

Frequently Asked Questions About Fuel Geysering and the Soter Fuel System (SFS)

Fuel Geysering—General Questions

1. What causes fuel geysering?

Fuel geysering occurs when fuel in a closed container (e.g., fuel tank, jerry can, fuel bottle) is superheated (the fuel is heated above the boiling point, but does not boil because it is under pressure) and is quickly depressurized. Depressurization occurs when you remove the fuel cap. All the liquid compounds that are supposed to be in a gas state (because they are heated above the boiling point) now instantly turn into gas. The stream that exits the container is a liquid/gas stream.

Gasoline is comprised of hundreds of different compounds, so it does not have a single boiling point. A good analogy is wildland fuels: smaller dead and dry fuels burn, but larger fuels are needed to sustain fires. Similarly, with gasoline, lighter hydrocarbons—such as butane and pentane (i-pentane and n-pentane)—are needed for startup and cold starts. Because the lighter hydrocarbons are more volatile or turn into gas more easily at a lower temperature, pressure builds up more quickly.

2. Is fuel geysering a new problem?

Reports of fuel geysers and injuries from fuel geysers involving tractors have been recorded since the 1950s. Similar to today, historic literature indicates that the problem was under-reported.

3. Will a fuel tank or container with a threaded fuel cap prevent fuel geysering?

No, fuel tanks or fuel containers with a threaded fuel cap are not immune to fuel geysering. There have been validated fuel geysering reports involving threaded caps on 20-liter fuel (jerry) cans, combo fuel containers (dolmars), and fuel bottles (MSR or Sigg). The question itself suggests that you can relieve the pressure in the fuel tank or container by slowly opening the tank, releasing pressure through the thread spline. However, when the fuel is hot enough, pressure builds up more quickly than it can vent and fuel geysering still occurs. In certain cases, specifically with fuel bottles and cans, you can completely remove the cap without the fuel initially geysering, but a slight agitation or breaking of the fuel surface tension induces a geyser.

Note: threaded fuel caps on newer models of Husqvarna chain saws begin to release pressure at three-quarters of a turn. Before that point, no pressure is released.

4. Why can't you use threaded fuel caps?

Chain saw manufacturers designed their fuel tanks to meet performance and regulatory requirements. This design decision applies to other equipment besides chain saws. Stihl, for example, uses the tool-less fuel caps on leaf blowers and string trimmers. Moving back to a threaded fuel cap is the manufacturers' decision and we have no control over. Also, as noted above, using a threaded cap does not guarantee that fuel will not geyser.

5. Can you vent a fuel tank or fuel cap?

Modifying the fuel tank is illegal because it tampers with an emission device, as stated in 40 Code of Federal Regulations (CFR) Part 1060—Control of Evaporative Emissions From New and In-Use Nonroad and Stationary Equipment, Subpart B, Section 1060.101 (excerpt below):

(ii) For anyone to design, manufacture, or install emission control systems with features that disable, deactivate, or bypass the emission controls, either actively or passively. For example, you may not include a manual vent that the operator can open to bypass emission controls. You may ask us to allow such features if needed for safety reasons or if the features are fully functional during emission tests described in subpart F of this part.

If the fuel tank was certified without the fuel cap, you can modify the fuel cap by adding a vent. We tested venting fuel caps and found it does not work for the same reason that threaded caps do not prevent fuel geysering or mitigate the risk of injury.

6. How long should you allow a chain saw and fuel to cool?

Cooling times vary depending on local conditions. For example, it takes longer for a chain saw to cool on a 100 °F day versus a 70 °F day. There are differences in cooling if you allow the saw to cool under shade rather than exposing it to heat from the sun, from fire, or from “hot black.” It is also important to remember that the engine temperature on most air-cooled engines rises after you turn the engine off. This is called heat soak; it occurs because the engine is no longer forcing air to cool itself down.

If a saw is exhibiting signs of vapor lock the operator should put the saw in the shade and await at least 30 minutes. Then feel the tank and engine and if either feels hot then wait another 15 minutes and feel again.

7. Will using a higher octane rating prevent or minimize fuel geysering?

No, the higher octane in gasoline prevents “knocking,” but does not prevent or minimize fuel geysering.

8. Will using ethanol free (E0) gasoline prevent or minimize fuel geysering?

No, ethanol has very little effect on fuel geysering. Ethanol has an initial boiling point (IBP) of 173 °F, compared with butane (IBP = 32 °F), i-pentane (IBP = 82 °F) and n-pentane (IBP = 97 °F).

9. Can geysering occur in a fuel bottle (sigg) or fuel combo can (dolmar)?

Yes, fuel geysering can occur in any enclosed fuel container subjected to heat or vibration.

10. In what conditions does geysering become more likely?

Anytime fuel is in a closed system that can be exposed to heat, agitation, or a change in elevation. Actual Evaluation of incidents reveal that the risk of geysering increases when:

- The engine is vapor-locked and “acts” as if it is out of fuel. This is an indicator that the fuel is hot. You should follow the hot start procedure to clear the vapor lock or should let the engine cool.

- The equipment or fuel container is exposed to direct sunlight (radiant heat) or another heat source, such as a fire.
- Fuel purchased is more than 30 days old. Although fuel can remain viable when stored in a tightly sealed container in a cool place, it may be too volatile for the current conditions you face. For example, you may purchase fuel in January but not use it until May. The fuel may be a winter blend designed to work in colder weather. When exposed to heat in May, the light hydrocarbons (added for cold weather performance) contribute to the pressure in the tank.
- You use fuel purchased in a cold-weather climate in spring (April and May) in a warmer climate. For example, you purchase fuel in Montana in May and use it in Arizona.
- The equipment or fuel container is agitated because it bounced around in a vehicle.

Soter Fuel System (SFS) Questions

1. Why are we testing the SFS?

The SFS reduces the risk of injury from fuel geysering by not exposing you to fuel. Because the SFS is a closed system, a very small amount of fuel is released (as the receiver plunger travels through the fuel, a small amount—less than 1 cubic centimeter—may accumulate in the receiver). This system is being evaluated by sixty six (66) crews from Forest Service, Bureau of Land Management, National Park Service and Bureau of Indian Affairs to determine whether it is suitable for use in the harsh field environment. Numerous laboratory tests and initial field evaluations show that the system works.

2. Is the SFS new?

The technology is not new; the SFS is based on a dry-break fueling system that was first used to fuel aircraft in WWII. Commercial applications include auto racing

<<https://www.youtube.com/watch?v=K1DVY0HcZQ0>>, motorcycle racing

<<https://www.bing.com/videos/search?q=dry+break+fuel+system+origins&&view=detail&mid=9D29E2397F9095A7800C9D29E2397F9095A7800C&&FORM=VRDGAR>>, and NASCAR

<<https://www.bing.com/videos/search?q=NASCAR+fuel+system&&view=detail&mid=11BFD8EE0C7F8B4F6A28&&FORM=VRDGAR>>.

3. Can you use the SFS receiver in all chain saws?

Currently, SFS receivers are available for Stihl chain saws with quarter-turn or tool-less fuel caps (models: MS193, MS250, MS251, MS271, MS280, MS362, MS440, MS441C, MS460, MS461) and Stihl backpack blowers with the threaded fuel cap (models: BR600 and BR800). The same fuel cap works for the Stihl MS660 chain saws. SFS receivers for Husqvarna chain saws are also available (models: Husqvarna 372XP, 550XP, 562XP and 572XP).

Prototypes for other equipment are being tested.

4. How do you release pressure from a chain saw fuel tank?

You can use the SFS to relieve pressure in a fuel tank without exposing yourself to the fuel. Pressure in the fuel tank will equalize with another fuel container attached to it. Ideally, you should balance pressure in the tank with an empty fuel bottle. For example, if the pressure in a chain saw fuel tank is 8 pounds per square inch (psi), when mated with an SFS probe installed on an empty fuel bottle

(near 0 psi), the pressure in the tank will equalize to 4 psi in the tank and fuel bottle, enabling you to safely open the empty fuel bottle. You can repeat this process several times to drop the pressure. Please note that if the chain saw is still hot, pressure in the tank will continue to build and will not remain at 4 psi but continue to rise.

5. Do you have to use the dust cap on the receiver?

You do not have to use the dust cap on the receiver, but we recommend that you do. The dust cap prevents dirt and debris from accumulating in the receiver. The lock/unlock feature on the dust cap allows you to lock or unlock the receiver while the cap is in place, preventing the inadvertent depressing of the receiver. You do not have to lock the receiver during cutting operations. The locking feature on the receiver was added so you can transport chain saws in rotor wing aircraft. At the pilot's discretion, you may transport chain saws in a helicopter without purging them.

6. How hard can you tighten the probe to the fuel can?

You must tighten the probe on the fuel can enough to compress the lower O-ring. However, further tightening may cause the O-ring to unseat and deform. You cannot maintain a good seal when the O-ring is deformed.

You must turn the combo fuel can probe until the probe filler neck contacts the flat washer, and then turn it another quarter turn. Like the O-ring on the fuel can probe, over-tightening may deform the washer.

7. What is the best way to check the fuel level in a chain saw?

The best way to check the fuel level in a chain saw is by looking through the translucent tank. In some instances where the fuel tank is dirty or is not translucent, you should use the SFS to fill and quickly confirm that the fuel tank is full.

8. Why doesn't the SFS require you to fill the fuel tank all the way?

The SFS requires you to fill the fuel tank to the manufacturer's recommended level, allowing for the proper headspace in the fuel tank.

9. How long does it take to release pressure in the fuel tank?

This depends on how much pressure is in the tank and how hot the fuel is. For higher pressures, you may have to repeat the steps outlined in question 14 to relieve pressure with the SFS. Pressure in the fuel tank will continue to build until the fuel is cool.

10. Do you always have to lock the receiver while in use?

You do not have to lock the receiver during normal use. The locking feature on the receiver was added for transporting fuel tanks in rotor wing aircraft so that, at the pilot's discretion, you may transport chain saws in a helicopter without purging them. The locking feature prevents the receiver from opening inadvertently. Also, the receiver should be locked if you need to clean debris from the unit before refueling or if the receiver dust cap is not in place.

11. Is the SFS only for chain saws?

No, receivers are available for Stihl blowers with threaded caps. Additional applications may be developed as needed.

12. What is the best way to tighten the receiver?

Ensure proper thread alignment and gently hand fasten the 08-0661 receiver into place. Carefully fasten the receiver clockwise using the screwdriver end of the bar tool in the receiver plunger slot. To fasten completely, engage the large hex end of the bar tool into the hex opening in the receiver. Complete fastening is typically achieved in 3.5 to 4 total turns. The instructions and quick-start guide provide complete installation procedures.

13. Will a geyser occur if the probe is misaligned?

Yes, it is possible for a geyser to occur when the probe is misaligned. The receiver and probe have features that help with the alignment, but it is possible for the receiver to inadvertently open without a complete seal when the probe is engaged at an angle. Take care to avoid side-loading the probe while it is engaged in the receiver. It is important to properly align the probe and receiver.

14. How often should you inspect/replace O-rings?

You should inspect the O-ring on the receiver and the plunger every time you replace the fuel filter or remove the receiver.

The probe has seven O-rings. The main O-ring seals the SFS probe to the fuel container (**note:** the combo fuel can adapter uses a gasket); you should inspect it for damage or wear. Two X-rings seal the SFS probe to the receiver. These X-rings are extremely susceptible to damage and you must properly install them without twisting them out of their normal, relaxed state. Two internal O-rings create the internal seal for fuel flow. You should use the probe service tool (according to the instructions provided) to inspect the two X-rings and one of the two internal probe O-rings for wear. The fuel container adaptor contains two O-rings to provide a seal between the probe and adaptor. You can only inspect these two adaptor O-rings and the second of the internal probe O-rings upon complete disassembly the fuel container probe. However, these three O-rings are the least susceptible to damage.

15. Will the SFS become dirty and clogged?

Most dirt and debris will not clog the SFS receiver and probe. However, large debris may lodge in the receiver and prevent the plunger from closing. Fine dirt may also accumulate in the probe and prevent the probe from sealing or actuating smoothly.

To prevent sealing or engagement issues, use the probe service tool to clean and lubricate the probe regularly.

16. How often should you clean the SFS?

You should inspect and clean the SFS receiver and probes when you replace the fuel filter on the saw or after about 100 hours of use.

17. Can you use the SFS to modify the chain saw fuel tank?

No, modifying the fuel tank is illegal because it tampers with an emission device, as stated in 40 CFR 1060—Control of Evaporative Emissions from New and In-Use Non-road and Stationary Equipment, Subpart B, Section 1060.101.

18. Is training available for the SFS?

Yes, an orientation video is available by visiting the National Wildfire Coordinating Group Equipment Technology Committee web page <<https://www.nwcg.gov/committees/equipment-technology-committee>>. Information about the SFS is under the “Vaporless Fueling System Field Evaluation” section. Information about fuel geysering is also available on the web page.