Environmental CleanTechnology

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Abstract:

"Green technology" or Clean technology is the application of the environmental sciences to conserve the natural environment and resources, and by curbing the negative impacts of human involvement. Our innovations have helped move the world from the industrial age to the information age. Today, at the beginning of the 21st Century, we must step forward to help solve the climate and energy crises and protect our environment. By using our local ingenuity, entrepreneurship, and creative talent, we can create solutions that change the course of global events. By capitalizing on the innovation in our community, we can create thousands of new jobs, grow city revenues, expand our local economy, and demonstrate how deploying clean and green technology is fiscally responsible. Without Clean Technology innovation, communities will become more polluted, the effects of global warming will increase, and our consumption of fossil fuels will continue our dependency on foreign oil. Thus, we can lead the nation in becoming more energy efficient, producing and using electricity from clean renewable sources, creating green buildings, diverting waste from landfills, creating greener street systems, delivering recycled water, and reducing greenhouse gas emissions.

When applying sustainable development as a solution for environmental issues, the solutions need to be socially equitable, economically viable, and environmentally sound. Some environmental technologies that retain sustainable development are; recycling, water purification, sewage treatment, remediation, flue gas treatment, solid waste management, renewable energy, and others. Some technologies assist directly with energy conservation, while other technologies are emerging that help the environment by reducing the amount of waste produced by human activities.

Membrane technology is the most innovative technology in which the energy savings as well as environmental protection is achieved. The footprints are reduced to a large extent. In purification methods using membranes, the latent heat is conserved and CO_2 emissions are eliminated against applying sterilization by heating or cooling using traditional methods. Thus energy conservation & environmental protection is achieved.

Use of biofuels such as biodiesel for transportation produces no net output of carbon in the form of CO_2 and achieves 30-50 % greenhouse gas savings. Using the syngas is more efficient than direct combustion of the original biofuel as more of the energy contained in the fuel is extracted. Using waste biomass to produce energy can reduce the use of fossil fuels, reduce greenhouse gas emissions and reduce pollution and waste management problems. Some technologies such as anaerobic digestion can be used as a distinct waste

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management strategy to reduce the amount of waste sent to landfill and generate methane, or biogas.The global reduction of greenhouse gases is dependent on the adoption of energy conservation technologies at industrial level as well as this clean energy generation. That includes using unleaded gasoline, solar energy and alternative fuel vehicles, including plug-in hybrid and hybrid electric vehicles.

If landfill gas is not harvested ,it escapes into the amosphere, this is not desirable because methane is a greenhouse gas , with more global warming potential than CO_2.. So, by harvesting and burning landfill gas ,its global warming potential is reduced in addition to providing energy for heat & power.Biologically produced alcohols, most commonly ethanol, and less commonly propanol and butanol, are produced by the action of microorganisms and enzymes through fermentation of sugars or starches, or celulose. Biobutanol is often claimed to provide a direct replacement for gasoline, because it can be used directly in a gasoline engine (in a similar way to biodiesel in diesel engines).

Thus, it is the need of hour to promote innovative green and clean technologies for sustainable environment.

Keywords: Environment, membrane, syngas,biofuels,CO_2

Our problems are man-made, therefore they may be solved by man. No problem of human destiny is beyond human beings.

– John F. Kennedy

Introduction

"Green technology" or Clean technology is the application of the environmental sciences to conserve the natural environment and resources, and by curbing the negative impacts of human involvement. Sustainable development is the core of environmental technologies.Some environmental technologies that retain sustainable development are recycling, water purification, sewage treatment, remediation, flue gas treatment, solid waste management, renewable energy and others. Energy sources such as solar power create less problems for the environment than traditional sources of energy like coal and petroleum. Scientists continue to search for clean energy alternatives to our current power production methods. Some technologies such as anaerobic digestion produce renewable energy from waste materials. Since electric motors consume 60% of all electricity generated, advanced energy efficient electric motor (and electric generator) technology that are cost effective to encourage their application, such as the brushless wound-rotor doubly-fed electric machine and energy saving module, can dramatically cut the amount of carbon dioxide (CO_2) and sulphur dioxide (SO_2) that would otherwise be introduced to the atmosphere.Thus, Some technologies assist directly with energy conservation, while other technologies are emerging that help the environment by reducing the amount of waste produced by human activities.

Technologies retaining sustainable development

Some environmental technologies that retain sustainable development are; recycling, water purification, sewage treatment, remediation, flue gas treatment, solid waste management, renewable energy, and others.When applying sustainable development as a solution for environmental issues, the solutions need to be socially equitable, economically viable, and environmentally sound.

Recycling:

Recycling is the reprocessing of materials into new products. Recycling generally prevents the waste of potentially useful materials, reduces the consumption of raw materials and reduces energy usage, and hence greenhouse gas emissions, compared to virgin production.Recycleables include glass, paper, aluminium, asphalt, iron, textiles and plastics. By harvesting and burning landfill gas ,its global warming potential is reduced in addition to providing energy for heat & power.Some technologies such as anaerobic digestion can be used as a distinct waste management strategy to reduce the amount of waste sent to landfill and generate methane, or biogas.

Biodegradable waste, such as food waste or garden waste, is also recyclable with the assistance of micro-organisms through composting or anaerobic digestion. Paper recycling began in Britain in 1921, when the British Waste Paper Association was established to encourage trade in waste paper recycling. Resource shortages caused by the world wars, and other such world-changing occurrences greatly encouraged recycling. The next big investment in

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recycling occurred in the 1970s, due to rising energy costs. Recycling aluminum uses only 5% of the energy required by virgin production; glass, paper and metals have less dramatic but very significant energy savings when recycled feedstock is used.so,first, we should start by reducing the quantity of waste we create. We can increase the amount we recycle, and can reuse more products and convert solid waste and biosolids into biodiesel, methanol, biogas, and electricity.

Water purification

Water purification is the process of removing contaminants from a raw water source. The goal is to produce water for a specific purpose with a treatment profile designed to limit the inclusion of specific materials .Chemical analysis, while expensive, is the only way to obtain the information necessary for deciding on method of purification.Various methods can be employed for water purification, such as ultrafiltration, reverse osmosis, ion exchange,etc.Along with maximizing water conservation efforts,the quantity of recycled water we produce & distribute should be increased.Recycled water has proven its value for irrigation, cooling and manufacturing, and there are many opportunities for growth in these uses.

Membrane technology :

Membrane technology is the most innovative technology in which a semipermeable membranes are used to achieve separation or purification. In this, the energy savings as well as environmental protection is achieved.The footprints are reduced to a large extent.In purification methods using membranes, the latent heat is conserved and CO_2 emissions are eliminated against applying sterilization by heating or cooling using traditional methods.Thus energy conservation & environmental protection is achieved thereby making it a cleaner technology.

Sewage treatment

Sewage treatment, or domestic wastewater treatment, is the process of removing contaminants from wastewater, both runoff (effluents) and domestic. It includes physical, chemical and biological processes to remove physical, chemical and biological contaminants. Its objective is to produce a waste stream (or treated effluent) and a solid waste or sludge suitable for discharge or reuse back into the environment. The final effluent after sewage treatment can be discharged into a stream, river, bay, lagoon or wetland, or it can be used for the irrigation of a golf course, green way or park. If it is sufficiently clean, it can also be used for groundwater recharge.

Solid waste management

The importance of proper solid waste management is one of the prime functions of the civic body, as insanitary management of solid wastes is a cause of much discomfort. Since waste management is the fundamental requirement for public health these wastes must be managed properly.The systemmatic management of solid wastes either in generation of electricity or recycling these wastes to form finished goods can help to protect environment from being polluted and also energy can be obtained , thus employing clean technology.

Renewable energy

Renewable energy effectively uses natural resources such as sunlight, wind, rain, tides and geothermal heat, which are naturally replenished. Renewable energy technologies range from solar power, wind power, hydroelectricity/micro hydro, biomass and biofuels for transportation. About 13 percent of the world primary energy comes from renewables, with most of renewable energy coming from traditional biomass, like wood-burning. Using waste biomass to produce energy can reduce the use of fossil fuels, reduce greenhouse gas emissions and reduce pollution and waste management problems.

Hydropower is the next largest renewable source, providing 2-3%, and modern technologies like geothermal, wind, solar, and marine energy together produce less than 1% of total world energy demand. Brazil has one of the largest

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renewable energy programs in the world, involving production of ethanol fuel from sugar cane, and ethanol now provides 18 % of the country's automotive fuel. The global reduction of greenhouse gases is dependent on the adoption of energy conservation technologies at industrial level as well as this clean energy generation. That includes using unleaded gasoline, solar energy and alternative fuel vehicles, including plug-in hybrid and hybrid electric vehicles.

Biodiesel production by transesterification using reactive distillation- A case study

Clean technology is a means to create electricity and fuels with a smaller environmental footprint.Investments in clean technology have grown considerably since coming into the spotlight around 2000. Biofuel is considered as a means of reducing greenhouse gas emissions and increasing energy security by providing an alternative to fossil fuels. Biodiesel the most promosing biofuel is produced from oils or fats using transesterification and is a liquid similar in composition to mineral diesel. Its chemical name is fatty acid methyl (or ethyl) ester (FAME).

Pure biodiesel (B100) needs to meet the requirements of ASTM D-6751 to avoid engine operational problems.

Table 1. ASTM D-6751 Standards for biodiesel

Flash point (closed cup)	130°C min. (150°C average)
Water and sediment	0.050% by vol., max.
Kinematic viscosity at 40°C	1.9-6.0 mm2/s
Ramsbottom carbon residue, % mass	0.10
Sulfated ash	0.020% by mass, max.
Sulfur	0.05% by mass, max.
Copper strip corrosion	No. 3 max
Cetane	47 min.
Carbon residue	0.050% by mass, max.
Acid number -- mg KOH/g	0.80 max.
Free glycerin	0.020 % mass

Total glycerine (free glycerine and unconverted glycerides combined)	0.240% by mass, max.
Phosphorus content	0.001 max. % mass
Distillation	90% @ 360°C

Biodiesel contains only trace amounts of sulfur typically less than the new EPA standards.Biodiesel offers safety benefits over petroleum diesel because it is much less combustible, with a flash point greater than 150°C, compared to 77°C for petroleum diesel.Biodiesel B20 is a proven fuel with over 30 million successful US road miles, and over 20 years of use in Europe. Biodiesel is biodegradable in water, up to 98% in three weeks.

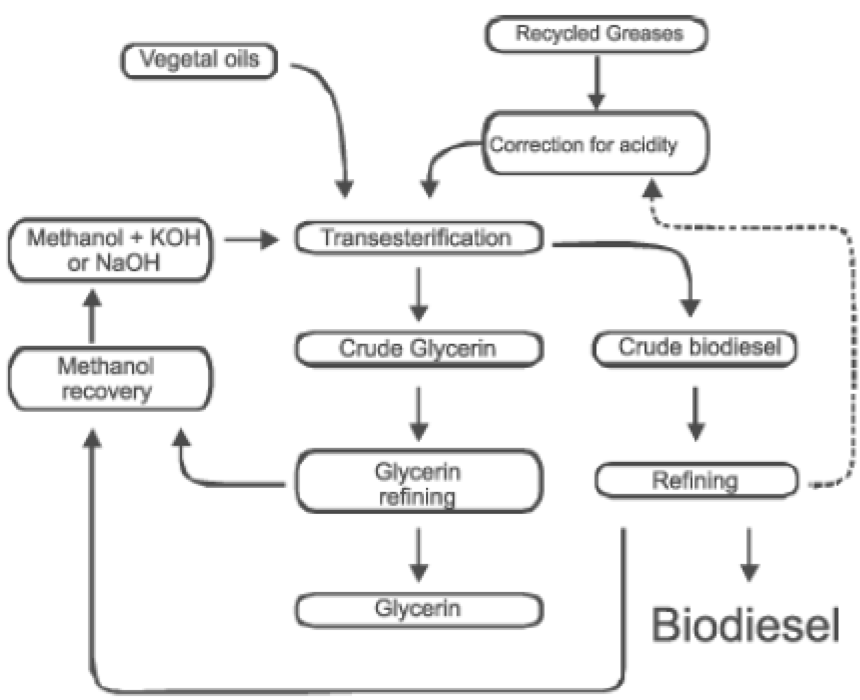

Fig.1. Schematic process for biodiesel production

Biodiesel production by transesterification using reactive distillation is one of the most promising clean technologies which involves less energy for production of biodiesel fuel from waste/nonedible/edible vegetable oils and it

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reduces carbon footprints to the large extent. Reactive distillation involves simultaneous reaction and separation in a single piece of process equipment.It is applicable to equilibrium limited reactions where one product is the most volatile component. Process intensification results in lower energy and capital costs. Each reaction system requires a unique approach for successful design and operation. Biodiesel, a mixture of mono-alkyl esters of fatty acids, is currently manufactured by trans-esterification of triglycerides with methanol using NaOH or KOH as liquid base catalyst.This catalyst is corrosive to the equipment, but this is easily overcome with little cost penalty, by constructing the reaction vessels out of stainless steel. However, the main drawback is that the liquid base catalyst has to be neutralized afterwards— typically using HCl—thus producing waste salt streams. Moreover, due to the presence of free fatty acids it reacts to form soap as unwanted by-product hence requiring more expensive separation. Another method to produce these fatty esters is the batch-wise esterification of fatty acids using H_2SO_4 as catalyst. However, the problem here is the batch operation mode that is not suitable for very large-scale production and again it involves costly neutralization and separation of the homogeneous catalyst.

Table 2. Average biodiesel emissions compared to conventional diesel

Emission type	B20	B100
Total unburned hydrocarbons	-20%	-67%
Carbon monoxide (CO)	-12%	-48%
Carbon dioxide (CO2)—life cycle production	-16%	-79%
Particulate matter	-12%	-47%
Nitrogen oxides (NOx)	+ 2%	+10%
Sulfur oxides (SOx)	-20%	-100%
Polycyclic Aromatic Hydrocarbons (PAH	-13%	-80%
Nitrated PAH’s (nPAH)	-50%	-90%

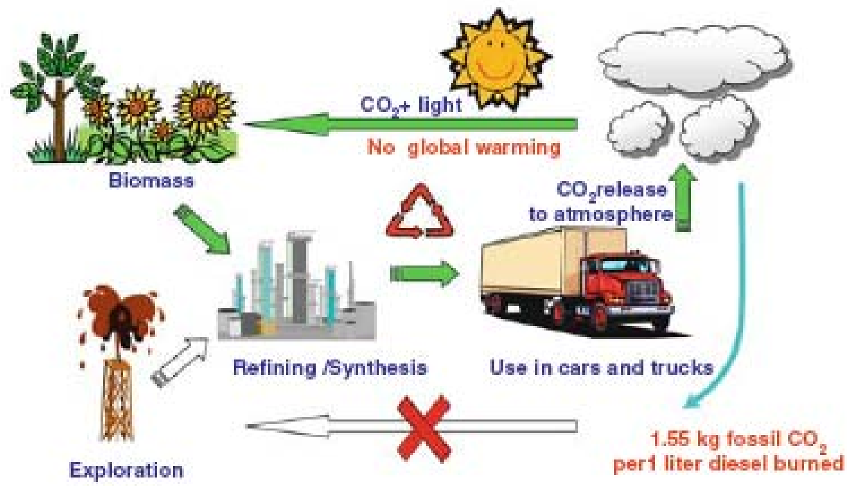
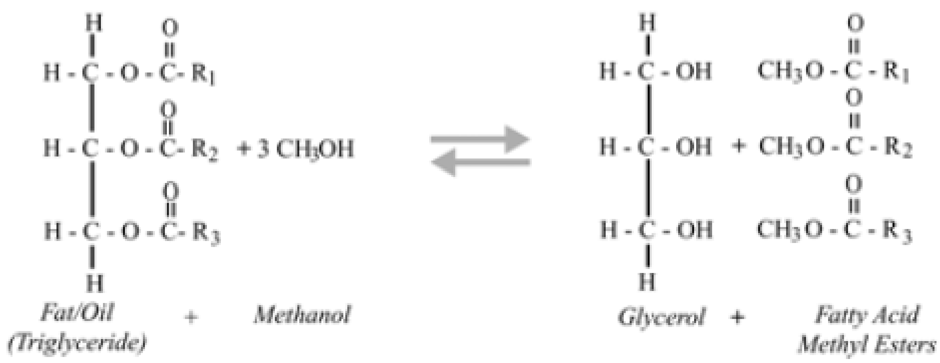


Fig.2 Lifecycle of biodiesel as environmentally-friendly fuel

Biodiesel Production process:

Biodiesel is produced by the transesterification reaction as shown below:



For achieveing more benefits transesterification can be coupled with reactive distillation.The reaction conditions such as reactants ratio, temperature and pressure determine the phase equilibrium. For temperatures below 100 ^{o}C, only low conversions can be achieved and an excess of alcohol is required to have only one liquid phase. For stoichiometric reactants ratio, two liquid phases exist at temperatures below 100^{o}C.If temperature exceeds 100^{o}C and the system is closed at over pressure then three phases exist: vapours–liquid–liquid. Liquid separation is undesirable due to catalyst deactivation in the presence of water.The best solution is working at temperatures above 100 ^{o}C, in a system

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with continuous water removal.By removing water as by-product the equilibrium is shifted towards ester formation.

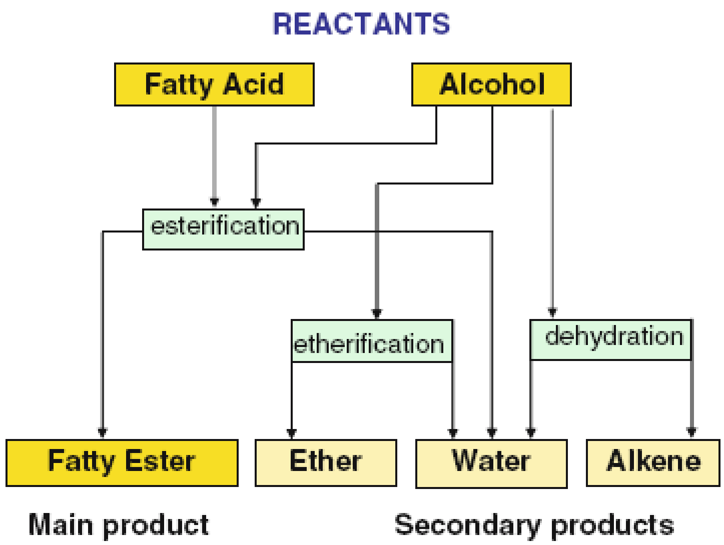

Fig.3 Reaction pathways and possible products

Hence, the ester will always be separated in the bottom of the reactive distillation column (RDC). Water is present as side product, and typically is removed as top product due to its lower boiling point, together with the alcohol if it is volatile (and not completely converted) or if it forms azeotropes with water.

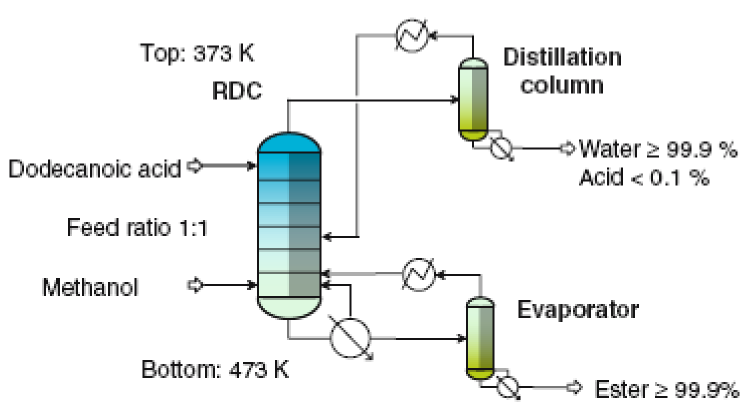

Fig.4 Biodiesel Production-Fatty acids esterification with mehanol

Fig.4 presents the flowsheet for esterification of dodecanoic acid with methanol. High purity final products are feasible. Note however that pure fatty acid esters cannot be the bottom product of the reactive distillation column because of the high boiling points and lower thermo-stability. By allowing 1–2% of alcohol in the bottom stream, the reboiler temperature in the RD column can be kept below 200°C. An additional evaporator is used for further ester purification. When an excess of alcohol is used the maximum reaction rate is located at the top of the column, with total acid conversion in the bottom but partial conversion of alcohol in the top. For the optimal reflux ratio the maximum reaction rate is located in the centre of the column, providing complete conversion of both reactants at the ends of the column. The composition and temperature profiles in the reactive distillation column are shown in figure 5.

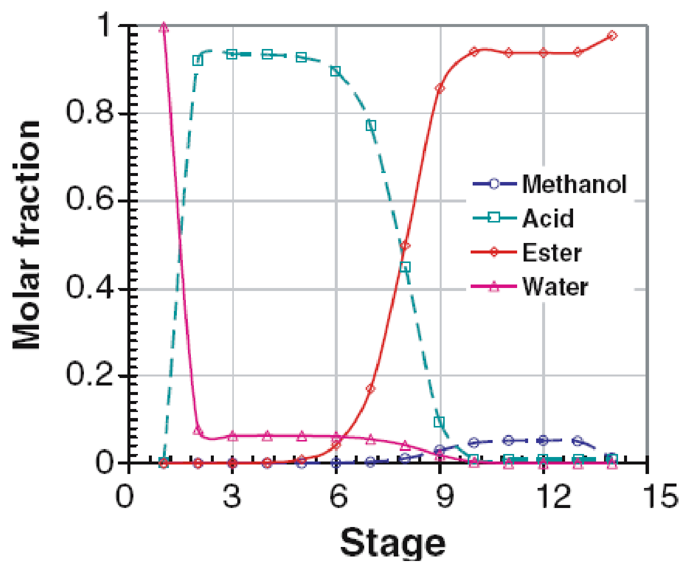

Fig.5 Reactive distillation column profiles- Liquid composition

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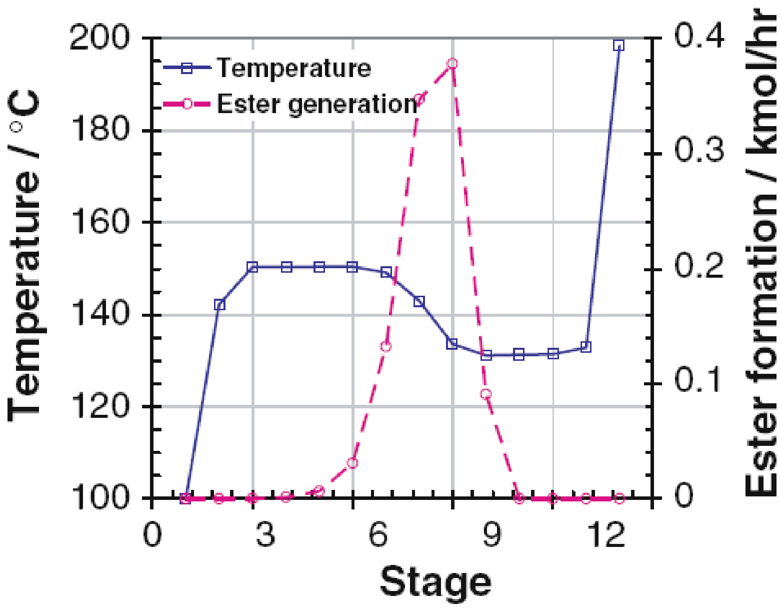

Fig.6 Reactive distillation column profiles- Temperature & ester generation

Conclusions

Through innovative partnerships with Clean Tech companies and leaders throughout our community, we can help solve the climate crisis while creating a new economic base.It will require unique partnerships between the City, residents, businesses, schools, and universities. It will require changing policies locally and advocating for aggressive change and investment at the State and Federal levels. Most importantly, it will require the enthusiasm and participation of every resident on this earth.

From the above case study,we can conclude that the biodiesel fuel can be produced by a sustainable continuous process based on catalytic reactive distillation.Pure biodiesel (100 percent biodiesel) reduces carbon dioxide emissions by more than 75 percent over petroleum diesel. B20 Biodiesel is one the most popular biodiesel blends presently available thoughout much of the U.S., Canada and Europe.Using a blend of 20 percent biodiesel reduces carbon dioxide emissions by 15 percent.The integrated design in above case study ensures the removal of water by-product that shifts the chemical equilibrium to completion and preserves the catalyst activity.

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Manufacturing of fatty acid esters by reactive distillation can be applied to a variety of alcohols and fatty acids, as a multifunctional reactor, the actual applications depending on the feedstock at hand. The process proposed here can dramatically improve the economics of current biodiesel synthesis and reduce the number of downstream steps. The key benefits are:

1. High unit productivity, up to 6–10 times higher than of the current process.
2. Lower excess alcohol requirements.
3. Reduced capital and operating costs, due to less units and lower energy consumption.
4. Sulfur-free fuel, since solid acids do not leach into the product.
5. No waste streams because no salts are produced

Engines in cars powered by B20 Biodiesel fuel will significantly fewer harmful exhaust emissions than those of regular petroleum diesel Engine performance (fuel economy, torque, and power) is less than that of diesel by 8% to 15%, because of the lower energy content of the biodiesel (121,000 Btu compared to 135,000 Btu for diesel fuel). Engine performance with B20 is virtually the same as with petroleum diesel. Every liter of biodiesel replaces 0.95 liter of petroleum-based diesel over its life cycle.For every unit of fossil energy used to produce biodiesel, 3.37 units of biodiesel energy are created. Biodiesel cuts emissions of cancer-causing compounds by 75 to 90 percent compared to those in petroleum diesel exhaust.

Thus,our goals are ambitious and therefore many innovative technologies can be used for sustainable environment. The actions that we take today will ensure a sustainable future tomorrow.However, together we can make this Green Vision a reality and ensure a sustainable environment for generations to come.

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