Second Strike

The Newsletter for the Superformance Owners Group

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I Got the Gasohol/Winter Gas Blues

Gasohol – A Pain in the Gas

Gasoline is a blend of more than 200 different hydrocarbon liquids. Prior to the mid-1980's, gasoline was blended to work in carbureted cars. From the mid-1980's on, fuel injection replaced carburetors and the fuel blends changed accordingly. The primary difference is that carburetors meter fuel at atmospheric pressure and fuel injection meters fuel at high pressure. The high pressure allows the use of a higher percentage of volatile elements in the blend.

Today the proper functioning of gasoline in carbureted cars is no longer included in the gasoline testing standards. That is why those of us with carbureted cars are experiencing increasing difficulties. The biggest change affecting carbureted cars is the increasing use of ethanol as well as the other volatile elements used in winter gas.

Until recently I never had gasohol/winter gas problems. In the past couple of years, I have had quite a few. The percentage of ethanol in gasohol around my home has been steadily increasing over the years and has reached a point where it is a serious problem for cars with carburetors. So I set about to understand why SP 218 was misbehaving and what could be done about it. This newsletter details those findings. Our cars and driving experiences are by nature personal so this is by necessity a personal story.

Critical sources of information gathering were the 2012 SSR in Murphy NC and 2013 Superfest in Georgetown CO - talking with other owners, inspecting the variety of engine installations, and the excellent laboratory of experimental driving conditions.

The Physics

The Root of the Problem

The boiling point of the200 different hydrocarbon liquids in gasoline range from 100F (38C) for the most volatile elements to 400F (204C) for the heaviest elements. Temperatures are given in Fahrenheit (i.e. 212F) and Celsius (i.e. 100C).

Gasohol contains up to 10% ethanol. Ethanol is ethyl alcohol, the same stuff in beer, wine, and liquor. The problem is that ethanol boils at a temperature lower than the operating temperature of most engines.

And as any moonshiner can tell you, ethanol boils out of the liquid it is mixed with at the boiling point of ethanol, not the boiling point of the mixture. The problem is that if the gasohol gets hot enough, the ethanol will boil and will either flood your carburetor or cause vapor lock in your fuel pump, or both.

Moonshiners make a living out of the physics that plague us

The boiling point of ethanol at sea level standard conditions is 172.9F (78.3C). The typical carbureted engine uses an 180F (82C) thermostat, which means that ethanol boils slightly below the normal operating temperature of the engine. This is a very marginal situation. When the fuel temperature exceeds 172.9F (78.3C), the ethanol will boil out of the gasoline at sea level standard atmospheric pressure. Clearly fuel temperature is the primary problem.

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Winter gas is created by adding more volatile elements to the gasoline so that it will vaporize at a lower temperature. This reduces emissions and improves operation after a cold startup. These volatile elements cause the same problems as ethanol, which is itself a volatile additive. The focus here is on gasohol. If you fix the gasohol problems, you will fix the winter gas problems at the same time.

There are conditions that make the gasohol problem worse.

Larger engines put out more heat in about direct proportion to their size. A 427 is 22% bigger than a 351 and puts out about 22% more heat. A monster 598 CID big block puts out 70% more heat than a 351. On that basis, the larger engines are more likely to have a heat related problem with gasohol than smaller engines. Physically larger engines also restrict the flow of cooling air through the engine compartment, adding to heat related gasohol problems.

The boiling point of ethanol drops at higher altitudes. So your car may run fine at lower altitudes, but begin to behave badly in the mountains. With an 180F thermostat, even 5,000 feet can be a problem as we found while climbing 4,784 foot Brasstown Bald in Georgia during SSR 2012.

Altitude, Ft.	Boiling Point
0	172.9F (78.3C)
1,000	171.1F (72.3C)
5,000	164.3F (73.5C)
10,000	155.8F (68.8C)
15,000	146.7F (63.7C)

Slow running reduces cooling airflow under the hood. Higher engine loads produce more engine heat and higher fuel temperatures. The combination, such as climbing Brasstown Bald or Pikes Peak behind a slow car, did cause heat related gasohol problems.

And of course the hotter it is outside, the more likely you are to have heat related gasohol problems.

A carbureted big block on a hot day at high altitude slowly climbing a steep hill is the perfect storm. We saw a lot of this at Superfest 2013. A nice laboratory. I talked to a lot of folks about how their cars ran in the mountains of Colorado, some good, some not so good. These observations and conversations were valuable input.

It should be noted that this is not typically a problem for fuel injection. The pressure in fuel injectors is 40 to 70 psi above atmospheric. The boiling point is 235F (113C) to 259F (126C) at sea level. The gasohol does not see atmospheric pressure until it is injected into the intake. If the gasohol boils after leaving the injector so much the better, because it provides better fuel atomization.

Sources of Heating

Fuel exists and can be heated in the fuel tank, fuel line, fuel filter, fuel pump, fuel pressure regulator, and the carburetor, Heat is transferred by conduction, convection, and radiation. Heat is also generated by the energy supplied to the fuel by the fuel pump. The combination of these locations and methods is how the fuel is being heated to boiling.

The only significant source of fuel tank heating is return fuel. If the return fuel is that hot, you have bigger problems which will be addressed. The fuel tank is therefore removed from further consideration.

An electric fuel pump is normally installed near the gas tank away from sources of heat. However the pump is almost always running far below rated capacity. The low fuel flow rate and extra work pumping against back pressure does heat the fuel.

The factory steel fuel line passes within eight inches of the left header exposing it to significant radiant heat. When fuel is moving slowly through the fuel line, it picks up more heat. A smaller fuel line has less surface area to pick up heat and a faster fuel flow rate. A smaller fuel line therefore runs cooler than larger fuel line.

For cars with a mechanical fuel pump, the fuel pump is bolted directly to the block. Heat is conducted from the block to the fuel pump. The back side of the mechanical fuel pump is also exposed to convective heat transfer from hot engine oil.

If the fuel filter is bolted to the engine or lies on the engine, it can add conductive heat transfer to the fuel. This is particularly true if the fuel filter has an aluminum housing.

Fuel pressure regulators typically have an aluminum housing. If the fuel pressure regulator is bolted to the engine, it can add conductive heat transfer to the fuel.

Conductive heating from the intake manifold is the main source of carburetor heating. Aluminum is an excellent heat conductor. The carburetor is typically separated from the intake manifold only by a thin gasket which is always soaked with fuel and provides little barrier to conductive heat transfer. The intake manifold is heated by conduction from the cylinder heads and by convection from engine water and from oil splashing on the underside of the manifold which are normally around 180F (82C) and can reach 212F (100C) or more during spirited driving, hill climbing, or very slow driving conditions.

Each of these sources of heating is investigated here and solutions recommended.

Sources of Cooling

The carburetor is potentially cooled by convection from three sources – external air passing over the carburetor, air passing through the carburetor, and fuel passing through the carburetor. The carburetor and intake manifold are also cooled internally by the evaporation of fuel.

At high speeds, there is more air over the carburetor, more air through the carburetor, more fuel through the carburetor, and more evaporation and hence more cooling. At lower speeds there is less of all four. Fast is good. Slow not so much so.

In most cases, the air flowing over and through the carburetor has already passed through the radiator. The temperature of the heated air depends on many things, but on a standard 59F (15C) day, it will be around 125F (52C) while cruising which is already half way to the boiling point of ethanol. Radiator exit air is not the best cooling solution.

Ethanol Related Problems

The Test Subject

Quantitative and qualitative test data have been collected. Changes have been and will be made. The pertinent configuration details for the test subject are:

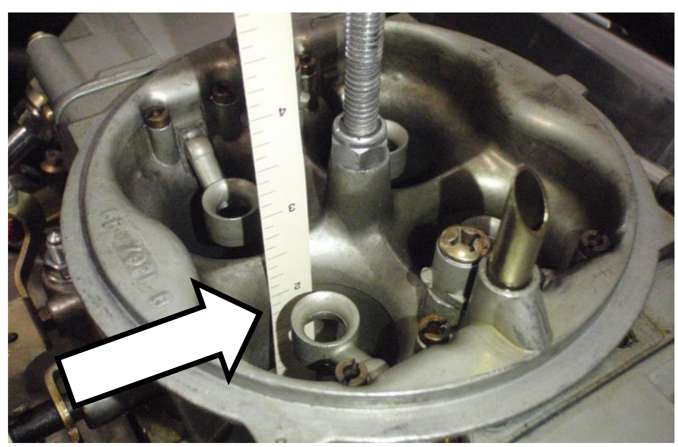
- Superformance Mk III S/C SP 218
- Standard stainless steel gas tank
- Holley Red electric fuel pump near the fuel tank. Left over from first engine. It is undersized and seldom used. The internal pressure regulator is not working.
- Standard 3/8" plated steel gas line
- Mechanical fuel pump in use
- Rubber fuel line from mechanical fuel pump to chrome plated copper fuel log.
- Holley HP 750 double pumper carburetor
- 427 CID Windsor engine
- RDI Z351 aluminum block
- Edelbrock Victor Jr aluminum heads
- Edelbrock Performer RPM dual plane aluminum intake manifold
- CV Products CV1511 14" x 3" NASCAR low profile air cleaner
- S/C style exhaust (side pipes) with Kenny Thompson custom headers.
- Standard radiator cooling fans with manual override switch.

Boiling Fuel in the Carburetor (Flooding)

The symptoms of flooding are typically that the engine will not run at all well below around 3000 rpm. Above that it will run, but not well. The fact that you can keep the engine running at elevated rpm distinguishes it from the second problem (vapor lock).

The fuel is pressurized by the fuel pump to around 7 psi above atmospheric. At this pressure the boiling point at sea level is 190F (88C), slightly above the operating temperature of the engine so the ethanol in the fuel line after the fuel pump may not boil. However when the fuel passes the needle and seat into the float bowl, the fuel is reduced to atmospheric pressure. If the fuel temperature and/or the carburetor temperature is above 173F (78C), the ethanol boils, much like releasing the pressure on a warm bottle of carbonated beverage. The boiling fuel expands and escapes out the main jets directly into the carburetor barrels, flooding the engine. In addition, the foaming fuel reduces the seating pressure on the needle and seat, allowing excessive fuel to flood into the float bowl.

In my experience with SP 218, the flooding problem occurred when the engine temperatures were elevated by spirited driving or hill climbing. The oil temperature was always 100C (212F) or higher. The first time this occurred to SP 218 (prior to the addition of the phenolic spacer); I pulled over immediately and removed the air cleaner. Major flooding. The fuel boiling out of the main jets filled the carburetor bores. The fuel in the bores was bubbling. The carburetor was as hot as the engine to the touch.



Boiling fuel filled all four carburetor bores to a depth of two inches

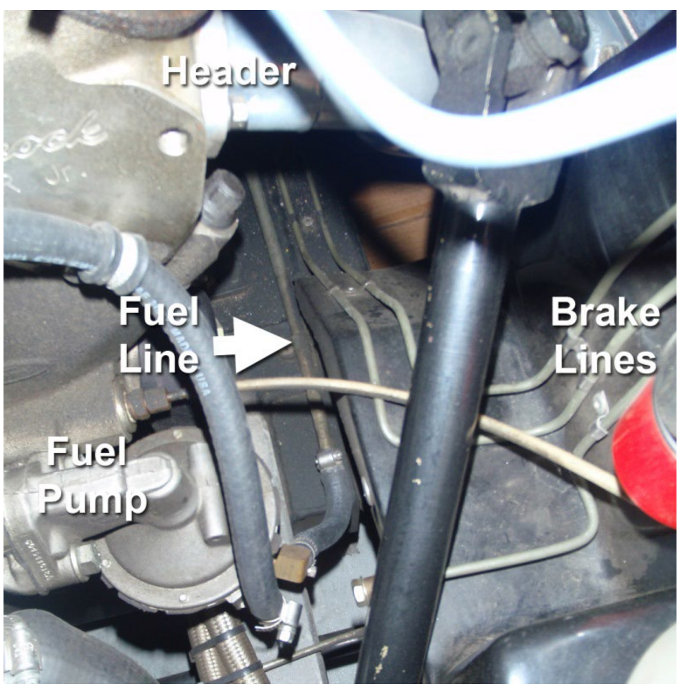
The fuel boiling problem occurred during slow speed cool down when the engine was still hot from running hard, but the cooling airflow and fuel flow were significantly reduced, or when hill climbing with heat-producing load but low airflow and fuel flow.

There are long term effects of this situation. The raw gas washes the oil off of the bore and accelerates ring wear. Not to mention setting the engine on fire, stalling in traffic, and other hazards.

Boiling Fuel in the Fuel Line (Vapor Lock)

The symptoms of vapor lock (fuel starvation) are very distinct from the symptoms of boiling fuel in the carburetor (flooding) so it is easy to tell one problem from the other. With vapor lock, the engine will run out of fuel and quit from fuel starvation. It will not run at elevated rpm. It will usually not restart without clearing the vapor lock. Vapor lock is caused by fuel boiling in or before the fuel pump. The fuel pump will not pump vapor and fuel flow is stopped. Vapor lock can occur when the car is parked and when it is running.

Vapor lock more commonly occurs with a mechanical fuel pump than an electric fuel pump. The factory steel fuel line passes within about eight inches of the left header and is exposed to radiant heat from the left header. This fuel line is not usually replaced with braided line or rerouted for engines with a mechanical fuel pump. The mechanical fuel pump itself is heated by conduction from the block and convection from engine oil.



Left inner fender showing proximity of header to steel fuel line and brake lines. Brake lines are closer to header than fuel line. Brake fluid has boiled at high speed track events.

Vapor lock can occur while hot soaking when stopped. The radiant heat from the left header and/or heat in the fuel pump can boil the ethanol in the fuel and cause vapor lock in the mechanical fuel pump.

I personally experienced vapor lock a number of times while driving at altitude at Superfest, always while hill climbing (heavy load) on steep hills on the interstate at speed including the long pull up I-70 West to Georgetown and the long pull up I-70 East to Vail Pass. In all cases the oil temperature was above 90C (194F). I observed that it is vapor lock because additional throttle made the stuttering worse. If it was flooding, additional throttle would have helped. A good way to tell the difference. I was fortunately able to clear the vapor lock by switching on the electric fuel pump for a few seconds.

I also had a flooding problem at Superfest while driving very slow (10 to 15 mph) behind a terrified tourist as we approached the summit of Pikes Peak at 14,000 feet. The heat of hill climbing plus the lack of cooling from low speed was enough to boil the fuel, causing some flooding and rough running. When we passed him and got to 30 mph the problem cleared. I checked the carburetor when we reached the summit and it was cool to the touch (phenolic spacer already installed). So the heating occurred before the carburetor and the fuel boiled as it passed the needle and seat.

To research this situation when we returned home, I ran the car at slow speeds until the water temperature reached 105C (221F) and the oil reached 95C (203F). Then I stopped and measured temperatures with an infrared thermometer. This did not replicate the conditions at Superfest, but it does indicate where the key sources of heat are.

Location	Temperature	Gain
Ambient	84F	Base
Fuel entering pump	124F	+40F
Fuel leaving pump	133F	+49F
Fuel entering carb	136F	+52F
Left header	172F	+88F
Inner fender near header	162F	+78F
Frame near fuel line	124F	+40F
Block at base of fuel pump	208F	+124F
Base of fuel pump	175F	+91F
Pump diaphragm enclosure	146F	+62F

The headers were a relatively cool 172F. The inner fender near the left header was 162F indicating significant radiant heating. Further away, the frame in the vicinity of the fuel line was 124F, the same as the fuel in the fuel line.

The fuel gained 40F passing under the header, 45% of the 88F gain for the header. At that rate, a header temperature of 282F would raise the fuel entering the pump to 173F, enough to cause vapor lock in the fuel pump. It does not take much of a hill to get the header that hot.

The block was 208F. The base of the fuel pump was 175F. The fuel pump diaphragm enclosure was 146F. The pump was heating the fuel while the fuel cooled the pump. If the fuel was hot enough, the pump could add enough heat to boil the fuel leaving the pump.

My conclusion is that under the right combination of circumstances (high altitude, high speed, steep hill in this case); the left header can heat the fuel to the boiling point before the mechanical fuel pump thus causing vapor lock.

Further, under the right combination of circumstances (high altitude, slow speed, steep hill in this case), the left header and mechanical fuel pump can heat the fuel to boiling exiting the fuel pump causing flooding.

The problem is twofold. The fuel line has to be routed near the left header to reach the mechanical fuel pump. The mechanical fuel pump is bolted to the block and gets hot.

Vapor lock is uncommon with an electric fuel pump because the pump is in the rear away from engine heat. The electric fuel pump also allows the fuel line to be routed away from the left header and other heat sources.

Physical Damage to Carburetor Components

Ethanol also causes physical damage to carburetor components. There are three problems.

The first is that ethanol is hygroscopic, meaning that it absorbs and retains water. It will literally absorb water vapor from the atmosphere. The ethanol/water mix is corrosive to metals like gas tanks and fuel lines.

The second is that the water causes galvanic corrosion in a mixed metal environment. Carburetors include steel, brass, zinc, and aluminum components and are prone to galvanic corrosion.

The third is that ethanol chemically attacks non-metallic components such as gaskets, O-rings, accelerator pump diaphragms and check valves, and power valves. This is more of a problem in older carburetors where the non-metallic components may not have been designed to withstand ethanol.

After nine years of service, the O-rings on the needle and seat on my Holley HP shrank to the point that significant fuel was leaking past the O-ring seal, flooding the engine. The symptoms were virtually identical to the boiling fuel (flooding) problem. During rebuild I compared the old needle and seat O-rings to the new ones. It was clear to the eye that the old ones were a bit shriveled up.

Gasohol Slime

Water vapor in the air combines with alcohol in the gasohol to form a colorless slime that can clog fuel pumps, fuel filters, and carburetors and cause the engine to stall. This occurs when gasohol is stored for a significant time period, such as over the winter. Because it is colorless, it is hard to detect visually.

Ethanol Solutions

I am looking for ways to make SP 218 work well with ethanol. I will not use my precious seat time driving around looking for the increasingly rare ethanol free gas stations.

Heating of the fuel to the boiling point of ethanol is the problem. The fuel is heated by the fuel line, fuel pump, and carburetor. The solution is reduce the heating of the fuel line, fuel pump, and carburetor

Emergency Fixes

Boiling Fuel in the Carburetor (Flooding)

If you have a mechanical fuel pump, to clear the problem temporarily wind the engine out at full throttle. The fresh cooler gas will usually cool the carburetor and stop the boiling. This temporary solution has worked when used. It does require a stretch of straight, unimpeded, and unpatrolled road.

If the engine stalls from flooding, it typically requires a fully open throttle to clear the excess fuel and restart the engine.

If you have an electric fuel pump only (a number of cars have both mechanical and electric fuel pumps) turn the electric fuel pump off to stop the fuel flow and give your engine a chance to clear.

Boiling Fuel in the Fuel Line (Vapor Lock)

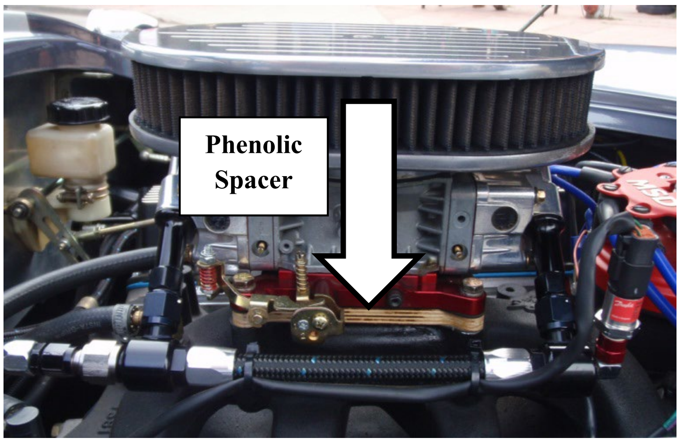
If your car will not start and you suspect vapor lock, remove the air cleaner and work the throttle. If little or no fuel comes out of the accelerator pump jets, you have vapor lock.

To clear the vapor lock, remove the air cleaner and place your hands over the carburetor throats forming a seal. Have someone crank the engine. The vacuum created in the carburetor will draw fresh fuel through the fuel pump and clear the vapor lock. Once fuel reaches the carburetor the engine will start. Remove your hands immediately. Be aware that carburetor flashbacks are not uncommon and can burn you.

Reducing Fuel Heating

Carburetor Insulation with a Phenolic Spacer

Mike Stenhouse SP 218 (427 CID Windsor). Every time I had had a boiling fuel problem, the carburetor was too hot to touch. I needed to insulate the carburetor from conductive heat transfer from the engine. After checking available hood clearance, I purchased and installed a 1/2” four hole phenolic spacer under the carburetor. I selected a Summit Racing part # SUM-G1402 includes gaskets and longer studs.



Larry Martinson SP 2266 (357W) - phenolic spacer insulates his carburetor from manifold conductive heat transfer.

After installation, I did a test drive. The test consisted of driving at slow speeds without radiator fans until the water and oil temperatures exceeded 90C (194F). The car was stopped and the following “At Stop” temperature measurements were made as quickly as possible. Temperature measurements were made again in “+1 Hour”. The engine did not indicate any rough running during the test. The results are shown in the table below in degrees F

Temperature	At Stop	+1 Hour	Change
Ambient	82F	82F	0
Gas tank	80F	80F	0
Water gauge	205F	158F	-47F
Radiator	195F	130F	-65F
Oil gauge	198F	122F	-76F
Oil filter	180F	118F	-62F
Intake manifold	155F	145F	-10F
Carburetor	90F	100F	+10F
Exhaust header	250F	106F	-144F

Analysis of these results leads me to the following conclusions:

- For “At Stop”, the carburetor was 90F, only 10F above the ambient and gas tank temperatures and certainly cool enough to avoid gasohol problems. The phenolic spacer was doing an excellent job of keeping the carburetor cool.
- For “+1 Hour”, the carburetor temperature increased by only 10F. This indicated two things.
  - First, the phenolic spacer prevented the hot soak from the manifold from significant heating of the carburetor while stopped.
  - Second, there was no other heat source capable of heating the carburetor to the boiling point.

The carburetor remained cool to the touch and caused no problems during Superfest, even on slow steep climbs up Pikes Peak and Mount Evans, both over 14,000 feet.

Interestingly, SP 218 runs much smoother at low rpm with the phenolic spacer. It now cruises comfortably without bucking at 1600 rpm.

Intake Manifold

Edelbrock Performer RPM Manifold

For manifolds like the Edelbrock Performer, Performer RPM, and Torker II, the carburetor pad and runners are cast integral to the valley cover and are therefore subject to heating from hot oil in the lifter valley.

Edelbrock Performer RPM Air Gap Manifold

For manifolds like the Edelbrock Performer RPM Air Gap, Victor, and Victor Jr, the carburetor pad and runners are separated from the valley cover by an air gap. The carburetor pad and runners are not subject to heating by the oil in the lifter valley and do allow more cooling airflow. Therefore the carburetor pad runs cooler.

The carburetor pads for the Performer RPM Air Gap and Victor Jr are about one inch taller than the carburetor pad for the Performer RPM. If you are tight for hood clearance and have to choose, the phenolic spacer is a better solution for carburetor heat reduction.

Exhaust Heat Crossover

Many dual plane manifolds like the Edelbrock Performer and Performer RPM have exhaust heat crossover to heat the carburetor pad. See the smaller center port just below the carburetor pad in the photo on page 6.

Most modern high performance heads do not have exhaust heat crossover. If your heads do, there will be an exhaust heat crossover port between the two interior intake ports.

If your manifold and heads both support exhaust heat crossover, you should block the exhaust heat crossover to eliminate it as a source of heat. The crossover can be blocked with a steel shim placed with the intake manifold gasket. Use steel. Aluminum will melt.

Recirculating Fuel

At anything other than full throttle high rpm operation, the engine only requires a small percentage of what the fuel pump can deliver. Slow moving fuel picks up more heat.

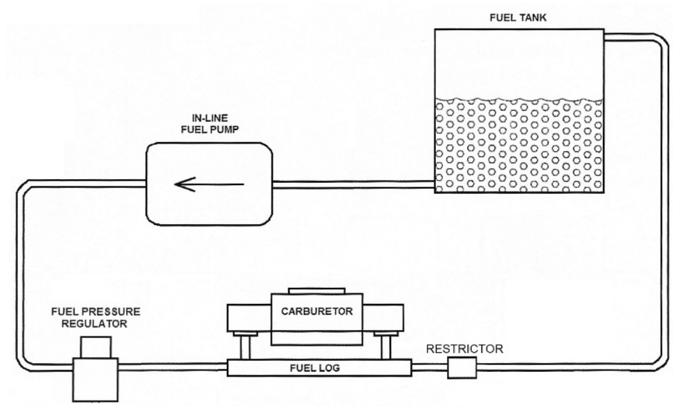
Recirculating fuel uses a return line to return a percentage of the fuel delivered by the fuel pump to the fuel tank. With the higher flow, the temperature gain in the fuel line and the fuel pump is reduced, reducing the chances of boiling the fuel.

The common vane type and gerotor type electric fuel pumps heat the fuel somewhat when working at higher pressure against a restriction. Recirculating the fuel reduces the backpressure on the pump by increasing the flow. This reduces the load on the pump and keeps it cooler. It also reduces wear on the pump.

Holley 12-841 Billet Aluminum Fuel Pressure Regulator. Bypass Style. It can be installed before or after the fuel log. Provision is made for a fuel pressure gauge.

Recirculating fuel can be implemented several ways. The following illustrations are derived from those in the current Holley catalog. In general, the bypass fuel pressure regulators shown are only used with electric fuel pumps and only those with no internal regulator.

Holley recommends a 100 micron pre-filter before the fuel pump and a 40 micron post-filter after the fuel pump. These filters are omitted from the drawings for simplicity.

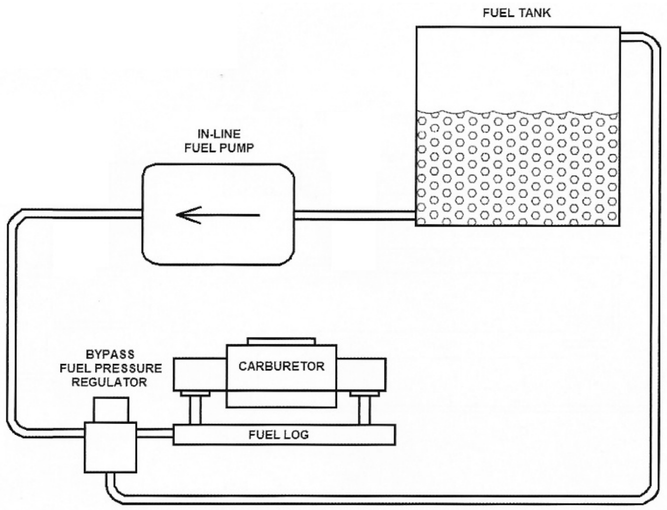


Bypass line with restrictor

Bypass with restrictor. Craig Aylsworth SP 1265 (598 CID big block) and others have added a return line. Craig's fuel line runs from the fuel pump to the fuel pressure regulator to the rear of the carburetor fuel log. The return line connects to the front end of the fuel log and runs back to the fuel tank. Craig initially had a restrictor in the return line which limited the return fuel. This proved to be a problem at high altitude during Superfest. Removing the restrictor in the return line allowed higher volume return which proved to be a successful strategy even in the high altitudes of the Colorado Rockies.

Craig Aylsworth SP 1265- bypass with restrictor

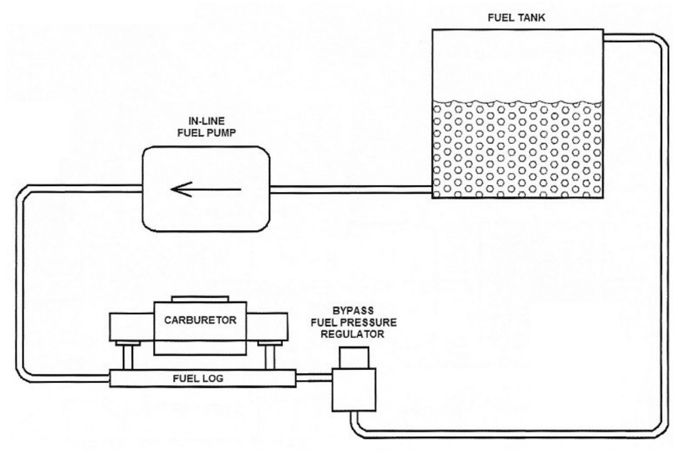
This is covered in the SCOF Technical Library. Look under ENGINE > MECHANICAL UPGRADES > FUEL RETURN LINE



Bypass regulator before the fuel log

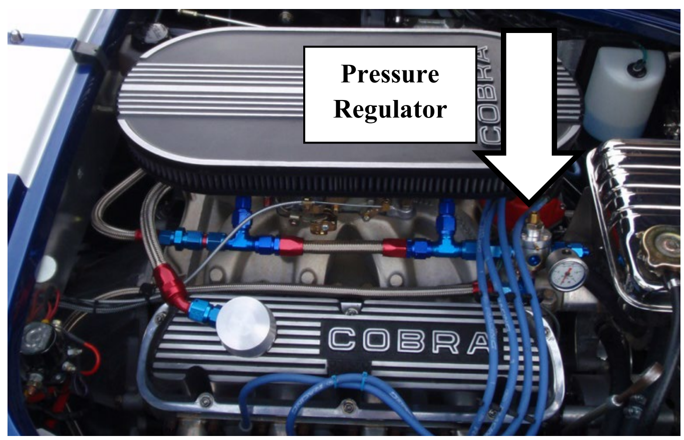
Bypass regulator before the fuel log. In Larry Peet's SP 1876 (427 CID Windsor) the fuel pressure regulator is installed in the engine compartment at the rear of the fuel log. The regulator has one port for incoming fuel line from the fuel pump, one port for the carburetor fuel log, and one port for the return line to the fuel tank.

*Larry Peet SP 1876- bypass regulator before the fuel log.
The regulator is behind the fuel pressure gauge.*



Bypass regulator after fuel log

Bypass regulator after the fuel log. Glenn Caspary SP 1854 (427 CID Windsor) has a bypass regulator after the fuel log based on the Mallory 4309 fuel pressure regulator. Glenn's fuel pump delivers fuel directly to the rear of fuel log. The pressure regulator is mounted on the front end of the fuel log. The regulator controls pressure by sending excess fuel in the fuel log back to the fuel tank via the return line.



Glen Caspary SP 1854- bypass regulator after the fuel log

Electric Fuel Pump

Mike Stenhouse SP 218 (427 CID Windsor). My original engine, a 410 horsepower 358 CID Windsor, had a Holley Red electric fuel pump which is rated for up to 425 horsepower. When the 550 horsepower 427W was installed, the Holley Red was not big enough so a mechanical fuel pump was installed on the engine. The vane type electric fuel pump does not impede fuel flow when not on, so it was left in place.

Whenever my engine sputters from the fuel starvation of vapor lock, I switch the electric fuel pump on for three seconds to clear the vapor lock. It works immediately every time. For long steep climbs like Route 6 over Loveland Pass, I switched on the electric fuel pump for three seconds every fifteen seconds and had no problems. I only did it for three seconds because the built-in pressure regulator in my Holley Red electric fuel pump is stuck. It is a problem with built-in regulators I am told.

The electric fuel pump has real advantages over the mechanical fuel pump.

- The electric fuel pump is at the rear of the car far away from engine heat. The mechanical fuel pump is bolted to and heated by the engine.
- The electric fuel pump provides real flexibility in fuel line routing to avoid heat sources and reduce fuel line heating. The mechanical fuel pump requires that the fuel line pass near the left header.
- The electric fuel pump is not as susceptible to vapor lock as the mechanical fuel pump.
- The electric fuel pump can be shut off to clear flooding. The mechanical fuel pump cannot.

Rerouted Fuel Line

Experience indicates that the factory steel fuel line passing within 8 inches of the left header is close enough for the radiant heat to boil the gasohol in high load or hot soak conditions. This can result in flooding or vapor lock or both. Corrective action is required.

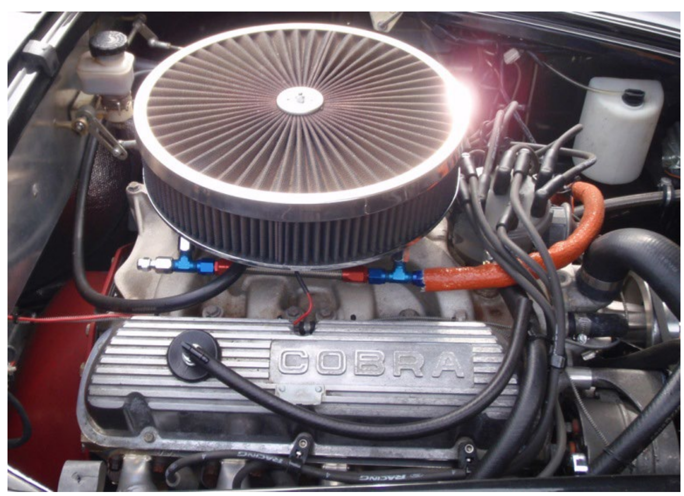
For electric fuel pumps, rerouting the fuel line up the center of the bell housing to the rear of the engine seems to work well. It increases the distance from the left header and gets the fuel line out of the line of sight of the left header. Radiant heat is line of sight.

Chuck Juergens SP 840 - rerouted fuel line

Chuck Juergens SP 840 (418 CID Windsor). The use of an electric fuel pump allowed the engine installer to route the braided fuel line over the center of the bell housing and up over the rear of the intake manifold. This routing removes the fuel line from the typical sources of heat, particularly the left header. Chuck did not have gasohol problem during Superfest. Several other owners at Superfest have fuel lines routed up from the center of the bell housing to the back of the engine.

Insulated Fuel Line

For mechanical fuel pumps, rerouting the fuel line may not be practical. One solution is to insulate the fuel line. A braided fuel line fuel line certainly offers better insulation than a steel fuel line and may be sufficient. Those with braided fuel lines fared better at Superfest.



Hal Taylor SP 1314 (351W) - insulated fuel line

The red Flame Guard insulating sleeve on SP 1314 is available from Earl's Performance Plumbing.

Additional Cooling

Manual Override of Radiator Fans

The radiator fans are thermostatically controlled and come on at 100C (212F). This is way past the boiling point of ethanol. The fans should be switched on manually when the water temperature exceeds 85C (185F).

If your car does not have the manual radiator fan switch, it is fairly easy to install one. All cars are already wired for one. All that is needed is to install and hook up the switch.

Carburetor Cooling Blower

Custom carburetor cooling blower

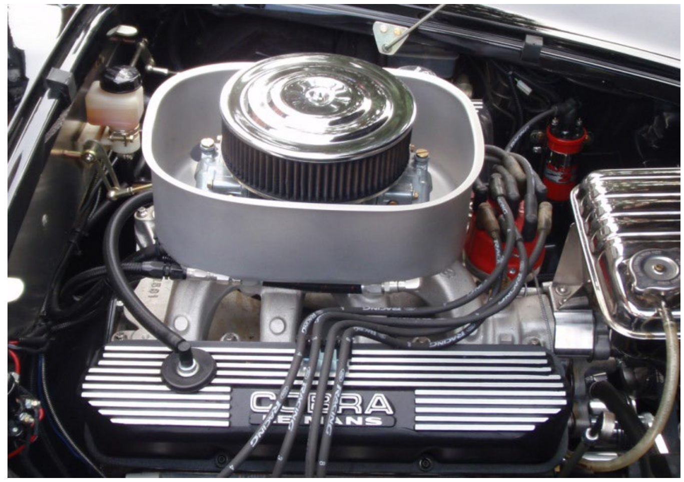
Randall Thomas SP 455 (351 CID Windsor) attached a carburetor cooling duct to the right side of his carburetor blowing cool outside air directly onto the carburetor. The air is drawn from the gills in the right fender by a switch controlled blower. Randall adds that the duct exit should also include the fuel log.

The physics are undeniable. This solution worked well for Randall at Superfest. A complete description can be found on the SCOF website Technical Library. Look under ENGINE > MECHANICAL UPGRADES > CARB COOLER

Turkey Pan

One source of cool outside air is the hood scoop. At 60 mph, the hood scoop can capture 400 cfm of outside air. At cruise, the engine is using about 20 cfm. The remaining 380 cfm can be used for carburetor cooling.

The tradition solution for providing cooler outside air to the carburetor is the "turkey pan", so named because the original was made from a turkey roasting pan. The cooler air (60F outside vs. 125F under hood for example) can be worth about 30 horsepower. Unfortunately the standard 8" Stellings & Hellings foam element air cleaner that fits in the turkey pan cost over 40 horsepower. Steve Edholm SP 2480 (427 CID Windsor) has reduced that loss to about 6 horsepower with a taller K&N felt filter element.



Steve Edholm SP 2480 - Turkey Pan

Physical Damage to Carburetor Components

The first problem is rust. The good news is that SP 218 has a factory stainless steel gas tank and plated steel gas line so rust is not a problem for these components.

The second problem is galvanic corrosion in the carburetor. The solution is periodic disassembly for inspection and correction. See the third problem solution following.

The third problem is ethanol attacking non-metallic components. Rubber and braided fuel lines do not rust, but older ones may be subject to ethanol damage. Non-metallic carburetor components are also at risk. Current versions of these components have usually been re-engineered to work with ethanol. I replaced all the rubber fuel lines with new ones. I purchased a Holley Fast Kit and rebuilt the carburetor, replacing all the non-metallic components. As a side note, the needle and seat provided in the Fast Kit were not the correct needle and seat for my carburetor. I purchased two correct needle and seat assemblies separately. You will need the part number of your carburetor to determine the correct Fast Kit and needle and seat assemblies.

Waiting for failure is a bad idea. A rebuild every five years or so is a good idea. During the rebuild, replace the non-metallic parts. Check metallic parts particularly fuel metering parts such as jets for signs of corrosion. If they are discolored, it is a sign of corrosion. Replace them. While you are at it, blow out all the fuel and air passages.

Lake Speed Jr., the fuel and oil specialist at Joe Gibbs Racing offered the following additional thoughts.

- Regular 87-octane gas will remain fresh for three to six months. Premium 93-octane gasoline will remain fresh for six months to a year.
- Gas stations with higher traffic have fresher gas which tends to contain less water.
- Higher quality gasoline contains extra detergents which are better for older cars.
- Keeping the gas tank full helps keep the gas fresh since a full tank reduces the exposure to the atmosphere.
- Ethanol-free gasoline is better for long term storage.
- Fuel stabilizers like Joe Gibbs Driven Carb Defender are designed for the unique needs of classic vehicles that spend much of their lives in storage between cruises and special events. If you use a fuel stabilizer before storage, drive the car enough to get the stabilizer into the carburetor.

The best advice – don't store your car for extended periods. Drive it regularly and keep fresh fuel in it.

Summary of Findings

Both the boiling fuel in the carburetor and the vapor lock problems are caused by the temperature of the fuel exceeding the boiling point of ethanol, 173F at sea level standard conditions.

The principal sources of fuel heating are:

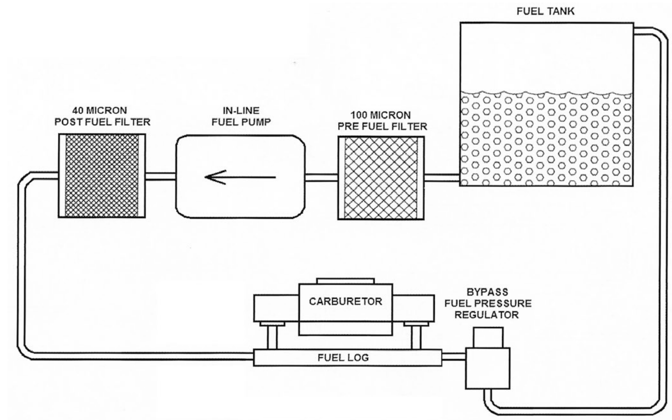
- Radiant heating from the left header heating the fuel line.
- Conduction heating from the block to the mechanical fuel pump
- Conduction heating from the intake manifold to the carburetor.

If the headers heat the fuel enough to boil the fuel in the fuel line before the mechanical fuel pump, it will cause vapor lock in the fuel pump. This can occur while driving or while hot soaking after stopping.

If the headers pre-heat the fuel enough that the additional heat in the fuel pump boils the fuel, it can cause vapor lock while hot soaking or boiling fuel in the carburetor while driving.

If the carburetor is hot enough to boil the fuel, it will cause boiling fuel in the carburetor. Pre-heating of the fuel in the fuel line and/or fuel pump can compound this situation.

The Comprehensive Solution



By looking at what others have done that works, I have envisioned a comprehensive fuel system design that works with gasohol. It will require replacing everything in my fuel system except the fuel tank. It will be an involved but interesting project and when I am done, I know it will be done right.

Our cars are very different and what works for me may not be what works for you. Even so, this is a good check list of things to consider.

Boiling Fuel in the Fuel Line

Electric Fuel Pump (Only)
Recirculating Fuel
Rerouted Fuel Line
Insulated Fuel Line

These need to be done together. The objective is (1) to move the fuel away from sources of heat and (2) to move it quickly to reduce heat gain in transit. It incorporates the same design elements that modern automobile fuel systems do to accommodate gasohol.

Mechanical fuel pumps have inherent heat issues. Recirculating fuel requires an electric fuel pump. I need to switch to an electric fuel pump only. The mechanical fuel pump will be removed and blanked off.

All electric fuel pumps should have a fuel pump shutoff switch to cut off the fuel pump in the event of an accident. One type senses a high acceleration force which is assumed to be an impact and shuts off the fuel pump. Some of these are reset by a reset button on the switch. Some are reset by cycling the ignition key. Another type senses oil pressure and shuts off the pump when a lack of oil pressure indicates that the engine is not running. Given the high acceleration forces available on a Cobra, the oil pressure type might work best.

The fuel system will include the recommended 100 micron pre-filter and the 40-micron post-filter. The fuel pump and filters will be mounted back near the fuel tank to get then out of engine compartment heat.

The bypass regulator will be mounted on the firewall away from engine heat. Installing the bypass regulator after the fuel log allows recirculating fuel to cool the fuel log and is the preferred implementation for that reason. The bypass regulator will have an attached fuel pressure gauge to adjust and monitor the fuel pressure.

The entire fuel system will be re-plumbed with -6AN braided stainless steel lines which will be routed away from significant heat sources such as the headers. The fuel line from the tank/pump/filters will be routed along the left frame rail, up over the bell housing, and connect to the fuel log. The new return line to the fuel tank will run from the other end of the fuel log to the bypass regulator and then down over the bell housing, along the right frame rail, and connect to the fuel tank vent on the right side of the fuel tank.

Status: High priority. The most important "to do".

Manual Override of Radiator Fans

This is essential to keeping under hood temperatures reasonable. The fans should be switched on as soon as the water temperature gauge reaches 85C.

Status: High priority. Completed.

Boiling Fuel in the Carburetor

Carburetor Insulation

The phenolic spacer was the single most important thing for me to do. It has done the job superbly and I will continue to use it and recommend it.

Status: High priority. Completed.

Exhaust Heat Crossover

If I had this situation, it would be high on my list. However, my Edelbrock Victor Jr heads do not have the exhaust heat crossover port.

Status: High priority. This is not an issue for Edelbrock Victor Jr. heads.

Air Gap Intake Manifold

I currently have an Edelbrock Performer RPM. The dual plane design is correct for my use. I would get a Performer RPM Air Gap if I had hood clearance, but I don't because I gave a half inch to the phenolic spacer. In reality, I really do want it, but I don't need it. The phenolic spacer is doing the job.

Status: Low priority for me. It will not fit my configuration.

Carburetor Cooling Blower

A good solution that works.

Status: I cannot use this because my very effective NASCAR air cleaner drops way down over the carburetor and is only clears the valve covers by one inch. There is no room for the plumbing.

Turkey Pan

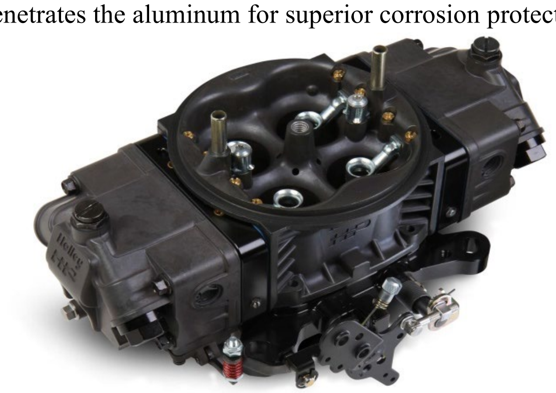
My NASCAR air cleaner will not come close to fitting in a standard turkey pan. However, gaining 30 ponies with cooler outside air is intriguing. I may look at a custom cold air feed to my current air cleaner sometime in the future. But that is another project.

Status: I cannot use a standard turkey pan so it is not on the "to do" list for this project, but a cold air intake is a potential future performance project.

Physical Damage to Carburetor

Corrosion Protection

For corrosion protection and other reasons, I am replacing my much loved Holley HP with a Holly Ultra HP Hard Core Grey. The Hard Core Gray is hard coat anodized which penetrates the aluminum for superior corrosion protection.



Holley Ultra HP Hard Core Grey

The Holley HP Ultra Hard Core Grey has had me drooling since it was announced. In addition to being gorgeous, it has several technical design features that will improve performance and drivability over my already excellent Holley HP.

Status: My head says medium priority. My heart says very high. The heart wins. This is the next "to do".

A Simple Solution

The **Comprehensive Solution** is the right way to design and implement a gasohol proof carburetor based fuel system for a new car. However, there are three simple steps for an existing car with a mechanical fuel pump.

(1) The phenolic spacer is an effective, inexpensive, and easy to install solution to prevent engine heat from boiling the fuel in the carburetor. Thousands of miles of testing have proved its effectiveness.

Summit Racing SUM-G1402 four-hole 1/2" phenolic spacer

(2) Rebuild your carburetor with new gasohol resistant components.

(3) For a mechanical fuel pump, insulate the fuel line to prevent vapor lock from the fuel boiling in the fuel line. Earl's Flame Guard Insulation is a tubular slip-on insulation available in a range of ID's (internal diameter) and lengths. Earl's Flame Guard Tape is a self-adhesive tape to finish the job.

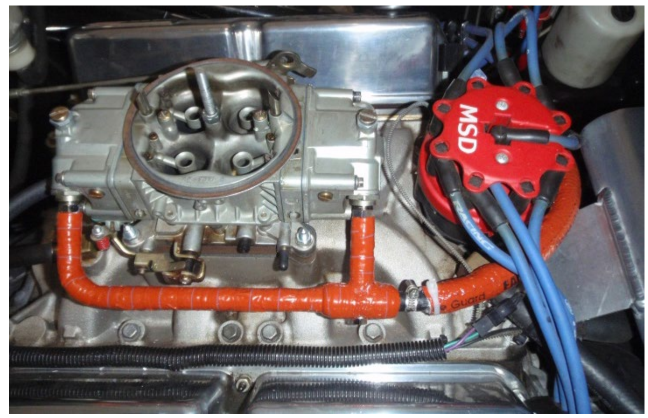
Earl's Flame Guard Insulation

Before you start, run the gas tank almost dry. Then jack up the front end to keep the gasoline from running out when you disconnect the gas line.

Insulate the 3/8" steel gas line from the fuel pump back to the transmission cross member with Earls 3/8" insulation. The gas line is attached with plastic clips pop riveted to the frame. It is not necessary to drill out the pop rivets. Simply cut the plastic clip at the base with a sharp wood chisel. Slip the insulation over the forward end of the steel line and back toward the transmission tunnel. When you get an inch from the end, cut the insulation so when you finish about 1" of the steel line is sticking out to attach the rubber hose to the fuel pump. Seal both ends with a zip tie.

Insulate the rubber fuel line from the steel line to the fuel pump and from the fuel pump to the fuel log with Earls ¾" insulation. Seal the ends with zip ties.

If you have a metal fuel log, insulate it with Earls 3/4" insulation. Slit the insulation end to end to get it around the tubing and tape it closed with Earls tape.



Insulted fuel log and fuel line

The phenolic spacer and carburetor rebuild have been extensively tested including in the high altitude mountains of Colorado and found to be effective. The fuel line insulation was added and tested recently and also found to be effective.

The best vapor lock test was found to be a long fast climb up a steep hill. The selected test area was the stretch of I-77 North as it crosses the Eastern Continental Divide near the NC-VA border. From VA Exit 1 to the Blue Ridge Parkway, the road rises 1332 feet in six miles, an average grade of 4.2%. On the upper three miles of this section the grade is 5.7%. The speed maintained was a constant 75 mph for the 5 minute run. The climbing load on the upper section added 85% to the to the horsepower requirements for 75 mph on level ground. This is sufficient load for sufficient time to have the headers get hot and heat the fuel line. The insulated fuel lines passed the test. Bye-bye Gasohol Blues!

Bill of Materials	Part No.	Qty	Cost
Phenolic spacer	SUM-G1402	1	29.95
Holley Trick Kit	Model specific	1	55.50
Holley Needle and Seat	Model specific	2	29.50
Earls 3/8 x 6 insulation	730606ERL	6 ft	41.97
Earls 3/4 x 3 insulation	730310ERL	3 ft	31.97
Earls 1 x 12 tape	731001ERL	12 ft	29.97

Testing the Simple Solution

I took SP 218 up my test hill Wednesday afternoon. The best vapor lock test was found to be a long fast climb up a steep hill. The selected test area was the stretch of I-77 North as it crosses the Eastern Continental Divide near the NC-VA border. From VA Exit 1 to the Blue Ridge Parkway, the road rises 1332 feet in six miles. On the lower three miles, the grade is 2.8%, fairly steep. On the upper three miles of this section the grade is 5.7%, close to the interstate maximum of 6% in mountains and steeper than Route 6 over Loveland Pass. The speed maintained was a constant 75 mph for the 5 minute run. Climbing the upper section took 185% of the horsepower required for 75 mph on level ground for 2.5 minutes. This is sufficient load for sufficient time to have the headers get hot and overheat the fuel line.

In testing prior to adding the insulation, fuel starvation occurred on the hill in as short as a quarter mile. Fortunately, with both electric and mechanical fuel pumps, I turned on the electric fuel pump and cleared the vapor lock in the mechanical fuel pump.

In the first test with the insulated fuel line, fuel starvation occurred at about 4 miles up the hill. A big improvement but I had a second problem. Gasohol slime was partially clogging the electric fuel pump and fuel filter. Enough fuel was getting by to cruise on level ground, but not uphill.

The electric fuel pump was rebuilt. New fuel filters before and after the electric fuel pump were installed. Subsequent tests were successful.

In the next newsletter, I will cover component selection and installation and a complete bill of materials. It may or may not be what you need or want to do. In either case it will be good food for thought.

Mike Stenhouse SP 218
Second Strike, the Superformance Owners Group
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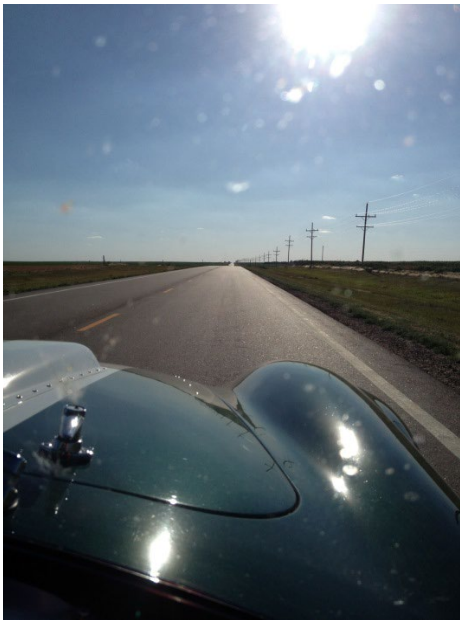
www.SecondStrike.com

Don't jump!!
OK, gasohol stalled your climb up Mount Evans.
Get a grip on gasohol, not that ledge!

Climb every mountain!! Even Pikes Peak.
Build a fuel system designed for gasohol.

Superfest 2013 Photo Gallery

Idaho Springs Roundup



Kansas Disappears Into Infinity

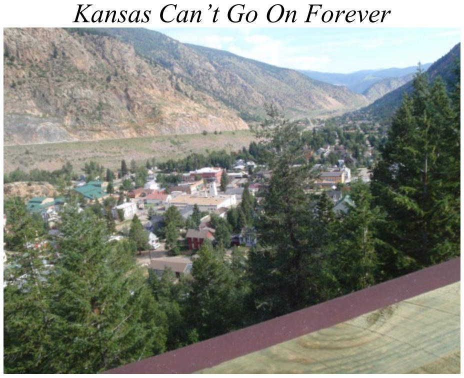
Hanging Out in Georgetown

Georgetown Loop Railroad

Just Put the Loud Petal Down Honey
Kansas Can't Go On Forever

Georgetown Mountain Inn
Home Away From Home

Made It To The Top Of Colorado



Georgetown From The Pass

Snakes On Main Street

Bob Olthoff's Willment Coupe
Shelby Museum, Boulder