Water accumulation in the Christen inverted oil system

Recent observations from Kjeller airport, Norway is that a few aerobatic aircraft with Lycoming Engines type AEIO 360 and the Christen Inverted Oil system have experienced water accumulation in the oil system. One to two cups of water has been drained from the lowest hose connecting the Christen 803 oil separator during 50 hour service. See figure 1 below. This water is also believed to have caused premature internal engine corrosion on engines with less than 3 years since new/overhaul.

Ice in the hoses connecting the Christen separator has also caused an engine failure in 2010, see preliminary aibn report SL2010/01P: https://www.google.no/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwj8y-LOjZTSAhVIDCwKHQr5B0cQFggaMAA&url=https%3A%2F%2Fwww.aibn.no%2FLuftfart%2FRapporter%2F2011-38%3Fiid%3D9045%26pid%3DSHT-Report-Attachments.Native-InnerFile-File%26attach%3D1&usg=AFQjCNE3n4ZpIvbjC0KuyJJLdZL5QWyIig&bvm=bv.147134024,d.bGg) In this case, water accumulation in the hose connecting the 802 Ball valve and Breather Tee 806 had frozen solid and caused loss of oil pressure during inverted flight that subsequent lead to an engine failure. Fortunately, the airplane landed safely without anyone being hurt.

We believe that a possible explanation to this is that water vapor from the hot oil condenses in the breather line during normal operation, as this line has a lower temperature than the engine itself, especially in cold weather. Droplets of condensed water then trickles down in the Breather Tee and accumulates in the hose above the 803 ball valve (see figure 1). When the aircraft is inverted, this hose becomes the suction hose to the oil pump and the accumulated water enters the oil system. When the aircraft is upright again, the cycle repeats, and when the flight is ended, there is some water in this hose that may freeze under sub-zero conditions in the hangar.

Other aircraft with a different breather line configuration, see figure 2 below, have seen no water accumulation and no corrosion under very similar operating conditions. With this hose configuration, there is no transport of humid gases in the breather line that becomes the oil suction hose when inverted, hence less risk of water accumulation other places than in the separator vessel itself.

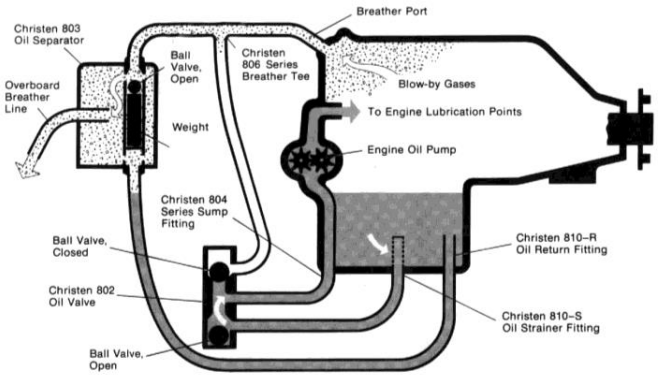
The number of aircraft we have compared is of course very small, but the observations are consistent. We are therefore interested to hear if this matches other operators experience, and if so, what can be done to reduce or eliminate the problem. Clearly to change the breather line confirmation to what is shown in figure 2 would work, but a recommendations should be gives as to what engine connection that should be used on various engine models. A temporary fix could be to re-orient the breather line Tee so that the branch line points upwards (if space/hose lengths allows) to avoid gravity flow of water into the hose.

Aircraft seen with figure 1 configuration and corrosion problem are CAP 10 and Decathlon. The figure 2 configuration has been observed on Extra 230, Slick 360 and Christen Eagle.

Your response to this letter is much appreciated.

Normal Flight

During normal flight, the weighted ball valve at the top of the Christen 803 Oil Separator is open, allowing blow-by gases from the engine crankcase to be vented from the breather port, through the Christen 806 Series Breather Tee, to the top of the Oil Separator, and out through the overboard breather line. The top ball valve of the Christen 802 Oil Valve is closed, and the bottom ball valve is open. This permits oil to flow from the sump out through the Christen 810-S Strainer Fitting to the Oil Valve, back through the Christen 804 Series Sump Fitting to the oil pump and engine lubrication points.



Inverted Flight

When the aircraft is inverted, engine oil falls to the top of the engine crankcase. The weighted ball valve in the Oil Separator closes, preventing overboard loss of oil through the top of the Oil Separator. Blow-by gases from the engine crankcase are vented from the sump to the bottom of the Oil Separator and out through the overboard breather line. The top ball valve of the Oil Valve is open, and the bottom ball valve is closed, allowing oil to flow out from the breather port, through the Breather Tee to the Oil Valve, through the Sump Fitting to the oil pump and engine lubrication points.

Any oil in lines which fails to return to the sump during the transition between normal and inverted flight drains into the Oil Separator. This oil then returns to the sump from the bottom of the Oil Separator during periods of normal flight.

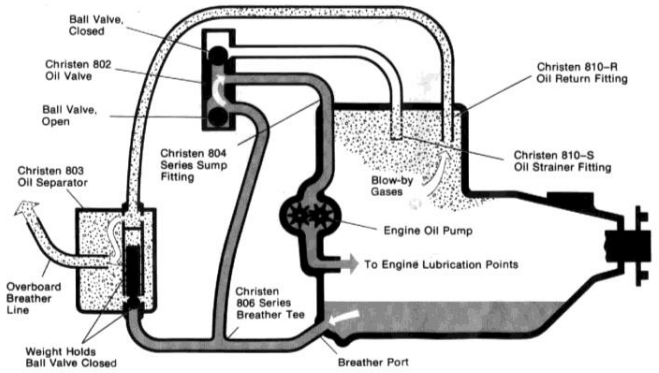


Figure 1, Standard configuration

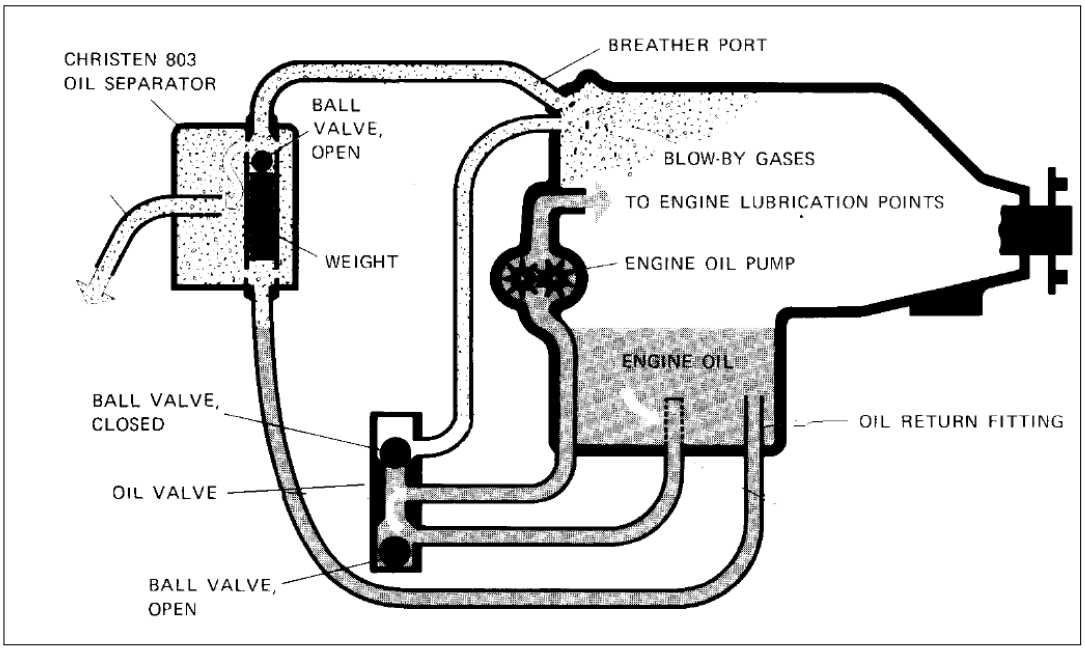


Figure 2, Alternative breather line configuration