Sizing Fuel Injectors According to Brake Specific Fuel Consumption

Electronic fuel injectors must satisfy two different masters. They must accurately match the fuel demands of an engine while meeting the electronic commands of the engine management computer. Obtaining the correct fuel flow from a group of injectors in an EFI system is similar to determining the right size jets for a carbureted engine. The fuel flow of both systems must be matched to the airflow requirements of the engine over a broad RPM operating range. The injectors must be able to supply a small amount of fuel to support engine idle, a large amount at wide-open throttle to prevent high rpm lean out, and transitional levels to cover all of the operating conditions in between. Forced induction engines place even more rigorous demands on an injectors range because of their increased airflow capability. Just as the wrong-sized jets in a carb can cause driveablity problems such as rough idle, surging, poor throttle response or even high-rpm lean-out resulting in scattered engine parts, so can incorrectly sized injectors. Below is a rule-of-thumb equation for estimating the required fuel flow per injector based on estimates of engine horsepower and Brake Specific Fuel Consumption (BSFC).

Injector Flow Rate (lb/hr) = (FWHP x BSFC) / (Number of Injectors x Duty Cycle)

1. FWHP must be a realistic estimate of engine flywheel output.
2. BSFC typically ranges from 0.4-0.8 for gasoline powered engines. A BSFC of 0.5 is a reasonable estimate for most naturally aspirated engines. For forced induction engines, 0.65 is a better figure.
3. It's unrealistic to establish fuel flow requirements based on a 100%injector duty cycle (wide open all the time). Although still a little on the high side, a more realistic injector duty cycle might be 90%, since racing engine management systems typically operate at 85-95% duty cycle at WOT.

Using the above formula and guidelines, we can calculate the required injector flow rate for a supercharged 450 HP engine with 8 injectors as follows:

$$\text{Injector Flow Rate (lb/hr)} = \frac{450 \times 0.65}{8 \times 0.9} = 40.63 \text{ lb/hr}$$

According to this formula, injectors with a rating of approximately 41 lb/hr static flow at 43.5 psi (3 bar) fuel pressure would be adequate injectors for this engine horsepower level and number of injectors.

Conversely, if we have a known injector fuel flow rate, we can solve the above equation for an estimate of the fuel system's horsepower capacity. For example, using 42 lb/hr injectors and the same BSFC, duty cycle, and number of injectors:

Maximum Supported FWHP = (Injector Flow Rate x Number of Injectors x Duty Cycle) / BSFC

$$\text{Maximum Supported Engine HP} = \frac{42 \times 8 \times 0.9}{0.65} = 465.23 \text{ FWHP}$$

This fuel system will support 465 flywheel horsepower.