The Effect of Additives on Ethanol Diesel Blend

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Abstract:
With the ever-increasing population, it has become extremely necessary to find an alternative to available fuel to increase the quantity of present fuel. One of the methods is to mix some chemicals in the present fuel to increase the quantity without damaging the vehicle and ecosystem. The best practice may be to get something from waste. Hence, Ethanol is selected as it can be extracted from sugarcane and other biomass materials. This experiment was conducted out to investigate the best additive to keep ethanol diesel blend stable to use as a fuel. The experiment was conducted in the chemistry lab of LIT College, Nagpur (Maharashtra) India. The result obtained verifies that 1% hexanol is the best additive which is stable till 216 hours. Hence can be the best additive.

Keywords: Ethanol and Diesel

Introduction:

Since the most recent couple of years, the energy proportions have been clustered by the non-renewable energy sources like oil, wood, coal, methane gas, and so forth, and sending of such energy sources was disregarded, for example, huge volumes of gases (CO and CO_2) (Voumik et. al., 2023) without thinking about our earth. Be that as it may, considering current natural contamination (Babarinde and Onyiaocha, 2016; Jafarinejad, 2016; Shindy, 2016; Sayed, 2015; Khan, 2022), there is have to embrace perfect and supportable innovations (Mumtaz et. al., 2016; Gangadhar and Prasad, 2016;). Furthermore, clues that, the pronounced financial upgrade is convincing us of life's underlying point, without a doubt which is of serious importance (Rossel, 2006). Today, the petroleum products portion, in the overall supply of energy is greater than 80%, while nuclear origin gives just 6% with parity to be maintained using inexhaustible methods (Stiles, 2009).

The transportation division is socially unmistakable with significant accomplice among the essential territories which use a colossal measure of the energy of all out utilization, which is continually developing and at present uses 27% of essential energy and it is evaluated that the interest will increment to 80% by the end of 2025 (Outlook, 2010; Mindali et al, 2004). Therefore, an alternative to fuel is required. An ethanol blend can be the best solution for its advantages (Yin et. al., 2021).

For ethanol creation, modern creation requires the aging of hexoses (starch/sucrose) in the crops of sugar-containing crops i.e., sugarcane, sugar beets, wheat & corn, & the result delivered in course of sugar creation is used for ethanol creation. Ethanol created using cellulosic feedstocks, for example, switch grasses or horticultural with municipal waste, is additionally a prospective replacement & these wastes are the subsequent objective of specialists for ethanol creation (Sanchez and Cardona 2008; Ribeiro, 2013)

In molasses, sucrose is lost which influences the process economy (Raj et. al., 2022; Gasmala et. al., 2012), in this manner, its change to ethanol gives essentially to the manufacturing plant benefit (Netsopa et. al., 2022; Khan et. al., 2007). Its creations economically will assume social jobs in the improvement of Rural with Urban regions and in the creation of employment (Nazir et. al., 2013).

Objectives:

1. To compare fuel properties between Ethanol and Other Fuels
2. To identify the best additive to keep the ethanol diesel blend stable

Ethanol:

Sometimes, Ethanol is also referred to as grain alcohol, ethyl alcohol, Methylcarbinol, or drinking alcohol. It is abbreviated EtOH. It is a substitutive energy source therefore obviously flammable. Ethanol is volatile in nature with no color. Apart from the fuel, it can also be used as a medical application such as disinfection, as an antidote, and as an antiseptic. It can be found in many cosmetics and beauty products. Ethanol is naturally produced alcohol by fermenting corn, sugar molasses, or another indistinguishable biomass substance. Essentially, there are 3 methods through which ethanol can be utilized as a fuel in transportation.

1. A mix of 10% ethanol with 90% gasoline (unleaded) known as “E-10 Unleaded”.
2. As a constituent of Reformulated gasoline, both straightforwardly or partially as ethyl tertiary butyl ether or
3. As an essential fuel with 85% ethanol mixed with 15% of gasoline (unleaded) known as “E-85”.

Source: Curriculum for ethanol blended fuels

Manufacturing Process of Ethanol from Sugarcane Molasses.

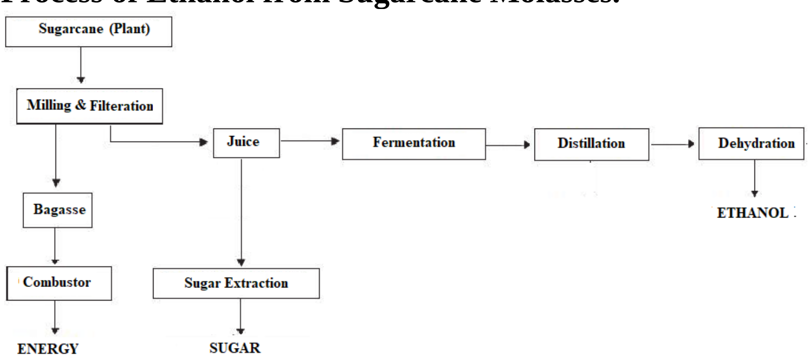

Figure 1: Ethanol Manufacturing Process from Sugarcane Molasses.

A fermentation process using sugarcane molasses is done to prepare Ethanol. The above figure depicts the process to get ethanal from the Sugarcane plant. Molasses is the source of alcohol left following the crystallization of sugarcane juice and is a dim-shaded thick fluid. Molasses holds about 60% sugar (fermentable). Fermentation is a succession of responses that discharge energy against natural molecules without oxygen. Right now, in fermentation, energy is gotten when sugar is altered to ethanol and carbon dioxide. After fermentation, its broth is boiled. The liquid obtained is further boiled in the distillation process to remove impurities to obtain Ethanol.

Table 1: The Production Cost of Ethanol from the Molasses in India (As of 2022)

			Stand Alone	**Integrated with**
			Distillery	**Sugar Production**

	Molasses price	Per MT	1100	1100
	Transportation Cost (In Rs)	Per MT	150	0
	Total Cost (In Rs)	**Per MT**	**1250**	**1100**
	Revival of Ethanol/MT molasses	Liters	220	220
	A) Production Cost (Direct Cost)		**Rupees/Liter**	**Rupees/Liter**
	Value of Molasses (After Milling)		5.42	4.85
	Steam Price @ Rice Husk Rs 500/T		0.30	0
	Cost of Power @ Rs 4.50/kwlu		0.62	0
	Cost of procuring Chemicals		0.2	0.2
	Workers Salary		0.25	0.25
	Reconstruct and Maintenance		0.15	0.15
	Molecular Sieve Replacement Cost		0.03	0.03
	Total Direct Cost		**6.97**	**5.48**
	B) Banking and Other Costs (Indirect Costs)			
	Indirect Cost incorporating overheads		0. 65	0.29
	Interest at 12% for the borrowed capital of Rs 7.2 cr (Debt/equity = 1.5:1)		0.98	0.98
	Interest at 12% for working capital for 1 month of Ethanol & Molasses		0.2	0.2
	Depreciation at 10% for Rs 12 cr		1.45	1.45
	All Indirect Value		**3.28**	**2.92**
	Total Cost (A+B)		**10.25**	**8.4**

Source: http://planningcommission.nic.in/reports/genrep/cmtt_bio.pdf

The table above, evident the overall value of producing Ethanol from molasses integrated with Sugarcane is very cheap. It can be produced for just 8.4 i.e., close to Rs 9 only. Hence it is cost-effective to produce ethanol and use it as an additive.

Table 2: Differentiation of Fuel Property

	Ethanol	**Diesel**	**Gasoline**
Molecular Formula	C_2H_6OH or CH_3CH_2OH	C3 to C25	C4 to C12
Atomic Weight	46.07	178.6	100 - 105
Carbon	52.2	84 - 87	85 - 88
Hydrogen	13.1	33 - 16	12 - 15
Oxygen	34.70	0.0	0.0
Specific Gravity 60^{o}F/60 ^{o}F	0.795	0.82 – 0.95	0.73 – 0.78
Density, lb/gal @ 60^{o}F	6.62	6.7 – 7.4	6.0 – 6.5
Boiling Temperature, ^{o}F	173.1	360 - 680	80 - 440
Reid Vapor Pressure (RVP)	2.30	0.2	8 - 15

Research Octane Number (RON)	120 - 135	--	87
Motor Octane Number (MON)	100 - 106	--	82 - 92
(R+ M)/2	115	N/A	87
Cetane Number (1)	5-8	45 - 55	0 - 5
Fuel in water, Volume %	100	Minimal	Minimal
Water in fuel, Volume %	100	Minimal	Minimal
Freezing point, ^{o}F	-172.38	-40 – 30[b]	-40
Centipoise (cP) @ 60^{o}F	1.21	2.6 – 4.1	0.37 – 0.44[a]
Flashpoint, closed cup, ^{o}F	61.88	125.6	-45
Autoignition temperature, ^{o}F	689	410	536
Lower	4.2	1	1.4
Higher	18	6	7.6
Btu/gal @ 60^{o}F	2.379	≈ 700	≈ 900
Btu/lb @ 60^{o}F	397	≈ 100	≈150
Btu/lb air for stoichiometric mixture @ 60 ^{o}F	44	≈ 8	≈ 10
Higher (liquid fuel – liquid water) Btu/lb	12,800	19,200 - 20000	18,800 – 20,400
Lower (liquid fuel – water vapor) Btu/lb	11,500	18,000 – 19,000	18,000 - 19000
Higher (liquid fuel – liquid water) Btu/gal	84,100	1,38,700	1,24,800
Lower (liquid fuel – water vapor) Btu/gal @ 60^{o}F	76,000[a]	1,28,400	1,15.000
A mixture in the vapor state, Btu/cubic foot @ 68 ^{o}F	92.8	96.9[c]	95.2
Fuel in a liquid state, Btu/lb or air	1,280	--	1,290
Specific heat, Btu/Lb ^{o}F	0.56	0.43	0.48
Stoichiometric air/fuel, weight	9	14.7	14.6[a]
Volume % fuel in vaporized Stoichiometric mixture	6.5	--	2

[a] is the Calculated Value, [b] is the Pour point and [c] is based on the cetane

Source: The U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. http://www.eere.energy.gov/afdc/altfuel/fuel_properties.html

The above table will provide the reader's detailed comparison of Ethanol with other fuels.

Procedure for Investigating:

Materials:

Various Materials utilized for this experiment are Ethanol, Diesel, Ethyl Acetate, Hexanol, Hexa-Floride, Benzyl Alcohol, Butanol, and Diethyl Ether.

The ethanol utilized in the test tube was confined to basically anhydrous ethanol since different sorts of ethanol are not solvent or have restricted dissolvability in by far most diesel powers. Similarly, butanol is also used. Both the chemicals are of logical evaluation and good quality. Diesel utilized is procured from the business provider.

Procedure for Blending:

The process for preparing the blend is as flows

1. Measure the fitting measure of diesel and empty it into a conical funnel
2. Add an individual measure of alcohol into the diesel for the required % of the mix.
3. Close the flask and utilize the magnetic stirrer or the electric fomenter for the best possible blending of alcohol. In the case of ethanol, the principal precautionary measure that needs to take while blending it in diesel, the flask ought to be appropriately closed with the goal that air contact can be forestalled.
4. Shaking is another choice for the blending of ethanol. It is conveyed for the hour of around 1-2 hours for legitimate blending.
5. The mixing of liquor and diesel by this technique is designated the "Splash Method".
6. Burette 1 consists of an Ethanol Diesel Blend without additives. The temperature at which it gets separated where noted down during a time interval as shown in table 3.
7. Additives (Ethyl Acetate, Hexanol, Hexa-Floride, Benzyl Alcohol, Butanol, and Diethyl Ether) were added to check the stability.

Observation (Table 3)

Time (In Hours)	**Temp (In ^oC)**	**15% Ethanol Diesel Blend without Additive**	**Additives**					
			1% Ethyl Acetate	**1% Hexanol**	**1% Tri Hexa Floride**	**1% Benzyl Alcohol**	**1% Butanol**	**1% Diethyl Ether**
		Burette 1	**Burette 2**	**Burette 3**	**Burette 4**	**Burette 5**	**Burette 6**	**Burette 7**
24	27 - 18	--	--	--	--	--	--	--
48	31 - 18	--	--	--	--	--	--	--
72	30 - 14	0.1 ml Separation	--	--	--	0.1 ml Separation	--	0.1 ml Separation
96	31 - 30	0.6 ml Separation	--	--	--	0.3 ml Separation	--	0.6 ml Separation
120	34 - 15	1.1 ml Separation	0.2 ml Separation	--	0.4 ml Separation	1.0 ml Separation	--	1.8 ml Separation
144	35 - 20	1.5 ml Separation	0.7 ml Separation	--	0.9 ml Separation	1.4 ml Separation	0.1 ml Separation	1.9 ml Separation
168	36 - 22			--				
192	36 – 25			--				
216	37 - 28			0.2 ml Separation				

From the table above, it is clear that stability blends vary with temperature. So, the temperature of the system was carefully recorded. Different additive shows different stability.
1% Benzyl Alcohol and Diethyl Ether act as the worst additive as they can be stable for 48 hours only. So, these additives are strictly avoided.
1% Ethyl Acetate and THF show good stability but up to 120 hours only.
1% Butanol proves to be a good additive and can sustain the system for 144 hours; Hence, it can be used.
But the best additive used here was 1% hexanol as there is no phase separation in the system till 216 hours, which is sufficient to keep the ethanol diesel blend stable.
So, from the above discussion, it can be concluded that, 1:15:84 hexagonal: Ethanol: Diesel is the best system that can be used as fuel for further application.

Factors affecting Blend Stability

The solubility of Ethanol in diesel is affected by the following factors:

1. Temperature; below about 10^{o}C the two fuels separate
2. Water content of the blend.
3. Aromatic content of diesel fuel; also affects the effectiveness of the emulsifier and co-solvent. The polar idea of ethanol instigates a dipole in the aromatic atom, permitting them to interface sensibly emphatically, while the aromatic stays perfect with another hydrocarbon in diesel fuel.

Conclusion

Fossil fuels have been used for ages for the transportation process, the time has come to evaluate an alternative resource to be used as fuels. Hence Biomass will show a vital role in the transition of fossil fuel into renewable fuel. Ethanol is a natural resource widely available, especially when extracted from sugarcane. The addition of Ethanol in petrol/Diesel is being used in many countries. Thus, adding ethanol to petrol/diesel is advantageous in many ways. From the above table, we get sufficient evidence that adding 1% hexagonal will provide the best stability as it does not get separated till 216 hours. It is also clear that the worst additives are Benzyl Alcohol and Diethyl Ether as it gets separated in just 72 hours and hence cannot be used effectively.

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