Hydraulic Lock

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Radial engines are a type of internal combustion engines in which the oscillation of the pistons within their cylinder occur outwards. The key components of a radial engine include cylinders, crankcase, values, connecting rods, pistons, crankshaft and a valve-operating mechanism. The cylinder heads contain valves and spark plugs, in which one value lies in the exhaust system’s passage, while one lies within the induction system’s passage. The movable piston inside each cylinder connects to the crankshaft through a connecting rod; however, some cylinders point downwards which make them vulnerable to a hydraulic lock (Aeronautic Guide, 2018). When the radial engine is not in use, oil can drain into the lower cylinder’s combustion chamber or gather inside intake pipes. Thus, when the engine starts, the accumulated or drained oil gets drawn into the cylinder, which in turn, hinders the piston movement at the compression stroke due to the incompressibility of the oil. This causes a lock in the piston’s movement as a result of the oil, preventing it from completing its full motion. Consequently, it can lead to a blown cylinder if the crankshaft continually rotates with the lock in place, from damage to the connecting rod.

In a hydraulic lock, gravity acts to cause the engine oil to seep down and fill the cylinder. During a pre-flight inspection, a hydraulic lock can be checked manually by cranking the propeller by hand for a specific number of turns to observe whether the crankshaft is rotating normally through the cylinders. The ignition switch has to be off before the inspection is carried out, then the propeller is pulled in the correct direction of its rotation. At least two turns are necessary, to pass the compression stroke, in order to detect the hydraulic lock which may possibly be present if any excessive resistance is encountered in the process. Upon encountering resistance while pulling the propeller, the cylinders that are particularly susceptible to the oil seepage have to be identified in order to remove excess oil from the piston’s chamber.

If a hydraulic lock is detected then the propeller should not be further rotated. Any resistance will indicate that the lower cylinders have excess fluid, which subsequently has to be removed. For this purpose after ensuring that the ignition is off, the spark plugs should be detached from the suspected cylinder, then rotating the propeller manually for a number of rotations to drain the accumulated oil. At least four complete rotations are necessary to drain it completely. In the case of a three-bladed propeller, it is usually the cylinder 6, 5, and 4 that will need its spark plugs removed to expel the oil. Furthermore, the rocker box recovery systems should also be cleaned of any excess oil to avoid a potential lock. In case of a large accumulation, simply drying out small amounts of oil may not be sufficient, and may require flushing out the fluid completely along with gasket replacements.

To prevent hydraulic locks, engine designs usually incorporate O-rings or lip seals that are situated between the intake area and the oil pump, on a separator plate, in order to prevent oil from seeping into the chamber. Cylinder skirts are installed that extend along the crankcase to prevent the oil from being drawn into the bore. However, even with these measures in place, oil may still accumulate in the combustion chamber when the cylinders remain vertically static for a prolonged time. Some designs introduce an additional value on the oil tank’s outlet and keep the oil pump inlet higher than the oil tank (MotorStarna, 2018). The valve can connect to switches that prevent engine ignition in case of oil leakage, thereby preventing further damage to the crankshaft or the engine.

# References

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