

DISPELLING A MYTH:

REFUELING FIRES – GASOLINE SPILLS ON A HOT ENGINE

On the Aero750 forum it's not uncommon for someone to mention concerns about the fire danger from spilling gas on a hot engine during refueling. It's the purpose of this discussion to dispel the myth that such fires are possible.

While I hope to discuss why gas spillage on a hot, dead engine presents no danger, it is of course not a good thing to do on general principals. But it makes no sense to be overly concerned about this non-danger when you pump gas, and hopefully I can explain why.

There are several physical factors that apply here...I'll try to minimize scientific mumbo-jumbo and attempt to focus on how things apply to motorcycles.

HOT HEADER HAZARD

Let's visit the question whether gasoline will ignite when splashed on the hot exhaust header of a non-running motorcycle engine. A few definitions are necessary:

Flashpoint = Lowest temperature of a fuel at which it can form an ignitable vapor in air

Autoignition Temperature = Lowest temperature at which a fuel will burn or explode without a spark or a flame (i.e., without an ignition source)

Flammable Range = The range by volume of fuel vapor in air at which the fuel vapor can burn or explode

Heat of Vaporization = Amount of thermal energy absorbed by a liquid in changing from a liquid state to a vapor state.

A few comments about these terms are appropriate, as they apply to gasoline. To put things in perspective, I'll also contrast the properties of gasoline with those of diesel fuel. It's important to note that gasoline will not ignite in its liquid state, it will only burn in its gaseous state.

Compared to other fuels, gasoline has a low flashpoint and a high autoignition temperature. Typical gasoline flashpoints are well below minus 45 degreesC, and usually are around minus 65 degreesC, or minus 50 degreesF. By comparison, diesel has a flashpoint well above PLUS 45 degreesC. Gasoline has an autoignition temperature of about 246 degreesC, whereas diesel autoignites at only 210 degreesC. Gasoline formulations can be very important in 2-stroke engines, since high Heat of Vaporization is necessary to provide internal cooling to the engine. In a Aero 4-stroke, the more pronounced effect is that the incoming charge of fuel in air is at a cooler temperature by virtue of the high heat of vaporization, and is therefore more dense, and more weight of fuel can be jammed into the combustion chamber per charge...i.e., more 'bang for

the buck' per combustion cycle. Diesels don't enjoy this luxury, which is why so many are supercharged or turbocharged, and then usually passed through an aftercooler prior to entry into the combustion chambers. Ethanol tends to improve this situation in gasoline, but I'm starting to digress...

Another property of gasoline vapor is that its density is significantly higher than air, therefore the vapors rapidly sink in still air. The flammable range of gasoline is 1.4% to 7.6% by volume, and believe me when I say that this is a very concentrated ratio of vapor to air...i.e., it is a very "rich" mixture!

So what's all this mean as you shut off your Aero next to a gas pump, suffering from a severe case of buzz-butt from a long ride, and shaky hands from too many adult beverages the night before? If you spill gas on your hot exhaust header, the liquid gas hitting the hot surface immediately flashes into a vapor. In doing so the hot surface temperature of the header rapidly plummets, due to gasoline's high heat of vaporization. The gasoline vapors are also driven away from the hot surface at very high speed, due to the volatility of gasoline. There's also a minor effect of further reducing the fuel-air ratio due to the fact that heated air in contact with the header is rising due to convective heating, and gasoline vapors are sinking, due to their high vapor density, and this turbulence rapidly disperses the vapors in the air. The temperature of the vapor rapidly plummets below its autoignition temperature as it is driven away from the hot surface, and in such movement the relative volume of gasoline vapors compared to air shoots downward to well below 1.4%.

Now envision the same screwup if you were on your unique, highly-modified diesel-powered Aero. Spill diesel on the hot header, dude, and you are likely to have some real serious problems! If I'm making any sense here, the relatively low autoignition temperature and relatively high flashpoint of diesel puts you in far more jeopardy than would gasoline! Ya folla?

So enough of this scientific razzle-dazzle...Now let me approach this from strictly an intuitive point of view. Envision pouring a cup of motor oil in a frying pan, and placing it on an electric stove set to high heat. Wait a few minutes, and while you're watching the oil come to a rapid boil you'll see the pan suddenly engulf itself in flames. Now do the same thing with gasoline (hey, you DO understand this is a MENTAL exercise, right?) and I'd predict that all you'd see was the gasoline boiling and rapidly evaporating away until the pan was empty.

No fair mentally doing this on a gas-burner stove...the gasoline vapors would fill the pan, ooze over the edge, sink down to the burner and due to the flame on the burner POOF!, you've got a fire.

Simply put, an ignition source is required to ignite gasoline vapors, either an open flame or a spark. A hot surface won't ignite it.

The tendency of gasoline vapors to rapidly sink in air also explains why so many boats blow up at the gas dock...vapors sink down into the cabin, engine room or some other enclosed area where the concentration of gasoline vapors in air can build to above 1.4% , and if there's a spark or open flame, it's big trouble!

This same phenomenon is why most building codes require hot water heaters in garages to be mounted on a box or platform, so the burner is about 2 feet above the garage floor where explosive gasoline vapors could be accumulating.

STATIC ELECTRICITY HAZARD

The presence of a spark presents a whole new world of danger in refueling with gasoline. All comments about grounding the bike and yourself are extremely valid and highly desirable, and I can only add one additional observation. Without going into detail, the mere action of gasoline flowing out of a nozzle causes a static electricity charge to build in your tank. I suppose it would have to be a bone-chilling winter day for the air to be dry enough to let this amount of static charge constitute an explosive hazard due to a spark jumping from the filler neck of the tank to the nozzle, but why risk it? I therefore encourage you to hold the metal nozzle so it's in contact with the neck of your tank's filling tube, so no spark can jump the gap in this fuel-rich environment, and then start pumping gas.

I believe virtually all refueling fires have been proven to be from static electricity... people sliding across their car seat during or immediately after fueling, then grabbing the nozzle. And I haven't looked at the statistics in many moons, but I recall an article which found that the vast majority of such fires involved women drivers, since they went back to the car and slid across the seat to get their purse after filling up. Kinda interesting...

Well, I've droned on and on, and for that I certainly apologize. I hope these comments shed some light on this gasoline and hot header misconception, and thanks for your patience.

Ride on, and spill away in complete safety!

Doc