Tire over-pressure test study

Advanced Automotive Technologies Corporation

INTRODUCTION to the FUEL MILEAGE TESTING

Will pressuring tires over the maximum sidewall rated limit improve fuel mileage? Will tire wear increase? We will see...

Accurately measuring and comparing fuel mileage changes is an exercise in paying explicit attention to the details and leaving no stone unturned. Having this same truck and trailer combination for the past seven years, I have tracked and recorded every single fuel stop and driving conditions for each of those legs in great detail. This includes weather, temps, speeds, road conditions, average wind direction and wind speed, fuel brand, tire pressures, terrain type, hill severity and also traffic conditions were all logged. The actual fuel filling procedure itself is painfully long. While it takes only 10 minutes to fill the first 54 gallons, waiting for the diesel foam to settle adds an additional 15 minutes to fill the remaining 5 or 6 gallons to top off the tank each time consistently with only liquid leveled at the top. Topping off means right to the very top of the filler neck each and every time, as well as then starting the engine and running out any and all air pockets which are purged as well as using a special manual valve on the vent roll over tubes during the filling process. Even the platform at the filling station is considered and a carpenters level is used during fill-up to ensure the tank level is always consistent. This type of redundant accuracy is absolutely necessary to guarantee fuel consumption readings are accurate and repeatable to the ounce, each and every time.

Having trailered over 30,000 miles with this same exact combination, the fuel mileage trends have become very easy to see and fuel refilling ranges have become quite predictable. Any differences or changes in economy, even minor ones, are easy to identify. In addition to that an onboard data computer monitor and recorder tracks every aspect of the truck's condition and operation in real time, including fuel consumption down to the ounce... unlike the vague inaccuracy that factory "fuel mileage meters" are infamous for. We've tracked up to 2-3 mpg error if not more on the factory MPG meters. Anything that can not be trusted consistently was not used or even referenced in these tests. and finally, the pen, paper and calculator had the final say at the pump... and nothing can be more accurate than that.

In order to duplicate driving styles only one driver was used in the tests. And in addition to that, a "load meter" on the engine was utilized which visually allowed the driver to see and replicate load percentages of the engine to regulate the throttle load going up and down hills, as well as both acceleration and deceleration on flat terrain. This allowed consistent and repeatable accelerations and hill accents regardless of the varying conditions and grades. This method is so accurate I can repeat an 83 mile test loop 5 times in a row and see no more than 1/10th (**0.1**) of a MPG difference in any of the cases, based on a 10 mpg average. That's a control benchmark of 1% repeatability and accuracy! On an 8 mpg vehicle that's less that 8/100ths (**0.08**) of a mile per gallon accuracy. To double check this benchmark we tested the truck with no trailer with the towing mirrors fully extended in the towing position and instantly saw a **0.1** mpg drop in fuel mileage (17.2), and pulled them in and folded them to the doors and saw a **0.4** mpg increase over the normal position (17.7). Mission accomplished. - *So the test is on!*

Test truck and trailer used

==========

SPECIFICATIONS

==========

- **TRUCK:** 2006 Ford F-350 6.0L Diesel 4x4 Dually Crewcab Longbox 3.73 gear
- **TRAILER:** 2005 Vintage Outlaw 44' (11.5' tall) gooseneck with living quarters
- **WEIGHT:** Total loaded maximum weight averages 25,300 pounds total (w/car in trailer).
- **MODIFICATIONS:** Aero-wing on cab, air tabs on trailer, Banks 4" exhaust, AFE air cleaner, Banks Tuner / IQ monitor EgR & Cat delete, Evans coolant, Heat wrapped turbo/down pipe, Gearvendors Double Over Drive

Tire over-pressure test study

TIRE PRESSURES

==========

Based on information discussed on Kevin Rutherford's Trucking Business and Beyond™ program hosted on the Road Dog Trucking® satellite network, those discussions emphasized several advantages resulting from "over pressuring" tires. More research concluded that some tire manufacturers revealed the "maximum pressure" rating as stated on the sidewalls of modern heavy duty tires are considered to be a *toned down* safety guideline to compensate for the many cheap and inaccurate tire gauges commonly in use. And while they would not put into writing *just how much* of an accuracy cushion there was, they admitted 10-15% was more than acceptably safe in most cases for modern radial tires. After testing numerous tires of varying manufacture, the reports stated that in most cases, over pressuring tires past the maximum rating by 10-15% yielded "significant" fuel savings and decreased rolling resistance with minimal negative drawbacks in wear and/or handling in normal road driving conditions. Not knowing what "significant" meant, and after a lot of research and skepticism I decided to try it on my own test bed in which the MPG's have been virtually un-movable in it's mileage no matter what I did... either by the addition of an aero-wing, air tabs, dual overdrive, larger exhaust, air filters, driving slower and yes, even airing up to the maximum tire pressures rated on the sidewalls... but *never over* the maximum. Before this I never even considered it. And so now, I am going to see for myself.

Prior to this test, while towing I typically had the front tires aired to 65-75 psi, and the rear duals to 55-65 psi for the best ride and handling compromise. So I thought running them all up to the 80 psi sidewall stated maximum would have to most definitely help since the difference in pressures were significant. But to my surprise, the fuel mileage results were immeasurable. Meaning, if there was an increase of over a tenth or two miles per gallon, it was not seen in the normal variance of the standard averages. One would have thought the results would be more noticeable when applied to all 12 tires for the truck and trailer, but in this case, it was not. *Strike one*.

I also backed this result (or lack thereof) up by testing *without* the trailer connected, where I normally run 35psi in the rear duals and 55 psi in the front for the best ride. And then I aired them all up to the side wall rated maximum of 80 psi all around with no trailer in tow. Again, virtually no difference other than few tenths of a mile per gallon, very little, which you *certainly* would have thought there would be a notable increase with that much more pressure in all 6 tires. It was tried again and again with little or no appreciable results. Quite interesting to say the least. *Strike two.*

So when it came time to add 10-15% to the rated sidewall maximum pressures, I could not see how it would be that much different than from increasing from a relatively soft 25psi to a much harder 80psi. Regardless, I aired all 12 tires, fronts, duals and trailer tires from 80psi max to 92psi all around. Or a 15% increase. *Let the testing, begin!*

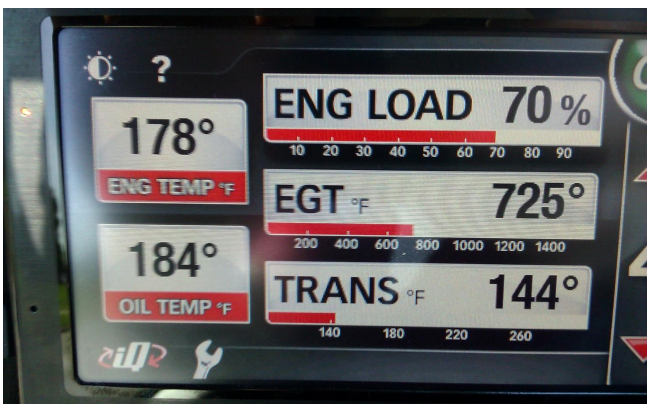
==========

PRE-TESTING OBSERVATIONS

==========

The first observation made was that the truck did not seem to ride any stiffer... and in fact, it almost seemed to ride slightly *smoother*, even though still firm. Perhaps the stiffer tires are not "rebounding" as much and making the suspension do all the control work rather than the two fighting each other. Surprisingly, the ride at 92psi was more palatable than at 80 psi... which was a nice start. The second observation was that while normal road handling did not appear any different on dry or wet roads, stopping and starting in the rain was actually improved slightly if anything. Something I also would not have predicted. Usually the lengthened contact patch of an aired down tire increases traction. Later, winter travel testing has confirmed that the over pressured tires at 92 psi also handled surprisingly well in snow, slush and ice. If not at least equal, but perhaps even slightly better than even when the tires were aired down to 25 psi rear and 55 psi front. All of this goes against conventional wisdom and theory, but you can't argue facts.

So while I could have tried really hard to get as good of fuel mileage as I possibly could by driving slower, more careful and coasting when possible during testing, instead I wanted to see if the fuel mileage would "come to me". Therefore I decided to drive as fast and as hard as I always have... 65-85 mph in 100-112 degree temperatures which would completely disregard and aerodynamic advantages of driving slower. If there was going to be a change in mileage due to the tire pressures, I'd either see it for sure, or not at all. Simple as that.



On-board operations monitor

RESULTS

==========

In the past I've driven this same 1,100 mile route from Wisconsin to Colorado nearly 40 times, 80 times counting the return trip back. So consistent speeds and up and downhill grades are approached with relative similarity and in the past 7 years of driving this particular truck and trailer I have become accustom to *exactly* where I will be required to take on a load of fuel... seeing as I ran out on several occasions trying to push it an extra 20-30 miles past that point.

Prior to this test, this exact truck and trailer combination has never been able to exceed 477 miles on a tank of fuel in similar conditions, and usually the distances on a full 63 gallon tank (59 usable) would be no less than 439 miles, and usually in the 450-460 mile range. So long before I was able to actually stop and refuel to crunch the numbers for the first stop with the over pressured tires, I knew something dramatic was happening. I passed the 477 mile standing record with over 3/8th tank to spare. That was *significant*. And then the 500 miles mark passed which was *amazing*. Then the 550 mark passed, which was *unimaginable*. And now at 600 miles and still going this was absolutely *incredible*. I kept on going until the odometer passed the 607 mile mark before finally needing to refuel. This was almost *unbelievable*. But... *could it be repeated*? And the answer was, a resounding "YES"! Below are the numbers...

Previous full-to-empty tank distance range average...

- 477 Miles *-best-* (previous all time record maximum range)
- 472 Miles
- 461 Miles
- 439 Miles *-worst-* *total average: 462.25 miles*

The NEW improved "High Tire Pressure" full-to-empty tank distances average...

- 607 Miles *-best-*
- 601 Miles
- 576 Miles
- 565 Miles *-worst-* *total average: 587.25 miles* (**125 miles & *27.2% improvement***)

fuel management monitor

All four of the new extended fuel stop mileage's were far beyond the previous all time limitation of only 477 miles. Repeatability is the proof of the results. And much of the *new* readings were in very resistive conditions with appreciable head winds. Therefore, under normal conditions it was possible even more fuel mileage could have been achieved.

==========

THE NUMBERS

==========

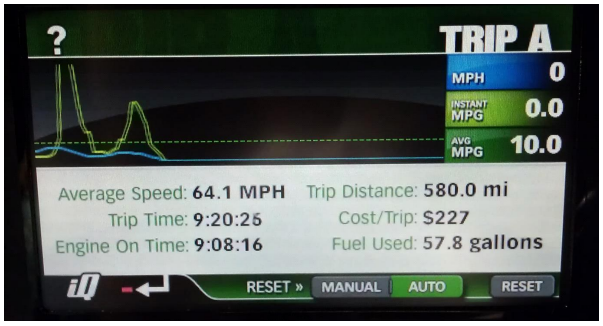
While fuel driving ranges and distances are all practical benchmarks, the real meat and potatoes comes in the accuracy of the actual fuel consumption in miles per gallon. Before this, this exact truck and trailer combination never exceeded 8.2 mpg in similar conditions *other than one* particular incident where there was nothing in the trailer (minus-3,500 pounds) and driving only 55-60 mph on flat open highway... that one single time I saw 8.9 mpg for a very short period.

Previous fuel miles per gallon trip legs are averaged below...

- 8.23 MPG *-best-*
- 8.01 MPG
- 7.76 MPG
- 7.42 MPG *-worst-* *total average: 7.855 mpg*

The NEW improved "High Tire Pressure" MPG trip legs below...

- 10.49 MPG *-best-*
- 10.19 MPG
- 9.71 MPG
- 9.56 MPG *-worst-* *total average: 9.988 mpg* (**2.1 mpg & *27.2% improvement***)



Onboard fuel tracking recorder

The difference was over 2 mpg *better* and a significant **27% improvement** in fuel economy and driving range overall***!*** As you can see, not only was the magical 9 mpg barrier achieved, but *consistent* numbers well above that number and even *over 10 mpg* were attained, and maintained. *No other* improvement yielded anything near this amount of increase, *combined*. And, it was free. I've never seen these kinds of numbers before so driving to an empty tank without taking a rest room break in between now has just become a whole new challenge in itself.

TIRE WEAR

==========

Now, you might think the tires would experience accelerated wear at the center from being over pressured. However in modern radial tire design, their job is to try to maintain a flat contact patch even when over or under pressured. While the top of the tire may appear flat or rounded, this shape is not indicative of the *surface pressure* across the tread when it contacts the ground. Visual assessments are meaningless and temperature guns remain useless in this situation. Only measuring accurate tread wear across the tread over time tells us how the tire is actually wearing.

1. **TRUCK Front tire wear** 10,000 miles (new 12 months prior)
SINGLE AXLE LT245/75-17 Rugged Trail (80psi rated max "E")
2/3 of it's life at 55psi, 1/3 at 92psi

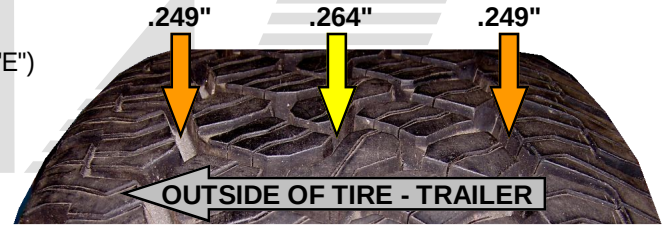
- OUTSIDE: **.405"** TREAD DEPTH
- CENTER: **.421"** TREAD DEPTH
- INSIDE: **.421"** TREAD DEPTH

2. **TRUCK Rear tire wear** 3,000 miles (new before this trip)
DUAL AXLE LT245/75-17 Rugged Trail (80psi rated max "E")
100% of it's life at 92psi

- OUTSIDE: **.437"** TREAD DEPTH
- CENTER: **.438"** TREAD DEPTH
- INSIDE: **.437"** TREAD DEPTH

3. **TRAILER tire wear** 10,000 miles (new 12 months prior)
TRIPLE AXLE ST235/80-16 Goodyear Marathon (80psi rated max "E")
2/3 of it's life at 80psi, 1/3 at 92psi

- OUTSIDE: **.249"** TREAD DEPTH
- CENTER: **.264"** TREAD DEPTH
- INSIDE: **.249"** TREAD DEPTH



The above shows the center tread *did not* increase wear, but generally the center had *slightly more* tread than the outside edges... most likely due to the shoulders wearing more when turning, so it balances the wear nicely. The front tires indicate they may have had more toe-in than necessary by the outside edge wearing more. Even after a year of continued driving at these elevated pressures and 14,000 miles later, wear across the tread is still exceptionally even.

You can't find many situations in the real world to really push a tire to it's physical limits more than over pressuring it by 15%, then running it at 75-85 mph across the desert plains at 100-113 degrees outside temperatures for 25 hours at a time non-stop other than a fuel stop every 8-10 hours as we did. That's about as tough as it gets other than racing.

Performance in heavy rain was uncompromised in this case, and in fact while there was not a notable difference in handling in the rain, braking and acceleration was somewhat improved. Normally the rear tires would "skip" under hard acceleration from a dead stop with the trailer on in the rain, or the front tires would slip slightly under hard instant braking in the 30-40 mph range in the rain. Both of these situations were improved as compared to the "lower" and "normal" pressures previously used.

One of the many fuel mileage tests in the American West

POST-TESTING OBSERVATIONS

==========

It was evident that the higher starting tire pressures tended to exhibit *very minimal* pressure increases during long distance, high speed and hot weather operation than lower pressured tires. The result was the higher pressures stayed more consistent, within **2-5%** in most cases we've tested. Lower starting tire pressures created more heat from the tire transitioning from a round to flat shape as it conforms to the road surface, sometimes as many times as 10 times a second, or 38,000 times an hour. This additional heat can arbitrarily raise tire pressures inconsistently as much as **10-20%**. But this increase in pressure will not make the tire "rounder" because it is a now much hotter and softer. *Note: The extra pressure and heat come from the resistance of the low pressure. If the elevated pressures due to the heat were to reduce resistance, the tire would cool down, drop pressure, and begin to make more resistance and then heat up again.*

This specific test of over pressuring tires was also tried on other tire types and on other vehicles and combinations ranging from SUVs to Sports Cars. After a series of data was collected, it was apparent that the **type of tire** construction **is the key factor** in the end results. It was evident that *stiffer sidewall* constructed tires were able to better contain the additional air pressure more efficiently and therefore used that additional pressure make the tire "rounder" under load. This decreases rolling resistance and increases fuel economy. On the other hand it was apparent that *softer sidewall* constructed tires allowed the additional air pressure to force the sidewalls out further instead of making the tire rounder. In many cases these tires allowed little or no improvement in economy, even when temporarily over pressuring those particular tires 20-25% above the sidewall rated maximum. And note that even though you may have several tires with identical load *ratings*, that does not necessarily reflect the *actual sidewall stiffness*, and among identically rated tires you may find a wide range of sidewall stiffnesses, and consequently, a wide range of varying results in over pressuring them. *As a perfect example, the tires we happened to use in our test, while carrying the common "E" rating, the sidewalls of this particular tire significantly stiffer than other "E" rated tires, requiring notably more time and effort to mount them on rims.*

==========

LONG TERM FOLLOW UP REPORT

==========

After this test was performed, this combination was closely watched for over a year of travel. Within that year the 10mpg plus number was *easy* to achieve and maintain while touring all areas of the country. In 30 fill-ups and over 6,000 towing miles, mileage never dipped below 9.6 mpg and many times exceeded 10.6 mpg in every trip. As long as these pressures were maintained, the mileage improvements were guaranteed. As a final baseline check, we aired the tires back down to our normal previous operating pressures, and our miles per gallons & distances dropped along with it.

FINAL NOTE: When increasing tire pressures, ensure tires are in good condition, no weather cracks, cuts or repairs. Use high quality, tested accurate tire gauges. **Caution:** Bias ply tires will not respond or react the same as radials.

If you are interested in an SAE fuel mileage article I wrote for Four Wheeler Magazine a while back, many principles are current today on both your daily driver, truck, or SUV. **http://performanceunlimited.com/projectmpg/results.html**

Author;

Randall j. Thomas

Advanced Automotive Technologies Corporation
www.performanceunlimited.com
766 Grand Avenue
Hartford, WI 53027
262-673-4077

Test truck and trailer next to an average truck and 24' trailer