TECH NOTE

No. 010

Original Date: 02/15/1993

Revision No.: 004 **Rev. Date: 05/16/2006**

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Hot Starts on Cessna Aircraft with Continental Fuel Injected Engines

One of the most frustrating tasks is trying to start a Continental Fuel Injected engine when the engine has been hot. However, the design of the fuel system on Cessna 200 series aircraft with Continental Fuel Injected engines allows for a procedure to deal with the hot start problem.

First let's look at what causes the problem. The main source of the problem is fuel being in vapor form where it should be in liquid form. For the fuel injection system to work the fuel must be delivered to the fuel injector nozzle on top of the intake valve in each cylinder in liquid form. The nozzle then sprays the liquid fuel behind the intake valve where the induction airflow into the cylinder vaporizes the fuel and creates the combustion mixture. Up to this point, in normal operation, the fuel stream has been entirely liquid from the fuel tank to the injector nozzle.

On the 200 series Cessnas the fuel leaves a wing tank and flows down the fuel lines in the door post area to a reservoir tank in the belly of the aircraft. Most of the 200 series have two reservoir tanks in the belly, one for each main tank. The purpose of the reservoir tank is act as a header tank to allow that there will always be a supply of fuel available to the engine no matter what the attitude of the aircraft. From the reservoir tank fuel flows to the selector valve, from the selector valve to the fuel strainer, from the fuel strainer to the auxiliary (electric) fuel pump, from the aux fuel pump to the engine driven fuel pump. The engine driven fuel pump boosts the fuel pressure and separates out small quantities of vapor that might be present and sends the vapor back to the reservoir tank. From the engine driven fuel pump the fuel flow goes to the fuel control unit which sends the correct amount of fuel forward to the engine at the correct fuel pressure for the positions of the throttle and mixture controls. The fuel control unit returns excess fuel supplied to it by the engine driven fuel pump that is not needed by the engine based on the positions of the throttle and mixture to the reservoir tank from which the fuel came utilizing the same return line that the engine driven pump is using to return small amounts of vapor to the reservoir tank.

From the Fuel Control Unit fuel, now referred to as "metered fuel" because the amount and pressure of the fuel has been properly proportioned for the engine, goes forward to the distributor valve mounted on top of the engine. The purpose of the distributor valve is two-fold, first it divides the fuel coming to it into six equal portions and sends each portion thru a thin steel line to an injector, and secondly the distributor valve has a spring loaded diaphragm that shuts off all fuel flow out of the distributor valve when fuel pressure drops below a certain level. This allows for a clean shut off of fuel when the mixture control is pulled out at shut-down. As mentioned previously, fuel from the distributor valve then flows, as a liquid, to the fuel injection nozzles, where upon discharge from the nozzle it is converted from liquid to vapor for the combustion process in the cylinder.

That's the way it is suppose to work. But here is what goes on with a hot engine that causes starting problems. After the aircraft has landed and stopped, the engine is still hot. However because the aircraft is not in flight there is no cooling airflow through the cowling to carry the heat off. This means that components in the engine compartment, such as the fuel strainer, fuel pump, fuel control unit and their associated fuel lines, will become heat soaked. This is particularly prevalent on many turbocharged 200 series Cessnas where the exhaust from the #1 cylinder is run behind the engine and right below the engine driven fuel pump to connect with the exhaust by the #2 cylinder. These heat soaked components will then cause fuel in the lines to vaporize, at least partially, and this vaporization will continue until these components and their fuel lines are cooled down. This vaporized fuel cannot be pumped by the fuel pump nor metered by the fuel control unit so you have a situation where the engine either is difficult to start or won't start at all.

The critical time window for this situation is from about 5 minutes after shutdown to about an hour after shutdown. Earlier than that and the components haven't heated up enough to cause problems, longer than that and the components have cooled enough so that fuel won't be vaporized from the heat.

To deal with this situation we must find some way to carry the heat off so that the fuel won't vaporize within the fuel injection system. What most operators don't realize is that a fuel loop can be set up that carries the heat off before a start is attempted. The two keys to this is that the engine driven fuel pump and fuel control unit return excess fuel to the reservoir tank and that with the mixture

control pulled out fuel is not allowed past the fuel control unit, this avoiding engine flooding.

First we push the throttle all the way in, creating a high fuel flow demand at the fuel control unit. Then we pull the mixture all the way out, preventing engine flooding by not allowing fuel past the fuel control unit, and finally we turn the auxiliary fuel pump on high, which causes fuel to flow from the selected reservoir tank forward through the system to the fuel control unit where, because the mixture is pulled out, the fuel is routed by the return line back to the reservoir tank. Cool fuel from the reservoir tank circulating in this loop will carry off the heat that has built up in the components and allow for a normal start. It takes about two minutes of running the auxiliary pump on high to do an effective job of carrying off the heat.

Often what people think is a hot start problem actually is a magneto coil problem. Most Cessnas only have a starting impulse coupling on one magneto and if the coil is weak it won't generate much of a spark when warm and only being turned by the coupling, though it will work fine when the engine is started.

If it is known that turn around time will be short, heat soaking of the engine compartment can be reduced by parking with the tail into the wind, cowl flaps open and opening the oil filler door on the cowling. This carries heat up and out of the engine compartment. Don't forget to close the oil filler door before getting back in the aircraft.

CPA RECOMMENDED HOT START PROCEDURE
200 SERIES CESSNAS WITH 520 ENGINE

1. Throttle In, mixture Out. This sets up a fuel system loop to carry off the heat without flooding the engine.
2. Boost Pump on high, run for two minutes. This circulates fuel through the loop, carrying heat and vapor back to the reservoir tank of which ever fuel tank is selected.
3. Mixture in, shut off boost pump immediately when fuel flow peaks. This puts fuel in the line from the fuel control unit to the distributor valve and the fuel injector lines. These were isolated from the fuel with the mixture pulled out so as not to flood the engine. The pump is left running only long enough to fill these lines.
4. Throttle to 1/4 position
5. Switch tanks. This will make cool fuel without vapor available to the engine.
6. Boost pump to low position
7. Crank engine to start, momentary high boost may be required to keep engine running after it first catches. Often what people think is a hot start problem actually is a magneto coil problem. Most Cessnas only have a starting impulse coupling on one magneto and if the coil is weak it won't generate much of a spark when warm and only being turned by the coupling, though it will work fine when the engine is started. If it is known that turn around time will be short, heat soaking of the engine compartment can be reduced by parking with the tail into the wind, cowl flaps open and opening the oil filler door on the cowling. This carries heat up and out of the engine compartment. Don't forget to close the oil filler door before getting back in the aircraft.