Gasoline and its Use in Internal Combustion engines

The topic for my senior project is gasoline, and its function as an energy source for an internal combustion engine. Because my chosen career path is to become an automotive technician, I feel researching this topic will help me enhance my understanding of the automotive fuel system and why different grades and octanes' of gasoline have different effects in the combustion chambers. Also, researching how gasoline is refined and its effects on the environment as a burned fossil fuel will help me understand why other alternative fuel sources are now entering the market place and how these new fuels and fuel delivery systems may impact me as an automotive technician in the future.

Gasoline may not seem like an exciting or important topic to do as a senior project. However, because of the importance of gasoline to our economic security — in fact to our very way of life in America — I believe gasoline is as significant as any topic to be discussed.

Gasoline is made from petroleum. Petroleum is also called crude oil and is taken directly from the ground. Crews drill holes into the earth, called wells that can be thousands of feet deep. Once an oil deposit has been reached it is then pumped from the well and sent to a refinery to be converted into useable products.

REFINING PROCESS

The first step in the reefing process is called distillation. During distillation crude oil is broken down into different parts of fractions (LPG, gasoline, kerosene, fuel oil and lubricating oils. A little known fact is, in the middle to late 1800’s, millions of gallons of gasoline were simple thrown away. During the refining process gasoline (which was too flammable for any useful application of the day) was a by-produce of widely used kerosene and was of no practical use before being used as a fuel source for internal combustion engine.

Antioxidants improve the operating characteristics of gasoline. This ensures every drop of gas burns at the same rate by atomizing (mixing) every possible molecule of gasoline with every available molecule of oxygen to produce the most volatile air/fuel mixture possible. Anti-knock additives slow down the rate gasoline burns (but not the volatility). This helps prevent engine ping and knock. Pink and/or knock are also called post and pre-ignition.

It is very important to remember that the air-fuel mixture burns violently and does not explode in the combustion chamber. Combustion is the power source that generates pressure on the pistons and the downward moment of the pistons rotate the crankshaft producing the energy to help make a vehicle move.

AIR/FUEL MIXTURE

The air-fuel ratio refers to the proportion of air and fuel present during combustion. The chemically optimal point at which this happens is the stoichiometric ratio where all the fuel and all the oxygen content in the air of the combustion chamber are in perfectly balance with each other during combustion.

For gasoline fuel, the stoichiometric air/fuel mixture is approximately 14.7 times the mass of air to fuel. This is the mixture that modern engine management systems employing fuel injection attempt to achieve in light load cruise situations. Any mixture less than 14.7 to 1 is considered to be a rich mixture, any more than 14.7 to 1 is a lean mixture.

Most fuels consist of a combination of heptanes, and other additives including detergents, and possibly oxygenators such as MTBE (Methyl tert-butyl ether) or ethanol/methanol. These compounds all alter the stoichiometric ratio. Vehicles using an oxygen sensor(s) or other feedback-loop to control fuel to air ratios (usually by controlling fuel volume) will usually compensate automatically for this change in the fuel's stoichiometric rate by measuring the exhaust gas composition.

FUEL SYSTEM MONITORING

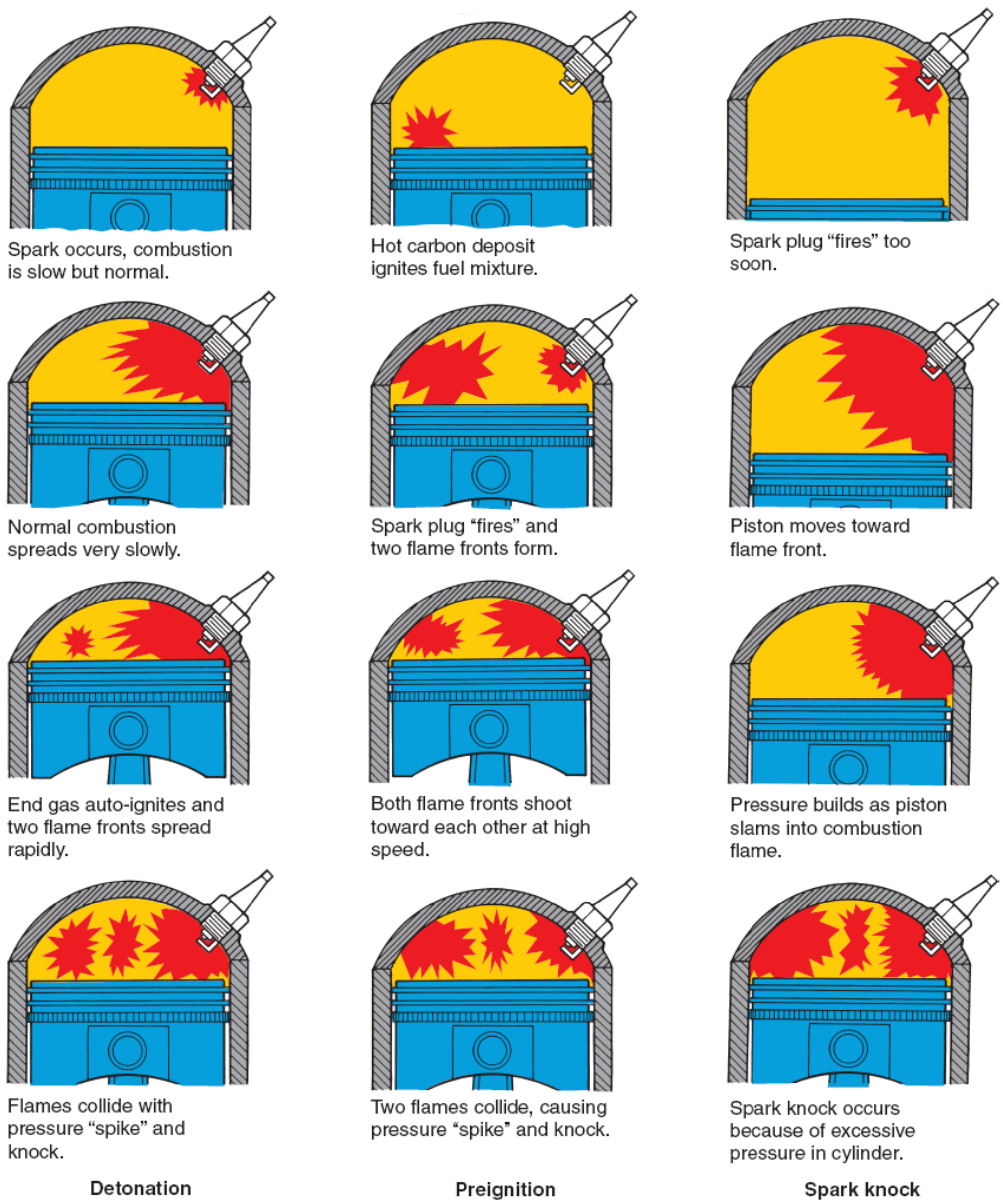
The fuel monitoring system pinpoints more specific problems during the combustion process. Today, high sophisticated sensors closely monitor different values and compared then against each other, plus the parameters built into a vehicles on-board computer system. Output actuators and injectors are closely monitored for proper operation. Vehicles using oxygen sensors enable the air-fuel ratio to be monitored by means of an air fuel ratio meter.

If the oxygen (O2) sensor signals poor fuel mixture, the engine control module (ECM) will temporarily adjust injector pulse width to correct mixture (short term fuel trim), or if necessary, permanently adjust injector pulse width (long term fuel trim). If the ECM cannot bring the air/fuel mixture into proper readings, it turn on malfunction indicator lamp MIL and set diagnostic trouble code(S) DTC if allowable parameters are not met.

POST AND PRE-IGNITION

Post and pre-ignition cause an abnormal rattling noise from inside the engine cause by rapid combustion. Before 1975 lead was added to gasoline to help reduce engine ping and knock and to help lubricate moving engine and fuel system parts. However, lead is a major source of the air pollution produced by automobiles. Today, leaded gasoline is no longer produced for passenger vehicles. A key change brought about by removing lead from gasoline was that engine valve seats, valve guides and the engine valves themselves needed to be redesigned and built from different materials.

Abnormal Combustion



OCTANE RATINGS

The only major difference between the two grades is the higher anti-knock quality (octane) of premium. This rating has nothing to do with fuel economy, engine drivability or engine efficiency. Buying gasoline that has a higher octane rating than your car needs provides absolutely no benefits. Higher octane does not produce more power, or performance, contrary to advertising claims. Most of today's vehicles are designed to use 87-octane unleaded regular. Premium fuel is not a better grade of fuel. Nor does it contain more additives or detergents than regular gasoline. According to “Automotive Handbook,” the properties in gasoline that might leave deposits that could affect valves are the same in type and quantity for both regular and premium grades of gasoline.

VOLATILITY

Another issue concerning gasoline and octane is its volatility. Volatility is gasoline’s ability to change from a liquid to a vapor. Higher-octane (premium) gasoline burns slower than regular. This can result in poor cold weather starting and rough idle until the engine has been running for a few minutes. Also, since higher-octane gasoline doesn’t burn as quickly as regular, carbon deposits can be left behind in the combustion chamber. Carbon is a result of incomplete combustion and can clog a fuel injector opening. This can ultimately result in an engine miss fire and poor drivability. In addition, on a cold morning carbon residue can absorb gasoline in its both liquid and vapor states. With out the correct amount of gasoline vapor in the combustion chamber an engine will crank over for a longer period until the engine starts. In rare cases a large amount of carbon in the combustion chamber can keep an engine from starting at all.

FUEL SUPPLY SYSTEM COMPONENTS

The basic parts of a fuel supply system include the fuel tank which stores gasoline, diesel fuel, or alternate fuel. The fuel lines carry fuel between the tank and the fuel metering system. The fuel pump draws fuel from the tank and pumps it to the fuel metering system and fuel filters remove contaminants remaining in the fuel after the refining process, or somehow entering the fuel system during transportation or storage.

ALTERNATE FUELS

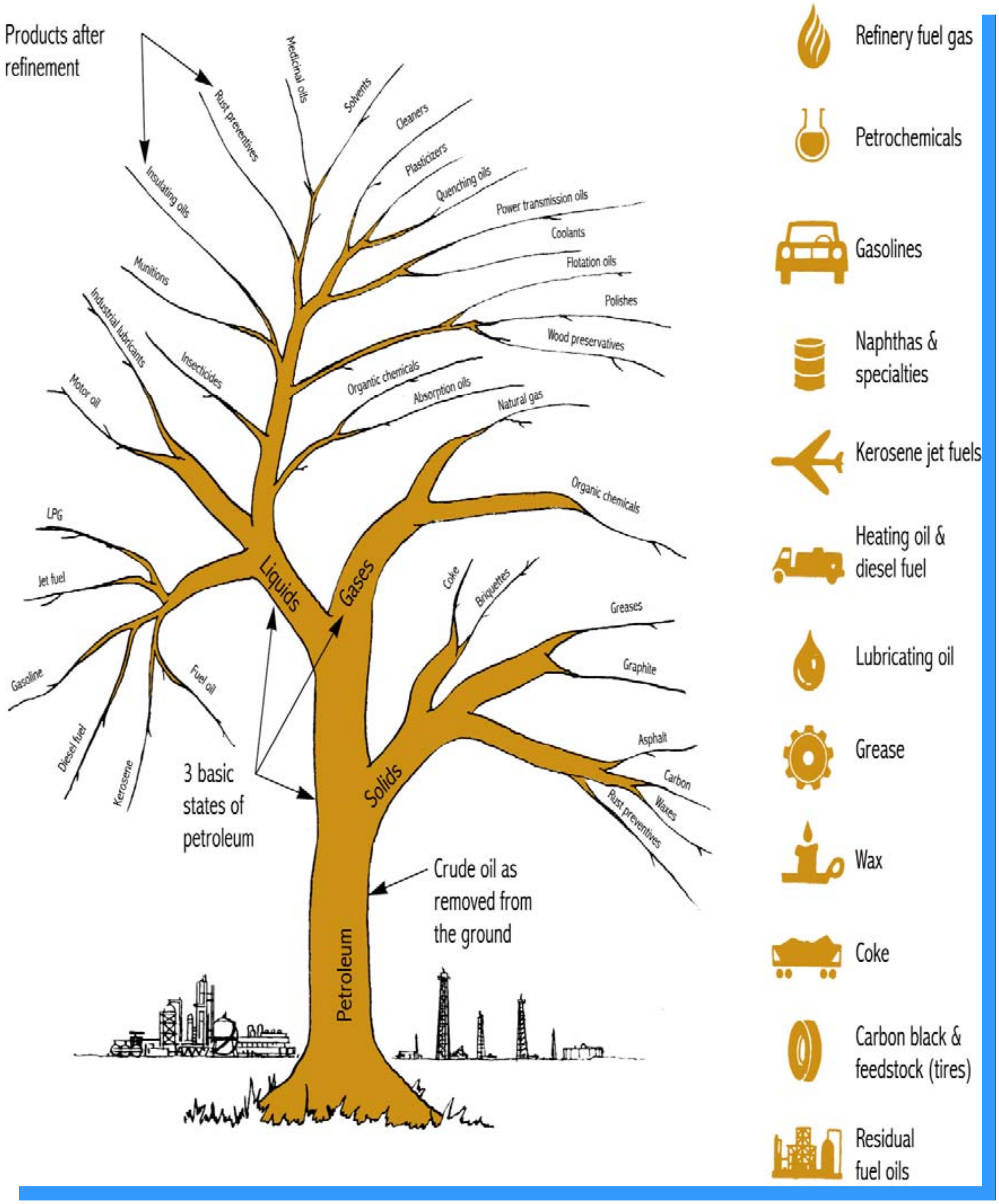
Some of the alternate fuels being tested for future use in automobiles are LPG, alcohol (methyl, or methanol) gasohol, synthetic fuels and hydrogen. LPG is seen as an interim fuel source. One of the lightest fractions of cruse oil, LPG burns very similar to gasoline, but burns cleaner than gasoline. This results in much lower tailpipe emission.

However, LPG needs a special fuel delivery system to meter LPG into the combustion chamber. Although widely used through our industry in forklift trucks, this type fuel system is very expensive to convert today’s internal combustion engines to use this fuel. Alcohol is an excellent alternative fuel source. Made from grains, wheat, sugar, potatoes, fruit and many other natural renewable sources, alcohol is a clean burning fuel for automobiles. However, it is very expensive to produce alcohol for use in an internal combustion engine, an engine would need to be modified to burn alcohol and it takes nearly twice the amount of alcohol must be burned in comparison to gasoline; reducing fuel economy by 50%.

Synthetic fuels are made from coal, shale and tar. Since all are petroleum-based products, they have the potential to replace fossil fuels as the main energy source for automobiles. Although it is more expensive to produce gasoline from these natural products, as crude oil fuels become more difficult to obtain due to world economic conditions, gasoline made from these products will surely become more practical.

Hydrogen is a highly flammable gas that is another promising alternative fuel. Hydrogen however will power electrically powered cars, not vehicles with internal combustion engines. Hydrogen fuel cells not only produce electricity, the “exhaust” or by-product of hydrogen combustion is drinkable water and harmless carbon dioxide. Today hydrogen is too expensive to produce and store. Moreover, the batteries and electric motors needed to propel a vehicle comparable today’s automobiles are very expensive to produce and not perfected. It is believed by most automotive engineers that one-day hydrogen will be the main automobile fuel.

In conclusion, during my research I discovered the simple task of starting a car that we take for granted is an integrate series of highly complex events that must take place in the proper order at just the right times under any conditions. Even then, there are other factors such as cold temperatures, the wrong grade fuel or a dirty fuel injector that can keep a car from starting and running properly. I have a greater understanding of how the fuel system works and what makes the gasoline we use so important to our driving. I also have a much great understanding of what gasoline is made from and what alternative fuels we might to use in the future.


Products after refinement
Medicinal oils
Rust preventives
Solvents
Cleaners
Plasticizers
Quenching oils
Insulating oils
Power transmission oils
Coolants
Flotation oils
Munitions
Polishes
Industrial lubricants
Wood preservatives
Insecticides
Organtic chemicals
Absorption oils
Motor oil
Natural gas
Organic chemicals
LPG
Jet fuel
Liquids
Gases
Coke
Briquettes
Greases
Gasoline
Fuel oil
Graphite
Diesel fuel
Kerosene
3 basic states of petroleum
Solids
Asphalt
Carbon
Waxes
Rust preventives
Crude oil as removed from the ground
Petroleum
Refinery fuel gas
Petrochemicals
Gasolines
Naphthas & specialties
Kerosene jet fuels
Heating oil & diesel fuel
Lubricating oil
Grease
Wax
Coke
Carbon black & feedstock (tires)
Residual fuel oils