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RESEARCH ARTICLE

A Review on Environmental Friendly Gasoline Substituent: Bio-ethanol

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ABSTRACT:

The recent energy concern and environment saving issue motivate us for thinking about alternative environment friendly energy source such as bio fuel (mainly Bio ethanol). Bio ethanol is a choice for high octane number and low cetane number. Cellulosic feed stocks can be employed for bio ethanol production very effectively. One citable problem with Bio ethanol generation is the unavailability of raw materials. Several modern measures are taken for Bio ethanol generation in now a day to negotiable the drawbacks. This paper review the history, worldwide status, producing processes and future aspect of Bio- ethanol.

KEYWORDS: Gasoline; Bio-ethanol; Fuel; Environment; Biomass.

1. INTRODUCTION:

Bio-fuel is basically known to us as fuels exist in liquid and gaseous state mainly used for the transportation purpose and biomass is the predominate source. Biomass is use as source for the generation of different type of fuel including liquid and gaseous fuel. Liquid bio fuels are not only use to run vehicles, but also use in fuel engines or fuel cells for production of electricity[1]. There may some causes for using bio fuels as a substitutional source in both growing and modern countries[2]. They include energy saving reason environmental concerns, socioeconomic issue etc. Due to environment friendly nature of bio fuel it will cover market fast in the next few years.

Worldwide liquid bio fuels are classified mainly into following 3 categories [1]:

- a) Bio alcohols.
- b) Vegetable oils and biodiesel.
- c) Bio crude and bio synthetic oil.

Any member of alcohol family can be used as fuel source because oxygen presents in alcohol lower the combustion heat practically. The alcohols used as vehicles fuel are bio ethanol (C_2H_5OH), bio methanol (CH_3OH), propanol (C_3H_7OH), bio butanol (C_4H_9OH). However among them bio ethanol and bio methanol fuels are most profitable for internal combustion engine from the view point of both technical and economical side [3].

2. NEED OF BIO ALCOHOLS:

Petrol and Diesel are considered as volatile liquids and it contains almost $C_4 - C_{12}$ hydrocarbons mixture. They are produced by process known as cracking from petroleum. They are the predominant fuel to carry car engine. 19 gallons of gasoline can be obtained from almost 1 barrel of petroleum [4]. Now a day in entire world almost 600 million passenger cars use various road of the whole world and this purpose almost 930 million gallons of petrol and diesel use daily. In 2012 only the U.S use almost 266 gallons of gasoline regularly [4]. But the day is not so far that there are no crude oil sources remaining for carrying vehicles. There are many adverse-affect mainly on environment as well as civilization for the heavy use of gasoline as fuel in many developing countries including U.S [5]. So we must look forward alternative fuel and for the purpose we think about bio alcohols.

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Secondly, Global warming rise up day by day for using more and more fossil fuels due to enhancement of CO₂ concentration in atmosphere generating from combustion of fossil fuel[6,7,8]. The combustion of fossil fuels generates almost 73% of the CO₂ in the atmosphere and makes the environment more and unhealthier towards both animal and plants [9]. So steps and awareness must be taken. These must diminish the Global Warming as well as control GHG emission [10]. Therefore search for alternative fuel source become a worldwide attention to reduce CO₂ emission as much as possible[11]. For this purpose Bio alcohols are the best choice as a recognized alternative in place of petroleum derived transport fuel[12].

3. Historical Development of Ethanol as a Fuel:

Liquid fuel can be generated from bio mass now a day because bio mass is renewable. One profitable as well as available methodology is to produce ethanol through fermentation of plant biomass derived simple sugar. Ethanol can be used as a alternative choice for giving power to petrol engine. The fermentation technique was used since 4000 B.C. Human being made alcohol as a drink from berries, grapes, honeys and cereals since that era through fermentation process. But it is the fact Ethanol was examined as engine fuel in 1913. Early in 1826, the American inventor Samuel Morey designed an internal combustion engine that was filled with a mixture of ethanol and turpentine to run a boat at 7 to 8 mph [6]. Thereafter in 1860 the German engineer Nicolas August Otto discovered another internal combustion engine that fueled by ethanol fuel blend[13]. Later the American industrialist Henry Ford constructed tractors that could be run on ethanol. The payment of tax imposed Ethanol was the major problem for using Ethanol as fuel during civil war in 1860[14]. Even when gasoline began to dominate in the late 1910s, many scientists gave their interest on whether Ethanol is sustainable or not in fuel industry[6].

In 1917, Alexander Graham Bell discovered the fact that there is available feed stocks which have a great potential to the production of Bio ethanol. The oil saving problem could be solved if we use a blend like 25% gasoline, 25% benzole and 50% ethanol, proposed in 1918 in a article of that time [13]. There are varieties of source available for Ethanol production like grains, cobs, fruits and shell; but excluding that from beverages since the 1930s because of the low cost[15]. Since the time period of oil crises probably from 1970, Ethanol became choice as an alternative fuel[16]. In 1975 only 7×10^6 liter of proof Ethanol was generated by fermentation compared to 7.95×10^6 liter by synthesis [15]., Ethanol has been considered one possible alternative choice as fuel in many countries from 1980[17]. The first bio ethanol plant with a distillation column was established at South Dakota University in 1979[13].

4. Reason behind Thinking Bio Ethanol as a fuel:

Several different biomass feed stocks can be used for Bio ethanol production and various conversion technologies are employed for this [17]. Bio Ethanol is an attractive choice as an alternative liquid fuel because

- It is produced from such bio-based sources that are renewable and due to presence of oxygen it has the potential to reduce CO₂ emission in internal combustion engines [18].
- Bio Ethanol has higher octane no (107), wider flammability limits. It has also more flame speeds and greater heat of vaporization than gasoline [19].
- It has larger compression ratio, required shorter time to burn. This make efficiency profits theoretically over gasoline in an compression engine [20].
- Ethanol has 35% oxygen in it, which decrease particulate and NO_x ejection to the atmosphere obtained from internal combustion of engine [17].
- It has a suitable antiknock value [17].

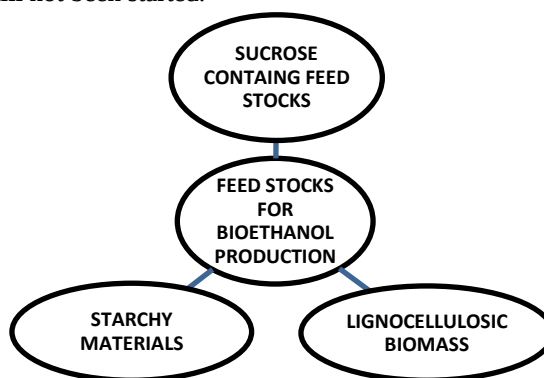
Some properties of alcohol fuel are shown in table 1.

Table 1: Some properties of alcohol fuels:

Cetane number	-	5	8
Octane number	100	112	107
Auto ignition temperature (K)	530	737	606
Latent heat of vaporization(MJ/Kg)	0.26	1.18	0.91
Lower heating value(MJ/Kg)	44.4	19.9	26.7
Source reference [20]			

5. Feed stocks For Bio Ethanol Production:

Oils from plant, sugar beets, cereals, waste from organic matter, and the other bio-mass are some main sources of Bio ethanol. Biological feed stocks having suitable amounts of sugar or such materials having possibility of converting into sugar such as starch and cellulose can produce bio ethanol through fermentation and it also be used in such engines running by gasoline [21]. The availability of feed stocks for bio ethanol depends considerably on season by season and geographic location also affects this. Bio ethanol source materials can be categorized into following three classes[17]. Among them Lignocellulosic biomass is the most usable feed stocks for the reason of its high availability and low cost but the large scale commercial formation from that source has still not been started.



Various feed stocks that can be used for bio ethanol generation and a comparative production potential are given below in Table 2.

Table 2: Ethanol generation from various sources

Sugar Cane	70
Sugar beet	110
Sweet potato	125
Potato	110
Cassava	180
Maize	360
Rice	430
Barley	250
Wheat	340
Sweet sorghum	60
Bagasse and other cellulose biomass	280

Source reference: [22]

5.1 Sucrose Containing Feedstocks

2/3 rd of the world Bio ethanol production is from sugar cane and sugar beet produce 1/3 rd [22]. But these two types of sources are found in two regions geographically distinct. Sugar cane is found basically in tropical and subtropical countries. On the other hand sugar beet is only appearing in such countries where temperature is little high. But mind it, "World cane sugar export has not enhanced over the time period 2000-2004" [23] [Table-3].

Table 3: Bio-ethanol Production

	2000	2001	2002	2003	2004
VALUE(\$ BILLION)	3.2	4.3	2.8	3.4	2.9
QUANTITY (MILLION TONS)	16.5	17.9	12.9	16.7	14.5

Source : [23]

5.2 Starchy Materials:

Other bio ethanol production source is starchy material [24]. Starch is a polymer found biologically and it's monomer is D-glucose and therefore it falls into homo polymer category [25]. North America and Europe utilized this type of feed stocks mostly for the bio ethanol production [26]. The large corn based bio ethanol production house present in the US having capacity almost over 15 billion per year [27].

5.3 Lignocellulosic Biomass:

Agricultural residues, wood and waste crops, are some attractive Lignocellulosic biomass material for bio ethanol production since it is the most abundant renewable source on the planet till now. Up to 442 billion liter /year bio ethanol can be produced from this kind of source [28]. Thus the total potential is 491 billion liter per year from waste materials, which is almost about 16 times larger than the recent world bio ethanol production [Table 4] [29, 30].

Table 4: Composition of representative Lignocellulosic biomass

Feed stocks	Hard wood (Eucalyptus)	Soft wood(pine)	Grass (switch grass)
Cellulose	49.50	44.55	31.98
Hemi cellulose	13.07	21.90	25.19
Lignin	27.71	27.67	18.13
Ash	01.26	00.32	05.95
Acids	04.19	02.67	01.21
Extractives	04.27	02.88	17.54
Source : [30]			

6. Bio-ethanol - What Generation it belongs:

Bio-fuels can be classified based on their production technologies:

- First generation bio fuels (FGBs)
- Second generation bio fuels (SGBs)
- Third generation bio fuels (TGBs)
- Fourth generation bio fuels

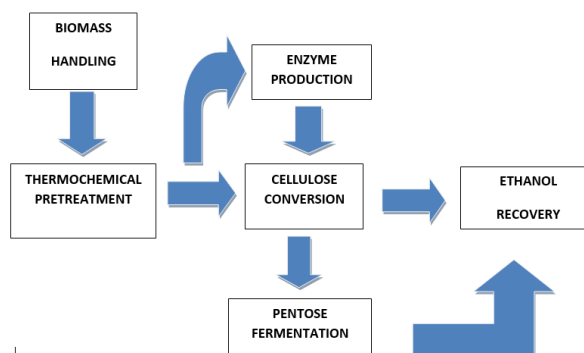
Table 5 shows the classification of renewable bio fuels based on their production technologies. From this tabular form it is cleared that bio ethanol basically belongs to both the first and second generation bio fuel [19].

Table 5: Classification of bio fuels on their production technologies:

Generation	Feed stocks	Example
First generation bio fuels	Sugar, starch, vegetable oil, animal fats	Bio alcohols, vegetable oil, bio syn gas
Second generation bio fuels	Non food crops, wheat straw, corn, wood, solid waste, energy crop	Bio alcohols, bio dmf, bio oil
Third generation bio fuels	Algae	Vegetable oil, bio diesel
Fourth generation bio fuels	Vegetable oil, bio diesel	Bio gasoline
Source reference: [19]		

7. Bioethanol processing options:

There are several processing options which can be used to convert Lignocellulosic materials to Bio-ethanol. Among them the process that is selected which is economically profitable along with high yield. Processing options are largely variable on the basis of hydrolysis methods converting cellulose and hemicelluloses into sugar [31]. Some options are shown below:



8. Steps Involving Bio-ethanol Production.

The popular procedure for producing bio ethanol from crops found from food is represented in fig below by showing arrows. It involves a number of steps such as [6]: Milling liquefaction Sacharification Fermentation Distillation

Milling → liquefaction → saccharification → fermentation
→ distillation
Denaturing drying

At first the given corn taken as the feed stocks are crushed to 3 to 4 mm powder, then after wetting with water slurry obtained, and heated up to 110- 120°C for 2 hrs into corn powder in presence of steam. During liquefaction (80-90°C) and sacharification (30°C) the enzymes α – amylase and glucoamylase are added respectively. The saccarified corn powder is then proceed to fermentation at 32°C for 50 hrs after adding yeast generating 8 to 12 % ethanol by weight. After that through distillation process Ethanol is recovered by passing through molecular sieves, and 2 – 5 % gasoline is employed for denaturation [32]. Almost 2.5 – 2.9 gal bio-ethanol can be produced from 25.4 kg corn grains.

9. Bioethanol production from starch:

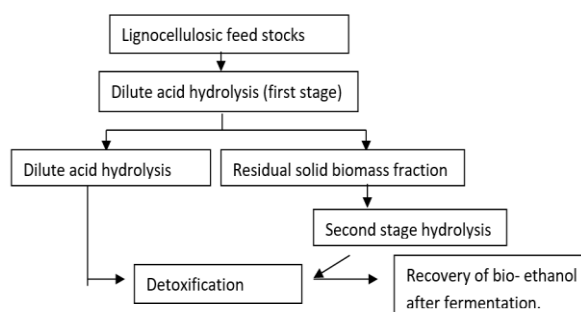
Starch is one of the major carbohydrate from which ethanol can be produced very effectively. Carbohydrate other than starch are cellulose (40 – 50%), hemicelluloses (25 – 35%) and lignin(15 – 20%) form bio ethanol also can be generated Starch is a glucose bearing polymer joined via α - 1, 4 and α – 1, 6 glycosidic linkage (amylase and amylopectine). Starch processing is carried through liquefaction carried in presence of enzyme and Sacharification. Through these steps a clean glucose steam is obtained and then saccharomyces yeasts helps in fermentation to ethanol [33]. Recent advance processes give emphasis on the low cost and efficiency of the process.

To gelatinized starch, that starch contain materials are steamed for at least one to two hours at 2 to 3 atmospheric pressure. Then the resultant is cooled to about 50°C and water and 10% malt is added is added in a volume ratio 1:1. The mixture is stand for a short time period and within this the starch is turned to dextrin. This Dextrin is converted to maltose first and then to dextrose when the temperature is raised gradually.

After that fermentation is allowed for couple of days after mixing yeast to that mixture obtained. As a result sugar converts into ethanol. The ethanol concentration is then raised up passing through additional column (95% ethanol). At last concentration is more improved by drying through extra active distillation process [34, 37].

10. Lignocellulosic bio-ethanol production:

Three categorization of cost for Bio ethanol production from Lignocellulosic materials are possible: the feed stocks cost, the sugar preparation cost, the costs of recovery. To overcome this two feed stocks treatment procedure have been proposed: acid hydrolysis and enzymatic hydrolysis [35]. The following pi chart shows the composition of Lignocellulosic materials. In order to release sugar in acid hydrolysis the Lignocellulosic bio mass is treated with acid solution. If we employ dilute acid then an environment with a high temperature (237°C) and high pressure (13atm) is needed. The sugar yield becomes low because this treatment is slow and continuous. Another cause of low yield is the production of several side products under this reaction condition. It is experimentally proved that 5 carbon contain sugar are cleaved more rapidly than one carbon more contain sugar. There are basically two steps to decrease sugar degradation. With this method is approximately 55 gallon Bio ethanol can be produced per dry ton wood [35]. A flow chart is given [36].

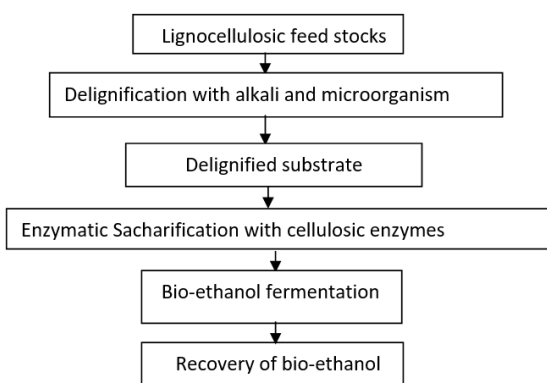
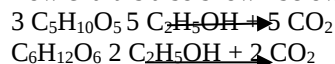


If we go with concentrated acid is used then to recover pentose that materials are initially treated with dilute acid at least for 2-6 hours condition is maintained as mild as possible. The hard residue is then washed by water; the obtained material is soaked in concentrated acid for 2-4 hours at least at 100- 150°C. Filtration is done to wash out lignin and the dilute acid is recycled for further hydrolysis. We can recover 80% ethanol by this process. There are two limitations for this process. One, the process is going in a slow manner and another, difficulty of recovery of acid form solution containing sugar. If acid cannot be recovered then lime must be introduced for carrying neutralization and this is far better than fermentation due to its additional cost and calcium sulfate waste [16]. This method create 60-70 gallon of ethanol/dry ton corn Stover [35].

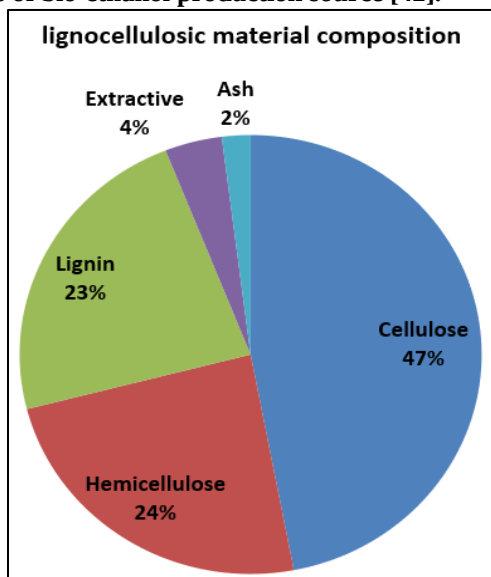
In enzymatic hydrolysis method active enzyme decomposes Lignocellulosic materials into simple sugars. But this task is not so easy because cellulose has organized crystalline structure and contain lignin layer [6]. Enzymatic hydrolysis has low money consuming compared to acid or alkaline hydrolysis because enzyme

hydrolysis is usually carried under mild condition and there is no corrosion problem arises as in previous methods [38]. Production yield is also attractive in enzymatic hydrolysis [39].

After hydrolysis Yeast is employed for carrying fermentation. Now Lignocellulosic materials not only contain glucose but also contain other various monosaccharides like mannose, xylose, galactose, arabinose and for this reason for carrying fermentation smoothly yeast is added. The reactions are as follow. A flow chart is also shown below in figure [40, 41].



Steps of bio-ethanol production source [42].



Composition of Lignocellulosic materials [6]

11. Modern measure taken for the production of Bio-ethanol:

There are two bio ethanol formation processes which are lied on thermo chemical reactions. The first cover basically a hybrid of thermo chemical and biological process. Cellulosic substances are gasified first by thermo

chemical way and the obtained gas passed through special fermenters [43, 44]. Then through a biological process designed by modern engineer in presence of micro organism fermentation step is proceed [45].

The second thermo chemical process occurs in absence of microorganism. In this process the first step is similarly done as in previous one and but in the very second step catalyst is employed instead of microorganism. Various research are going on this manner that how this thermo chemical method is improved. Till now almost 50% bio ethanol can be obtained in this process. Through some processes methanol is first obtained and then this methanol is converted to ethanol with the help of catalyst and with the help of this process 80% Ethanol is achieved[17].

Unfortunately, the cost of thermo chemical processes is the major barrier for the production of bio ethanol [43, 44, 45]. But day by day this process is appeared as a promising option for bio ethanol production because of its higher benefits from the view point of life cycle and research are going on[46].

12. Bio-ethanol and US picture:

At present the United state use approximately 20 million barrels of petroleum oil daily of which almost 60% is taken from outside. 70% of the total is utilized as liquid fuel for transportation purpose. According to The US energy policy acts of 2005 "the oil industry is required to blend 7.5 billion gallons of renewable fuels into gasoline by 2012"[47]. Additionally many states have started already the using of bio ethanol and blend fuel. Till now the most renewable fuel is ethanol and recently United State achieves a capability of production almost 4 billion gallon bio ethanol, which is twice than global production. Starch (corn grain) is the major raw material used for bio ethanol production in the United State. From this source the US has the ability to produce 13 billion gallons per year and fix a goal to the 7.5 gallon per year as soon as possible within the next few years[33].

14. Bio-ethanol and World Picture:

In 2005 the world Bio ethanol production was 12.1 billion gallons and in 2006 the amount was reached to 13.5 billion gallons [48]. Among all bio fuel Bio ethanol production cover 94% with the main using source as sugar cane [49]. About 60% entire bio ethanol productions are done from cane sugar and remaining 40% from other crops [50]. The world's leader in the production is Brazil and the United States. They basically use sugar cane for this purpose and they together produce almost 70% of the world bio ethanol formation. However, the US and Brazil also depend on crude oil also side by side. But they always try to carry out their research for searching alternative fuel source. The top ten bio ethanol producers are presented in the following table.

Table 6: The top ten Bio ethanol producer (billion gallons)

USA	3.54	4.26	4.85
Brazil	3.99	4.23	4.49
China	0.96	1.00	1.02
India	0.46	0.45	0.50
France	0.22	0.24	0.25
Germany	0.07	0.11	0.20
Russia	0.20	0.20	0.17
Canada	0.06	0.06	0.15
South Africa	0.11	0.10	0.10
Thailand	0.07	0.08	0.09

Source reference [48].

Nearly US produce their all-bio ethanol through fermentation method from glucose and Brazil use sucrose. Any country can use this method only when they have good agriculture and economic condition both. During the last two decades several technologies are found for bio ethanol production from non-food plant source [51]. Large scale production will be start soon.

14. Disadvantages of Bio-ethanol Production:

Among all existing crops starch and sugar are two most important sources for bio ethanol production [52]. Availability of raw materials is a big obstacle for this production. The reason occurring for the season change and geographical area govern the fertilization of feed stocks. Side by side the cost price of these are increasing day by day and facing another major problem. 60-75% of the total bio ethanol formation cost cover by feed stock cost. But the technologies are not so much improved that can reduce this problem[53]. Bio ethanol can also be produced from Lignocellulosic materials but the same production cost become major barrier [54]. Side by side drawbacks also arise from environmental and food-versus-fuel issue.

15. Disadvantages using Bioethanol:

There are many problems facing of using of bio ethanol as an alternative fuel for internal combustion engine for a long time. These include:

- 1) Biodiversity – A large area is required for producing required crops. For this rainforest as well as natural habitat places may be seriously affected.
- 2) The food V fuel debate – Due to high production cost some farmers disagree to grow crops required for bio ethanol production.
- 3) Carbon emissions – Due to combustion of internal engine CO₂ must emit though bio ethanol is used as fuel. Research is going on to overcome this problem.
- 4) Bio ethanol has lower energy density than gasoline which makes it's not a good fuel at all.
- 5) Corrosiveness and toxic effect on environment are two major disadvantages of using bio ethanol.

There are so many cars which can never go with bio ethanol because they become too old and fuel economy is one of the major concern for that [55].

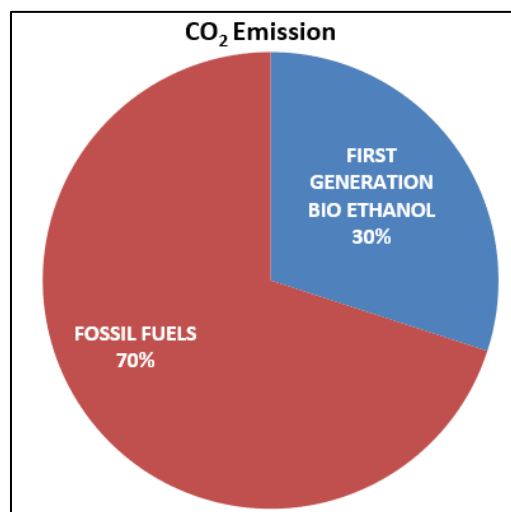
16. Advantages of Bio-ethanol:

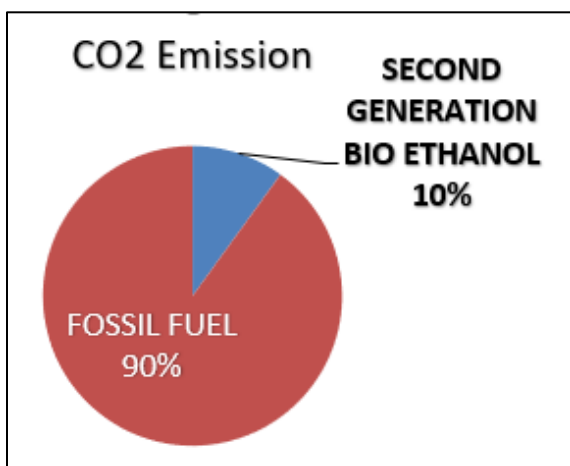
In spite of the above limitations bio ethanol has some advantages. CO₂ emission can be reduced up to 90% by using Bio ethanol as fuel instead of petrol in internal combustion engine. This is also good for life-cycle Sugar cane used for starting material in bio ethanol production can also be used for the production of heat energy. Nevertheless current European technologies reduce the emission around 35-65% based on the production method which is very significant. Lower tax is required for bio ethanol production and using now a day makes it good fuel as choice. The UK government imposes low tax on bio ethanol production cost. The first Bio ethanol as E85 was sold in the market by UK government and its price was 2% cheaper than conventional petrol. But if you use 100% bio ethanol then you can save 50% fuel from using conventional one. [56]

17. Environmental Impact:

Globally one fifth CO₂ is emitted by the transportation sector in every year. If we do not look any attention to that then transport become the main driver of global CO₂ emission in future. Alternative to fossil fuel are Bio ethanol and Bio diesel.

First generation bio ethanol has a capability of reducing CO₂ emissions up to 20 and 50% in comparison to petrol and diesel fuels based on the production efficiency of the bio ethanol plant. More CO₂ can be reduced by developing suitable methodologies in future. Second generation bio ethanol is able to reduce CO₂ emission up to as 90% compared to petrol and diesel fuels. Though research is going on how this emission can be more minimized. The following pie diagrams show the comparison between two generation bio ethanol. From this it also can be said that bio ethanol is more environmental friendly compared to fossil based fuels. This environmental benefit makes it a good future choice as fuel. Environment becomes more and more 'greener' if we use more and more bio ethanol.





18. Bioethanol Economy:

The cost of bio ethanol production basically governed by efficiency of used ethanol plant, feed stocks availability, distillers dried grains (DDG) natural gas, enzyme, yeast and chemicals used, electricity, and waste products. The bio ethanol plant of proper size can produce 51.5 million gallons of denatured bio ethanol annually from 18.1 million corn bushels. 154, 500 tons of DDG is produced additionally with the same plant. The cost allotted for generation of bio ethanol with a dry mill plant recently total US\$1.65/gallon. Corn cover 66% costs for carrying operation and 20% of operating costs is covered by fuel boilers and dry DDG [57].

Till date, in the world Brazil has the largest production house of Bio ethanol. Brazil mainly uses sugar cane for forming bio ethanol and sugar cane is more effective as well as profitable feeds stocks than corn grains [58]. Among all over the world the production cost in Brazil is the lowest. The range is US\$0.68-US\$0 [59] per gallon. Factors responsible for low production cost in Brazil are low labor cost, and well developed infrastructure over at last three decades and climate condition is also helpful very for good production [60].

19. Bio ethanol vs. Ethanol:

Some common misdeals are present for Bio ethanol and Ethanol difference. All time it is said that Bio ethanol is more friendly for environment than Ethanol, and but it is not the proper answer.

On the ground of the chemical formula it can be said that both Ethanol and Bio ethanol are same. They have dissimilarities lied on their production process. Bio ethanol is considered to be processing through fermentation which is more eco-friendly and some starting materials are straw, sugar beet, wood and corn. But Ethanol, is produced from feed stocks based on petrochemical and for this ethylene is hydrolyzed in presence of acid catalyzed environment.

In spite of their source material their functions are almost similar. They are very environmental friendly fuels because they contain oxygen responsible for lowering emission of particulate.

Sustainability is the point of difference. The production based on fossil fuels obviously a less-clean and sustainable production choice. On other side the materials used for Bio ethanol production may not sustainable as well as valuable because it is generally made from organic and food sources. Thus ethanol production is more sustainable than bio ethanol production [61].

Ethanol can be produce in modern time from some new non-food alternatives such as tree trimmings, sawdust and agricultural waste like wheat straw and from such grasses which are growing fast.

Bio ethanol is more 'greener' compare to ethanol for its source materials. But both are identical solvent and these are also the best choice as alternative fuel due to their great environmental benefits as well as some other advantages.

21. Bioethanol Vs Biodiesel:

	Bio ethanol	Biodiesel
Method of generation	Dry-mill method	Trans esterification
Environmental utility	Both has capability of reducing emission of GHGs because they are produced from crops which can absorb obtained CO ₂	
Selectivity	Suitable for selected gasoline-based automobiles	any diesel-based engines can be run with this.
Costs	Cheaper	More expensive
Generation amount	420 gallons per acre corn.	60 gallons of per acre soybeans.
Energy Generation	93% energy can be generated by per gallon	Only 25% of total energy can be generated.
Amount of GHG emission	Almost 12% lower than conventional diesel	Almost 41% lower than regular gasoline

Source reference [61, 62]

22. Future Aspects:

Some facts like CO₂ emission during bio ethanol production, more use of pesticides for agriculture production of bio ethanol source create some environmental issues. Globally day by day the required amount of bio ethanol rises up as alternative choice and scientist till now are trying to improved production technologies. All these are thinking with a great attention only because of only based on the fact that bio ethanol is more environments friendly. Most environment friendly organization think that bio ethanol is the best alternative to control rapid rise of environment pollution. Fuel ethanol also generates greenhouse gas during their production. "fertilizers and agricultural processing, transportation of the biomass, processing of the fuels, and

transport and delivery of bio fuels to the consumer" are some common sources for this CO₂ emission. Though some production processes emit less CO₂, for example formation of bio ethanol from sugar cane through fermentation process. However it is observed that the suitable technologies are savings at least 50% CO₂ emission than conventional fossil fuel [62]. From much analysis it is seen that the major problem of bio ethanol production is its production cost. However a great focus is given by many sciences from various countries in order to avoid that problem and hopefully this can be achieved as soon as possible. Production cost basically rise from feed stock and most of the research giving their attention to that fact how production cost of feed stocks can be in controlled. Much of this attention has been given to converting the total feedstock plant into more useful end products, which allow lowering of ethanol cost as production becomes more economically suitable. In southern Africa they focus their attention to restrict the practice of burning sugarcane residues after harvesting. Side by side electricity also can be generated with these residues, as well as sugarcane bagasse (a fibrous waste-product of sugarcane extraction), allowing export electricity to the neighboring localities (Johnson, 2000). Brazil already sells excess electricity to maintain local works. For this reason bio ethanol become a very choicable option in electricity market also. This electricity generation from residues also becomes an area of interest for further research for developing amount as well process of generation of electricity. This Additional research also gives a new light towards the way of lowering production cost of bio ethanol. Additionally, the increasing demand of bio ethanol in the modern market also make happy situation for farmers because they become more interested on fertilizing sugar cane and other Lignocellulosic feed stocks more and more. It is good sign for future.

22. CONCLUSION:

From the past several years significant progress had been seen in all aspects of Bio ethanol properties and production. For this reason government take several policies and steps for further improvement. Bio ethanol is the most common alternative fuel source worldwide. Today human being as well as plant world is facing some major problems a) high fuel price b) climate change c) air pollution. So Bio ethanol must be promoted as alternative choice in place of fossil fuels. Green-house gas (GHGs) emission also can be reduced by increasing use of it which is very good message to our environment. Therefore we need improve bio ethanol production more and more by maintaining sustainability and biodiversity criteria.

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