CHEMISTRY

Assessment Task: Ethanol

Construct a table that lists the problems and benefits of using ethanol as an alternative car fuel.

Problems and benefits of using ethanol as an alternative car fuel.

Advantages	Disadvantages
• Renewable source of energy. • Can be economically produced from renewable resources (corn, sugar cane, grains...) →reduce the customer's dependency of foreign oil. • E85 can reduce greenhouse gas emissions ('carbon neutral') created by car exhaust to 37%→ decrease in the ozone formation. • Perform a more complete combustion which brings less impact on the environment. • When used as gasoline additive, ethanol is less harmful than MTBE and lead. • Spills easily biodegraded and easily diluted to non-toxic concentrations. • Richer in octane →can cut emissions of cancer-causing benzene and butadiene by more than 50%. • 10% of ethanol can be added to petrol without any need of engine modification. • In accidents, ethanol is less dangerous than petroleum because of its low evaporation speed and non explosive.	• Ethanol has a lower heat of combustion than petroleum. • Existing car engine need to be modified if more than 10% ethanol used in fuel. • Large areas of land needed to grow the crops. • Water presented in plant matter makes the process to produce ethanol become inefficient. • Ethanol can absorb water and if water enter the fuel tank, it dilutes ethanol and causes problems with corrosion. • Waste generated from ethanol production, called swill is harmful to the aquatic life. • Consumer have to pay more for ethanol fuel since energy used in distillation ethanol is taken from burning fossil fuel. • Ethanol burns more for the same distance compared to petroleum → drivers have to fill their car more often and drive extra distances to special services to buy ethanol. • Non conductive to pipeline transport →needs other form of transport.

MTBE: methyl tertiary butyl ether an additive in gasoline, at room temperature it is volatile, flammable and highly soluble in water

Use the information from the table to write an exposition that:

i) Assesses the current success of ethanol as a car fuel.
ii) Justifies future research into the use of ethanol fuels and government subsidies of their use.

ETHANOL – FUEL FOR THE FUTURE

Ethanol is considered as an alternative fuel in vehicles. It is renewable and friendly to the environment as it reduces the amount of emissions and greenhouse effect. It also reduces the dependence on non-renewable fossil fuel and importing oil. Alternative fuel for vehicles is no longer a problem that future generation will need to mention, it is becoming our current worry as the world's oil reserve is running out. This fuel crisis has forced the government to search for cheaper, safer and effective fuel to replace fossil fuels. And ethanol is becoming a reasonable answer as it performs a lot of advantages which are superior to gasoline. It is being blended with petrol such as E10, E85 which performs very well and has been developed in several countries such as United State, Brazil, Australia, Canada...Despite the higher cost and some other disadvantages, governments can provide price subsidies or tax incentive to increase the consumption of ethanol fuel in the future. Research is also processing to invent the cheaper methods to produce ethanol although they are not yet widely available.

Model T Ford which was introduced in 1908, is the first vehicle run by using ethanol as a fuel. But the attraction of petroleum was too strong. Now because of the rise in cost and lack of oil's reserve, ethanol is making the way back to the fuel market. Brazil is the world's largest producer of ethanol, producing about 40% of the world ethanol production, with USA coming second. Brazil was once dependent on foreign oil supply, but now become self-supply for fuel by heading a revolution in fuel industry: using ethanol which is manufactured from biomass. Australia is currently using the by-product of sugar and wheat processing. By early 2009, there were approximately eight million E85-compatible vehicles on U.S. roads. It clearly shows the potential of ethanol in replacing gasoline in the future.

One of the benefits that makes ethanol become a potential fuel is that ethanol is a renewable source of energy hence it contributes to the greener environment. It is manufactured from the fermentation of glucose such as starch, corn, sugar cane, wheat…Ethanol has the advantage of its chemical structure, contains 30% of oxygen so when being burned, it releases methane which is biodegradable and water, hence it lessens the amount of pollutants, resulting in a lower potential of ground level ozone formation. A study by US Department of Energy in 1997 had shown that by using ethanol, the fossil energy will be reduced by 50-60% and greenhouse gas emissions by 35-46%. In addition, ethanol has higher octane level than gasoline which has been used widely in race cars for years.

While gasoline is still the number one fuel and being used over the world, ethanol does contribute to reduce the total amount of oil need to import. Account that there is only 5% of the crops used in food industry. If the remaining (95%) could be used to convert into energy, it will reduce the dependence of human on fossil fuel enormously. As the consequence, it will boost the economy by increasing the demand of ethanol and theoretically, it would help to develop the requirement of local labour.

However, the decision to produce and apply ethanol as a main fuel requires the consideration of both positive and negative sides. The controversy rises when the cost of production of ethanol is far more expensive than gasoline. It includes the cost of transportation, storage, equipments, growing crops, harvesting, labour cost… The quality of the crops can still be affected by drought, insects or bad weather. Plus, in order to produce enough corn or sugar cane to supply for ethanol industry, there would be a large amount of lands required and farmers also need to decide how much of the

crops they should put aside for the production of ethanol and how much to sell for food industry. The consequences may include deforestation, soil corrosion and also the drop in food supplies which often means higher price. On the other hand, the issue can be handled if a well- plan is set up to balance the needs between food and fuel industries.

Although ethanol does reduce the amount of toxics released by car exhaust, it is less efficient than gasoline. Drivers will need more ethanol to run the same distance compared to gasoline, and they are expected to drive further distance to find a suitable gas station which offers E85 ethanol. Fuel with more than 10% ethanol is not compatible and may cause corrosion to the car engine. In addition, the method of transporting ethanol need to be altered as ethanol will pick up water and contaminants within the pipelines. These factors have contributed to the rise in cost of ethanol. That's why gasoline with cheaper price is still preferred by the consumers.

Another issue that is raised is what environmentalists called the "net energy". Is there more energy required to grow and process the raw material than energy contains in ethanol itself? But the study of US Department of Agriculture has proved that there is about 34% more of energy than it used to grow the crop and distill it into ethanol.

Ethanol has been used in many countries over the world in the last 2 decades. In Australia, a 10% ethanol mix with petrol (E10) is being considered, not only for environmental reasons but also for economical reasons as petrol's price is rising. Brazil- the country which fully depend on foreign oil, has reduced the rate of importing petrol from overseas by using crops as feedstock for production of ethanol fuel. This has extended the agriculture industry to grow crops for ethanol production. In 2008, 10% of energy usage in Brazil is from ethanol. Other countries in the world are considering following. This may become an economical reason (more countries are heading to ethanol) that can lower the cost of ethanol, and makes it an alternative and renewable energy sources.

In 1070, the government of Brazil began to launch the National Fuel Program, which aimed at increasing the share of produced fuel in the country's fuel pool. It achieved great success. By 1980, ethanol had a larger market share in the transportation sector than gasoline. As oil prices began to increase and "flex-fuel" cars, which can run on petrol, ethanol or any combination of the two became available in 2003, the shift moved again towards ethanol. Today, government regulates the market by changing the rate of blending anhydrous ethanol, sale from strategic reserves and credits for storing ethanol. Also, ethanol has the advantage of tax concession over gasoline. Due to the government subsidies, ethanol in Brazil costs around 50 cents per gallon, which make it quite competitive compared with gasoline.

In Australia, the Federal government in 2000 exempt fuel excise around 0.38 AUD per litre. It supports 2 ethanol projects; one in North Queensland, which intends to use molasses and sweet sorghum as feedstock, other in Brisbane which currently produce 10% ethanol-gasoline blend. In 2002, ethanol production subsidy at the same rate as ethanol used in petrol; the government also increased the cost of importing ethanol from overseas, hence boosted the local ethanol production industry. It contributes significantly to broaden the ethanol fuel industry in Australia.

Nowadays, fuel ethanol has been subsidising in all over the world such as U.S, China, the European Union, Canada, Peru and other Latin America. Also people who oppose ethanol argue that subsidising ethanol including tax incentive cannot make ethanol replace gasoline in the fuel market. But ethanol produced from biomass can compete with ethanol if it is produced more cheaply. Sugar canes and corns are potential sources of feedstock but sugar cane can't survive in cold condition, while corns fluctuate with the market price and also contribute to lift the price of ethanol. That's why research is being to set up to look for cheaper and more efficient ways to produce ethanol. One of these ways is using cellulosic ethanol which is made from wood, grasses; agriculture plant waste instead of corn or sugar cane. The major advantage to cellulose-based ethanol is that it is much more efficient than corn-based ethanol. While corn-based ethanol decreases emissions only 10 – 20% over gasoline, cellulose-based ethanol decrease emissions by 80-90%.

Also, current research has found a cheaper way to produce ethanol. Traditionally, ethanol is produced by fermentation of yeast, but genetic engineering now introduces a new process called enzymatic hydrolysis, using a new bacterium called Zymononas mobilis which has shorter fermentation time; it has higher rate of ethanol tolerance and provide better yield. However, Z.mobilis can only be used in glucose, fructose or sucrose for ethanol production, further research need to be carried out in order for Z.mobilis to utilises in different kind of agriculture plants. More over, distillation of ethanol from fermentation mixture can require half.

Enzymatic hydrolysis: process is used to convert starch and cellulose in plant stalk, leaves, wood and other biomass by the addition of enzyme

Distillation is being replaced by low energy methods such as using solid zeolite minerals as filters

So, is ethanol a promising alternative fuel for future…?

The benefits that ethanol brings up is undeniable. It is a renewable source of energy. Ethanol has been used in oil industry for at least 30 years and its roles in contributing to a greener environment and reducing addiction of consumers to petroleum are significant. While ethanol might be more expensive to produce at the short-term, it will provide a better long term solution for the future when world oil's reserve is restricted and problems about greenhouse effect and climate change created by petrol are raised. Today, ethanol is being produced and blended with gasoline in a lot of countries in the world such as US, Brazil, Canada, China, and Thailand… where there is a lack of oil reserve or excess in biomass source. Besides, there are a lot of challenges need to be consider, for example, the crisis between food and fuel industry or the need of modified vehicle engines and transport pipelines. Thus, government subsidy does give a chance to ethanol to be used more widely, plus the increasing in ethanol-fuel stations, development of flex-fuel technology and current research in a easier and less complicated ways of producing ethanol are contributing to lift the ethanol industry into a new phase.

Ethanol - Current Research And Outlook http://science.jrank.org/pages/2577/Ethanol-Current-research-outlook.html#ixzz0Yi1YG2RK

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CURRENT RESEARCH AND OUTLOOK

DOE's research partners are developing a process, called enzymatic **hydrolysis**, that uses special strains of **yeast** to manufacture ethanol in an inexpensive, high-yield procedure. This project is also developing the use of waste products as a fuel for ethanol production.

CURRENT RESEARCH AND DEVELOPMENT

Feedstock is the most significant cost element in ethanol production. One important area of research is the identification of starch- and/or sugar-containing crops that can be grown on poor land and that require a minimum amount of cultivation and chemical inputs (e.g., fertilizers). Such feedstocks must be compatible with the local climatic conditions, the water resources, and the soil type. They should not disrupt the local agricultural economy. Alternative feedstocks under evaluation in various parts of the world include sago palm, bamboo, sweet potatoes, and honey locust trees. Once potential crops are identified, research will be directed toward increasing yields, adapting crops to specific situations, and developing cultivation, harvest, and storage techniques.

Alternative feedstocks will require research to adapt starch hydrolysis and fermentation equipment and procedures to the particular feedstock characteristics and concentration of fermentable sugars. Fermentation research might also include the selection of yeast strains for improved fermentation efficiency. Improvements could include increased tolerance to high sugar and ethanol concentrations, tolerance to high fermentation temperature, or adaptation to particular feedstock characteristics.

Research needs in ethanol and by-product end uses could include evaluation of technology and economics for uses of ethanol other than as a motor fuel; evaluation of conversion techniques for specific types of engines; and evaluation of specific feedstocks for recovery and use of by-products. Research on integration of ethanol fuel production with agricultural economies could cover a broad range of topics, including feedstock economics and cultivation, plant and equipment design to fit specific local constraints, process fuel sources, impacts on employment and income distribution, and effects on national balance of payments.

http://www.appropedia.org/Understanding_Ethanol_Fuel_Production_and_Use#Ethanol_Use_in_Appliances

CHOOSING THE APPROPRIATE TECHNOLOGY

Decisions regarding plant scale, equipment, and process design depend primarily on feedstock, the availability of markets for both ethanol and its by-products, and the availability of plant financing. Economies of scale in ethanol fuel production are much less important than well-planned integration of ethanol fuel production with agricultural economics, local transportation, local utilities, and end uses.

Economic decisions regarding ethanol production may rely more on the ability to meet such objectives as increasing rural employment, achieving energy independence, and providing alternative markets for crops than on direct evaluation of production costs and market values. Technical decisions regarding plant scale, process design, and equipment may be influenced by the ability to meet such objectives as the use of local labor and locally manufactured equipment, the creation of alternative markets for agricultural crops as feedstocks, and the local use of process energy.

The emergence of ethanol as a viable alternative to gasoline has led to two major controversies that can affect decisions regarding ethanol fuel production.

The first controversy concerns the question of net energy yield; that is, whether the energy content of the ethanol is greater than the energy consumed in production. However, one recent analysis, which took into account the energy used to cultivate feedstocks and to transport feedstock and products, calculated that ethanol production consumes more energy than is produced. In ethanol production, low-quality, diffuse primary energy sources are upgraded to a high-quality, liquid fuel. Solar energy in the form of plant carbohydrate and low-quality boiler fuels is converted to a fuel suitable for use in transportation. In simple terms, the response is that automobiles cannot run on cassava. When ethanol is viewed as an energy conversion system, the net energy question is largely irrelevant. Nevertheless, the question is useful because it points out the need to select those feedstocks requiring relatively little cultivation and low inputs of fertilizer and chemicals, and the need to use low-quality boiler fuels.

The second controversy surrounds the issue of food versus fuel; that is, whether the use of agricultural crops for ethanol fuel production will adversely affect the amount of land available for food production and food supply, as well as affecting food prices. This is a complex question to which there are no absolute answers. On the one hand, a large-scale diversion of food crops to ethanol production could reduce food supplies and increase food prices. On the other hand, a carefully planned and well-integrated ethanol fuel industry does not necessarily result in direct competition for agricultural land and food supplies. Low-value crops grown on marginal land are often good alcohol feedstocks with poor food value. Cultivation of low-value crops may contribute to the economy through conversion to a high-value product. Increased rural employment may increase people's economic access to high-quality food. Ethanol might also be produced from agricultural commodities that would otherwise be exported. Sugar cane, for example, may be worth more as a feedstock for domestic fuel production to displace imported petroleum than as an export crop. The issue of food versus fuel emphasizes the need for careful planning but does not mean that ethanol fuel production is an inappropriate technology.

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Since most U.S. ethanol is produced from corn and the required electricity from many distilleries comes mainly from coal plants, there has been considerable debate about how sustainable corn-based bio-ethanol could be in replacing fossil fuels in vehicles. Controversy and concerns relate to the large amount of arable land required for crops and its impact on grain supply, direct and indirect land use change effects, as well as issues regarding its energy balance and carbon intensity considering the full life cycle of ethanol production. Recent developments with cellulosic ethanol production and commercialization may allay some of these concerns.

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