, termed “redlines”, that represent the maximum allowable value for a given parameter. The engine is certified to perform safely at these redline conditions. However, continuous operation at redline values may shorten the service life of the engine. For example, engines continuously run at the maximum possible cruise setting at maximum TIT (Turbine Inlet Temperature) will probably require a top overhaul of cylinders before engine TBO (Time Before Overhaul). Operating consistently at the maximum allowable engine parameters does not promote optimum service life. There are balances between aircraft and engine performance.

Lycoming recommends that a cruise setting of 65% power be used for typical flight profiles. This power setting corresponds to 2400 RPM, 29 in. Hg. manifold pressure. Recommended TIT is 1650°F or 100 degrees richer than peak TIT whichever is less. On a typical 400 nm trip, the use of 65% in place of the high performance cruise setting will require approximately 9 minutes more time. Fuel savings will be 2 gallons per hour. No matter what approved power setting is used, cylinder head temperatures must not exceed 435°F in level flight cruise. For optimum service life, maintain cruise cylinder head temperatures below 400 degrees. Adjust power setting and mixture accordingly.

There is a popular advertising gimmick regarding operation of the –AE2A engine on the “lean side of peak TIT”. This entails leaning through peak TIT until the temperature begins to drop 50-100 degrees. On some engines, a very small improvement in fuel economy may be realized with this technique. Unfortunately there is a corresponding power loss related to this lean operation. The suggestion then is to increase manifold pressure to raise the engine power level. This method of operation is not new and has been used on large supercharged or turbocharged radial engines. It is important to remember that these powerplants typically had a full time flight engineer maintaining the operating parameters within acceptable limits. Many were equipped with detonation monitors in the cockpit. Lycoming also recommended this operating procedure on certain engines in the 1960’s. This was rescinded due to very unfavorable service experience. The engine will operate satisfactorily in this manner on our test stand with laboratory instrumentation and full time operators. However, operating on the lean side of peak TIT with elevated manifold pressure substantially reduces or may entirely eliminate the detonation margin. It is certainly not a procedure that is operator friendly to be used in today’s environment with high ATC (Aircraft Traffic Control) attention and traffic demands. The cost of replacing a burned valve or piston will more than offset the small savings in fuel burn. If a $5 per hour savings in fuel is necessary for an operator to afford the use of a Mirage at the risk of engine wear or damage, this is not the correct powerplant or aircraft.

Whenever the mixture is adjusted, rich or lean, it must be done slowly. At all times, caution must be taken not to shock cool the cylinders. The maximum recommended temperature change is not to exceed 50°F per minute.

It is not possible to properly set engine conditions with inaccurate instrumentation. Lycoming strongly recommends that all engine instrumentation be calibrated annually. Many people believe that incorporating a multi-probe system somehow eliminates the need to maintain their primary aircraft instrumentation. The aircraft certification and performance is based on parameter data from the standard instrumentation. The TIT limit is based on one probe, one location and only that instrument. The data from individual cylinders or other probes is not valid in establishing leaning temperature trends. Piper Service Bulletin No. 995 calls for mandatory replacement of the primary TIT probe every 250 hours and calibration of the readout system. Typically, the failure mode for the TIT probe is

a progressive condition whereby the indicated temperature is lower than actual. As the probe failure progresses, the difference between indicated and actual becomes greater. It is important to cross check the TIT indication against other related parameters such as fuel flow, cylinder head temperature, and even airspeed. For example, if the TIT probe provides a low indicated temperature, the pilot will lean further. This will result in relatively higher cylinder head temperatures, lower fuel flows, and possibly different airspeed. If not recognized, this condition could result in operating at substantially higher engine temperatures or even outside of approved limits. (Piper Service Bulletin No. 1008 discusses engine operation with TIT gage inoperative.)

Descent

Plan ahead to make a smooth temperature transition between cruise and descent. Start descent early and allow airspeed to increase within aircraft limits. Maintain power and mixture setting as required. Cylinder head temperature change rate is not to exceed 50°F per minute to avoid rapid shock cooling. Spoilers may be used if so equipped.

Maintenance

Owners should be familiar with applicable Piper and Lycoming service documentation, Service Bulletins and Instructions that apply to the Mirage and TIO-540-AE2A. As with any engine, it is good maintenance practice at each oil and filter change to open the paper filter element and examine for any quantity of material. Remove, examine, clean and reinstall the oil suction screen at each oil change. Spectrographic oil analysis can also be a useful tool in monitoring engine condition. To be effective, the analysis results must be trended over several checks. The same laboratory should be used for all samples. It is critical to take the oil sample in the same manner for each check. The results of the oil analysis should be used together with careful examination of the oil filter and suction screen. Lycoming recommends a 50 hour oil change interval for the TIO-540-AE2A engine. **However, due to differences in operating techniques and engine service life, the operator may find that the oil gets extremely dirty or black prior to the 50 hour event. In this case, reduce the oil change interval accordingly.**

Owners should be knowledgeable of Piper S.B. 995, Turbine Inlet Temperature System Calibration and probe Replacement, Piper S.L. 1008, Inoperative Turbine Inlet Temperature System, Lycoming S.B.'s 521, Inspection of Engine Exhaust System, S.B. 531, Turbocharger Inspection, and S.B. 480, Oil and Filter Change. Always refer to the latest published revision of these important documents.

Typical oil consumption for a large turbocharged engine such as the –AE2A may vary between 3-10 hours per quart depending on the time in service. If oil consumption exceeds 1 quart in 2 hours consistently, maintenance action is required. If the oil is being burned, most likely a top overhaul of the engine is necessary to restore the piston rings and cylinder barrels. Barrel wear and piston ring life is very dependent on the engine operation conditions, cylinder head and TIT temperatures experienced during service life. Cylinder reconditioning or replacement may be necessary before engine TBO is achieved.

Operating Recommendation Summary:

Takeoff at 42 in. MAP, 2500 RPM, Full Rich.
When clear of obstacles, **reduce power** to 2500 RPM, 35 in. MAP, 32 gph and **climb** at 125 KIAS.
Above 24,000 ft., **reduce** MAP to 34 in. or below.

Recommended cruise at 65% power, corresponds to 2400 RPM, 29 in. MAP.

Lean to 1650°F TIT or operate 100 degrees rich of peak TIT, whichever is less.

For optimum service life, **maintain** CHT's in cruise below 400°F.

Regardless what power setting is used, cruise CHT's **must not exceed** 435°F.

Calibrate engine instrumentation annually.

Comply with Piper S.B. 995, Turbine Inlet Temperature System Calibration and Probe Replacement and Piper S.L1008, Inoperative Turbine Inlet Temperature System.

Comply with Lycoming S.B 521, Exhaust System Inspection.

Comply with Lycoming S.B. 531, Turbocharger Inspection.

Comply with Lycoming S.B. 480, Oil and Filter Change.