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“EXPERTS” ARE EVERYWHERE TO HELP YOU

THE “NEW” OLD *LEANING* TECHNIQUE

SSP700

SP700

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The “New” Old Leaning Technique
Textron Lycoming Part Number: SSP700

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EXPERTS ARE EVERYWHERE TO HELP YOU

THE "NEW" OLD LEANING TECHNIQUE

There are many "experts" today with new products and techniques to help customers in the operation of their engines. One that is receiving public attention by way of aggressive advertising is a company manufacturing fuel injection nozzles and espousing an operating technique that is "better" than that recommended by the engine manufacturer. The newly discovered method of operating on the lean side of peak exhaust gas temperature has been known since Charles Lindbergh employed it to navigate the Atlantic Ocean and Max Conrad established distance records in his Comanche. This procedure was employed on large supercharged and turbocharged radial engines effectively during the era of large transport aircraft such as the Lockheed Constellation and Douglas D-6. Of course those of you who are knowledgeable about that part of aviation history know that there was a full time member of the flight crew, the Flight Engineer, responsible for engine management. He did not have to worry about flying the airplane or dealing with complicated ATC clearance instructions. There was a full panel of engine instruments and controls directly in front of him, including a detonation monitoring system and, in some installations, a torquemeter to avoid critical operational areas.

Operating on the lean side of peak exhaust gas temperature (EGT) or turbine inlet temperature (TIT) involves leaning the engine until the EGT or TIT reaches a maximum and starts to decline. (Reference attached chart.) Theoretically it is the area of the combustion regime that corresponds to best economy (most miles per gallon). Lycoming recommends cruise operation at peak EGT or TIT, which is the point where the best economy range starts. For optimum service life, Lycoming suggests operating 50 degrees rich of peak EGT or TIT. On an engine like the TIO-540-AE2A, this translates into a difference in cruise fuel economy of approximately 2-3 gallons per hour compared with peak or lean of peak operation.

Operating lean of peak results in substantial reduction power output, more than 8% from that obtained with best power fuel flow. If leaning is initiated at 75% power and continued through 50 degree F lean side of peak, the actual power output at that point will be approximately 69%. No wonder the indicated fuel flow shows a dramatic reduction. Although the fuel economy seems attractive, the aircraft cruise speed suffers. To keep from wallowing through the sky, proponents encourage opening the throttle once leaned to regain lost power.

This is where the plot begins to thicken. There is a big difference between normally aspirated and turbocharged engines when employing this technique. With a normally aspirated engine, if leaning is initiated at 75% power and leaning past peak EGT is accomplished, it is unlikely (but not impossible) to induce detonation by opening the throttle to regain power. In our initial examples, both Lindbergh and Conrad were operating engines that had little potential for detonation based on the fuel they were using. A highly turbocharged engine is another matter. Employing this same technique will put the engine into a narrow operating envelope where detonation is possible if the mixture is richened slightly. The only reason the engine does not experience detonation is that the mixture is too lean to support it. At this point, there are a number of factors that can assume control over your engine and cause problems. If the initial leaning is not accomplished carefully it is possible that the engine is not really set at 50 degrees lean of peak where intended. Properly leaning an engine is undoubtedly the least understood area of power management. Most pilots lean too fast when looking for peak, thus they overshoot. Instead of moving the mixture lever gradually, the exercise becomes a series of rapid movements that ultimately fails to arrive at the correct setting. The best technique to establish peak EGT or TIT is to lean in small increments and allow time for the temperature to stabilize after each lever movement. Continuous movement of the mixture control lever should be avoided since it does not allow for adequate stabilization time. That there are not more problems resulting from improper mixture control is because considerable margin is built in through the development and certification process. With turbocharged powerplants, the potential for causing engine damage through mismanagement is much greater. Remember that those large radial powerplants used as examples for the lean of peak methodology were cautiously operated at cruise powers of 65% and below where the possibility of bad results was greatly reduced.

During the attempt at power recovery, it is a major assumption that opening the throttle to regain power will not cause a richening of the mixture. Unfortunately, some fuel metering units tend to provide richer fuel schedules as the throttle is opened and manifold pressure is increased. This phenomenon is not discouraged since it helps promote engine cooling at high powers. Sometimes the amount of enrichment may vary from unit to unit. When adding manifold pressure on the lean side of peak TIT, this tendency could be catastrophic if the mixture richens significantly from the original desired set point.

Also, opening the throttle increases the pressure ratio across the turbocharger compressor which in turn, raises the induction air temperature and decreases the air density. This decrease in induction air density will effectively result in a richer mixture. The expert says that operating lean of peak safeguards your engine in the event of a plugged fuel nozzle. Apparently, the expert does not understand how current Precision Airmotive fuel injection systems really operate. Fuel is metered at the servo, then sent to the fuel nozzles. Plugging a nozzle actually results in sending more fuel to the remaining open nozzles. This essentially richens the mixture and may be enough to move one or more of the cylinders into detonation. Unfortunately, many of these variables are out of the control of the operator who is relying on the premise that this is just a simple leaning technique.

As the last strike, once the engine has been established in the lean of peak condition, and the throttle has been advanced for power recovery, there is no means to confirm that the mixture is properly leaned. The only way would be to richen the mixture to confirm peak TIT. This could move the engine into detonation. It is also not possible to confirm what margin remains between the setting and the onset of detonation. Detonation is not necessarily marked by the characteristic rattling or pinging readily identifiable by the operator. Instead it may be occasional or sporadic but still with the same potential for causing serious engine damage. The lean of peak methodology places strong emphasis on proper pilot techniques, accurate calibrated engine instrumentation, and does not allow for confirmation of the proper mixture setting. Any lapse in either can be financially costly or worse.

Lycoming is in complete agreement that it is possible to operate an engine on the lean side of peak TIT. It is done on engines in our well-instrumented Experimental Test laboratory every day. There is nothing detrimental in operating an engine in this manner. However, we can attest to the fact that things that work well in the test laboratory have not always proven successful in service. In the sales literature provided for this “new” technique, it is stated that Lycoming recommended this operational procedure in an owner’s manual that dates back to the late ‘60’s. No mention is made why it is no longer recommended on our present engines. The fact is that the technique of operating lean of peak and power recovery was discontinued due to the resulting increase in service issues. Burned pistons, valves, ruined rod and main bearings were traced to the inability of pilots to utilize this technique with the instrumentation and distractions found in the typical general aviation aircraft. If Lycoming felt that this was indeed an efficient and reliable method of operation, you can be sure that it would be in our recommended procedures. Contrary to some beliefs, neither the automotive or aircraft engine manufacturers are in secret collusion with the oil companies to drive up fuel consumption. The end customer might be assured that if there is a problem resulting from engine mismanagement, the “experts” with their fuel nozzles and leaning recommendations will not be offering to pay the warranty to repair or replace the engine. When asked about this warranty policy in the event of a problem, the answer came back that this is regarded as a “improper operation on the part of the operator”. If you have a problem resulting from operating according to the expert’s recommendations he does not intend to cover your repair or replacement costs.

Our piston aircraft engines are rugged and withstand a lot above and beyond their normal operating requirements. The operating procedures that Lycoming recommends combine techniques that have been found to promote good engine service life and accommodate normal pilot skills. Lycoming does not custom design operating instructions for each pilot skill level or individual aircraft based on instrumentation. Today, pilots must contend with higher traffic levels and more complex ATC demands that reduce the attention time for powerplant management. Electronic engine controls that are currently being developed will allow operation in ranges not feasible today due to full time computer monitoring. In the meantime when one of the "experts" tells you how to operate your engine better than what the factory recommends, exercise extreme caution. Its easy for someone to recommend new techniques when they have no obligation to cover the warranty or out of pocket cost if there are problems down the road.

Operating an engine "on the edge" is possible provided the pilot is extremely precise, has good instrumentation, and monitors the engine condition full time. For 98% of the pilots, it is an invitation to potential trouble. It only takes one brief episode of mismanagement to incur deep internal damage that will cost money later. Most people do not even realize when it happens since the engine continues to operate without any sign of distress. For a highly turbocharged engine, the supposed fuel savings amounts to $4.00-6.00 per hour. Considering the total operating expense for a high performance aircraft, is the small saving in fuel cost worth the price of an engine? You do not need to ask the "expert" for help with that one.

ENGINE TRENDS VS FUEL FLOW