Installation Instructions

Why install the Raven Inverted Oil System?

Oil pressure is critical to aircraft engine operation and longevity! An aircraft engine draws its oil supply from a sump via an oil pump and pick-up tube. Oil must be available at the oil pump pick-up tube at all times. If at any time there is no oil available at the oil pick-up tube there will be immediate loss of oil pressure and no oil will be circulated through the engine. The engine's original design does not pose problems as long as the aircraft maintains normal, level flight. However, aerobatics and inverted flight do pose problems.

Regardless of whether your engine is equipped with a horizontal or vertical pickup tube the operational principals are the same – during normal flight, oil is picked up by the pump via a pick-up tube from the bottom of the sump. However, during inverted flight, the sump is upside-down and the oil is now in the top of the crankcase instead of the botton of the sump where the pick-up tube is located, leaving no oil available to the pickup tube and resulting in loss of oil pressure. To make matters worse, substantial loss of oil occours as the oil now flows freely out of the breather line at the top of the crankcase.

Installation of the Raven inverted Oil System works to block the oil flowing from the breather tube during inverted flight, oil is then picked up at a point at the rear of the engine case then directed back to the oil pump to keep the engine supplied with oil, thus maintaining critical oil pressure and eliminating oil loss.

This kit is designed for Lycoming aircraft engines, and becomes an extension of the engine's existing lubrication system. The gravity-operated valves require no electrical connection, and operates in both enverted and negative-g flight maintaining proper engine lubrication without time restriction. The Raven system has three basic configurations, one for vertical-sump engines, one for horizontal-sump engines and one for angle valve K series 6 cylinder engines. Certain engine types may require an additional port to be installed in the sump. You may also opt for sump port relocation that places oil pick-ups in optimal locations extending and enhancing system performance in vertical or knife-edge flight.

These instructions will guide you through the installation of the Raven Inverted Oil System. Please take the time to read all instructions and carefully plan the installation before you begin. Review the diagrams to gain a complete understanding of the function of the system. Different engine configurations and mounting preferences may necessitate slight modifications to installation methods depicted in the diagrams. If you have any questions about the type of installation necessary for your particulare engine, please contact a Raven technician before you begin.

Look over the main diagram (Fig 8)and note the location of all components and the hose routing, this will help you understand where everything is located and the approximate routing of the hoses.

How does it work?

Installation of the Raven Inverted Oil Ssytem results in the modifications shown in figure1 and 2. (4 Cylinder engines), and figure3 (6 Cylinder engines). Compare these diagrams to familiarize yourself with the modifications. During normal flight (see figure 4) the ball valve at the top of the Oil Separator (the round tank) is open, allowing blow-by gases from the engine's breather port to be vented normally. The top ball valve in the Oil Valve (the round part with 3 ports) is closed and the bottom valve is open, allowing oil to flow from the pick-up tube in the bottom of the sump,

through the valve and to the oil pump. When the aircraft is inverted (see figure 5) engine oil is now in the top of the crankcase and the pick-up tube in the sump is no longer in oil. The weighted ball valve in the Oil Separator closes preventing oil loss through the breather port while venting blow-by gases from the sump instead and out through the breather line. The top ball valve in the Oil Valve is now open and the bottom valve closed. Allowing oil to be picked up and redirected to the oil pump. Oil left in lines during the trasition between normal and inverted flight is captured by the Oil Separator and is returned to the sump during normal flight.

Fig 6 shows the optimum modification to use on the K series 540 engine with the stock sump, inquire for more information of this new kit offered by Raven Aircraft.

Installation Precautions

Carefully plan the location of components and routing of hoses before you begin actual installation. The following rules are critical to proper system performance:

- The Oil Separator must be mounted as high as possible. This ensures rapid emptying of the separator following transition to normal flight. Make sure to install the seperator so that the larger ¾" NPT fitting is up and the smaller ½" NPT is down.
- The bottom of the Oil Separator must be at least two inches above the top of the sump and the centerline of the Oil Separator must be at least ten inches from the sump centerline on the side of the engine *opposite the oil return port on the sump*. This prevents oil loss during some maneuvers such as knife-edge flight.
- For horizontal-screen sump engines, the Oil Valve must be located such that its center port is vertically aligned as close as possible with the sump screen access port, it can be positioned any place horizontily on either side of the engine. For vertical-screen sump engines, the Oil Valve must be aligned such that its center port is vertically aligned as close as possible with the bottom surface of the sump. You can rotate the new adjustable Raven oil valve so that the ports will line up to allow the easiest and shortest routing of the hoses.
- The oil line fitting in the bottom of the Oil Separator must be either straight or 45-degree to ensure rapid emptying of oil in the separator to the sump.
- Keep hose lengths to a minimum, however hose routing should be smooth and sweeping. Avoid sharp bends which would collapse hose walls and restrict oil flow. However it is best to have the valve located off to one side of the engines port to make installation of those hoses easier
- The hose from the bottom of the Oil Separator must extend in a continuous downward slope to the bottom of the sump. This ensures complete emptying of the separator.
- An appropriate breather fitting must be provided to permit connection of the breather hose. Six cylinder engines normally use 1-inch diameter hose while four cylinder engines use 3/4" , these can be reduced to 7/8" or 3/4" cylinder and 5/8" for 4 Cylinder engines if there is no way possible to run the larger lines.

Caution: Use care when threading fittings into aluminum! Aluminum pipe threades are subjuct to damage from over-tightening! ALWAYS use an anti-seize compound on the threads. Do not use tefion tape but liquid Teflon is OK. Pipe threads will seal with only moderate force when using an appropriate thread compound. If installed fittings cannot be turned to the desired angle using only moderate force, remove the fitting and tap the hole threads slightly deeper to allow additional angle. Take precautions to ensure that metal chips do not enter the engine or system componets.

Proceed with the Installation

1. Remove drain plugs from the sump and drain all engine oil.

2. If your installation requires the installation of additional sump bosses, remove the sump. Locate boss positions as shown in figures 1 and 2. Bosses are attached by pre-heating the sump then tig welding them into place, normally 4 Cylinder sumps are Aluminum and 6 Cylinder sumps are Magnesium so make sure you get the correct weld boss kit for your application. Carefully shape the base of the boss to the sump to provide a snug fit prior to welding. Once welded, re-tap the threads. Clean, repaint and re-install using a new gasket and lock washers.

3. For horizontal-screen sump engines, install the Sump Plug and Sump Fittings as follows. (Refer to figure 7).

    a. Remove and discard sump screen access plug at rear of sump.
    b. Remove sump screen.
    c. Insert the sump Plug through the sump screen access port (using a long AN3 bolt or a length of 10/32 threaded rod) and press firmly into position, make sure the plug is indeed correctly seated by giving it a light tug with bolt/threaded rod still in place, it should take some force to unseat it. If is pulls very easily out check it to make sure the O ring is in place, if it is still loose when reinstalling check with us regarding possible solutions. When you are sure it is installed and seated correctly unthread the bolt/threaded rod and proceed with the rest of the install.
    d. Shorten the sump screen by removing 3/16 inch from one end (if using the straight fitting, if using the 45 degree swivel fitting you will need to shorten the screen considerably more). Clean the screen to remove burrs and chips.
    e. Test-fit the screen by placing the sump screen into the recess in the front of the Sump Fitting and insert the screen through the sump screen access port without the gasket. The front of the sump screen will slide over the hub of the previously installed Sump Plug. Screw in the Sump Fitting finger-tight until the sump screen is firmly seated.
    f. Measure the gap between the front of the Sump Fitting flange and the face at the access port. This will indicate the amount that the screen needs to be shortened to reduce the gap to approximaately 1/16 of an inch (the thickness of the copper ring).
    g. Remove the sump screen and carefully shorten the screen by the amount determined. Clean the screen.
    h. Repeat steps e, f and g until the proper gap is attained.
    i. Install the sump sump screen with the gasket and Sump Fitting. Tighten the fitting firmly, if using the 45 degree fitting position the outlet to the desired angle then tighten the set screw.

4. For Vertical-screen sump engines, install Sump Fittings as follows:

    a. Remove and discard sump screen access plug in bottom of sump.
    b. Remove and discard sump screen.
    c. Verify that the internal O-ring is in place in the Sump Fitting. Apply a coat of engine oil to the O-ring.
    d. Make sure that the internal oil pickup pipe is centered then place gasket over the Sump Fitting and install in sump screen access port.
    e. Install elbow and set position to point towards the Oil Valve mount location.

5. Securely mount the Oil Valve in position on the engine mount or firewall. Verify again that the center port is properly aligned as previously discussed. NOTE: If installing a used or early version of our valve (First generation are square shaped, second generation are round with bare aluminum caps) Check the valve as follows: Hold it vertical and simply blow into the top port, there should be no leakage, turn over and repeat, next with the valve vertical again check to make sure that the spring is free to move, (you can use a small screwdriver or something similar to lift the spring), it should have a minimum of 1/8" free play, rotate and check again. Lastly with the valve vertical again, hold the ball in the top port lightly in the seated position, rotate valve and make sure the spring holds the 2 balls apart so that they cannot come together, this is very important for proper operation. If unsure about any of this check with us at Raven Aircraft.
6. Securely mount the Oil Separator is as high as possible and aligned as previously discussed.
7. Install remaining fittings.
8. If installing a Vac Adapter make sure the 90 degree AN Fitting is installed first and install the housing so the fitting is at the bottom, test fit to obtain the best angle to adjust the fitting to as this area is tight.
9. If using a Non-accessory oil pickup be sure to remove the gear AND gear housing (This is VERY important because if you install the pickup with the gear and housing in place you will have zero oil pressure when inverted and if you remove the gear only you will have low oil pressure at all times). You may have to use long spacers when installing the pickup after removing the gear and housing but this is ok to do as you run the risk of breaking the studs to replace them with shorter ones.
10. Measure, cut, and install breather line hose using worm-drive hose clamps. Avoid sharp bends and kinks and observe hose markings to avoid helical twists. To prevent hose collapse on bends of less than a 4-inch radius, install a Breather Coil.
11. Measure, cut and install hose for remaining oil lines. Remember to allow exactly 1 inch for each hose fitting if using 303 hose. To install Aeroquip fittings first thread the outer sleeve counter clockwise onto the hose, thread it far enough until it bottoms out then back off a quarter turn. Mark the hose with tape at the base of the sleeve, (this is used for reference to ensure the hose does not get pushed out when installing the internal part). Next clamp the sleeve into a vice and install a mandrel tool threaded into the remaining part of the fitting. Use lots of oil in the hose and on the fitting at this point, next simply thread the inner part clockwise into the outer sleeve until it almost bottoms out, (leave enough room so that the nut will rotate freely), check to make sure the hose has not been pushed out of the outer sleeve and remove the mandrel tool, now you are done!
12. Inspect your work! Double-check hose bends for smoothness, check each fitting for tightness, and verify all components are securely mounted!

Initial Ground Check

1. Add oil to the correct level.
2. Start engine. Oil pressure should rise to normal readings after 10 to 15 seconds. There may be a slight variation in pressure reading from standard readings prior to installation of the Inverted Oil System. If oil pressure fails to rise after 30 seconds, shut off the engine and begin *troubleshooting procedures.*
3. While engine is idling, inspect all fittings and hoses for leaks. If any noted, take corrective action.

4. When engine is at normal operation temperature, check oil pressure reading again. It may be necessary to compensate for oil pressure reductions caused by the additional oil flow through the Inverted Oil System. The pressure can be adjusted by resetting the pressure relief valve. Adjust according to the engine manufacturer's recommended setting. This adjustment is done either by turning a screw or by adding shims, depending upon engine model.

Initial Test Flight

The system checks on the ground also have verified the system as it would operate during level flight. To check the system in aerobatic flight, perform the following steps:

1. Fly the aircraft at a safe altitude and roll to inverted attitude, it is best to do this over an airport. There will be a momentary drop in oil pressure but should return to normal pressure within five seconds. If no return to normal pressure occurs within 15 seconds, roll to normal flight immediately. Initial system operation may take several attempts, as it can be difficult to start oil flow in dry hoses and passages. Try a series of abrupt inverted high-g dives and climbs. If inverted oil pressure still fails to rise, land the aircraft and troubleshoot the system.
2. Note that due to the longer oil flow path during inverted flight, oil pressure may be 5 to 10 pounds less during inverted flight than during normal flight.
3. Land the aircraft and inspect all hoses and fittings for leaks.
4. If after rolling inverted then back to level flight you do not notice oil pressure attempt to re-seat the valve by pulling G's.

System Maintenance and Troubleshooting

With the proper operation of the Raven inverted Oil System, only very small losses from normal oil level will occur, due to certain combinations of aerobatic maneuvers that do not allow for the drainage of the oil separator during periods of normal flight. Abnormally large losses of oil could occur should the aircraft perform a lengthy series of certain maneuvers with little or no normal flight attitude to allow drainage of the oil separator. Aviod this by simply allowing for normal flight attitude during aerobatic flight.

If oil pressure is normal during normal flight, but low during inverted flight, remember that a 5 to 10 pound difference in pressure is normal due to the longer flow path the oil must take. However, other conditions may also exist such as:

1. Damaged or leaking valve seats in the Oil Valve or Oil Separator.
2. Faulty seal at Sump Plug allowing air to be drawn into the system. Check sump plug for tightness and proper seal with O-ring.
3. Accumulated sludge or foreign material in Oil Valve or Separator. Remove and clean.
4. Collapsed or kinked breather hose. Check for smooth curves.
5. Obstruction in hoses. Clean thoroughly.

Low oil pdressure in normal flight may be attributable to one of the following:

1. Clogged sump screen. Clean thoroughly.
2. Obstruction in Oil Valve. Clean thoroughly.
3. Defective oil plump or pressure gauge.
4. Need to adjust oil pressure as outlined above.
5. Obstruction in hoses. Clean thoroughly.

Maintenance.

Normal maintence is simply checking hoses and fittings for deterioration and leaks at normal inspection intervals, but you may need to occasionally clean the valve. To do this simply remove and rinse thougouhly with solvent, then blow out with compressed air.

If the valve needs to be taken apart, heat the ends with a heat gun to soften the liquid teflon before removing the plugs.

After re-assembling the valve you can check for proper operation by simply holding the valve vertically and blowing into the top port then turn it upside down and repeat.

If you have any quistions or concerns please do not hesitate to contact us at (604) 597-9296, or email us at ravenair@uniserve.com.