

## Boosting Injector Flow

Increasing fuel rail pressure to get more through your standard injectors.

*By Julian Edgar*

It's a common problem. You've upped the power that your engine's producing and now you haven't got enough fuel getting to it. The pump's okay, as are the fuel lines - but those injectors are all working flat-out (ie with a duty cycle near 100 per cent) and the mixtures are still lean. Or, the ECU can't compensate enough for the changed fuel demands and the mixtures are lean, even though the injectors appear to be big enough. So whaddya do?

There are a number of approaches you can take. You can:

- Fit larger injectors - which can be very expensive;
- Add an ancillary injector - which can cause fuel distribution problems when the manifold is then required to flow an air/fuel mix, not just air;
- Or increase the fuel pressure going to the standard injectors - and yes, as with any mods, this also has some potential problems!

## AutoSpeed - Boosting Injector Flow

However, increasing the fuel pressure causes more fuel to flow through the original injectors, meaning that it's a cheap and effective approach to take. So how does this work? If at high loads the injectors are being held open all of the time (ie a duty cycle of 100 per cent), running a higher fuel pressure means that more fuel will be squeezed past the injector pintle. Or, for the same injector pulse width coming from the ECU, more fuel will flow through into the engine.

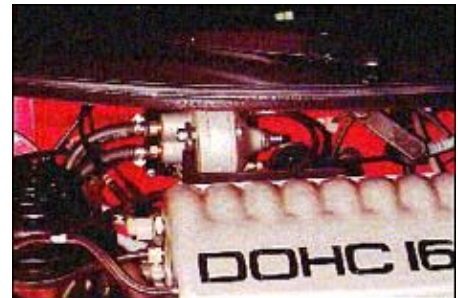
### Fuel Pressure Regulators

Increased fuel pressure can be provided in one of two ways. Firstly, a manually adjustable fuel pressure regulator can be used. This means that the fuel pressure can be wound up over standard, holding the same increased headroom pressure over intake manifold pressure all of the time.

So, what's this about 'headroom'? . In all but a few racecars, the fuel pressure is constantly varying. However, it's always kept the same amount higher than the pressure in the intake manifold. So, for example, when the intake manifold pressure is atmospheric (ie full throttle in a naturally aspirated car), the fuel pressure might be 33 psi. But when there is a vacuum occurring in the manifold (eg at light loads), the fuel pressure will actually be less than 33. That's why fuel pressure regs have a vacuum line going to the plenum chamber - so that the regulated fuel pressure can always be the same amount higher than manifold pressure.



Using a manually adjustable fuel pressure reg to lift the headroom pressure means that the injectors will flow more fuel at all engine loads (ie at all manifold vacuums and rpm). So taking this approach is ideal if you have an engine with programmable management and the injectors are just a little small for the application. Wind up the fuel pressure, re-map the engine, and everything's sweet. But if you don't have programmable management, lifting fuel pressure all of the time will mean that the engine will run very rich, everywhere except probably at full load (where the increased amount of fuel will make up for the formerly lean mixtures!).



So what if you have a turbo car or supercharged car and the lean mixtures only occur at max boost? In this case you can fit a rising rate fuel pressure reg. This type of design increases fuel pressure **disproportionately** to manifold pressure, usually only on the boost side of things. So instead of fuel pressure rising from, say, 33 to 43 psi when there's 10 psi of boost occurring, the regulator can be set to lift fuel pressure twenty psi to 53 psi. That way, more fuel flows through the injectors only when it's needed.

## Injector Flow Theory

But surely there's a catch to this? Aren't injectors designed to operate at around 36 psi? What's going to happen to the flow when you bump up the pressure? With the assistance of Adelaide company Fueltronics, AutoSpeed did some flow testing of different injectors. We varied the fuel pressure, and also changed the pulse width to see if that influenced the specific flow vs pressure behaviour.

But before we look at those results, what does the theory say? The following equation can be used to predict how much extra fuel will flow through an injector at a lifted fuel pressure.

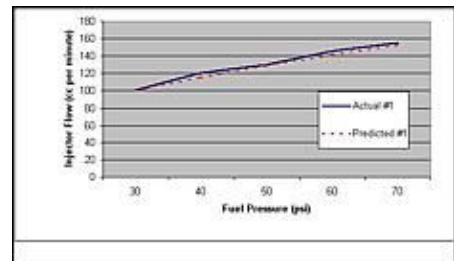
$$\sqrt{\frac{50}{30}} \times 100 = 129$$

So let's imagine that we have an injector that flows 100 ml/minute at 30 psi fuel pressure. What will the flow be, all things being equal, when the fuel pressure is lifted to 50 psi? This is found out by:

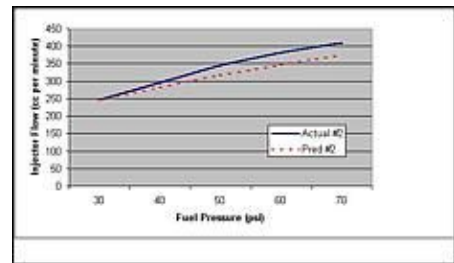
$$\sqrt{\frac{\text{New Fuel Pressure}}{\text{Old Fuel Pressure}}} \times \text{Old Fuel Flow} = \text{New Fuel Flow}$$

So, in this case, lifting fuel pressure by 67 per cent has increased fuel flow from 100 to 129 cc/min, an increase of 29 per cent. Hmmmm, but does this apply at all pulse widths, or only when the injector is being held permanently open (ie 100 per cent duty cycle)? And, can you just keep going up and up in fuel pressure, or does even a small increase in pressure cause the injector pintle to lift of its seat more slowly - or even not lift at all.....?

## Injector Flow Testing

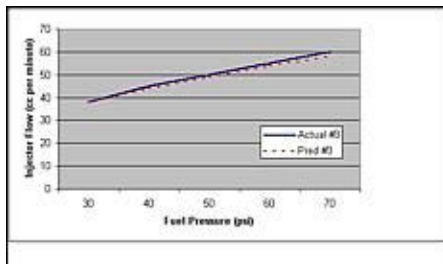


First up on the Fueltronics flow bench was a Nissan JECS A46000001 injector. Triggered with a pulse width of 11.9 milliseconds and at a frequency of 59 Hertz, its flow at 30 psi was 100 cc/min, ranging up to 155cc/min at 70 psi. As can be seen, the actual measured flow of this injector **very** closely matches the flow predicted by the equation.



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The second injector tested was a large, unknown number, Bosch unit. Having around 2.5 times the flow of the first injector, this injector was also triggered with a pulse width of 11.9ms and at 59Hz. As can be seen from the graph, this injector actually outflowed the prediction based on the equation. At 70 psi fuel rail pressure its flow was about 9 per cent higher than expected.



The third injector - a Bosch 0 280 150 024 - was triggered with a much smaller pulse width. Using a pulse width of 2ms (still at 59Hz) this injector also showed a very good correlation with the predicted flow.

In addition to the flow tests shown here, six other injectors were tested at very high pressure - 70 - 80 psi. None of these injectors stopped operating - all giving excellent spray patterns (better as the pressure increased) and in no cases locking the pintle.

## Conclusions



The equation shown above can be used to fairly safely predict the increased injector flow that's possible by increasing fuel pressure. But as with any modifications, it's best if it's done in moderation. Going ballistic with the fuel pressure will cause the pump to wear fast, and may cause the injectors to overheat if they are always working against a much higher than standard pressure. But for gains in fuel flow of 20-30 per cent, increasing injector fuel pressure is a viable and cost-effective approach.

Thanks to: [www.fueltronics.com.au](http://www.fueltronics.com.au)

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