



## *Effect of Fuel Additives on Gasoline Volatility*

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### **ABSTRACT**

Oxygenated additives are added to the base gasoline for such purposes like increase in Octane Number, improvement of engine performance and decrease in exhaust emissions. In Iran, Methyl Tertiary Butyl Ether (MTBE) is used as an additive to the base gasoline. Due to the destructive environmental effects of the mentioned material, our country, the same as other developed countries, should seek to use a replacement for the mentioned additive. The combination of the base gasoline and fuel additives has such limitations like increase in the quantity of volatility, the Reid vapor pressure (RVP) and decrease in calorific value of the fuel obtained. In this research, Ethanol, Tertiary Butyl Alcohol (TBA) and Methyl Tertiary Butyl Ether, in the volumetric ratios of 2.5, 5, 7.5, 10, 15 and 20, are blended with the base gasoline of Tehran Oil Refinery Company (TORC). The behavior of volatility of the obtained fuel has been investigated based on ASTM standards. The results obtained from the done investigation reveal that in case of using Ethanol as a fuel additive, certain changes should be made in the formulation of base gasoline. The mentioned combination has an undesirable effect on the other characteristics of fuel such as Octane Number. Addition of Tertiary Butyl Alcohol to gasoline shall result in trivial increase in the Reid vapor pressure. Consequently, there will be no need for the replacement of light straight run gasoline (LSRG) compounds with heavier compounds in order to decrease the Reid vapor pressure.

### **KEYWORDS**

Gasoline, Oxygenated Additive, MTBE, Ethanol, TBA, Reid Vapor Pressure.

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## 1- INTRODUCTION

The additives used in the adulteration of commercial gasoline can be classified as oxygenated, aromatic, and light and heavy aliphatic hydrocarbons, in which the majority of these compounds are being natural constituents of gasoline. The addition of solvents changes the original composition of the fuel, affecting in physicochemical properties in different ways. Distillation curves, vapor pressure and octane rating are the properties closely related to the fuel composition and the characteristics of its components. Simple alcohols and ethers are used as gasoline additives to reduce the pollutants from vehicle exhaust gases. Proponents of these oxygenates claim several advantages: they are octane enhancers, have fuels, can be produced from renewable agricultural raw significant anti-knock properties important for unleaded materials instead of fossil sources, reduce carbon monoxide emission from the vehicle exhaust. Moreover, reducing the emission of carbon monoxide (CO) and unburned hydrocarbons, minimize the emission of volatile organic compounds. Methyl tert-butyl ether (MTBE) and ethanol are the oxygenates most commonly employed to increase the octane number of gasoline. Use of MTBE has become restricted due to its toxicity and contamination of groundwater. In addition to MTBE, other alcohols such as Ethanol (EtOH) and tertiary Butyl Alcohol (TBA; tert-Butanol) have led to the growing interest as oxygenated additives.

It is notable that if the permissible range of RNP in mild and cold seasons are 9 and 10 psi, MTBE and Ethanol for using in mild seasons will transcend the permissible range and in order to use the mentioned additives, we have to change the base gasoline formulation and the replacement of light gasoline additives such as LSRG, Pentane, LIN with heavier additives such as HIN, is inevitable. This process will be influential on other gasoline properties such as the Octane number and causes some problems in optimizing the gasoline.

In this study it can be seen that the addition of oxygenates lead to a distortion of the base gasoline's distillation curves, which becomes more marked the higher the oxygenates content. All oxygenates decrease the distillation temperatures significantly. The Reid vapor pressure (RVP) of gasoline was found to increase with the addition of the oxygenated compounds.

## 2- METHODOLOGY

The purpose of this paper is to study the effect of oxygenate additives into the gasoline for the improvement of physicochemical properties of blends. Methyl Tertiary Butyl Ether (MTBE), Tertiary butyl alcohol (TBA), and Ethanol (EtOH) have been blended into unleaded gasoline with various blended rates of 2.5%, 5%, 7.5%, 10%, 15%, and 20%. Physicochemical properties of blends were analyzed by the standard American Society of Testing and Materials (ASTM) methods. The distillation characteristics were measured

according to the ASTM D 86 standard, Reid vapor pressures are measured following the ASTM D 323 standard.

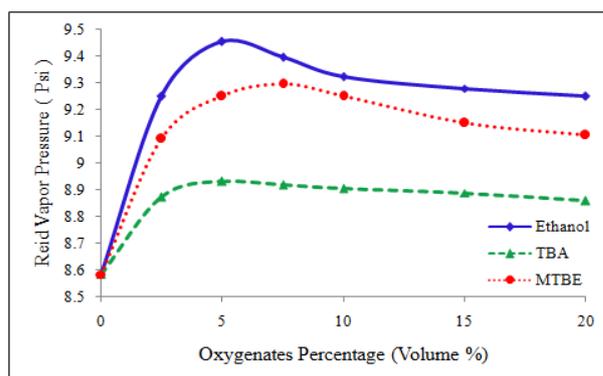
## 3- RESULTS

The effect of increase in Ethanol, MTBE and TBA on RNP has been stated in table (1) and figure (1).

As can be seen, the increase in Ethanol instead of MTBE in consuming gasoline, with the ratio of 10% volumetric, increases the RNP in comparison to the base gasoline %8.62 while this amount in gasoline with 10% volumetric of MTBE is %77.7 and in gasoline with 10% volumetric of TBA is %3.77.

**Table (1): vapor pressure of base gasoline containing addition of 2.5, 5, 7.5, 10, 15, 20 % v/v of Ethanol, TBA, MTBE**

Additives (%)	0	2.5	5	7.5	10	15	20
TBA	8.58	8.78	8.93	8.92	8.9	8.89	8.86
MTBE	8.58	9.09	9.25	9.3	9.25	9.15	9.11
Ethanol	8.58	9.25	9.45	9.4	9.32	9.28	9.25



**Figure (1): Reid vapor pressure of base gasoline containing addition of 2.5, 5, 7.5, 10, 15, 20 % v/v of Ethanol, TBA, MTBE.**

Figure (2) indicates that, among the oxygenated compounds used as additives for base gasoline, ethanol was the one that caused the most marked change in the distillation curve. Clearly, this results in the front end to the first region of the curve being heavily distorted in terms of significantly increasing the volatility of the fuel in these regions.

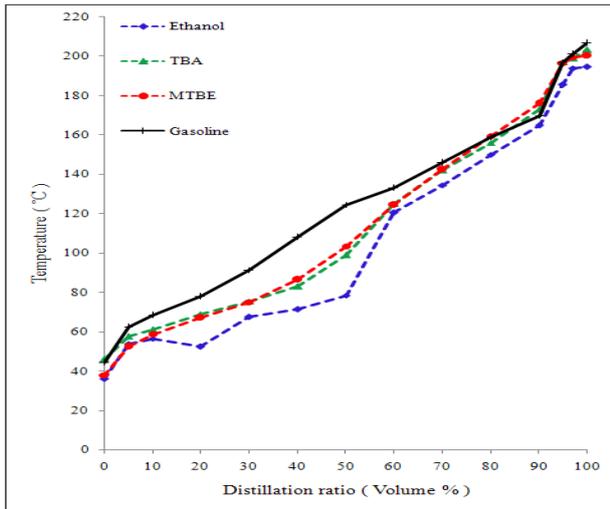


Figure (2): Distillation curve of base gasoline and its blend with Ethanol, TBA, and MTBE in the volumetric proportions of 15%.

#### 4- CONCLUSION

In this essay the influence of the addition of the oxygenates MTBE, Ethanol and TBA on the parameters Reid vapor pressure, distillation curves and driveability index. The addition of all oxygenates led to mixtures' increased RVP and the highest and lowest effect on the RVP have been obtained the addition of Ethanol and MTBE respectively.

The resulted Drivability Index from the mix of MTBE and gasoline is more than the state that the fuel is a mixture of TBA or Ethanol with the base gasoline, and Ethanol will have the utmost reduction in drivability index. Consequently, the gasoline blends, which encompass Ethanol in their blends as additives, in colder weather will cause the warmth in the engine more quickly.

The utmost reduction in Distillation temperature and consequently the volatility increase happens in all of the used additives in blends which contain 50% volumetric, this amount for Ethanol, TBA and MTBE are %40.8, 25.6 and 26%, respectively. As it could be noticed, the maximum volatility increase in blends containing 50% volumetric, from these additives, is related to the containing Ethanol fuel.

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