TECH NOTE

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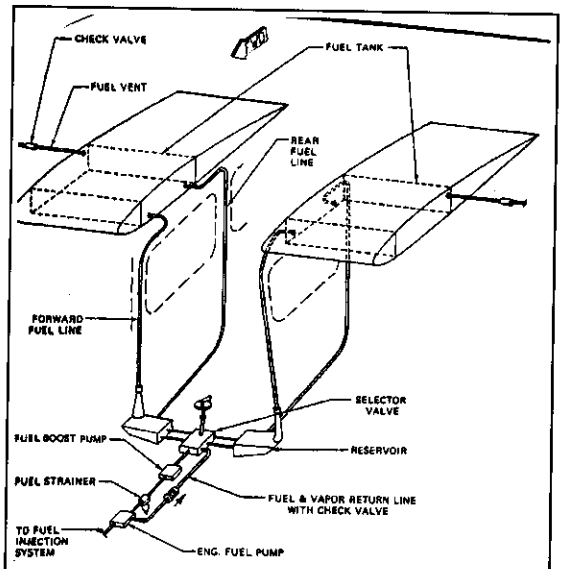
Vapor Lock Problems in 210 Series From 1964 thru 1981 Model Year

It is important to understand what is causing vapor problems in some 210 series aircraft. The way fuel was fed from the fuel tanks to the engine remained pretty much the same on the 210 Centurion from the 1964 model year through the 1981 model year. The fuel system is designed to feed fuel from the wing tank to a reservoir tank for that wing tank which is mounted in the belly of the aircraft. This fuel flows to the reservoir tank through two fuel lines that come from each wing tank and run down the forward and rear door posts, each line connecting to the reservoir tank at a separate location on that reservoir tank. There are two reservoir tanks in the belly of 1967 thru 1981 210s, one that is fed from the left wing tank and one that is fed from the right wing tank. The purpose of the reservoir tanks is to provide a nonfluctuating source of fuel to the engine driven fuel pump, a necessity with the Continental Fuel Injection System.



T210/P210 FUEL SYSTEM SCHEMATIC

Fuel flows from the reservoir tank to the selector valve and then forward to the fuel strainer, through the auxiliary pump and then onto the engine driven fuel pump.

At the engine driven fuel pump any vapor that has formed in the fuel being fed to the engine driven fuel pump or from the action of the fuel pump itself is separated out. Fuel under pressure is then sent to the fuel control unit on the back of the engine where fuel is metered in proportion to the throttle and mixture settings and the appropriate amount of fuel is sent to the flow divider mounted on top of the engine for distribution to the fuel injectors.

The engine driven fuel pump delivers more fuel to the fuel control unit than the fuel control unit requires for distribution to the fuel injection nozzles and this excess fuel is sent back to the pump where it is joined by the vapor that has been separated out of the fuel coming down the fuel feed line and this mixture of vapor and fuel is returned to the reservoir tank from which it came. The vapor, being lighter than the fuel, rises to the top of the reservoir tank where it makes its way up the forward fuel feed line to the wing fuel tank. Arriving at the selected wing tank the vapor rises to the top of the fuel where it remains, with some fuel condensing out of the vapor and returning to as liquid in the tank.

This system worked well on the normally aspirated aircraft. However, introduction of the turbocharged 210 in 1966 brought some problems that had not been anticipated. Basically the biggest problem is that a much greater amount of fuel vapor can be introduced into the system by a turbocharged aircraft than by a normally aspirated aircraft. The reasons for this are as follows:

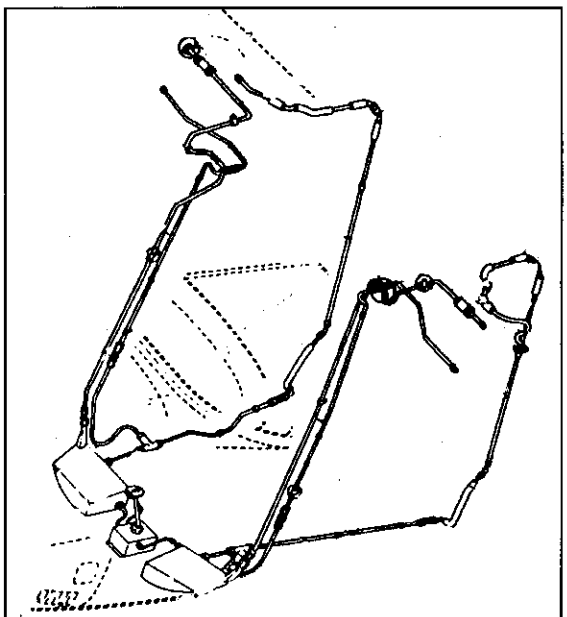
1) A turbocharged aircraft maintains a rapid rate of climb to much higher altitudes than a normally aspirated aircraft. Air pressure declines as altitude increases, which means that fuel will be venting off vapor. At the slower climb rate of the normally aspirated aircraft at higher altitudes this venting occurs at a slower rate than with the fast climbing turbocharged aircraft. Also due to the rapid climb the fuel initially is warmer at altitude than the fuel in a normally aspirated aircraft. This warm fuel also will vent off vapor. It is for these reasons that we tend to see more vapor problems during the first hour at altitude than later on. As the flight progresses further the fuel is stabilizing in temperature and in venting from decreased air pressure.

2) The turbocharged aircraft generates more heat in the engine compartment at altitude than the normally aspirated aircraft. Not only do you have all the exhaust plumbing for the turbocharger heating things up but the turbocharged aircraft is usually operating at higher power settings at altitude compared to the normally aspirated aircraft. This is

particularly a problem on the T210 where the turbocharging installation runs an exhaust pipe around the back of the engine, right underneath the engine driven fuel pump and the fuel control unit.

Now lets go back to how vapor is handled by the 210 fuel system. The vapor is separated at the fuel pump and then sent back to the reservoir tank from which it goes up the forward fuel feed line to the fuel tank that is selected. However the turbocharged aircraft can, under certain circumstances, produce so much fuel vapor that the system is overwhelmed.

The reservoir tank fills with vapor faster than it can migrate up the forward fuel feed line. While restricting fuel flow down the forward fuel feed line the vapor is also being sucked into the line going forward to the engine driven fuel pump in increasing amounts. Eventually not enough liquid fuel is getting to the pump to meet the engine's demands and the fuel flow fluctuations start.



210 FUEL SYSTEM AFTER SE81-33 MODIFICATION

The important thing to remember in this situation is that the other reservoir tank associated with the other wing tank is sitting there full of fuel with no vapor in it. Simply switching tanks will correct the situation almost immediately.

Some 1976 210L/T210L and 1977 210M/T210M aircraft were delivered with undersized fuel reservoir fittings which may have abnormally restricted the fuel vapor out of the reservoir tank and back to the main tank. Service Bulletin SE77-38 "FUEL RESERVOIR FITTING INSPECTION" called out for replacement of the undersized fittings.

Cessna issued service bulletin SE81-33 which applied to serial numbers 21061040 thru 21063640 and P21000001 thru P21000385. SE81-33 called out for modification of the fuel system so that the forward fuel feed line is teed into the rear fuel feed line prior to the reservoir tank. The connection on top of the reservoir tank where the forward fuel feed line used to hook up is now attached to a line solely dedicated to vapor return, running up the front door post and going into the fuel tank near the top. This modification can greatly reduce vapor collection in the reservoir tank and thus vapor related problems. The cost is somewhat high.

The last price of the kits when they were available was around $700. They are no longer available as kits but the same modification can be done by obtaining the same parts as were in the kit. It takes about 17 man/hours to install the kit so you are looking at a total modification cost in the neighborhood of $1500.

One modification that Cessna did with the 1980 and later model years of the 210/T210/P210 aircraft that are not part of the SE81-33 modifications is increasing the rear doorpost fuel feed line diameter from 3/8" to 1/2". The reasoning behind this change is that fuel will flow more easily down the larger rear doorpost line, thereby reducing the flow demand on the forward doorpost fuel line. Supposedly this makes it easier for fuel vapor to return to the main tank from the reservoir tank up the forward doorpost fuel lime.

For awhile there was an Airworthiness Directive related to vapor that has now been rescinded. AD 80-04-09, called for the insulation of fuel lines to reduce vapor formation. This was a modification that Cessna had introduced on the 1981 model year 210 Centurion. The FAA rescinded that Airworthiness Directive because it was found that insulating the fuel lines was not significantly effective in reducing the vapor problem in the 210 Centurion.

A earlier Airworthiness Directive, AD 79-15-01, which dealt with the subject of fuel vapor in Cessna 210s remains in effect. This AD called for the installation on the instrument panel a placard that contained specific instructions on what to do if major fuel flow fluctuations/power surges were encountered. The instructions are to turn the auxiliary fuel pump on and adjust the mixture, switch fuel tanks and when the flow steadied resume normal operations. Expanded instructions were included on procedure card Cessna P/N D1189-13 for aircraft prior to the 210N/T210N/P210N and via a Pilots Operating handbook Revision for the later aircraft.

The fuel feeding system for the Cessna 210/T210/P210 was completely redesigned beginning with the 1982 model year. The changes included:

1. A single reservoir tank replaced the dual tanks.
2. Fuel selector has a "BOTH" position for the first time on a 210.
3. A vent inter-connect line is installed between the two

fuel tanks. This is necessary any time a "BOTH" position on the fuel selector has fuel feeding from two different tanks. There must be a means to assure that head pressure in both tanks is equal to maintain an equal flow from both tanks.

4. "ON-OFF" shut-off valve installed forward of the fuel selector.

5. Vapor and excess fuel from the fuel pumps is returned not to the reservoir tank but directly to the tank from which fuel is being drawn. This is done by stacking a separate valve to control vapor return on top of the selector valve with the two valves sharing a single shaft and thus working in conjunction with each other.

6. The fuel feed lines are vented, again to maintain equal pressure and thus equal flow.

This was an extensive modification of the fuel system which virtually did away with any vapor formation problems. There is no Cessna kit to retrofit this system to earlier aircraft. Such a modification has been performed in the field but it is a very extensive and expensive modification.

It should be noted that abnormalities in the fuel system can also give similar symptoms to vapor problems. These abnormalities could include:

1. Twisted, clogged or restricted fuel supply hoses, lines or strainers.
2. Sticking auxiliary fuel pump by-pass valve.
3. Restricted vapor ejector or vapor return lines.
4. Vapor return check valves damaged or improperly installed
5. Fuel selector valve not operating properly.
6. Improperly set or malfunctioning engine driven fuel pump.
7. Restricted fuel tank vents.

Air leaking into the fuel system can also cause the aircraft to have fuel flow fluctuations and power surges. Sources for air leaks can include:

1. Leaks in fuel lines, loose connections, cracked or leaking flare fittings
2. Loose fuel pump through bolts
3. Leaking fuel selector valve
4. Malfunctioning or leaking fuel injection system components.

Power hesitations on takeoff may indicate a air leak in the fuel feed system, especially if use of the boost pump corrects the condition.

Cessna 210 Fuel System Changes

1961	210A	84 gallon long range tanks option.
1962	210B	Dual fuel feed lines and reservoir tanks. Fuel selector valve design changed.
1964	210D	Fuel reservoir tanks relocated forward of door posts. Fuel vapor return lines deleted at S/N 21058352 forward fuel feed line becomes both fuel feed and vapor return. Fuel boost pump changed to one single vane type. Fuel boost pump changed with low side operated in conjunction with the start position of ignition switch. High side of two speed, with speed dependent on throttle position.
1965	210E	Glass fuel strainer changed to metal design at S/N 21058601.
1967	210G	Cantilever wings with 45 gallon integral tank in each wing.
1970	210K	Capacitance type fuel gauging system replaces float type.
1971	210K	Fuel boost pump circuit changed. Fuel gauges read in both gallons and pounds.
1974	210L	Fuel boost pump circuit changed again.
1975	210L	Fuel line routing changed to accommodate retractable steps. Throttle switch installation changed.
1978	210M P210N	Capacitance type fuel gauging system removed, control monitor eliminated, float type system reintroduced. Fuel gauges located on floor at pedestal.
1980	210N P210N	Beginning with S/N 21063661, fuel lines from firewall to strainer and strainer to tunnel changed from aluminum to stainless steel with insulated sleeving. Fuel hose from fuel pump to check valve, check valve to firewall and fuel pump to tunnel fitting are all firesleeved. Check valve is also firesleeved. These modifications can be retrofitted back to 1976 models with kit SK210-93. Rear fuel feed line increased in size from 3/8" to 1/2".
1982	210N P210N	Complete redesign of fuel routing system to deal with ongoing vapor problems in Non T210 and P210. Venting and reservoir tanks changed. Fuel selector becomes a double valve with a fuel side and a vapor side. Fuel selector has a "BOTH" position. Fuel "ON-OFF" valve installed.