

Lycoming Flyer

OPERATIONS

Hard Facts About Engine Break-in

Most people seem to operate on the philosophy that they can best get their money's worth from any mechanical device by treating it with great care. This is probably true, but in many cases, it is necessary to interpret what great care really means. This is particularly applicable when considering the break-in of a modern, reciprocating aircraft engine. Aircraft owners frequently ask about the proper procedures for run-in of a new or rebuilt engine so they can carefully complete the required steps. Many of these recommended break-in procedures also apply to engines which have been overhauled or had a cylinder replaced.

The first careful consideration for engine run-in is the oil to be used. The latest revision of Lycoming Service Instruction 1014 should be consulted for this information. The basic rule which applies to most normally aspirated Lycoming piston engines is simple: use straight mineral oil of the proper viscosity for the first fifty hours or until oil consumption stabilizes. Then switch to ashless dispersant (AD) oil.

The exceptions to the basic rule above are the O-320-H and the O/LO-360-E series. These engines may be operated using either straight mineral oil or ashless dispersant oil; however, if the engine is delivered with ashless dispersant oil installed, it must remain on ashless dispersant oil. The Lycoming oil additive P/N LW-16702 must be added to the O-320-H and O/LO-360-E engines at airframe installation, and every 50 hours thereafter or at every oil change. An FAA-approved lubricating oil that contains, in the proper amount

gas temperature and turbine inlet temperature in the aircraft should be included in this annual calibration.

Regardless of the fuel metering device, fuel management of normally aspirated engines is primarily dependant on the instrumentation available. The method is the same for both fixed- and controllable- pitch propellers.

Lycoming recommendations for leaning turbocharged engines in this Service Instruction refer to Lycoming-supplied turbocharged engines. For aftermarket turbocharger installations, contact the STC holder for proper leaning instructions.

CHT (cylinder head temperature) and TIT (turbine inlet temperature) probes are required for leaning turbocharged engines. Refer to the latest edition of Service Instruction No. 1422 for proper TIT probe locations and depth.

A. GENERAL RULES

1. Without exception, observe the red-line temperature limits during takeoff, climb and high-performance cruise power operation.

- a. Cylinder head temperature — maximum limit listed in the Lycoming Operator's Manual.
- b. Oil temperature limit — maximum limit listed in the Lycoming Operator's Manual.
- c. TIT - maximum allowable limit specified in the Ly

3. Maintaining engine temperature limits may require adjustments to fuel flow, cowl flaps or airspeed for cooling.
4. All normal takeoffs, with turbocharged power plants, must be at full-rich mixture regardless of airport elevation.
5. If manual leaning of the mixture is permitted at takeoff, climb power or high-performance cruise, it will be specified in the POH/AFM and will list required ranges for fuel flow, power settings and temperature limitations.

6. Leaning to best economy mixture.

- a. Set manifold pressure and RPM for the desired cruise power setting per the aircraft POH/AFM.
- b. Lean slowly in small steps, while monitoring instrumentation, to peak TIT or maximum allowable TIT, whichever occurs first.

7. Leaning to best power mixture.

Before leaning to best power mixture, it is necessary to establish a TIT reference point. This is accomplished as follows:

Proper Leaning at Cruise Aids Safe Flight and Saves Dollars

This Article Now Incorporates Material From "A Special On Fuel Management" Which Has Been Eliminated

Various Lycoming Flyer articles have emphasized proper leaning at the manufacturer's recommended cruise power. Before delving into the savings to be obtained by leaning, it may be appropriate to again review those factors that affect leaning at cruise.

First, we must know that cruise power for Lycoming normally aspirated engines is generally considered to be 55% to 75% of the maximum power for which the engine is rated. At these power settings, the engine **may be leaned at any altitude**. There has been confusion about the reference to not leaning below 5000-foot density altitude. Remember that this reference only applies to those power settings above the cruise range — those normally used for takeoff and climb. Once cruise power has been set, leaning to best economy should be standard procedure as damage to the engine will not occur from leaning at cruise power settings.

In this article, we will expand our discussion of leaning and explain (1) how it saves dollars, and (2) how it aids safe flight. In a practical approach to our subject, let's look closely at the chart printed below:

who does not understand the principles of operation in the thin air at altitude may observe that red-line takeoff RPM is 2700 RPM, and is then reluctant to lean either for cruise or climb despite the altitude because he is pulling almost the same RPM as at takeoff.

However, the pilot can and should lean the engine at these altitudes despite the high RPM, for the horsepower is down to 75% because of the thinner air. On the other hand, with any direct-drive normally aspirated Lycoming engine, the pilot can and should lean the mixture at any altitude as long as the aircraft is in cruise configuration at 75% power or less.

Let's look at the airframe manufacturer's power chart for the O-360, 180 HP engine, and observe the gradual increase in RPM required with the increase in altitude, but maintaining 75% for cruise at each altitude. What the chart will not show here is that for flight above 7500 feet, it is not possible to achieve 75% power with a normally aspirated engine (meaning not turbocharged or supercharged).

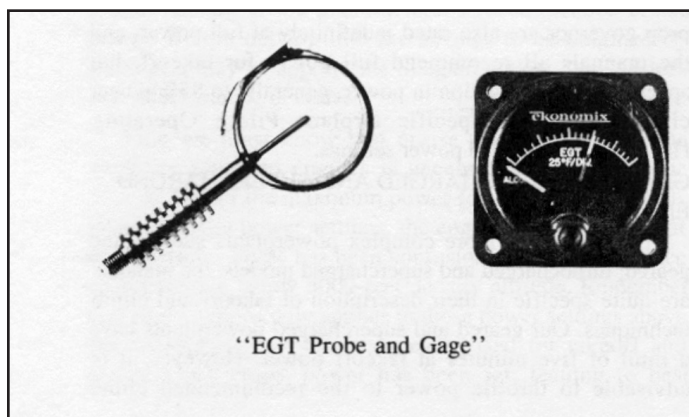
POWER CHART			

INSTALLATION INFORMATION

The mechanic must carefully follow the installation instructions concerning placing the probe in the exhaust stack. If it is closer than 1 ½" to the cylinder head, probe life will be limited, or if too far down toward the end of the exhaust stack, the response on the gage will be slow. Should there be doubt concerning in which stack a single probe is to be installed, that information may be available from the airframe dealer's service department. The operator might desire the more expensive installation of probes in all cylinders, therefore the accompanying gage will generally have a selector switch for individual readings on all cylinder exhaust stacks. Again, it is most important that the installation instructions are carefully followed in order to get reliable readings.

INTERPRETING THE SYSTEM

Most of the EGT manufacturers have standardized on gage increment markings of 25° F (see illustration). A few EGT manufacturers will go further and show the temperature range on the gage as 1200° F to 1700° F.



BEST ECONOMY MIXTURE

Best economy mixture as it relates to the EGT system begins at peak. For all practical purposes with Lycoming engines, peak EGT is right at the edge of best economy mixture, and is our only practical point of reference in the best economy mixture range. At the manufacturer's recommended cruise power, peak EGT causes a slight loss of horsepower usually reflected in two or three miles per hour of airspeed. If the pilot attempts to go leaner than peak EGT (with fuel injection only), the power decreases rapidly as fuel flow decreases.

BEST POWER MIXTURE

Best power mixture, or sometimes termed maximum power range, as depicted on the EGT gage, is in the range of plus 100° F on the rich side of peak. Best power mixture will provide fastest indicated airspeed for a cruise power setting, although it is generally not considered a practical economic mixture for cruise purposes. However, best power mixture generally provides a safe amount of fuel for a power setting higher than the engine manufacturer's recommended cruise, except that needed for takeoff power.

Again, we repeat that maximum leaning (peak EGT) does not damage an engine at the engine manufacturer's recommended cruise power. Damage is caused by maximum

PROCEDURE FOR LEANING

1. The fixed-pitch propeller — lean to maximum RPM at full throttle prior to takeoff where airports are 5,000 feet density altitude or higher. Limit operation at full throttle on the ground to a minimum time.
2. The direct-drive normally aspirated engine with a prop governor but without a fuel-flow gage, set throttle at full power and lean mixture at maximum RPM with smooth operation of the engine as a deciding factor.
3. With fuel injection, if the power plant has a marked fuel-flow gage, then set mixture in accordance with instructions on the fuel-flow gage and/or in accordance with the airplane Pilot's Operating Handbook.
4. Pressure carburetor — All Lycoming engines equipped with Bendix PS carburetors have an automatic mixture control which does not require leaning for takeoff.
5. Turbocharged and supercharged engines — All takeoffs must be at full-rich mixture, because the engine is brought back to sea level horsepower which does not permit leaning.

DESCENT

Regardless of the field elevation where the pilot intends to land, the descent from cruise altitude to traffic pattern altitude should be made with the engine leaned for smooth engine operation. Low elevation fields (below 5,000 feet density altitude) will require that the mixture be moved to full rich in the "before landing checklist

THE COMPLETE CHART FOR 65% POWER IS SHOWN AS FOLLOWS:

Altitude	2100 RPM	2400 RPM
SL	25.9 MP	22.9 MP
1,000	25.6 MP	22.7 MP
2,000	25.4 MP	22.5 MP
3,000	25.1 MP	22.2 MP
4,000	24.8 MP	22.0 MP
5,000	F. T. MP	21.7 MP
6,000	F. T. MP	21.5 MP

After studying the power chart, the pilot would undoubtedly then ask what combination of RPM and MP would be best to use at cruise. We recommend the pilot try the various combinations offered by the power chart over a five-minute period when flying in smooth air, and use the listed

POWER TABLE SETTING —
LYCOMING MODEL IO-540-K, -L, -M SERIES, 300 HP ENGINE

Press. Alt. Feet	Std. Temp F	165 HP - 55% Rated RPM and MAN. Press.				195 HP - 65% Rated RPM and MAN. Press.				225 HP - 75% Rated RPM and MAN. Press.		
		2100	2200	2300	2400	2100	2200	2300	2400	2200	2300	2400
SL	59	22.5	21.8	21.2	20.7	25.6	24.7	23.8	23.2	27.6	2	

And finally, power-off letdowns should be avoided. This is especially applicable to cold-weather operations when shock-cooling of the cylinder heads is likely. It is recommended that cylinder head temperature change not exceed 50° F. per minute. Plan ahead, reduce power gradually and maintain some power throughout the descent. Also keep the fuel/air mixture leaned out during the descent. If an exhaust gas temperature gage is installed with a normally aspirated engine, keep it peaked to ensure the greatest possible engine heat for the power setting selected; for a turbocharged installation, lean to peak during descent unless otherwise specified in the Pilot's Operating Handbook, or under conditions where the limiting turbine inlet temperature would be exceeded.

Exposure to snow, frost and cold weather while flying requires the consideration of many factors, both airframe and engine related. This discussion deals with issues relating to the engine. While there may be other issues, those items which are asked about most frequently have been discussed. Safer flying and longer engine life could result from careful consideration of the material addressed.

National Transportation Safety Board Warning on Simulated Engine-out Maneuvers

The fatal crash of a light twin in which a flight instructor and an applicant

We suggest that in order to help the mechanic diagnose the problem, the pilot or some member of the crew should make a written record of the engine instrument readings during the above flight condition and present it to the maintenance people.

A first step in diagnosing abnormal cylinder head temperatures would be ensuring that the gages are providing accurate readings. If they are, the mechanic can then proceed to check engine baffles that may have deteriorated, proper flow of the fuel metering device, and then other more time-consuming checks for ignition or mechanical malfunction.

More on Cylinder Head Temperature

The cylinder head temperature gage (CHT) helps the pilot protect his engine against the threat of excessive heat. Most General Aviation aircraft take the CHT off the hottest single cylinder of the four- six- or eight-cylinder power plants determined by extensive flight tests. Optional installations offer readings from all cylinders. In Lycoming engines, all cylinders are drilled to accommodate a CHT bayonet-type thermocouple.

Some operators in the field have been using a spark plug gasket-type installation in order to get cylinder head temperature readings. Lycoming Engineering does not currently approve this method of determining CHT. Not only is the method less accurate than the recommended thermocouple type

Pilots should, however, be advised that excessive throttle priming can cause flooding of the carburetor and airbox, and result in a fire in the induction system or on the outside where the fuel drains overboard. If the operator floods the engine by pumping the throttle and has a fire, it is possible to handle such a fire in the early stages by continuing to turn the engine with the starter, thereby sucking the fire back into the engine. Furthermore, if there is any fire on the outside of the engine, if the engine starts, there is a good chance it will blow out the external fire.

If there is flooding of the engine without a fire, the operator should open the throttle full and close the mixture; (see Operator's Handbook on mixture) turn the engine over several times with the starter to clear it; then begin again with a normal start routine.

Most Lycoming fuel-injected engines are simply primed by turning the fuel boost pump on, opening the mixture briefly to full rich, and cracking the throttle. Any pumping of the throttle is ineffective until the engine begins to fire.

FUEL CONTAMINATION — Water (says the FAA) is the principal contamination of aviation fuel. For a safe flight, carefully drain fuel s

ANSWERS TO QUESTIONS

A. Multiple choice response

- | | | |
|------|-------|-------|
| 1. d | 7. d | 13. c |
| 2. b | 8. a | 14. c |
| 3. d | 9. c | 15. b |
| 4. c | 10. b | 16. d |
| 5. b | 11. b | 17. b |
| 6. b | 12. d | 18. a |

B. Essay response

1. Loss of engine oil out the breather can cause engine damage or failure.
2. a. Lubricate moving parts.
b. Aid internal cooling of the engine.
3. a. Straight mineral.
b. Ashless Dispersant.
4. At any altitude.</

