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Effect of Ethanol as a Blending Agent on Gum Formation Tendency of Gasoline

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ABSTRACT

Commercial Gasoline available in the market always has a tendency to form deposits known as "gum". Solvent washed gum can contribute to deposits on the surface of carburetors, fuel injectors, intake manifolds, ports, valves and valve guides. Thus, to avoid these problems, standard limit is given for maximum allowable gum formed by gasoline fuel. Now-a-days, alcohol blended gasoline fuel is used. The impact of solvent washed gum on malfunctions of modern engines that can operate on ethanol fuel blends has not been fully established. An attempt has been made to determine the trend of gum formation tendency of ethanol blended fuel.

Keywords:

Fuel, Gasoline, Alcohol, Ethanol Blended Fuel, Gum Formation.

INTRODUCTION

In refinery gasoline is commonly produced by blending various types of gasoline range products like straight run gasoline, cracked gasoline, reformate gasoline, alkylated gasoline, polymeric gasoline, etc. The demand and consumption of gasoline as a fuel is very high and it is increasing day by day. To fulfill these, the less value material i.e. residual material from different refinery operations is subjected to various cracking processes in refinery to yield valuable gasoline. But, the cracking product consists of olefinic hydrocarbons which have a tendency to get oxidized in presence of atmospheric conditions to form deposits known as gum. During storage, gasoline may oxidize slowly in the presence of air and form undesirable oxidation product called gum. The gum is usually soluble in gasoline but may appear as a sticky residue on evaporation. These residues may deposit on carburetor surface, intake valves, stems and guides and cause a problem during the working of the engine. Hence commercial gasoline contains a special chemicals i.e. antioxidants to prevent oxidation and gum formation along with various types of other additives. Again as petroleum product is non-regenerative and hence to conserve these ethanol is blended into gasoline. [1, 2, 3, 4, 5, 6, 7, 8]

AIM

The tendency of gasoline fuel blended with ethanol for gum formation has not been fully established.[9, 10] Hence, a research work is proposed to determine the tendency of gum formation for various composition of alcohol blended gasoline fuel.

MATERIALS AND METHOD

The ethanol content of blended fuel is a critical parameter as it can affect the various tests or norms prescribed for gasoline fuel. The quantity of ethanol in blended fuel sample is greatly characterized by the gum formation tendency of that sample.

The test for solvent washed gum content, measures the amount of residue after the evaporation of the final and following an n-heptane wash. The heptane wash removes the heptane soluble, non-volatile material, such as additives, carrier oils used with the additives, etc. Unwashed gum content consists of fuel-insoluble and fuel soluble gum. Actually n-heptane able to remove the gum form by lighter hydrocarbons and gum form by heavier hydrocarbons remain as it is in the sample. The gum formed by lighter hydrocarbons is soluble in gasoline itself hence not harmful but gum formed by heavier hydrocarbons is not soluble in gasoline and are able to form deposites. This insoluble gum is known as solvent washed gum. The fuel-insoluble portion can clog fuel filters. Both i.e. washed and

unwashed gum can be deposited on surfaces when the fuel evaporates. But, during the use, fuel insoluble portion create the deposition problem.[9, 10] Hence, in this study, ethanol blended gasoline fuel characterization is restricted to solvent washed gum only.

As the gasoline available commercially is always blended with alcohol and additives hence, cracked gasoline obtained from pyrolysis of used oil with boiling range IBP to 200^0C is considered and selected as gasoline sample. Similarly, ethanol available in laboratory is distilled up and a distillate alcohol is used as a component of blend. The ethanol-gasoline fuel blend is prepared with 5%, 10%, 15% and 20% of alcohol in gasoline. The samples so prepared were then kept in an air tight conical flask. These samples are then analyzed for various tests as per IP/ASTM norms.[11, 12]

FIGURES AND TABLES

Table

Comparison of properties of unblended gasoline and alcohol blended gasoline fuel

S. N.	Characteristics	Unblended Gasoline Sample	5% Ethanol Blended Sample	10% Ethanol Blended Sample	15% Ethanol Blended Sample	20% Ethanol Blended Sample
1.	Colour	Bright, Clear, Pale Yellow	Bright, Clear, Pale Yellow	Bright, Clear, Pale Yellow	Bright, Clear, Pale Yellow	Bright, Clear, Pale Yellow
2.	Copper Strip Corrosion 3hrs at 50 ^{o}C, Max	Not worse than No. 1	Not worse than No. 1	Not worse than No. 1	Not worse than No. 1	Not worse than No. 1
3.	Density at 20 ^{o}C, gm/ml.	0.710	0.712	0.714	0.718	0.720
4.	Solvent Washed Gum, mg/100ml, Max	5.88	6	6.5	6.8	7.1
5.	Distillation					
	IBP, ^{o}C	37	37	38	38	38
	10% Recovery, ^{o}C	42	44	48	50	51
	30% Recovery, ^{o}C	70	60	61	62	65
	50% Recovery, ^{o}C	110	102	80	72	74
	70% Recovery, ^{o}C	121	121	120	78	80
	90% Recovery, ^{o}C	155	156	156	154	152
	Final Boiling Point (Restricted to 98.2% recovery)	198	195	196	192	190
	Residue, ml, Max	1.3	1.2	1.0	0.8	0.7

RESULT AND DISCUSSION

For unblended and ethanol blended gasoline samples, various test are carried out, that includes color, copper strip corrosion, density, solvent washed gum and distillation as per IP/ASTM norms.

From this, it is observed that all samples have same colour appearance and same values for copper strip corrosion. Density values are slightly increasing as the percent of ethanol in blended sample increases. This is due to the density difference of gasoline and ethanol. Unblended gasoline has density 0.710 gm/ml. at 20^0C whereas the standard values for density of ethanol at 20^0C is 0.789 gm/ml.[13, 14] Hence ethanol blended gasoline samples show higher values of density as the percentage of ethanol in gasoline increases.

From ASTM distillation test, it is observed that the tendency of vaporization is slightly less than the pure gasoline for up to 10% recovery. Above 10% recovery temperature is less for the ethanol blended sample as compared with pure gasoline sample. This trend is continuous up to 70% recovery and it is more strongly observed for high ethanol blended sample.

Now the important trend is observed in the determination of solvent washed gum. It is observed that, as the percent of alcohol in blended gasoline fuel increases, the solvent washed gum is also found to be increases. The primary purpose of this test, as applied to motor gasoline, is the measurement of oxidation products formed in the sample prior to or during the comparatively mild conditions of the test procedures. Since many motor gasoline's are purposely blended with non-volatile oils or additives, the heptanes extraction step is necessary to remove these from the evaporation residue so that the deleterious material, gum, may be determined.

The gum formation tendency is due to the oxidation of sample. Ethanol itself consists of oxygen in the molecular arrangement.[13, 14] The inbuilt oxygen get increases as the percentage of ethanol in blended gasoline sample increases, that leads to accelerated the oxidation tendency of the alcohol blended gasoline sample, which leads to form more oxidative products i.e. gum. Hence, in above observation, as the percent of ethanol in blended sample increases, the value of solvent washed gum is also found to be increases.

CONCLUSION

During storage, gasoline may oxidize slowly in the presence of air and form undesirable oxidation product called "gum". Low gum will ensure absence of induction-system difficulties. ASTM specification for Automotive Gasoline (D439) limits gasoline to a maximum of 5 mg of gum/100 ml of gasoline.[9, 10] Oxidation leads to form gum by reaction of unsaturated hydrocarbon material. In the ethanol blended sample, inbuilt oxygen present with each ethanol molecule accelerate the oxidation and leads to form more gum. From this study it is concluded that, as the percent of ethanol in blended gasoline sample increases, the values of solvent washed gum also increases.

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