AVOIDING ENGINE LIQUID LOCKS

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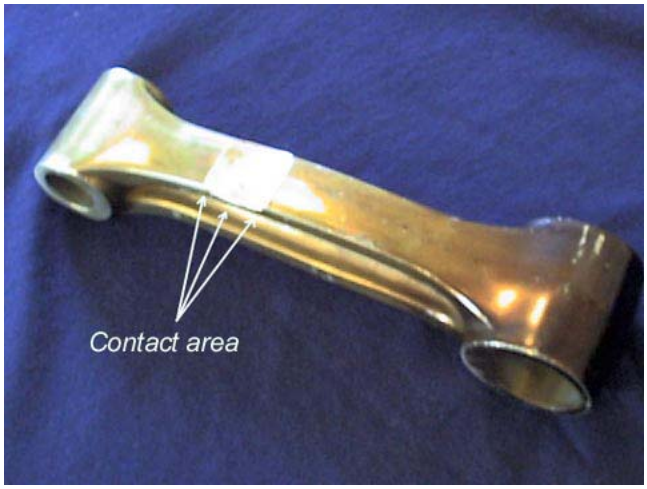
By the very nature of its design the radial engine finds itself prone to the dreaded hydraulic or liquid lock. By gravity oil is drawn into the lower two cylinders (#4 & #5 on a seven cylinder engine, #5 & #6 on a nine cylinder engine) where it pools in the combustion chamber awaiting the next start up.

If the quantity of oil is small it will not affect the start up and will either be burned in the start up (blue smoke) or be expelled as oil droplets (wet start). If, however, there is sufficient oil in the cylinder to contact the piston as it reaches top center, a liquid lock will occur. The piston will attempt to compress the oil which cannot be compressed, and one of several engine parts will fail. Most common is the bent link rod, but piston pins can bend and cylinder heads have been known to crack or even separate completely from the barrel.

W670 Continental, Lycoming R680, and most engines with I-beam steel link rods usually either break the link rod or bend it in two planes with the result that the engine locks up. The Jacobs engine, however, with its thick cross section aluminum rod will often bend the link rod but continue running. It is common to disassemble a running R755 at TBO to find a #4 or #5 link rod bent so badly that it is striking the cylinder skirt with each revolution (see below).



The owner is often unaware that a problem exists but such an engine is headed for a catastrophic failure when the bent link rod finally flexes in two.

Avoiding liquid lock, as you can see, is critical to safe engine operation. The first line of defense in preventing this problem is to <u>always</u> pull the propeller through prior to starting the engine. Even if the engine has not run for only 30 minutes, pulling the engine

through is good insurance against liquid lock. Two complete revolutions of the crankshaft will take each cylinder through all of its cycles and insure that the cylinders are clear of excess oil. If, as the engine is pulled through, hard resistance is felt, STOP. Remove the #4 and #5 front spark plugs and drain whatever oil has accumulated in these cylinders. NEVER pull the engine backwards (opposite to the direction of normal rotation) to clear a liquid lock. Though this procedure will often clear the oil from the combustion chamber, it merely moves the oil to the intake pipe where it is much more difficult to get rid of. The oil will sit in the intake pipe until it is drawn back into the combustion chamber by the vacuum created when the engine starts. Then you not only have a liquid lock, but also the inertia of the spinning propeller which will pull the engine through the lock and bend or break the link rod.

As important as always pulling the prop through is, an even better solution is to address the problem one step back: How can I keep oil out of the cylinders? The difficulty with the Jacobs engine is one of design. Originally the R755 was a manually greased rocker arm engine with no oil to the rocker boxes. Then, just prior to WWII the engine was fitted with automatic valve lubrication (through the push rods and into the rocker arms) effectively doubling the quantity of oil in the engine. As long as the engine was running, everything was fine. However, when the engine was shut down the small sump on the Jacobs engine was simply not large enough to handle the additional oil. This oil overflowed the sump and found its way to the bottom of the engine, which unfortunately meant the #4 and #5 cylinders.

One way to deal with this problem is to install a drain on the rocker scavenge tube, drain the oil into a can while the engine is not running, and add it back to the oil tank before start up. Such systems are in use today on many radial engine models and according to all accounts, work well. A more elegant answer (no moving parts and no can of oil to add before flight) for the Jacobs engine is the oil recovery system marketed by The 195 Factory and known as the “Clean Kit”. This unit is essentially two additional remote sumps which increase the capacity of the rocker boxes and the sump of the Jacobs engine. As the engine sits in the three point attitude the Clean Kit is lower than the engine sump and therefore collects the oil that would normally overflow the sump. Upon start up the engine oil pump scavenge system removes the oil from the Clean Kit and cycles it back to the oil tank.

Another modification to the design that has helped with this issue of liquid locks is the installation of “sniffle valves” on the lower intake pipes. The valve is open when the engine is not running and closes itself when the engine starts, thus allowing oil that would normally collect in the intake pipes to drain through the valve and into a hose directing the oil into a collection can. This oil can then be recycled into the engine. In 2004, Radial Engines, Ltd. obtained FAA approval to install these valves on nearly all small radial engines.

A moderate amount of caution before starting your engine, coupled with a modern improvement or two, can virtually eliminate the possibility of engine damage due to liquid lock.