

Tip-top props

10 ways to get maximum performance from your propeller.

Thursday January 17th 2013 - by Terry Hope



Follow Terry Hope's 10 tips to get maximum performance from your propeller. Lisa Gordon Photo

1. Know your propeller system maintenance requirements.

Manufacturer publications are a great resource for general information, restrictions, maintenance practices and continued airworthiness requirements. Check the owner/operator manual for the required maintenance schedule.

Also check for compliance. Carry out an airworthiness directives search to determine your specific requirements. Check for service bulletin compliance. Finally, check for hourly and/or calendar requirements.

2. Check the time between overhaul requirements.

Follow overhaul recommendations. Overhaul is the periodic disassembly, inspection, repair and replacement of worn or damaged protective coatings and plating, followed by reassembly and a bench check of the propeller.

Several factors affect time between overhaul (TBO), including:

- i. Corrosion and erosion, depending on calendar time and on the operating environment. External corrosion is usually visible and easily corrected. Internal corrosion is directly proportional to calendar time; it is unseen and potentially catastrophic.
- ii. Internal and external wear is a function of hours in operation and types of flying. High cycles per hours flown result in much higher wear rates than low cycles per hours flown.
- iii. Deterioration and loss of resiliency affecting seals is proportionate to the calendar time in service.

3. Visually inspect the propeller.

Carry out routine inspections as per the published requirements.

At minimum, a routine inspection should include a check for damage; smooth operation; a safety check [lock wire, rings, and pins]; oil or grease leakage; looseness of propeller on shaft; and looseness of blades in hub. Check the owner/operator manual for additional tasks, such as a pressure check.

If there is leakage, perform a visual inspection without cleaning the parts. Locate the origin of leakage. Check for leakage from a seemingly solid surface. Check blades and compare blade to blade difference in looseness. Check the blade track. Manually attempt to turn blades by hand. Clean the blades and hub. Cycle the propeller four to five times to seat the blade seals. Check for continued leakage.

Grease leakage is not normally a flight safety issue; however, leakage that persists beyond the first 10 hours of operation should be re-investigated.

If there is oil leakage, there is the possibility it will get worse. On a single engine tractor installation, visibility may be impaired. The engine may pump all of the oil overboard and seize, and, if the propeller has an internal oil leak, the propeller may get a hydraulic lock, preventing the operator from changing the pitch of the blades. Oil leakage can be a safety of flight item and should be thoroughly investigated prior to the next flight.

Check steel parts for rust and corrosion. External rust or corrosion is an indication of internal corrosion. Check aluminum parts for condition of paint, for corrosion and nicks. Check composite parts for a breakdown in the protective coating.

Carry out special inspections after abnormal occurrences such as lightning strike, overspeed, overtorque, foreign object strike, sudden stoppage, fire or heat damage, oil contamination, and submersion. Abnormal occurrences require specific additional inspections to be carried out.

4. Maintain the blades.

Aluminum blades are heat-treated aluminum alloy and cannot be welded, as the strength of welded aluminum is much lower than the minimum requirement.

The centrifugal force pulling at the blades at takeoff can be up to 50,000 times their weight. Check blades for damage or corrosion.

When rework is required, check the owner's manual for "how to" instructions. FAA AC43.13-1B is the basis for maintenance procedures, but it is only to be used when there are no manufacturer's publications. Most manufacturers have developed specific procedures for the maintenance of their products.

When repairing aluminum blades, it is important to remove the correct amount of material from the blade using the correct procedures. To avoid stress risers, always file and sand length-wise, never cord-wise. Stay within maximum field limits and make sure that the repairs do not cause the blade to go under the minimum blade dimensions.

Depending on the amount of material removed, balancing may be required. After repair is carried out, inspection and refinishing are critical steps to maintaining the integrity of the propeller blade.

Check composite blades for worn or damaged protective coating, as this damage will lead to a broken moisture seal that will allow moisture to enter the blade, which can lead to expensive repairs or blade replacement.

Repair methods vary by manufacturer. Frequently wipe aluminum propeller blades with a clean cloth dampened with light oil. Clean blades with a non-oil-based solvent. Apply a coat of standard automotive paste wax.

5. Check wood and composite fixed pitch propeller mounting bolt torque.

Attaching-bolt torque needs to be checked every 50 flying hours and at every change of season. A wood propeller will change dimensionally over time and with temperature and humidity.

A loose propeller will generate heat between the flange and the hub, drying the hub out further. Over-tightened bolts can crush the hub, breaking the moisture seal and allowing moisture to enter the hub, causing swelling.

6. Lubricate the propeller.

An over-greased propeller may leak grease and have sluggish operation. An under-greased propeller often does not change pitch smoothly.

Correct lubrication is essential to the well-being of the propeller. Check the owner/operator manual for the proper procedure.

7. Investigate abnormal vibration immediately.

Visually check for cracks. Check for a loose propeller on the engine. Check blades and compare blade to blade difference in looseness. Check the blade track. Check the spinner. Carry out a dynamic balance of the propeller system.

A smooth flight starts with a balanced propeller. All propellers vibrate to some extent during operation. Assuming that the engine itself is not at fault, roughness relative to the propeller could be caused by loose or binding blades, blades out of track, difference of blade angles, incorrect mounting of the propeller on the shaft, or spinner imbalance.

Propellers are statically balanced during a bench check. Dynamic balancing fine tunes the precise balance of the airframe, engine and propeller system to achieve the smoothest possible operation. Dynamic balancing provides a smoother, quieter experience by reducing cabin noise and vibration.

A well-balanced propeller reduces the cycle fatigue of air boxes, exhaust stacks and radio equipment. It reduces cracking in sheet metal and cowlings, and wear in the controls that link fixed portions of the aircraft to the engine. Reduced component wear, coupled with a more enjoyable cabin environment for passengers and crew, makes dynamic balancing an essential procedure. In normal use, propellers should be dynamically balanced every 400 to 600 hours, and after every propeller or engine overhaul. If significant repairs are made to the propeller, dynamic balance should be rechecked.

8. Ground runs.

Be careful when running your engine and propeller over loose stones or gravel. It is a good practice to sweep the run up area clean. Keep the rotations per minute (RPM) as low as possible to avoid foreign object damage.

9. Don't forget the governor.

The governor's function is to sense and control engine RPM by boosting engine oil pressure and hydraulically adjusting the propeller blade pitch.

Over time the relief valve spring weakens, the flyweight toes wear, and the pilot valve sticks, causing sluggish operation or surging. Typical governor flying hour TBO is similar to engine TBO, but the governor will not operate as it should after an extended number of years.

10. Propeller Operating Restrictions.

Check minimum and maximum RPM. Check the airframe flight manual or airplane flight manual supplement to determine maximum propeller RPM. Check the accuracy of the tachometer. To confirm maximum RPM setting, flight check the aircraft. Many aircraft will not achieve maximum RPM on the ground. If adjustment is required, check for a correctly set governor, correctly set propeller low pitch and excessive propeller friction.

- Governor - As a general rule, engine redline RPM cannot be reached during a full power static run-up. The governor is not controlling the propeller at this time; the propeller is against its low pitch stop. Attempting to increase propeller static run-up RPM by adjusting the governor high RPM screw will have no effect and will probably result in a propeller overspeed during the takeoff roll.
- Propeller – back the governor maximum RPM stop out one turn. If engine speed stabilizes at the rated RPM to 50 RPM lower than the rated RPM, then low pitch is set correctly. Adjust the low pitch stop, return the governor to the original position or perform flight test and proceed to adjust governor. During takeoff acceleration, record maximum propeller RPM. When sufficient altitude is reached, level out the aircraft, leaving propeller control in full RPM position. Maintain this setting for three to five minutes, while monitoring propeller RPM.
- Minimum RPM setting – there is a potential safety of flight item with four-, five-, and six-blade propellers installed on turbine engines. During ground operations, if the minimum propeller RPM is too low, the propeller can enter a vibratory resonant condition known as a reactionless mode. In this mode, two blades are pulling forward, ahead of the hub centerline, while two are pulling back, behind the hub centerline. At the same time, two blades are flexing towards each other while two blades are flexing away.

Make sure that the propeller is rigged in accordance with the applicable installation and rigging instructions. See FAA SAIB NE-06-13 for suggested warning for the AFM, AFMS and AMM. Check the airframe flight manual or airplane flight manual supplement to determine if there are any propeller RPM restrictions. Check the accuracy of the tachometer. Perform an engine run-up and determine if the engine and/or propeller rigging permits operation of the propeller below the minimum specified propeller idle RPM. If the propeller can be operated below the minimum specified propeller RPM, determine the required corrective action. Corrective action may be as little as correcting the rigging to a propeller overhaul or propeller replacement.

Terry Hope is the president of Hope Aero, an aircraft component maintenance firm specializing in propeller overhaul, wheels and brakes, dynamic balancing and non-destructive testing.