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A REVIEW ON ETHANOL PRODUCTION AND APPLICATIONS

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ABSTRACT

Ethanol is a viable and ecologically friendly fossil fuel replacement. Sugarcane molasses are waste products from the sugarcane processing industry that may be used to produce ethanol. Bioethanol is a kind of ethanol generated during the fermentation process by microorganisms such as Saccharomyces cerevisiae. For this fermentation, industrial quick dry yeast was chosen since it could be used as a starter right away, simplifying the production procedure and reducing the risk of bacterial infection. This review study gives an overview of ethanol and its production from sugar cane and cellulosic biomass components, as well as bioethanol's applications in diverse industries, such as medical, hand sanitizers, and medical wipes. In the future, ethanol will be widely used as a fuel additive and engine fuel. Because ethanol has no negative effects on the environment. Biofuels are superior to fossil fuels since they do not produce pollution.

KEYWORDS: *Cellulosic biomass, Ethanol, Fermentation, Molasses, Yeast, Fuels.*

1. INTRODUCTON

Bioethanol is a common byproduct of plant fermentation that is produced by hydrating ethylene. Ethanol is always a liquid at room temperature, with a melting point of 156 K and a boiling point of 351 K. It's one of the most important elements of virtually every alcoholic beverage's marketing strategy. It is frequently used in the manufacture of cough syrups, tonics, or tinctures iodine because it is an excellent solvent. Bioethanol is a chemical molecule that belongs to the alcohols family. It is also known as wood alcohol or grain alcohol. Bioethanol is a popular industrial chemical product that may be used as a solvent, a fuel additive, or to make a variety of organic compounds. Ethanol is a psychoactive ingredient present in a variety of alcoholic beverages, including wine, beer, and distilled spirits. Sugarcane, wheat, maize, sugar beets, and cassava, among other agricultural products, are fermented to produce ethanol. The overwhelming majority of the world's ethanol is made from sugarcane, which is mainly mass-produced in Brazil. Biofuels are seen as long-term alternatives to fossil fuels that are beneficial to the environment. We can assist the environment by conserving natural resources or reducing greenhouse gas emissions. Despite the fact that everyone knows it, the use of fossil fuels has been steadily rising throughout time. There has been a rise of around 84 percent in fossil-fuel carbon emissions between the 1980s and now, with an increase of nearly 7% only at the start of this decade[1].

Sugarcane feed is mainly made up of disaccharide, which is sugar. Saccharomyces cerevisiae, the microorganism employed, rapidly ferments sugar into ethanol. Crushing sugarcane stalks to get sugar-rich cane juice is the first step in making ethanol from sugarcane. The cane juice is collected and transported to a fermenter, where the yeast manufacturing process occurs. Ethanol is created when cane stalks pass through an extractor or expeller. Following the juice distillation process, the fibrous waste known as bagasse (45-50 percent moisture content) is burned to generate heat and power for plant use. After fermentation, beer is a manufacturing broth that contains about 5-12 percent ethanol by mass. The bioethanol is then transferred to the distillation process, where it is recovered or a liquid residue known as vinasse forms at the bottom of the column. A second water separation phase is required since the grade of bioethanol may reach 92-95 percent in this process. Dehydrating residual water using molecular sieves produces fuel-grade anhydrous ethanol (200 proof or >100 percent ethanol) as the end product.

Sugarcane harvesting: A majority of the harvesting is done by hand, particularly in tropical regions. In certain instances, harvesting is done mechanically. The goods is then transported quickly by truck to minimize losses. When sugarcane is chopped or crushed with water, a liquid with 10-15% solids is produced, which is subsequently used to extract the sucrose. The juice contains unwanted chemical components that may cause sugar inversion. This is followed by the clarifying step, which is required to avoid sugar inversion. In the clearing stage, the fluid is heated at 115°C and treated with lime and sulfuric acid, which precipitates unwanted components[2].

Cane fermentation produces a 10-20 percent sugar solution when juice and molasses are combined. Because fermentation is exothermic, cooling is required to keep the process inside the fermentation environment. Nutrients (nitrogen or trace elements) are given to yeast along with yeast to keep it alive. Batch or continuous reactors may be used for fermentation, although Brazil prefers permanent reactors.Sugarcane has a diagram of the ethanol manufacturing process, as well as the choice of producing refined sugar water (73-76%), soluble particles (10-16%), dried out fibre, or biogases (11-16 percent). The two main products, ethanol and sugar, are produced through a series of chemical and physical reactions that occur in seven stages[3].

1.1.Sugarcane Ethanol Production Process:

A sugar mill provided molasses made from sugarcane. As an ethanol producer, I purchased immediate dry yeast as well as commercial dry active from a grocery shop.Saccharomyces Cerevisae is a kind of microorganism.

1.2. Preparation of seed cultures:

2900 mL of cane sugar molasses are contained in shaking flasks. & the 2.5 percent (w/v), 0.5 percent (w/v) yeast extract, or 0.5 percent peptone, 1 percent instant dry yeast was produced. The yeast inoculum was cultured for 24 hours at 28°C.

1.3. Media that has not been pretreated:

Molasses medium was created by diluting cane sugar molasses in normal water in a 1:1 ratio and beginning with a pH of 5.2. Dilution was accomplished by diluting cane sugar molasses with ordinary water to produce sugar concentrations of 20%, 25%, and 30%. Each sugarcane molasses fermentation medium also received 0.1 percent yeast extract or 0.1 percent peptone. The solution was then autoclaved at 121°C for 15 minutes[4].

1.4. Media that has been pretreated:

Molasses medium was created by diluting cane sugar molasses in normal water in a 1:1 ratio and beginning with a pH of 5.2. By adding concentrated H2SO4 solution, the pH of the solution was increased to 3.9. (96.1 percent). The mixture was then cooked for 10 minutes at 95°C before being left at room temperature overnight. After that, the sugar content of the pretreatment molasses was adjusted to 20%, 25%, or 30%. Some required nutrition, such as 0.1 percent yeast take out or 0.1 percent peptone, was given to pretreated molasses to ensure optimum yeast growth during ethanol production. After that, the medium should be autoclaved for 15 minutes at 121°C.

1.5. Fermentation temperature:

Feeding (Feeding I & Feeding II) was utilized to induce substantial cell growth during fermentation. In a 2 liter glass container, I mixed a 200 ml seed culture with 400 ml sugarcane molasses to make the feed (20 percent , 25 percent and 30 percent). The samples were then incubated at 320°C for 6 hours. The start of the fermentation process was believed to be the first feeding (0 hour). The feed II was then completed by adding an additional 400 cc of cane molasses (20 percent, 25 percent, or 30 percent) to the mixture. After that, it was maintained at 32°C for 48 hours. Every 12 hours, the total dissolved solvent (TDS) (percent brix), decreasing sugar (total sugar), pH, cells, and ethanol concentration were all monitored[5].

1.6. The distillation procedure is as follows:

The fermenter was relocated to the column and steam was supplied from the bottom to maintain a temperature of 78-80°C. To generate vacuum, condensers were employed. Vapours concentrated and cooled as they traveled from the column to the condensers. After that, the fluid was heated to eliminate impurities before being delivered to a rectification column. When optimizing the procedure, temperature, pH, and agitation speed were all taken into consideration. Three variables were monitored and studied throughout the fermentation process in order to obtain the optimum ethanol concentration. The aim of the design experiment is to identify the optimum Saccharomyces cerevisae bioreactor and fermenter settings. The main goal of this industrial-scale fundamental research is to reduce overall production costs by improving process conditions[6].

1.7. Cellulosic Biomass Hydrolysis for Bioethanol Production:

Initial treatment refers to the dissolution rate or separation of one or more of the four major components of biomass (lignin, hemicelluloses, cellulose, and extractives) in order to chemically or biologically treat the remaining solid biomass. Hydrolysis breaks down the hydrogen bonds in the hemicellulose and cellulose fractions into their sugar component, hexoses or pentoses [9].

After that, the carbs may be processed to produce bioethanol. There are two techniques for hydrolyzing cellulosic biomass for fermentation into bioethanol after the pretreatment phase. There are two different kinds of techniques that are frequently used. Enzymatic hydrolysis vs. chemical hydrolysis (concentrated acid hydrolysis & dilute). There are a slew of other hydrolysis techniques that don't rely on chemicals or enzymes. Irradiation with ultraviolet light, electron beams, or microwaves, for example, may hydrolyze lignocellulosic material. Those procedures, however, are irrelevant in terms of business.

Pretreatment is required for both chemical and enzymatic hydrolyses to enhance the sensitivity of cellulosic materials. Chemical hydrolysis combines pretreatment and hydrolysis into a single process. There are two types of acid hydrolysis: dilute acid and concentrated acid, each with its own set of advantages and disadvantages[7], [8].

1.8. Hydrolysis of Dilute Acid:

The concentrated acid reaction takes place at very high temperatures and pressures, and takes minutes or seconds to complete, allowing for continuous processing. For example, utilizing pure cellulose and a dilute acid method with 1% sulfuric acid in a continuous flow reactor at 510 K with a residence time of 0.22 minutes, a yield of almost 50% sugars was obtained. The presence of acid, high temperatures, or pressure necessitates the use of specialized reactor materials, which may be costly. Cellulosic materials are converted to sugar in the first process, and the sugars are subsequently converted to other compounds in the second.

The main benefit of dilute acid techniques is their quick reaction time, which allows for continuous processing. Because 5-carbon carbohydrates degrade faster than 6-carbon sugars, a two-stage technique is one way to reduce sugar deterioration. Under moderate conditions, the 5-carbon sugars are recovered in the first phase of the process, whereas the 6-carbon sugars are recovered in the second stage under more difficult conditions[9].

1.9. Acid Hydrolysis in Concentrated Form:

Hydrolyzing cellulose materials with high sulfuric or hydrochloric acids is a rather ancient technique. The strong acidic process runs at low temperatures, with just the pressures produced by pumping materials from one tank to another. Reaction times are often much longer when compared to dilute acid. This method usually utilizes strong sulfuric acid followed by dilution with water to dissolve & hydrolyze or convert the substrate into sugar. This technique transforms cellulose to glucose and hemicelluloses to 5-carbon sugars fully and rapidly with little degradation. The first-stage residue is dehydrated and immersed in a 40 percent sulfuric acid solution for 1 to 4 hours. The liquid is hydrated, dried, and then rehydrated, giving a 70% acid content. After interacting for 1 to 4 hours at cold temperatures in the other vessel, the fluids are removed to recover the sugar and acid. The sugar/acid solution from the second stage is returned to the first stage and used as the acid in the hydrolysis of the first step. Low temperatures and pressures also delay sugar degradation. Unfortunately, it's a time-consuming procedure, and developing cost-effective acid recovery methods has proven challenging. If the acid cannot be retrieved, the sugar syrup will be treated with a significant quantity of lime to neutralize the acid. This neutralization produces a significant quantity of calcium sulphate, which must be disposed of, increasing the cost.

1.10. Hydrolysis by Enzymes:

Another broad-spectrum form of hydrolysis is enzymatic hydrolysis. Plant enzymes are proteins found in nature that catalyze chemical reactions. Two technological advances are enzymatic and direct microbial conversion methods. The cellulosic biomass must be chemically processed before enzymatic hydrolysis. In the early days of enzymatic hydrolysis, separate hydrolysis and fermentation procedures were used. Enzymatic hydrolysis is carried out by cellulolytic enzymes. A number of "cellulases" may be used to cleave the hemicelluloses and cellulose. In order to operate properly, enzymes need interaction with the molecules to be digested. This involves either removing lignin to reveal hemicelluloses and cellulose molecules, or removing hemicelluloses and breaking down the crystalline structure of cellulose[10].

Bioethanol's Applications

- Ethanol is used in a variety of hand sanitizers and therapeutic wipes due to its antibacterial and antifungal characteristics.
- Bioethanol is an antiseptic and disinfectant.
- Bioethanol is often utilized as an antidote in ethylene glycol and methyl poisoning conditions.

- Ethanol is often used to dissolve medicines that are water insoluble. Ethanol is used as a solvent in certain analgesics and mouthwashes, for example (in concentrations ranging from 1 percent to 25 percent).
- Ethylene is a key component in a number of alcoholic drinks that are used orally for therapeutic reasons. In humans, it acts as a psychoactive drug, reducing anxiety and increasing creativity.
- Ethanol is used to make ethyl diethyl ether acetic acid, as well as ethyl amines and esters.

DISCUSSION

Ethanol production is steadily growing since it is one of the most environmentally friendly products. Which has no negative effect on the environment. Sugarcane and sugar beet biomasses offer higher energy indices for ethanol production than maize, particularly in the industrial phase, making them the most viable biofuels to replace fossil-based fuels in the near future. Despite the fact that sucrose-based feedstock conversion needs fewer processing steps, the growth of bioethanol production is hampered by a lack of a cohesive and clear government policy. Cane sugar biomass is once again the best in terms of the environment, resulting in the largest reductions in greenhouse gas emissions. In the future, the price of gasoline will progressively rise, allowing us to utilize bioethanol instead of gasoline in cars. It is less expensive than gasoline. Bioethanol does not pollute the environment. Ethanol is a gasoline additive or motor fuel that is widely utilized. It has been discovered that certain kinds of gasoline contain up to 25% yearly ethanol. This chemical has also been used as rocket fuel in certain bipropellant rockets. Biofuel is anticipated to decrease carbon monoxide and nitrogen oxide emissions when used as a fuel.

The use of ethanol is related to significant natural resource use, including water, soil degradation, and the needed arable land for sugarcane farming. These resources are often ignored when mass fluxes, embodied fuel energy, and economic assessments are performed. However, they have a significant environmental effect on a local and regional level. To produce bioethanol from cellulosic biomass, a pretreatment procedure is needed to decrease the sample size, break down the hemicellulose to sugars, and then open up the structure of the cellulose element. The cellulose component is hydrolyzed by enzymes into glucose sugar, which is fermented to create bioethanol. Bioethanol is made by fermenting carbohydrates called hemicelluloses. Ethanol has the potential to be a low-pollution and low-carbon fuel. The use of gasohol (a mixture of ethanol and gasoline) as an alternative car fuel has been steadily increasing throughout the globe for a variety of reasons. The connection between ethanol and alcoholic drinks, paint solvents, and motor fuels is shown in Figure 4. Ethanol is often used as a gasoline additive, motor fuel, alcoholic beverage, and solvent for paints, varnishes, and perfumes.

CONCLUSION

As a method of lowering greenhouse gas (GHG) emissions, the increase in liquid biofuel production from different feed stocks is causing concern among prospective importers and users. Ethanol is one of the most ecologically friendly products. Which has no negative environmental consequences. Major users are concerned about the rapid increase in the production of liquid biofuels from various feed stocks, especially in terms of the most important expected benefits, such as reduced greenhouse gas (GHG) emissions in transportation and the long-term viability of each biofuel alternative's entire production chain. The usage of ethanol is linked to significant natural resource use, such as water and soil degradation, as well as the need for agricultural land to grow sugarcane. When it comes to mass fluxes, material form fuel energy, or economic evaluations, these resources are often overlooked. On a local and regional level, however, they have a major environmental effect. Similarly, CO2 is produced during the production of ethanol from sugarcane owing to the use of gasoline or other industrial inputs during cultivation, manufacture, and transportation. It's also worth mentioning that large-scale bioethanol production will reduce the amount of accessible arable land for food crops. These costs may be reduced by adopting more sustainable techniques, such as organic farming, that reduce resource consumption, especially non-renewable resources. Bioethanol production and usage as a fuel by individuals may assist to reduce reliance on foreign oil, trade imbalances, rural job development, air pollution reduction, and global warming mitigation. Despite the fact that much research has been done on this topic, there is still plenty of space for future investigation.

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