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"Factors Affecting the Production of Biofuel Ethanol in Sugar Industry"

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ABSTRACT:

Bioethanol is produced from renewable sources like sugars, starch, hemicelluose etc, are alternatives to petroleum products. Biofuel ethanol obtained from sugar containing crops like rice, maize, sugarcane, barley, sorghum etc, by the fermentation process with the help of micro-organisms or enzymes. Now a days demands of fuel increases, hence alternative source of fuels are required to fulfill the energy source. Biofuel ethanol reduces the CO_2 production, green house effect, and environmental pollution.

A number of factors like temperature, pH, Sugar concentration, rate of agitation etc are affected the production of bioethanol and their optimization is the most important key points for the ethanol production in sugar industry. Production of biofuel ethanol from sugar involves two types of feedstock like as free fermentable sugar (more reliable) & starch. First generation biofuels (eg.- Sugarcane, Maize etc) second generation biofuels, (eg.-hemicelluose, lignocellulose etc.) and third generation biofuels (algal biomass).

The demand for bioethanol has increased manifold over the few years. The main objective here is to study various process, improvement compared to the an going situation.

Key Words : Biofuel, Bioethanol, Sacchromyces Cerevisiae, pH, Temperature, Sugar Concentration, Rate of Agitation, Fermentation, etc.

Introduction :

Ethanol is produced by fermentation process with the help of micro-organisms mostly by yeast (Sacchromyces Cerevisiae) in which zymase enzyme is present which convert

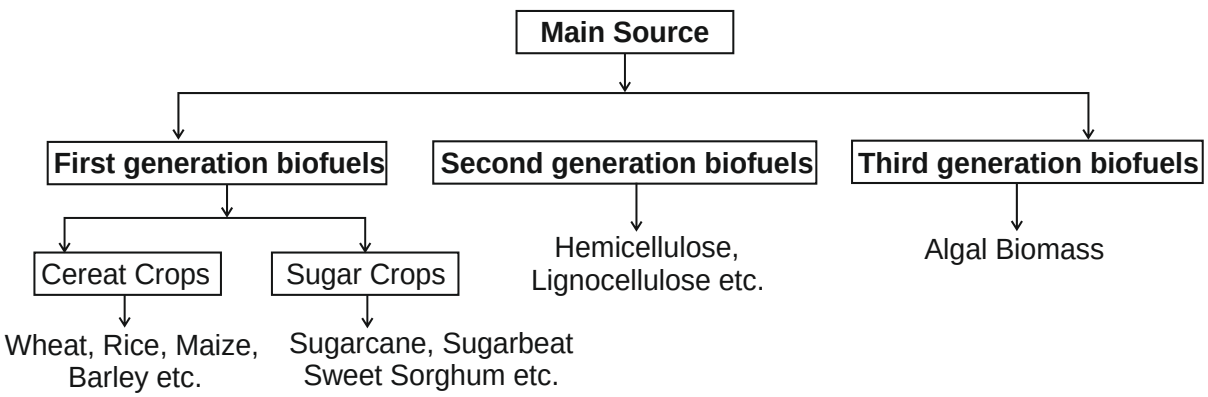
carbohydrates like glucose, into ethanol, now a days ethanol is used as a substitute of gasoline or petrol, hence called bioethanol.

Petroleum products increases the concentration of CO_2 in atmosphere after burns or oxidation, this is very hazardous to the environment and hence, causes global warming, so alternative energy source, biofuel ethanol can be used. Carbohydrates such as glucose, starch, sucrose etc, are changed into ethanol by fermentation process.

In the production of ethanol India ranked fifth. Demand of bioethanol increases in few years, hence study of the factors affecting the production of like concentration, temperature, pH etc. affecting the production of bioethanol is necessary.

Bioethanol can be produced by fermentation process mainly like batch, fed-batch and continuous. Fermentation process gives some advantage over conventional batch method likes as maintenance of viable cell concentration, less effect of inhibitor and control of several factor like pH, temperature, concentration of sugar and dissolved oxygen at a level through feedback. Remarkable features of bioethanol, as fuel energy, high octane number value, greater flame speed, flammability etc, then that by gasoline or petroleum products. The blended bioethanol used in U.S.A. is 10% ethanol with 90% petrol, in Brazil 24% ethanol with 76% petrol, in European Union 5% bioethanol is blended with 95% petrol, whereas in India 10-20% ethanol is blended with petrol. Starch and molasses are the primary feedstocks to produce ethanol in industry.

Main Ingradients for Bioethanol



Methodology and Discussion :

Biofuel ethanol can be produced from the sugary containing crops like sugarcane, rice, maize, sugarbeet etc, by the fermentation process with the help of particular micro-organisms. fermentation sugar mostly contains sucrose, which converts into glucose and fructose with the help of invertase enzyme. Several researchers reported that membrane filtration of sugary juice give higher purity than that to lime-process.

Sugarcane (C_4-plant) is the important feedstock used as juice or molasses (by-product in sugar industry) for bioethanol production. Fermentable sugar (F.S.) in sugarcane is about 12-17%, contains 90% sucrose. Its percentage varies with variety, harvesting time, areas, maturity etc.

Uses of micro-organisms in the fermentation process is the important part of ethanol production. It is anaerobic process i.e., in the absence of oxygen. Single cell fungus, yeast contains zymase enzyme, which converts glucose into ethanol and carbondioxide.

$$\underset{\text{glucose}}{C_6H_{12}O_6} \xrightarrow[\Delta]{\text{Zymase}} \underset{\text{ethanol}}{2C_2H_5-OH} + 2CO_2\uparrow$$

Different micro-organisms like saccharomyces cerevisiae, S. diastaticus, Piehia Kurdriavzevii, Klebsiella oxytoca etc, have been studied for biofuel production. Due to greater efficiency and versatility yeast (Saccharomyces Cerevisiae) is the right choice to fermentation.

Optimum pH range of Saccharomyces Cerevisiae is 30-35°C but some micro-organism tolerate temperature upto 40°C, Zymomonas mobilis is facultative anaeorbic bacteria have ethanol tolerance and high glucose uptake nature, also used in fermentation process.

Micro-organisms require nitrogen and carbon source to grow and survive in culture medium. Hence, nutrients are required in proper amounts to grow and sustains the yeast cell. Wheat, Rice, Maize, Sugarcane, Sugarbeet etc., produces bioethanol is the first generation

biofuels, hemicellulose, lignocellulose etc. produces second generation biofuels, whereas algal biomass produces third generation biofuels.

Production of bioethanol in industry by three types of fermentation.

1. **Batch Fermentation :** In this, feedstock and micor-ogranisms are added in fermentation vessel, along with nutrients. It is simple fermentation process due to low cost, easier sterilization and less control requirement.
2. **Fed-batch Fermentation :** In this, feedstock and micro-organisms are added in the vessel, one or more ingredients are also added during fermentation process. It is broadly employed in industrial production.
3. **Continuous Fermentation :** It involves a constant and certain input of ingredients and regular removal of output from the vessel. It is carried out in two basic types of reactors for eg.- continuous stirred tank reactor and plug flow reactor.

Factors Affecting Bioethanol Productions :

Various factors like temperature, fermentation time, pH, sugar concentration, agitation rate, inoculum size etc., enhances the fermentation process and the production of bioethanol.

1. **Temperature :** It is an important factor in the fermentation process bioethanol production depends on the fermentation temperature, its optimum range is in between 20-35°C. High temperature is very dangerous to the survival of micro-organisms, hence, enhances the production of bioethanol. Enzymatic activity is regulated by the temperature and it is very sensitive to the high temperature. Fermentation process have optimum temperature range for their better activities and growth. The optimum temperature for the cell of Saccharomyces Ceravisiae is nearly 30°C. According to various reseachers at 28°C, ethanol production is 75.8% and at 37°C, ethanol production is nearly 90%.
2. **pH :** pH factor is the very important factor for the production of bioethanol in sugar industry. It enhances the production of ethanol. The optimum pH range for Saccharomyces Ceravisiae is 3.8 to 5.0, whereas, optimum pH range for broth using Z. mobilis is 5.0-6.0, but different optimum pH range was also reported by several

researchers.

The optimum pH range of sugarcane juice is 2.8 to 3.54 and 4.0 to 4.5 for sucrose.

3. **Sugar Concentration :** Initial sugar concentration shows direct effect on the cells of micro-organisms and the fermentation rate fermentation rate increases with the increase in the concentration of sugar at certain level. In batch fermentation production of ethanol increased at the higher initial sugar concentration, but it takes longer time and increased recovery cost. The optimum sugar concentration in Batch fermentation was found to be 24°Bx (190.0g/L).

4. **Agitation Time :** It is also the important factors in the bioethanol production during fermentation process, it is increases the permeability of nutrients and consumption of the sugar, and also the reduction of the inhibition of ethanol on cells. Agitation rate is 150-200 rpm for Saccharomyces Cerevisiae in fermentation.

According to Liu and Shen maximum ethanol yield (85.73%) at 200 rpm of agitation rate.

Conclusion :

Bioethanol production from feedstock is more valuable and environment friendly is better than gasoline or petroleum products, Energy demand increases day by day. Bioethanol production in industry by fermentation process employs mainly starch and free fermentable sugars. Free sugars directly uses without any pre-treatment. Greater production of bioethanol depends upon the better fermentation process, choosing efficient micro-organisms, developed techniques potent choosing breeds of crops etc, as well as the various optimum range of factors like temperature, concentration of sugars pH, agitation rate etc.

Second generation feedstock (eg.- lighocellulose) and third generation feedstock (eg.- algal biomass) required pre-treatment conditions.

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