Maintenance for increased and maintainable fuel efficiency!

Physics and Human Affairs
EAST/EMPACTS Project

Austin Stevens, John Miller, Flor Gonzalez, Henry Barrara, Levi Stell, Ethan Charles, Brant Chenoweth

Melody Thomas, Instructor
Group Members

- Austin Stevens
- John Miller
- Flor Gonzalez
- Henry Barrara
- Levi Stell
- Ethan Charles
- Brant Chenoweth
Project Purpose

- Our group's purpose with this EAST project was to provide information as to how drivers can increase their fuel efficiency through simple maintenance practices. As well as to examine various physics connected concepts at the fundamental core of these actions. By doing so we hoped to increase drivers’ knowledge about their vehicle and to provide steps they can take to keep them running efficiently. Such steps can save the amount of fuel burned, saving money and producing less negative impact on our planet. Hopefully everyone can utilize the information presented today!
There are many variables that can affect your vehicle's fuel efficiency; here are some of the main ones that we will cover in our presentation that are easily performed at home with little prior knowledge or experience:

- Tire pressure & air vs. nitrogen
- Air filter
- Oil & oil filter
- Spark plugs
Tire pressure and substance

- Under-inflated tires require more energy to roll which in turn translates to a greater power output required by your engine which leads to more stops at the gas station.

- On your actual tires there will be a maximum PSI (pounds per square inch) listed however it is a common misconception this is the proper inflation level. However you can find the proper inflation levels for your vehicle they will usually be listed by the manufacturer either in the owners manual or on a sticker on the door jam on the driver side.
According to fueleconomy.gov you can improve your gas mileage by up to 3.3 percent by keeping your tires inflated to the proper pressure. Under-inflated tires can lower gas mileage by 0.3 percent for every 1 psi drop in pressure of all four tires. Properly inflated tires are safer and last longer.
Tire pressure and substance

- Aside from keeping your tire pressure at proper levels the actual substance you use to fill them can have an impact on your fuel efficiency as well as on the longevity of your tires utility.
- Inflating your tires with nitrogen (NO₂) can have positive benefits for your fuel economy and tires for several reasons. It has been utilized in professional racecar circuits, airplanes, and even NASA space shuttles for decades as a solution to high performance demands that air cannot provide as an inflator.
  - Nitrogen is slightly more expensive than air (usually free) costing anywhere from $3-10 per tire however it lasts longer per fill up and has many benefits for your tires.
  - It's lighter and “fluffier” for better gas mileage
  - Increases the life of your tire by up to 30%
  - Nitrogen leaks slower than oxygen which is important because the rubber that makes up your tires is not entirely impermeable.
  - Nitrogen also maintains better pressure than oxygen when heated or cooled.
  - Available at your local Sam's Club automotive center and many tire centers in your area.
Air Filter

- Engines require air for the purpose of mixing with the fuel to form a combustible vapor that is required to fire the pistons that turn the crank that powers your vehicle.
- All air that is taken into your engine first goes through your engine's air filter, so it is important to keep this changed regularly according to your vehicle's maintenance schedule.
- City driving usually calls for a change of the air filter around every 15-20,000 miles however rural settings with lots of gravel roads and dust can call for a change to take place more often.
Air Filter

- To find out what kind of filter you need just consult your owner's manual or almost any local automotive part supplier in your area.

- While they differ on all makes and models changing an air filter is generally a very simple process taking less than 15 minutes.

- Just pop your hood, they are generally encased in a plastic box on top of or to the side of your engine. Take the top off of the box and remove the old one which are usually made of a papery substance in bright colors such as white, yellow, red, or orange. Install the new one and ensure the fit is tight. Securely replace the lid and your done!
Spark Plugs

- Spark plugs are a vital part of your engine’s combustion process. They produce the spark of electricity that ignites the air/fuel mixture within your cylinders to power your vehicle. At their peak levels, spark plugs produce enough electrical power to efficiently burn the contents of your engine’s cylinders. However, several things happen over time that reduce the efficiency of your spark plugs and your fuel mileage as well. Replacing worn or broken spark plugs can increase fuel economy by up to a few miles per gallon. Saving you gas and money!
Spark Plugs

- Some newer model cars have plugs designed to last up to 100,000 miles however many older cars do not last as long and require changing about every 30,000 miles as a general rule.
- Always follow your manufacturer recommended guidelines when purchasing new plugs to ensure your safety and the well-being of both your bank account and engine.
- Changing your plugs yourself can be a bit more of a challenge for the inexperienced or if you do not already have the proper tools to do so. However, a do-it-yourself job can save you up to 50% of the cost of having it done professionally.
- To do so you generally remove the spark plug cover first. Then, using a wrench, unscrew the old ones and replace with the new, then return the cover. However details vary from make and model.
Oil is the blood of the automobile engine and has been since its incarnation more than 100 years ago.

An extremely thin layer of oil that rides in-between the moving parts of an engine is the only thing keeping heat generated from friction from reeking havoc on the internal parts of your motor.

If oil is the blood of an engine the oil filter would be the liver. Its purpose is to filter any particles out of the oil as it is used in the engine and to retain these particles within the filter media.
Oil & Oil Filter

- As oil is used, the oil as well as synthetic additives within begin to undergo thermal and mechanical degradation. Eventually the oil will begin to burn off reducing in amount at which point it becomes rapidly ineffective at reducing wear on moving parts.

- That is why it is very important to keep your engine happy and healthy with a regular oil change. A good rule of thumb is to change your oil and filter every 3,000 miles.

- If you do not change it often enough eventually your car will lose power from inefficient transfer of energy due to excess friction.

- This will in turn reduce your vehicles fuel efficiency.
To change your oil consult your vehicles owner manual to find what type of oil and oil filter your engine uses. As well as the amount of oil you will need when performing a standard oil and filter change. It is best to begin this process after you have driven some as the oil will be warm.

You will have to locate the oil cap under the hood as well as the oil filter. Then locate the oil pan and drain nut beneath your car.

Put your car up on a ramp or crawl beneath it removing the nut and draining the oil into a pan. Once drained replace the nut.

Remove the filter, some can be removed by hand others require a special tool. Once removed, take the new filter from the box and wipe a bit of the old oil around the rubber gasket on the new filter to ensure a snug fit and seal. Replace and screw on tightly.

Then fill your car with the proper amount and type of new oil. Replace cap and you are good to go for another 3,000 miles.
Theory: Relation and Explanation

- Conservation of Energy states that energy cannot be created or destroyed, so in an engine all of the energy put into it must go somewhere.

- The second part of the Second law of Thermodynamics states that it is impossible to create a 100% efficient heat engine.
Theory: Relation and Explanation

- To obtain the actual efficiency of a heat engine, use the equation \( \text{EFF} = \frac{(Q_{\text{in}} - Q_{\text{out}})}{Q_{\text{in}}} \)

- In a typical heat engine, about 25% of energy put into the engine is actually turned into useful work.

- Experiments show that upon combustion, 1 liter of gasoline releases about \( 32 \times 10^6 \) J of energy. A car going 80 km/hr will use 70 kw of energy during that hour. Typical gasoline consumption is 10 km/liter so a car traveling 80 km/hr would use 8 liters of gasoline in that hour. \( 8 \times 32 \times 10^6 = 2.6 \times 10^8 \) J. There are 3600 seconds in a day so... \( 2.6 \times 10^8 \, \text{J}/3600\,\text{s} = 70,000 \, \text{J/s} \) or 70,000 watts. = 70 kw.
Theory: Relation and Explanation
Field Work & Data

- Two members of the group performed some of the maintenance tips that were outlined in our presentation.
- In both field tests results concluded that gas mileage increased after maintenance.
Field Work & Data

- Austin’s Ride: 1998 Oldsmobile Intrigue with a V-6 3.8l
- Maintenance: Replaced spark plugs, changed oil, and added fuel injector cleaner to the gas tank.
- Materials: Bosch Platinum +2 spark plugs, Bosch Platinum wiring kit, Castrol high mileage oil, and STP fuel injector cleaner.
- Results:
  - Miles/Tank pre-maintenance -199.3 miles
  - Miles/Tank post maintenance – 214.8 miles first post maintenance tank and 221.2 miles second post maintenance tank
  - That’s an increased efficiency of almost 11% by the second post maintenance fill up.
Field Work & Data

- Maintenance: Oil change, oil filter replacement, tire inflation.
- Materials: Castrol high mileage oil, Fram 3593a oil filter, compressed air for tires.
- Results:
  - Miles/Tank pre maintenance-243.9
  - Miles/Tank post maintenance- First tank 259.8, Second tank 286.3
  - That is an increase in efficiency of almost 17% after the second fill up
Maintenance Video!
Technology utilized

- Mac book
- Microsoft Office 2008: Power Point
- Video Recording Device.
- World Wide Web
- Microsoft Movie Maker
- 2000 Honda Passport
- 1998 Oldsmobile Intrigue
Conclusion

- By utilizing this information you can save yourself money and time spent on fuel and at automotive service centers. As well as helping to conserve our planets non renewable resources and reduce emissions that are harmful to our natural environment. We hope this has been of interest and that you may leave with a better understanding of key variables surrounding your vehicles fuel efficiency rate.