Gasoline Composition

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Gasoline is a mixture of many different hydrocarbon compounds. But not just any hydrocarbons will do. The specification requirements, especially for antiknock and volatility, impose rather severe limitations on the compounds that can be used in gasoline.

COMPOSITION

Carbon Number Distribution First, the distillation and vapor pressure requirements limit the boiling points and, therefore, the molecular weights or carbon numbers of the hydrocarbons. The carbon numbers range from about four (butane) to ten, with the most prevalent carbon number being eight.

Classes of Hydrocarbons Second, other requirements limit the hydrocarbons predominantly to the isoparaffinic and aromatic classes. For hydrocarbons in the avgas carbon number range, it shows the potential contribution of each class to three important avgas performance properties. Because the properties of isoparaffins correspond well to the three chosen avgas properties, isoparaffins are very beneficial. Aromatics are beneficial for antiknock properties but detrimental for low-temperature fluidity. Naphthenes, in general, are neutral to detrimental. Normal paraffins, except for butane, are very detrimental.

PROPERTY/COMPOSITIONRELATIONSHIPS

For mixtures, the values of some properties are weighted averages of the property's values for all the individual components. Properties that obey this relationship are called *bulk* properties. Density is a bulk property; to a first approximation, the density of a mixture is the volume average of the densities of all the components. This is a very good approximation when all the components of a mixture are chemically similar, e.g., a mixture of hydrocarbons. It is not as good when some of the components are chemically very different from the rest, e.g., a mixture of alcohols and hydrocarbons. The values of other properties are determined by components present in small or trace amounts, typically less than 1000 ppm, and often less than 100 ppm, and are not reflective of the bulk composition of the mixture. The trace components may be present in the hydrocarbon base fuel as manufactured or come from another source, such as additives or contaminants.

ADDITIVES

Additives are hydrocarbon-soluble chemicals added to a product in small amounts to enhance or maintain properties of fuel performance or fuel handling. Typically, additives are derived from petroleum based raw materials and their function and chemistry are highly specialized. They produce the desired effect at the parts per million (ppm) concentration range. (One ppm is 0.0001 mass percent.)

Only additives specifically approved by the specification may be used in race gasoline. The approved additives are identified by their chemical formulas. For the leaded grades of gasoline, tetraethyl lead additive and the identifying dye are mandatory; antioxidant, anti-icing, and electrical-conductivity additives are optional.

Antiknock Additive

The most important racing gasoline additive is **tetraethyl lead**. It is added as part of a mixture that also contains ethylene dibromide and dye**. Ethylene dibromide** acts as a scavenger for lead. When race gas is burned in an engine, the lead in tetraethyl lead is converted to lead oxide. Without a scavenger, lead oxide deposits would quickly collect on the valves and spark plugs. If the deposits become thick enough, they can damage the engine. Ethylene dibromide reacts with the lead oxide as it forms and converts it to a mixture of lead bromide and lead oxybromides. Because these compounds are volatile, they are exhausted from the engine along with the rest of the combustion products. Just enough ethylene dibromide is added to react with all of the lead. However, because the reaction does not quite go to completion, a small amount of lead oxide deposit is found in the cylinders of piston engines.

Icing Inhibitor

Icing inhibitors are used to prevent the formation of ice in the fuel system. Either of two additives is allowed, **isopropanol** or **di-ethylene glycol monomethyl ether (di-EGME)**. Generally, icing inhibitors are not added to race gas when it is manufactured. They are used at the discretion of the racer. Since isopropanol is more expensive than di-EGME and it can also reduce the knock rating of the fuel, possibly to below the specification minimum, di-EGME is used more often when an icing inhibitor is required.

Antioxidants

Antioxidants, also called ***oxidation inhibitors***, suppress the Formation of peroxides and hydroperoxides, soluble gums, and insoluble Particulates in a fuel. These by-products are formed by multi-step reactions, some of which – perhaps including the initiating ones – are oxidation reactions. Antioxidants interrupt the chain of oxidation reactions that lead to Formation of gums and sediment. Fuels containing olefins are much more susceptible to forming the above by-products because olefins react more readily with oxygen than the other classes of hydrocarbons.

Dyes

Dyes are used to color-code the different grades of avgas so they can be visually distinguished from one another and from other fuels. This is a safety measure to prevent misfueling of a car.

Electrical-Conductivity Additive

As a safety precaution, Stadis® 450 may be added in concentrations up to 3 mg/L to improve the electrical conductivity of race gasoline. Conductivity additives are often referred to as *static dissipator* additives (SDA). Since a fuel treated with this additive may lose electrical conductivity over time, retreatment with the additive is allowed up to a maximum cumulative total of 5 mg/L. If race gasoline is treated with electricalconductivity additive, its conductivity must be between 50 CU and 450 CU at the point of use.

Corrosion Inhibitors

Corrosion inhibitors were approved for use in the military avgas specification but are not currently approved in either the ASTM or Defence Standard specifications.