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Getting the Most Possible Mileage Out of a Pickup

Good to the

By Gary Witzenburg

As you know, GM and Ford offer higher-efficiency models of their full-size pickups, the Silverado/Sierra and Tahoe/Yukon XFEs and the F-150 SFE. All boast EPA ratings of 15 mpg city and 21 highway (22 highway for Silverado/Sierra), about 1 mpg better in both tests than comparable models. (For 2010, models powered by the 5.3-liter V-8 with VVT, AFE, the six-speed automatic, and standard 3.08:1 rear axle, also get 15/21 mpg, partly thanks to a new fuel-saver mode.)

What's the big deal about 1 mpg? It's a bigger question when you consider that these more fuel-efficient specials do sacrifice some performance and capability. For example, the GM XFEs offer 7000-pound towing capacity and the F-150 SFEs boast 7500 pounds.

Because today's EPA ratings are fairly realistic, thanks to the recent change in how they're calculated, these trucks should be about 1 mpg better in real-world use as well. But at $2.40 a gallon at an average 18 mpg (versus 17), if you drive 12,000 miles each year, that 1-mpg difference will save $94 a year. Which raises the question: Why are these trucks just 1 mpg better? Why can't automakers improve the fuel economy by 10, or even 12?

FUEL ECONOMY 101

For starters, how much fuel any roadgoing vehicle consumes is first and foremost a function of its weight, or, in engineering speak, mass. Sir Isaac Newton's Second Law of Motion says, "F=ma" (force equals mass times acceleration). It takes X energy to accelerate Y pounds to Z mph. "When you're talking about a 5000-pound truck," says Toyota USA senior powertrain principal engineer Dan Yerace, "that's a lot of mass to move." Pile on a load of cargo, hitch up a hefty trailer, and you're looking at single-digit mileage.

Once the vehicle is up to speed, it consumes energy mostly by plowing air out of its way. Aerodynamic drag is a function of frontal area and slickness of shape—the latter expressed as "coefficient of drag," or Cd—and it increases with the square of velocity. That means a truck burns more fuel at speed than a typical car simply because it's big and blocky, and a whole bunch more at 75 mph than at 60 or 65.

Next comes powertrain, which includes engine, transmission, and drive axles. An engine's fuel efficiency derives from its complex combination of design and technology—much more than displacement, number of cylinders, or peak power capability. A large engine loafing typically does better than a smaller one overworking to move the same mass at the same speed. More transmission gears (a six-speed versus a four-speed automatic) offer better efficiency by spreading out the ratios–lower on the bottom, taller on top, more closely spaced in between—while taller (numerically lower) drive axles trade off some low-end performance for high-end efficiency. Four-wheel drive burns more fuel than 2WD, even when it's not engaged, because it adds mass and friction and consumes still more energy when it's being used.

After that come lesser contributors such as tire rolling resistance, friction (from bearings, seals, lubricants, brakes,

Last Drop

and everything else that rotates and reciprocates), and electrical loads—how much energy it takes to run the air-conditioning, the lights, even the audio system. There's another important factor: the driver. Accelerate and brake gently, keep your tires well inflated, don't carry more load than you need to, and you'll burn less fuel in whatever you drive.

SPECIAL MODELS

Compared with conventional counterparts, GM's XFE pickups reduce drag with a lowered suspension, a deeper front air dam, and a soft tonneau cover over the bed. They reduce mass with aluminum lower front control arms and 17-inch aluminum wheels, including the spare. Their 5.3-liter aluminum V-8 uses cylinder shutoff when engine load is light, driving through a six-speed automatic and a 3.08:1 rear axle (standard is 3.42:1), and roll on low-rolling-resistance tires. The Silverado XFE starts at $33,900, nearly $2900 higher than a base 2WD shortbed crew cab.

Nathan Wilmot, a performance engineer on GM's Energy Expert Team, estimates that the tonneau cover gives a 0.1- to 0.2-mpg improvement, the air dam maybe 0.05 mpg, and the slightly lowered suspension another 0.05 mpg. "A rough rule of thumb is about 0.1 mpg EPA combined improvement for each 10 'counts' [0.01 Cd] reduction on a full-size truck," he says. "There's no real gain on the city test, but you'll see more than double that in highway mpg."

Another rule of thumb, Wilmot adds, is about a 0.7-mpg (EPA combined) benefit per 500 pounds in weight savings. But since the total weight savings of the (costlier) aluminum parts on the XFE trucks is much less than that, he estimates their combined benefit at maybe 0.2 mpg. A further 0.2- to 0.3-mpg improvement, he says, comes from the low-rolling-resistance tires and another small increment from the taller axle ratio, which saves fuel mostly at highway speeds. Add those tenths up, and the total rounds off to the advertised 1.0-mpg improvement.

Ford's F-150 SFEs pack a 4.6-liter V-8 coupled to a six-speed automatic, plus a 3.15:1 rear axle and low-rolling-resistance all-season tires. They have no extra drag- or weight-reducing features but benefit from a host of aerodynamics, technology, and other improvements that came with a substantial upgrade to all F-150s for 2009. Among these are such fuel-saving features as open valve injection and deceleration fuel cutoff on 4.6- and 5.4-liter V-8s. The SFE package is a no-cost option on XLT SuperCrew trucks but adds about $1100 on the base XL SuperCrew.

Eric Kuehn, chief engineer for Ford's full-size trucks, says the F-150's new six-speed automatic contributes roughly a 0.25-mpg improvement, depending on the configuration, and a substantial 0.5-mpg gain comes from lowering engine idle speeds by about 100 rpm, which is not as simple as it sounds. "There might be 30 different engineering actions required to allow us to do that," says Vehicle Engineering manager Jeff Lewis, "everything from NVH [noise, vibration, and harshness] actions, adding dampers, and retuning things to changes in transmission pumps to revisions to the climate-control system."

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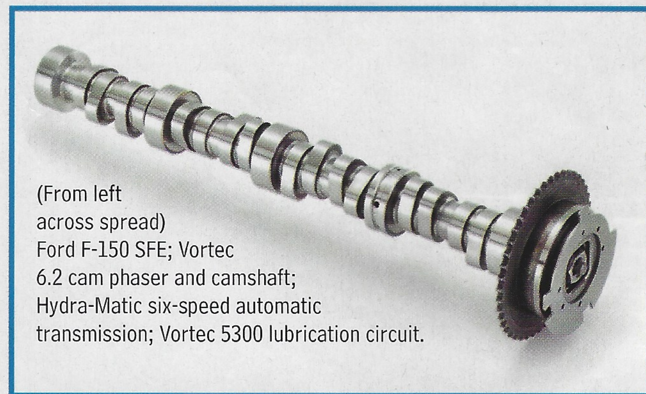


(From left across spread) Ford F-150 SFE; Vortec 6.2 cam phaser and camshaft; Hydra-Matic six-speed automatic transmission; Vortec 5300 lubrication circuit.

Lewis adds that aerodynamic improvements on the 2009 F-150s average around 15 counts, or 0.015 Cd. "That 15-count improvement gets you on the order of 0.12 mpg highway, and to get those 15 counts, we made maybe 8-10 specific actions on the vehicle. We lowered the front air dam, revised the roofline with a flush-mount center high-mounted stoplight on top, added a tailgate spoiler—which is part of the styling—made subtle changes in ride height and even did things like optimizing the front license plate bracket.

"We get fuel economy 1/100th at a time," Lewis continues. "And we work really hard, looking at all the details, to get those hundredths. Systematically, we went to high-efficiency alternators, changed pulley ratios on power steering pumps, and changed water pumps in the engine to make them more efficient. The engineering that goes into just making a water pump change—you have to take out restrictions in other parts of the engine, open up hoses, and redesign and repackage things to make sure you haven't traded something off. Those get us hundredths of a mpg. But if you get 10 of those, next thing you know, you're up to a tenth."

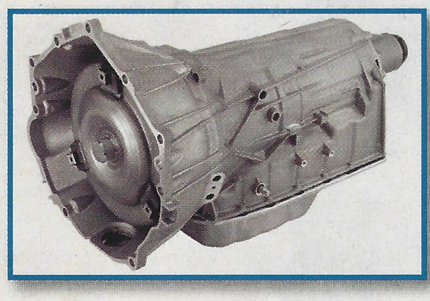
While there is no special higher-mileage model of Dodge's all-new, vastly improved 2009 Ram, Chrysler says its engineers "pulled out all the stops to offer customers significantly better fuel economy." Among many other things, they substantially reduced aerodynamic drag, went to lower-rolling resistance tires, improved the efficiency of the transmission torque converter, and added variable valve timing to the available 5.7-liter Hemi V-8 engine, which already had Chrysler's cylinder-deactivating Multi Displacement System. All this achieved an average 1-mpg improvement over 2008 models, making the new Rams roughly equal in efficiency to comparable non-XFE/SFE GM and Ford trucks.

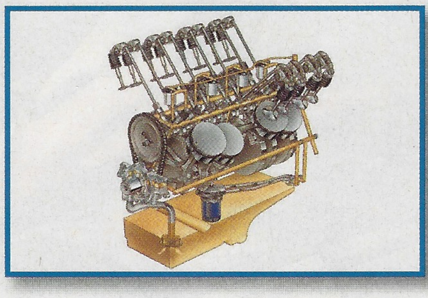
Interestingly, all three domestic makers boast "best-in-class" aero drag, probably because different body configurations tested in different wind tunnels produce results that are not directly comparable one with another. Chrysler says its Ram Crew Cab 4x4's Cd is 0.419, GM says its Silverado/Sierra XFEs tests at 0.412, and Ford says its SuperCrew 4x2 comes in at 0.403. Those numbers are all very close, and buyers should know that shorter cabs, longer boxes, add-on boxes, and even bigger mirrors will increase drag and reduce fuel economy.

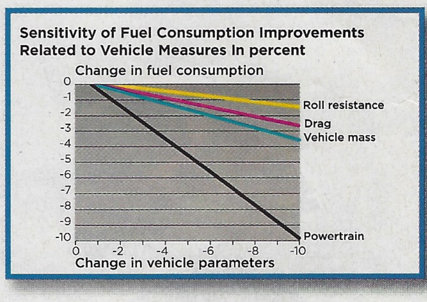
The North American market's two other full-size-truck competitors, Toyota and Nissan, have trailed the U.S. makers in this area but are working hard to compete. "We have the same options available to us as GM and Ford," says Toyota's Yerace. "One of the key things to look at is engine downspeeding. For a given speed, say 65 mph, maybe the engine is turning 2000 rpm. By changing to a lower numerical final drive, maybe now we can go down the road at 65 mph at 1800 rpm. You'll notice it more on the highway than in the city, and you will lose some passing performance and some 0-to-60."

Yerace also offers a pair of mass-versus-efficiency rules of thumb: "A 50-pound weight reduction is worth about one percent in fuel economy. Or, if you can reduce the mass by 10 percent, that's worth about a 3.5 percent improvement. But certain vehicles lend themselves better to weight reduction than others, and it gets really difficult on a truck. The reason people buy trucks is for their capabilities. The last thing you want to do is make a truck get better fuel economy but lose its ability to do the job. You'll lose a lot of customers if you do that. The real challenge is to maintain capability *and* get better fuel economy."

Shunichi Inamijima, director of powertrain engineering for Nissan North America, says Nissan's Titan pickups got a number of efficiency improvements when they were updated for 2007. Among those on the engine were continuous variable valve timing and such friction-reducing measures as piston ring coating and camshaft microfinishing, as well as some transmission tuning. He says







the addition of CVTC alone is worth about 0.3 mpg.

Mr. Inamijima also has rules of thumb: Reducing a truck's aerodynamic drag by 10 percent, he says, can improve its fuel economy by 1.5-2.0 percent, or about 0.45 mpg. Reducing its weight by 100 kilograms (220 pounds) can boost economy by about 1.5 percent, or 0.3-0.4 mpg. Reducing rolling resistance by 10 percent can get you 0.2-0.3 percent better economy. "But a 10-percent drag reduction is almost nonachievable," he adds. "That is drastically changing the style of the body. In the real world, two or three percent is really tough for us. And 100 kilograms of weight is almost a hopeless number. That is almost downsizing the truck, which is really tough. Honestly, 1 mpg is a huge number for me."

COSTS AND FUTURE IMPROVEMENTS

"Speed costs money. How fast do you want to go?" is an old auto racing saying that applies almost as well to fuel efficiency. Technology costs money. Lightweight materials are more expensive. The engineering hours required to design, develop, test, and validate even the smallest changes can add substantial cost. How efficient can we afford to be?

"There is a certain threshold that a rational customer should be willing to pay," says GM's Wilmot. "Given a vehicle's life and a dollars-per-gallon fuel cost, he should be willing to spend X amount for a technology that improves fuel economy Y mpg. We take all available initiatives, rank order them in dollars per mpg, pick the ones from which the customer will get the most value, and then apply some strategic decision-making criteria to choose which fuel economy enablers will be most cost effective and impactful."

So, beyond further incremental reductions in aerodynamic drag, mass, friction, rolling resistance, and electrical loads, what efficiency-enhancing measures will we likely see as both customer and Corporate Average Fuel Economy demands accelerate? Smaller-displacement engines, for one, probably boosted by direct gas injection and supercharging or turbocharging to maintain power and torque. We've already seen signs of this with Ford's EcoBoost engines.

For 2010, the Toyota Tundra offers a new 310-horsepower, 4.6-liter V-8 with a six-speed automatic that raises the 2WD's EPA ratings to a competitive 15 mpg city/20 highway and 4WD models to 13/18.

"We have to improve our fuel economy," says Toyota's Yerace, "and we're working on that for all our products, not just trucks. But we have to be affordable and don't want to decrease capability. A lot of technologies, such as VVT—which reduces pumping losses, especially at part throttle—are already in all our products, but we need to improve."

Nissan's Mr. Inamijima confirms that the company's variable-valve event and lift system and low-friction diamond-like-coatings technologies, already in some of its VQ-family engines, will find their way into trucks as well. But they are not inexpensive. "V-VEL is used for fuel economy and performance," he says. "But if we used it only for fuel economy, a significant improvement such as 5-10 percent might be possible." He adds that incremental improvements in calibrations can deliver tenths of mpg, "but won't help us improve fuel economy by three to five percent, which is really visible to the customer. So we will need to implement relatively expensive technologies."

All agree that substantially improving the fuel efficiency of full-size trucks with real functional needs—towing, hauling, off-roading—will be very difficult without adding significant cost and/or trading off capabilities. It will be a major challenge for the industry's tireless and talented engineers to figure out ways to retain the function we need at prices we can afford while meeting ever-increasing fuel economy requirements. **TT**