Titan 340CC Engine Break-In & Oil Management Procedures for Owners

Adapted from ECi® Engine Break-in and Oil Management Instructions

Airplane owners, builders of aircraft engines, component suppliers such as Engine Components International (ECi®), and aircraft manufacturers such as CubCrafters have a mutual interest in engine break-in. All want the engine to perform properly and give long and satisfactory service life.

CubCrafters has designed the engine cowling airflow, fuel distribution, and engine air intake systems to assure proper cylinder cooling throughout the life of your new Titan 340CC aircraft engine. The 340CC engine should provide excellent service life if certain steps are taken by the pilot(s) operating the airplane during the first hours of operation to break-in the engine properly.

A new aircraft engine is an expensive investment. Break-in is the most important time in the life of your engine and is critical in determining its performance and longevity. Seventy-five (75%) percent of the total normal wear of an engine occurs during the break-in period. New piston rings, pistons, and cylinder bores will be more sensitive to break-in than any bearings, and any break-in procedure acceptable for rings and bores will be agreeable to the bearings. Therefore, the first consideration in the break-in mode should be to accomplish the ring-to-bore seating process.

When an engine fails to give satisfactory service, it can be due to unseated piston rings due to improper break-in. During the break-in period, piston scuffing or seizing can be caused by overheating or unseated rings that allow blow-by to displace the oil film between the piston and cylinder bore. Additionally, bearing and crankshaft wear can be caused by under-lubrication.

Run-in vs. Break-in

A new 340CC engine will have been both run-in and test flown prior to the aircraft being released for delivery to the customer. However, this run-in was never intended to be a break-in run. The objective of the run-in test(s) are to:

1. Prove that the engine will produce rated power.
2. Correct any oil, fuel, or induction leaks.
3. Check general operation of the fuel system.
4. Allow engine oil pressure to be set.
5. Provide initial stage of break-in.

After run-in and test flight assure safe operation, the aircraft can be released to the customer to complete the engine break-in process. Should the new owner be unwilling or unable to follow the following engine break-in procedures, CubCrafters recommends that the first critical 10 hours of break-in flight be done by factory staff or other appropriate and qualified personnel.

Break-in Procedures

Limit any ground run-up to three minutes. Head the aircraft into the wind and establish initial engine RPM at 1200 to obtain oil pressure, and then maintain 1200 RPM to minimize cam lobe stress. If oil pressure is not obtained within 30 seconds, shut down and investigate the cause. Oil pressure for the 340CC engine should be between 60-75 PSI after 30 seconds.

Note that while low RPM increases stress on cam lobes, cylinder head temperatures should not be permitted to exceed 400°F or oil temperature to exceed 200° F. Break-in flight when OAT is above 90°F is not recommended. A short application of full power is advisable to assure take-off power is available prior to flight. Normal ground idle may be used after the first 10 hours.

Keep aircraft weight to a minimum. Only required crew should be aboard the airplane for initial flight(s). On take-off, use minimum power to start the takeoff roll before then applying required take-off power. CAUTION: Determine that there is sufficient runway remaining in order to reach take-off airspeed.

Use full take-off power only as long as necessary to get to best climb speed. Quickly reduce manifold pressure and/or RPM to the minimum required for clean in-flight attitude at best rate of climb speed. After takeoff and clearing any obstacles, set power to 75% (~2450 RPM) and use minimum rate of climb with maximum air speed consistent with terrain avoidance.

Full rich mixture should be used for all settings above 75% power. Where safe, it is recommended to operate the aircraft at or below a density altitude of 6500 feet. Above that altitude, it is not possible to maintain 75% power, even at wide open throttle (WOT).

When desired altitude is reached and cylinder head and oil temperatures are satisfactory, aircraft should be operated at 75% power until 20-30 minutes of satisfactory flight time have elapsed. The engine should then be operated at 65% - 75% power (2325-2450 RPM), and engine operating parameters observed, until at least 45 minutes of flight time have elapsed. All power changes should be made very gradually, especially power reductions.

During break-in flight(s), any time that a persistent high oil or cylinder head temperature is noted, a precautionary landing and inspection should be made to determine the cause. Maximum cylinder head temperatures during break-in flight should not exceed 420°F for any extended period of time. Following break-in, maximum CHT for the 340CC is 450°F. During break-in, the engine should be leaned to 150-200 degrees rich of peak (ROP), although richer mixtures up to full rich may be required to maintain proper CHT.

Until the ring-to-bore seating process has happened, at least 30 minutes of satisfactory high power flight time at different RPM settings between 65% -75% power should be accumulated between landings. At each landing the engine should be re-inspected; oil use noted; and, if excessive, investigated before further flight. Operators should be cautioned against long ground runs and prolonged climbs at low air speeds.

Notes should be kept for each flight and results should be compared to previous flights to determine changes in operating condition and oil consumption per flight hour. The break-in period differs for individual engines, but the critical ring-to-bore seating generally happens within the first 10 hours of operation. At this point, oil consumption will begin to stabilize, however, optimum oil consumption is frequently not achieved until 50 or more hours of operation have been achieved.

Ground operations and continuous climb at low airspeed should be minimized until the engine has accumulated at least 25 hours operating time. Cylinder overheating can cause cylinder bore glazing and/or piston scuffing at any time during engine operation but cylinder assemblies are most susceptible to these problems during the first 50 hours of operation.

Use only 100LL for engine run-in and break-in for an engine that was designed, tested, and certified on 100LL avgas. Under no circumstances should unleaded auto gas (mogas) be used when breaking in an engine. In the event a warranty claim is made, CubCrafters and engine suppliers reserve the right to deny the warranty claim if, in their sole judgment, the problem giving rise to the claim resulted from the use of automobile gasoline.

Lubrication for Both Break-in and Long Term Operation

Air-cooled aircraft engines typically encounter far more stress and strain than any other kind of reciprocating engines. Therefore, the operational lubrication needs are four-fold. Reduced to its simplest tasks, oil has four major functions: to lubricate, to suspend dirt and wear particles between oil changes, to aid in cooling, and to seal the combustion chamber, thus it offers protection against heat, pressure, corrosion, oxidation, and contamination.

Oil in piston aircraft engines must work in an environment that is radically different from those found in automobile, industrial, and agricultural engines. One major difference is that aircraft engines are air-cooled. Air cooling has evolved as the simplest and most effective method of regulating engine and cylinder temperatures in an aircraft engine which must operate in extremes of altitude and temperature. While it provides lighter weight and less complexity in its systems, an air-cooled aircraft engine typically sees a wider range of temperature than its liquid-cooled counterpart.

The widely varying operational boundaries experienced by aircraft engines dictate that components for their oils be different from those used in other applications. Piston aircraft engines are subjected to extreme temperature variations and starting conditions. Many aircraft fly frequently. Many aircraft don't fly enough. Successes (and lack of) suggest there is simply no single viscosity that is always the best for all flight environments. Multi-viscosity Mineral Based oil is often the best choice.

The lubrication demands imposed upon your engine during run-in and break-in period are different from its operational needs. During run-in and break-in your lubricant should:

1. Provide immediate oil flow and pressure for start-up protection.
2. Provide protection against extreme temperature changes.
3. Eliminate oil related by-product deposits.
4. Suspend contaminants.
5. Enhance the engine's break-in processes.

General aviation service history records are much less favorable for aircraft engines that have been operated on synthetic blends or semi-synthetic oil products. CubCrafters encourages using only mineral based (non-synthetic) oils; preferably Phillips SAE20W-50 ash-less dispersant (AD) oil for the 340CC.

Phillips SAE20W-50 multi-viscosity oil provides quick lubrication for improved start-up with the SAE20W low temperature viscosity. All multi grade oils lubricate three times faster than straight weight, yet its full bodied SAE 50 viscosity will completely protect the engine at high temperatures and operational loads. The ash-less dispersant in this oil keeps your engine's lubrication system free from oil related contaminants. The dispersant additive further enhances the system by suspending contaminants and operational wear metals in solution rather than allowing them to settle to the bottom of your crankcase forming harmful engine sludge. Finally, this 100% mineral product will enhance the mating of all the parts involved in systems requiring operational break-in.

CubCrafters recommends the following lubrication schedule for the 340CC (without oil filter reduce intervals to 25 hours or 3 months, whichever comes first):

At 00 Hours	Initial Oil Fill-up (Phillips X/C SAE 20W-50)
At 10 Hours	Change Oil and Filter (Phillips X/C SAE 20W-50)
At 35 Hours	Change Oil and Filter (Phillips X/C SAE 20W-50)
At 60 Hours	Change Oil and Filter (Phillips X/C SAE 20W-50)

Every 50 Hours or 3 Months thereafter change oil and filter. Phillips X/C SAE 20W-50 is recommended for the entire service life of the engine.

There are times when cylinders will glaze or prematurely lose their ability to “grind-in” the ring face. This condition is usually marked by lack of any reduction of oil consumption (oil is usually found on the belly of the airplane due to a pressurized crankcase) during the first 10 hours of operation. By removing the spark plugs and checking for fouled electrodes, the offending cylinder(s) can be identified.

Should glazing and/or scuffing become severe, the only remedy is to remove the offending cylinder(s), mechanically remove the glaze, replace the piston if necessary, and install a new set of rings.

NOTE: Should you ever need to change out a cylinder you will not need to switch to a straight mineral oil for break-in. Since Phillips X/C 20W-50 is 100% mineral it will ensure the break-in process for newly installed cylinder(s).

CamGuard® Additive

At the fourth oil change (or after 80 hours of operation), CubCrafters recommends the use of CamGuard for internal engine corrosion protection. This additive measurably reduces engine wear metal and corrosion over the life of the engine. CamGuard combined with Phillips X/C SAE 20W-50 will result in simply the best protection you can get both in terms of anti-wear and anti-corrosion. Note: due to the lower oil capacity of the CC340 you only need a half bottle of CamGuard per oil change, so one bottle will cover two oil changes.

Avoid Over-Servicing Engine Oil

If soon after shutdown you add oil to your engine in an effort to get the oil quantity/level indication back up to the full mark on the dipstick, you will most likely be over-servicing your 340CC engine and in some cases, by as much as two quarts. During your next flight at the higher oil level, the crankshaft accessory drive gear will project below the top of the oil surface in the oil pan, and will revolve through the oil in the pan and make vapor and micro-droplets. The vaporized oil and droplets will exit through the oil breather system and thus be spread over the gear and belly of the aircraft. To avoid such mess and reduce the anxiety of blowing oil vapor overboard, (concern that you are using oil), these five oil-servicing guidelines should be followed:

1. Aircraft should be as level as possible when checking the oil. Use the same level area, as often as practicable, when checking oil at your home airport.

2. Note and mark the dipstick's top orientation after properly servicing the engine with a known quantity of oil. Maintain that orientation throughout future oil checks. Readings can vary by as much as 1/2 quart simply by having the dipstick's orientation 180° in error.

3. Measure oil drain-down quantity. Do so by measuring the oil quantity immediately after shut down, then again 12 hours later. Note the increased indication of oil level after the 12-hour period--typically due to oil draining from the oil filter, the oil cooler, and engine oil passages. Hot engines may indicate as much as 1 quart lower than the actual level, which can result in over-servicing when the engine is hot.

4. The total capacity of the 340CC engine in the Carbon Cub is 6 quarts. However, the recommended 340CC oil level for normal operations is 4 quarts. For normal operations, one quart of oil is added when the cold (drained-down) level on the dipstick reaches the 3.5 quart level.

5. For long flights, especially over remote areas, service the engine to its full (6 quart) capacity. Knowing that at full capacity some oil will be blown overboard, expect to wipe off the airframe accordingly without becoming anxious about seeing excess oil.

Oil Filtration

High temperatures associated with normal air-cooled engine operation produce two contaminants which end up in lubricating oil: oxidation by-products and coke. In addition to combustion generated contaminants, the engine takes in a significant quantity of dirt by breathing it into the cylinders during engine operation.

The lubricating oil with an AD additive is very helpful in keeping the solid contaminants in suspension but when all of the AD is tied up with dirt and coke, additional contaminants introduced into the engine are free to deposit in unwanted locations. There are only two ways to prevent solid contaminants from depositing in the engine when the oil is overloaded; change the oil or install a filter.

A filter will do nothing to remove oxidation by-products, e.g. sludge, varnish, acids, and water. Water can be vaporized by operating the engine for sufficiently long periods of time to dry out the oil but liquid contaminants will pass right through a filter and remain in the oil no matter how good the filter media is on the filter. Draining the oil is the only way to get rid of the liquid contaminants.

Solid contaminant loading in the oil can be minimized with a full flow filter. While most aircraft piston engines come equipped with an oil screen, these screens have limited filtering efficiency. By pumping oil through a filter, particles are lodged in the filter thereby permanently removing them from the system.

A spin-on oil filter with the paper element is the most effective method to remove solid contaminants. Since serial number 294, every new CubCrafters aircraft produced has been factory equipped with a spin-on oil filter. The oil filter should be changed every time the oil is changed.
CubCrafters recommends that earlier engines without spin-on filters be retrofitted with an oil filter adapter. Contact CubCrafters Parts and Accessories department for more information regarding the specific oil filter or adapter to use with your engine if in regard to an older CubCrafters aircraft.

The oil filter should be cut open at each oil change and the interior paper media then examined to look for excess particulate matter. If metal shavings, chips, or other concerning particulates are seen (especially after break-in when an engine has had previously satisfactory oil changes), a qualified engine mechanic should be consulted to determine if further action or investigation is necessary.

Oil Consumption

It is normal for aircraft engines to use different amounts of oil based on flight profiles, age, and other factors. According to SI 1427B, the maximum normal oil consumption for any Lycoming type engine can be determined by the following formula: (.006 X BHP X #Cylinders) / 7.4 = quarts/hour

For example, a 340CC at 2,200 RPM at 4,000' altitude is generating 80 HP. As such, (.006 X 80 X 4) / 7.4 = .25 quarts per hour, or put a different way; one quart every 4 hours would be the maximum normal oil consumption at an 80 HP cruise setting.

Oil Content Reports

Oil content reports over the life of an engine can be a valuable tool for aircraft owners and mechanics in assessing the overall health and remaining longevity of an aircraft engine. Certain parts of both Continental (TCM) and Lycoming engines, such as rocker shafts and piston rings, typically wear and deposit small quantities of normal wear particles in the oil. It is a function of engine design.

The quality of the oil sample has a great deal to do with the report. The individual taking the oil sample should use caution not to take the first oil out of the drain, because the majority of the wear metals could have settled to the bottom of the oil pan. Such a procedure could result in an erroneous reading of the metal concentration. In addition, oil samples should only be taken from hot oil. Preferred engine warm-up should be done slowly, beginning at idle RPM for a brief period limiting idle to 1200 RPM. If a dip tube is used, it must not make contact with the bottom of the oil pan where concentrations of wear metals are likely to be exaggerated. Engine pre-heat should be used when the OAT is below 20°F.

New or recently overhauled engines may have higher than normal metal particle reports; however, most laboratories are aware of these situations and usually make appropriate adjustments to their reports when advised of the total time since new or time since recent overhaul status of the engine. One report, especially one deviation from normal report, is not necessarily sufficient reason to become alarmed. There are a number of considerations associated with taking an oil sample as well as preparing the report; plus, there are a number of mechanical considerations associated with estimating engine longevity or reliability.

If you have questions or concerns regarding oil content reports or other aspects of oil management for the 340CC engine, please contact:

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