FUEL LINE SIZING

A question that is often asked when dealing with high horsepower applications is: "My fuel line is nominal 3/8" id. Don't I need to increase the size of the fuel line to at least ½" id (from a #6 to a #8 or #10) to support say 600 HP"?

The answer is "NO"! A 3/8"id fuel line can easily support 600 HP given sufficient "pump head"!   Given a big enough pump a 3/8" steel line could support 1000 HP.

The simple way to know is to install an electronic fuel pressure gage. If the pressure falls as the engine RPM's go up you need more pump head. More pump head can be achieved with a bigger pump, higher pump voltage and/or increasing the line size. But before you do check out the following (and remember a dirty fuel filter is often the culprit of falling fuel pressures!).

The reason most people do not understand why is because "back in the day" when carburetors ruled and everybody ran a Holly electric fuel pump running at 14 psig then into a rail mounted PRV set to 6 psig the "pump head" was insufficient to overcome the pressure drop thru the 3/8" line: particularly if the pump was at the front of the vehicle.

Let's see why today this is what I call a "wives' tale". For this example I will use gasoline. If we use alcohol we need about double the flow or with E85 we need to increase the flow numbers by around 30% .

At WOT (Wide Open Throttle) a BSFC (Brake Specific Fuel Consumption) of ½ pound of fuel per horsepower is quite safe: resulting in A/F ratios of 11:1 or richer. Remember that maximum HP occurs at an A/F ratio of 13:1. We won't go into why one chooses such rich air fuel ratios; suffice to say that using a BSFC of .5 is generous. Since gasoline has a weight of 5.994 lbs/gallon (@ a SG of .7201 typical) then in round numbers we need 1 gallon of gasoline per 12 HP (5.994/.5). The reason I am making all these conversions for you is because typical fuel pump measurements are made in volume versus mass although mass is more accurate.

OK stay with me now as we calculate how much gasoline fuel we need to support say 1000 HP. 1000 divided by 12 = 83.3 Gallons Per Hour or 315 Liters Per Hour.

Now we are going to calculate the pressure drop thru a 3/8" steel line for a typical vehicle at a flow of 83.3 gph or 1000 HP. Most of you know that the pressure drop thru a straight pipe is less than an elbow or a 45 (same principle as your air ducting from your blower thru the piping and on into the engine). Lets assume we have about 10 feet of 3/8" fuel line. Let's double that to say 20 feet to take care of the bends in the steel pipe from the gasoline tank up to the engine fuel rail. Ingersoll-Rand publishes an engineers' handbook called "Cameron

Hydraulic Data". In there they list the "Friction Of Water" thru various types of pipe. Using the pressure drop thru a new steel pipe of .364" id at 1.388 gpm (83.3 gph) we get a head loss of 35 feet per 100 feet of pipe with water as the medium. 2.31 feet of water = 1 psi therefore 35/2.31 = 15 psi per 100 feet. If I use 20 feet of steel pipe then that is 1/5 of 15 or 3 psi using water (gasoline is less viscous and flows more freely). A Fuelab Model 41401 can deliver 90 gph @ 70 psig. Can I tolerate a 3 psig drop if I need the fuel delivered at 60 psig? Yes. Will increasing the line size to ½" help? Yes the pressure drop thru a ½" line is a nominal 5 feet versus 35 feet for the 3/8" id fuel line. The ½" line will result in a ½ pound drop versus the 3 pound drop for the 3/8" line at the stated flow of 83.3 gph (enough to support 1000 HP at a BSFC of .5). The pressure drop at 1320 HP thru a 3/8" steel line might be around 5 psi.

The key to sufficient fuel supply is pumping power. As another example let's look at a flow of 1 gallon per minute at a required fuel rail pressure of 70 psig. That is enough fuel to support 720 HP. The pressure drop thru a 3/8"id line at 60 GPH is less than 1 psig! Switching to a ½" id line would result in a pressure of about 1/10 of the 3/8" line. However, given sufficient pumping power, a one (1) pound drop versus a tenth (1/10) pound drop is insignificant. At 500 HP the pressure drop is even less.

<u>VISCOSITY</u>

SG plays no role in friction loss. The key factors are viscosity and surface tension of the liquid being pumped. Gasoline has lower viscosity and much lower surface tension than water, which is why it flows more easily thru a pipe. Consider that most greases have a lower SG than water but much higher viscosity. Which do you think flows more easily thru a pipe? SG becomes a factor if there is vertical lift of the liquid involved or very long pipe runs (which represent a large physical mass of liquid.) SG simply determines the weight of the liquid per unit volume and it boils down to more weight requires more power (HP) to move it. Friction loss is the mechanical resistance exercised by the pipe wall on the liquid. Low surface tension and/or low viscosity liquids overcome that resistance more easily. Here is a litle experiment you can try. Water has relatively high surface tension. Alcohol greatly reduces that tension. Place a small drop of water on a counter top. (The counter top is analogous to the pipe wall) The water lays on the counter as a small bubble. Don't touch the water but let a very small drop of alcohol drip into the water. Watch the water immediately spread out on the counter top. The alcohol broke down the surface tension and the water molecules were free to move. If you put a drop of gasoline or alcohol (low surface tension liquids) on the counter top you see they immediately spread out. BTW, this is an area of misunderstanding with people.