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Alcohol generation from beet molasses bio-degradation based on recent developments (A review)

Malek Hassanpour

Department of Environmental science, UCS, Osmania University, Telangana State
Corresponding author email address: Malek.hassanpour@yahoo.com. Tel: 091-8978811723
ORCID address: 0000-0001-9662-0623

Abstract: In Iran, the quantity of produced beet reached up to 9 million tons/year, and about 40 ethanol production plants have currently participated in the processing operation. The waste materials procured and created a relevant resource and feedstock for lots of demands. The basic knowledge needs to be promoted in parallel with the nation's development and civilization. The updating available knowledge in the alcohol generation from beet molasses bio-degradation was the objective of the present review. The data and information gathered by the current review were a collection of new techniques reported in scientific databases. The present review comprised the description of ethanol generation of beet molasses from project level to new and novel technologies developed. The exploitation of new technologies is recommended to culminate the efficiency and productivity of manufacturing products in individual or integrated configurations. Reviewing the alternative technologies paves the way for decision-makers to figure out the relevant technology in this regard. Also, the introduced technologies attract decision maker's ideas in decision-making theory and assign multi-criteria decision-making models to select and prioritize the best alternatives regarding the criteria of technologies. The aggregation of industry information in the framework of project identification regarding new technologies applicable in the way of economic prosperity can be mentioned as a great achievement and conclusion of the current review.

Keywords: Alcohol generation, bio-degradation, beet molasses, industries.

1. Introduction

In Iran, the quantity of produced beet has been reported to be more than 9 million tons/year, and about 40 ethanol production plants are currently active. The ethanol generation from beet molasses reported in lots of nations due to the overconsumption of fuels, oil, and petroleum over the world [1]. The biofuels emerged in three states of matter which comprised bio-ethanol, biodiesel, biogas, bio-methanol, bio-syngas, bio-oil, bio-char, biohydrogen, Fischer–Tropsch liquids petroleum, and vegetable oil [2-4]. Bio-ethanol is usually generated from sugarcane (mostly around 60%) and the remaining percentage allocated for agro-residues totally includes rice-straw, wheat straw, sugarcane bagasse, maize, sugarcane tops, and beets, cotton stalk, soft bamboo, bamboo processing wastes, etc. in the global levels. The bio-ethanol generation reached up to 66.77 and 88.69 billion liter in 2008 and 2013 and estimated to rise about 90.38 in 2014 with a dramatic rise in future years [5-6]. The bio-ethanol generation from sugar cane, corn grain, or cellulosic biomass and similar components have been ascertained via innovative and modern techniques. The starch and lignocellulose biomass compounds are processed via hydrolysis and fermentation techniques supported with or without a pretreatment step to generate bio-ethanol. Despite these modern technologies sound great hopes, but the bio-ethanol generation from lignocellulosic materials is not yet economically feasible at an industrial scale due to the processing outlays related to the recalcitrant nature of lignocellulose compounds [7]. The global demand for ethanol generation does not meet the demands raised because of food and feed worth of initial feedstocks especially in traditional agro-residuals [4].

Molasses is a by-product of beet and sugar industries which releases out as animals feed and feedstock of some chemical and biological industries [8]. The combustion of molasses is dangerous to the environment because of the dissipation of greenhouse gases and the wastage of existing resources. Therefore, the recycling of molasses to produce ethanol as the cheapest feedstock has been recognized widely over the world [9]. The composition of beet molasses included Brix, specific gravity, total solids, total sugars, crude protein, total fat, total fiber, ash, calcium, phosphorus, potassium, sodium, chloride, sulfur around 79.5%, 1.41%, 77%, 48%, 6%, 0%, 0%, 8.7%, 0.2%, 0.03%, 4.7%, 1%, 0.9%, and 0.5% respectively [10-11]. The materials structure of molasses included 50% of the weight for sugar and the remaining for organic and inorganic components plus water [12].

Ethanol as short-chain alcohol encompassed a low-level viscosity and relatively corrosive in the liquid form. It depends on components making up of its structure [7]. The ethyl alcohol, pure alcohol, grain alcohol, or drinking alcohol are other names of ethanol which is characterized as volatile and flammable matters, and also a colorless liquid [13]. Kopsahelis [8] completed the ethanol generation process via defrosted and dignified brewer's spent grains in the presence of molasses with and without additives mixtures for the cell immobilization process at 20-30°C. Ethyl alcohol or ethanol, which is used in medical usages must pass through a proper legal channel in terms of quality so that it can be easily consumed. For this purpose, the Iranian Institute of Standards and Industrial Research, with the help of technicians and employing the standards approved by other countries like India has developed a standard number 161 for the properties of ethanol [14]. In addition to the standard of India, other Iranian standards of 337, American Pharmacopoeia 1973, and standards of 321 of 1964 and 3753 of 1967 of India have been used in mentioning the desired specifications. Alcohol factories are required to strictly observe them. In addition to the quality of the product regarding the type of packaging and labeling containers in this standard, the necessary specifications are given in the following pages under the heading of packaging materials. They will be referred to adherence to the alcohol standards in the mandatory production system and failure to pay attention to it will face legal forfeits. Besides, as can be seen, there are differences between some characteristics of medical alcohol and absolute alcohol, including the degree of alcoholism, residual evaporation, aldehyde, and so on [15-16]. About the fact that the purpose of beet molasses biodegradation is not ethanol generation for fuel consumption in Iran like many other counties, the descriptions of the present review encompassed ethanol in non-fuel applications. It needs to explain that depend on the type of initial feedstock the layout of processing units will be varied. Various physical, chemical, physic-chemical, and biological layouts will be assigned and allocated pertain to the type of initial feedstock to generate different types of ethanols.

There are different types of industrial alcohol and alcohol is divided into two general categories: medical alcohol (white) and industrial alcohol. In various industries such as dyeing, lacquer production, and chemical industries, in order to observe the factor of cheapness and being competitive in the market, industrial alcohol is mainly extracted from useless wood and factories like sawdust, etc. are producing the alcohol by hydrolyzing it with acid. In some countries, medical alcohol is made from agricultural wastes such as sugar beet molasses in the United Kingdom and corn in the United States, and some methyl alcohol is added to make them non-drinkable. Drinking pure methyl alcohol and industrial alcohol has adverse consequences and can lead to death or blindness. Methyl alcohol was first generated as a by-product of charcoal from the dry distillation (without exposure to air) of woods such as maple and oak, hence it is also called wood alcohol. This type of alcohol, which is called industrial alcohol or wood alcohol or methyl alcohol, which is briefly described, is now prepared by synthesis and further processing to distilling ethyl alcohol is used to prepare formaldehyde, car antifreeze, and many dyes and drugs. Another type of alcohol that is the subject of the present review is ethyl alcohol or ethanol. Also, ethyl alcohol or ordinary alcohol is a type of alcohol that is present in all soft drinks like wine and it is called white alcohol or medical alcohol [17]. Ethyl alcohol is used in the pharmaceutical and medical industries. Today, due to the overconsumption of alcohol in the pharmaceutical industry, etc., and insufficient primary resources for its production, such as grapes and other fruits, the use of beet molasses, which has enough sugar, has been recommended. In addition to what has been said, it is mentioned again that the various uses of ethanol can be summarized as follows: (1) As a disinfectant (2) As a solvent (3) As a secondary raw material.

Therefore, due to the problems in some cases in the way of achieving this substance for various purposes, scientists have synthesized a special substitute for each case. But in the case of the use of this substance as a primary and secondary substance, they have not yet been able to find a similar product, or they have not found a suitable product in terms of economic or production conditions. For example, alcohol is used as a raw material in the production of industrial acetic acid by an acetate component or acetaldehyde as a secondary material [18]. Because it is included in the chemical formula. It is the best material to date and has not been replaced by a substitute. But in some other cases, such as the use of disinfectant, there are substitutable products, such as betadine and formalin, for example. In the case of solvents, there are dozens of chemicals used in the paint and cosmetics industry. Alcoholic substitutes are defined as commodities. Besides, in some cases, such as making cosmetic lotions and skin medications, alcohol is an almost irreplaceable matter and due to its rapid sublimation, it can release cosmetic fragrances into the air [19-20].

All in all, it should be said that if a single disinfectant is formulated solely as a substitute for the production of those substances, such as formalin, etc., this will not be economically justified just for the use of this purpose. However, if alternative products can be produced to make other products (such as formalin to make melamine, formaldehyde, and hexamine), they can be used instead of alcohol. However, alcohol is the most suitable raw material in terms of raw materials in most industries such as industrial acetic acid production. It is not easy to use other components instead of maintaining economic aspects [21]. This fact asserts the important role of ethanol in daily applications.

As it is known, ethanol is one of the commodities that are under the strict control of the government in terms of production, sales, and prices and is sold under the label of Economic and Financial Administration (bundle). Therefore, this product is different from other goods in terms of sales and cannot compete in terms of price. The price of ethanol is strictly controlled and is sold at a distinguished price. Due to the unprincipled uses that may be made of this product, buyers for the factory must be well-defined or have quotas commensurate with the consumption of the goods sold. Buyers of this product are pharmacies or medical centers, hospitals, medical laboratories, and similar centers [22].

2. Ethanol Production Methods

Ethanol is formulated by two general methods: fermentation of hydrocarbons and oil (petroleum) synthesis. In the oil synthesis method, the procedure is carried out by combining gas containing hydrogen and carbon monoxide or by combining ethylene with water under special conditions. Due to the use of its special technology, which does not exist in Iran, and through the provision of foreign machinery and equipment related to the implementation of this type of technology, this method has not been removed a lot of currency dependence and has not been able to open a suitable place for its supply. Especially in countries such as Iran, where sugar and hydrocarbons of beet molasses are abundant due to their agricultural nature, they can be used for this purpose [23-24].

Another method for producing ethanol, which is common in the world and developing countries and is a suitable alternative for investment in small industries, is the fermentation method. The fermentation process needs to couple to some Physico-chemical processes depends on the quality of product and initial feedstock employed as explained above. In this method, the raw materials for the fermentation process are mainly starchy and sugar products such as cereals, potatoes, sugarcane bagasse, and sugar beet molasses, and similar products. At present, due to the existence of a variety of sugar factories from sugar beet and large sugar units from sugarcane, sugar beet molasses and bagasse are abundant in the country and can be also used as raw materials for ethanol generation. From the point of view of machines, it should be said that most of the required machines can be supplied and manufactured in Iran, and the only part of the equipment and machines will be purchased from out of the country like distillation system, which is easy to provide and does not create any special dependence. Therefore, by comparing the abundance of raw materials and machinery, the appropriate methods for the production of ethyl alcohol, using beet molasses or sugarcane bagasse, is the fermentation method currently in Iran. This method is also comprised of 3 practices as a continuous method and non-continuous method and is also divided into semi-continuous techniques. Large factories have a continuous system and have imported complete machinery from abroad. In this method, all the application of the process is done automatically, and due to the use of fully automatic machines and control systems, it demands a high price. It is not economically viable for a production unit. In the non-continuous method, production operation is done in batch ambient using basic equipment, which is not cost-effective for a production unit due to its low efficiency and capacity. The third or semi-continuous method is a combination of the above two methods and has special advantages. In this method, while the price of facilities, especially distillation systems, is significantly reduced also it is possible to offer a product with appropriate quality comparable in quality with the product released by the continuous system [25].

3. Steps, Areas and Methods of Quality Control in Alcohol Production

Since alcohol is used in a variety of applications as raw material, it is important to perform quality control operations and special attention should be paid to it like other industries. The quality control in this product can include three parts: quality control of raw materials, production process, and quality control of the final product.

Beet molasses is the main raw material of ethanol generation and should be relied on the percentage of sugar, in such a way that it can be consumed economically. As we know, some sugar factories, equipped with required facilities that take some of the sugar in the molasses and may sell the rest to the distilleries. This type of molasses is not very useful for the production of alcohol and unsweetened molasses should not be used. When the molasses enters the factory, it should be controlled in terms of quality along with other tests such as invert sugar, and the quantity of existing sugar. Although other raw materials (such as ammonium salts and sulfuric acid) are controlled in terms of quality by the manufacturers some precautions need to be taken into consideration. So, it is better to randomize the initial tests accomplished on them. Regarding yeast, it should be noted that the primary yeast whose is purchased for reproduction units needs to be seriously tested to determine the well-being of the yeast. Otherwise, a series of yeast-making operations will have problems and doubts will be created about its correct execution system [26-27].

In the next step, the quality control of the reproduction of yeast, and the distillation system is considered and must be done carefully. During the yeast multiplication stage, the sterilization of the solution, the percentage of nutrients added to the solution, the sterilization temperature, and the secondary breeding operation, and finally, the conditions of the stored yeast should be under quality control [28-29]. This should be done by removing samples from the solution and measuring the percentage of salts added in it and the sugar, as well as controlling the temperature randomly during cultivation and acidity of the solution before and after adding the acid. Quality control in fermentation is also of particular importance. Proper sterilization by pH (4-4.5) adjustment, control of the operating temperature, and cooling time of the solution are some of the things that should be considered and controlled the quality of the fermentation process for different stages. Then, by adding yeast to the fermentation tank, the percentage of yeast to be added is indispensable to be checked. In the fermentation stage, the percentage of alcohol released must be measured and its fluctuations need to be determined so that if there is a disturbance in the reaction due to the presence of other substances, it must be corrected immediately. Quality control in the distillation stage and secondary distillation system is another aspect of this operation. During the primary distillation, alcohol is extracted, and in the secondary distillation, the final alcohol is obtained. In the final distillation process heavy hydrocarbons chains, chemicals such as furfural, etc., must be separated and bereavement of impurities in them must be tested.

Finally, the generated product must be alcohol 96-degree. The quantity of ester, lead, copper, annoying and dangerous alcohols such as methyl alcohol, ketones, and other items in the mandatory orders need to be checked. Now that the necessary tests have been performed on the final solution, if approved, the product should be transferred to the filling and packaging section. In this part, the use of white bottles for filling alcohol is recommended. The cleanliness of containers and precise control of the amount that should be poured into each bottle need to be checked [30-31].

The present review targeted to discuss the recent developments expanded in the field of ethanol generation of beet molasses that has been taken into consideration to the concept deeply from project level to novel methods. In Iran, the allowable licenses to construct a project follow the project assessment levels according to Figure 1.

Environmental Impact Assessment (EIA) is a necessary part of industrial projects in Iran and all over the world. The Iranian evaluator team of in-charge organizations does the best practice of project approval in this regard. So, many of the data have been picked up based on the assessment of the industrial project (screening step according to Figure 1) of ethanol generation of beet molasses. The following sections have been explained the data and their applications as much as possible.

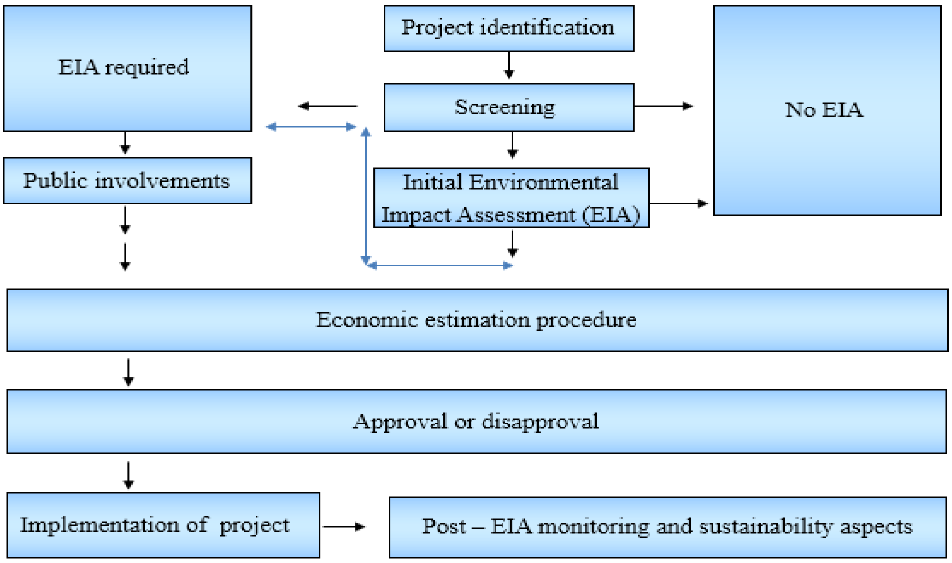

Figure 1. The assessment steps of EIA [This study].

4. Ethanol Generation in Iranian Industries

The beet molasses production method is semi-continuous and consists of three parts comprising the powder preparation (initial feed preparation), fermentation, and distillation steps in Iran. In the preparation step, the molasses is diluted. In the dilution section, first, the molasses absorbs water up to 1.77 times of initial volumes. Then the nutrients of sugar, sulfate, and ammonium diphosphate are added in the value of about 0.5 g/l and sulfuric acid addition is done up to 7.7 g/kg of molasses and is sterilized and stored by water vapor, while the temperature of the solution is at 37°C. The diluted solution is stored in a special tank and is pumped into the fermentation tanks and 7% by volume of the molasses solution, yeast is added and aerated for 1-1.5 h and the fermentation process begins. Finally, the reaction stops after the materials are cured. During the reaction, the enzymes adenosine triphosphate and adenosine diphosphate and several other enzymes needed for fermentation operation are produced, along with CO_2 which is dissipated on the solution via fermentation operation. The fermentation period is 48 h, and at the end of the reaction, the temperature declines to 12°C. In the initial distillation stage, alcohol 40-70 degrees is acquired, then the alcohol is passed through the second distillation step to sweep the heavy hydrocarbons and other pollutants to release the alcohol of 96 degrees which is stored in tanks for packaging purpose. Alcohol distillation takes place at 80°C. The final product is poured into 0.6-liter white glass bottles and then, with a metal lid and a stopper, the entrance door is labeled with alcohol properties and is sent to the market in 12-digit cartons. The procedure, materials, and facilities applied for ethanol generation have been explained in Figure 2 and Table 1 in Iranian industries [32-33].

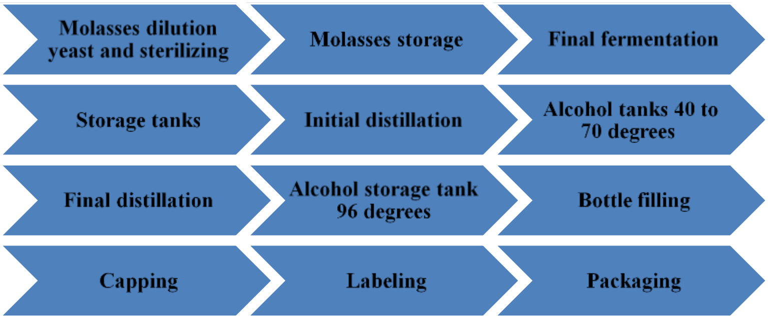

Figure 2. Ethanol generation steps [32].

Table 1. Annual requirements of alcohol generation (Ethanol 96%) from beet molasses bio-degradation (nominal capacity of 5000 bottles = total annual rate) [32].

The annual materials and equipment	Total annual rates
Equipment and devices	
Cooking and sterilizing equipment for molasses	3 No
Equipment for breeding, 3000 L	2 No
Fermentation equipment, 20000 L	2 No
Initial distillation system, 3000 L	6 No
Final distillation, stainless steel, 7500 L	1 No
Alcohol storage tank, stainless steel, 2000 L, 40°C	4 No
Alcohol storage tank, 96°C, 10000 L	3 No
Automatic electric filler, 5000 bottles/shift, 8 kW	1 No
Labelling machine, 6000 No/shift, 2 kW	1 No
Capping machine, 5000 No/shift	1 No
Pumps, 1, 6, 1.5 kW	4 No
Pure acid storage tank, 20000 kg	1 No
Materials demands	
Beet molasses, consists of 47-50% sugar	5400 tons
Yeast	2900 kg
Types of Ammonium Salt	14100 kg
H_2SO_4 98%	37800 kg
Sugar	7800 kg
Antifoam	4000 Liters
Bottles of 600 cm^3	1417 No
Label	1390 No
Cartons having 12 empty spaces	114750 No
Tape	2500 No
Ammonium salt solution	14100 kg
Employees	
Staffs salary	41 Persons
Energy consumption	
Required water	50 m^3/day
Split AC (Internal wiring, transformers, and emergency power generators)	132 kW/day
Required fuel (Stoves)	241 Giga Joule/day
Required land and landscaping	
Required land	7100 m^2
Construction of infrastructure (Buildings)	2038 m^2

No = Number

5. Distillery Wastewater in Ethanol Generation

The main concentration of distillery wastewaters in the alcohol generation of beet molasses biodegradation allocated for some aromatic components and phenolics such as lignin or tannins and their ability to degrade melanoidins. So, the recent researches noticed to use of microalgae, aerobic and anaerobic treatment, physic-chemical treatment, coagulation/flocculation, electrocoagulation process, adsorption, advanced oxidation, membrane treatment, thermal treatment, evaporation/combustion process, and cyanobacteria degradation for the wastewater treatment operation with successful results [34-36]. The study of Malik et al. [36] noticed that the biodegradability of distillery effluent by wet air oxidation efficiently runs as a pretreatment step. So, lots of biological treatment reactors can be employed to reduce the biological oxygen demand of distillery wastewaters. The COD (mg/l), BOD (mg/l), COD/BOD ratio, Total nitrogen (mg/l), Total phosphorus (mg/l), Potassium (mg/l), Sulfur as SO_4 (mg/l), and pH of beet molasses wastewater reported to be about 91100, 44900, 1.95, 3569, 163, 10030, 3716, and 5.35 respectively [10].

6. The Recent Ethanol Generation Technologies

There are two major technologies for producing ethanol from the biodegradable part of wastes generally. Each of which pursues separate goals in addition to ethanol generation depending on the strategy chosen for waste management. According to all aspects, both of two technologies are considered suitable options. The first technology is the fermentation of bacterial syngas and the second technology can be called the enzymatic breakdown of cellulose and complex components. But recent studies introduced lots of individual and integrated technologies in this regard.

The yeast species whose generate the fermentation operation of ethanol are various strains of *Cerevisiae*, *Kluyveromyces fragilis*, *Kluyveromyces marxianus*, *Candidashehatae*, *Candida utilis*, *Pichiastipitis*, and *Pachysolen tannophilus*. Bacterial species whose generate ethanol as the main fermentation product are the mesophilic organism of *Clostridium sporogenes*, *Clostridium indoli*, *Clostridium sordelli*, *Zymomonas mobilis*, *Spirochaeta aurantia*, *Spirochaeta stenostrepta*, *Spirochaeta litoralis*, *Erwinia amylovora*, *Escherichia coli*, *Leuconostoc mesenteroides*, *Streptococcus lactis*, *Klebsiella oxytoca*, *Klebsiella aerogenes* and *Mucor Fusarium* and *Mucor indicus* [4, 9, 37]. In a run-up of lignocellulosic complex compounds in the reactor, some fungi species of rot, white and soft types can be applied to dissociate the components and facilitate the fermentation process. This process can be called a pretreatment step [4, 38]. Lots of enzymes assist in the hydrolysis of the complex compounds to convert to monomers. It demands negligible energy and mild ambient in comparison to acid hydrolysis conditions. For instance, in this technique, the cellulose enzymes comprised micro-organisms such as *Clostridium*, *Cellulomonas*, *Thermonos-pora*, *Bacillus*, *Bacteroides*, *Ruminococcus*, *Erwinia*, *Acetovibrio*, *Microbispora*, *Streptomyces*, and other fungi such as *Trichoderma*, *Penicillium*, *Fusarium*, *Phanerochaete*, *Humicola*, *Schizophillum* sp. [39]. Therefore, acid hydrolysis can be replaced by enzymes efficiently. The complex components encountered the high electron beam radiation are easily converted to simple monomers to use in fermentation operation. Lots of plasma techniques can also be exploited in the same way as electron beam radiations [8, 3]. To improve the performance and efficiency of fermentation and distillation reactors the waste of distillation system is recirculated to the processing unit to promote the recycling operation and optimize the costs [40].

Imprisonment of cell or enzyme in a media of support or matrix to exchange of the medium is called immobilization technology. The main and important achievement of this technique is rising in the functionality of efficiency and promote reproducibility [41]. To be mentioned other merits of immobilization are reuse, continuous utilization, less labor input, thrift in outlays, minimum reaction period, less chance of contamination in products, more stability, continuous process improvement, high enzyme-substrate ratio. The demerits of mentioned technology can be mentioned to difficulty in industrial scale-up, loss in catalytic ability in some cases, instability, adverse effects of temperature rise, and high expenses for isolation, purification, and recovery of the enzyme. Immobilization methods divided into (1) Adsorption (A), (2) Covalent Bonding and Cross-Linking (CBCL), (3) Entrapment (E), (4) Copolymerization (C), and (5) Encapsulation (EN). A cost-effective and efficient reactor conducted for ethanol generation using molasses as feedstock and Saccharomyces cerevisiae immobilized in steady-state conditions at 30-40°C, for 32 days [42-43]. Table 2 displays the bioethanol generation by applying the immobilization technology.

Table 2. Bioethanol generation using immobilized yeast cells [44].

Yeast strain	Feedstock	Method	Carrier	Ethanol conc. (g L^{-1})
Various types of cerevisiae species	Sugar molasses	CBCL	Alginate composite	78.6
	Cane molasses	CL	Bacterial cellulose-alginate sponge	92
	Glucose and sucrose	A	**	92.7
	Sugarcane bagasse	A	**	15.4
	Blackstrap molasses	A	Thin-shell silk cocoon	80.6
	Sugar beet thick juice	A	Sugar beet pulp	52.3
	Sorghum juice	A	Sweet sorghum stalks	98.5
	Mahula flower	E	*	25.8
	Corn meal	E	*	88.9
	Wheat straw	E	*	37.1
	Glucose	CBCL	Mineral Kissiris	48
	Molasses	CBCL	Orange peel	58.9
	Orange peel waste hydrolysate	CBCL	***	60
	Orange peel waste hydrolysate	CBCL	****	72
K. marxianus	Orange peel waste hydrolysate	CBCL	***	56
	Orange peel waste hydrolysate	CBCL	****	73

* Calcium alginate
** Sorghum bagasse
*** Type of char
**** Vineyard prunings

The economic retrieve of sugar beet to bioethanol reported by Razmovski and Vucurovic [45] via agricultural residues as media for immobilization purposes and by the presence of *Saccharomyces cerevisiae* in pilot plant scale [46].

The promotion in employed facilities is a type of technology enhancement for rising the efficiency in recycling and distillation operation. Using multistage distillation units containing various channels of input and output materials as two-end, three-end, continuous, countercurrent, vacuum, and vapor-liquid channels are also recent progress and development in this regard [47].

The production of ethanol from beet molasses is considered as a renewable and alternative source of ethanol instead of fossil fuels. In order to increase the production efficiency of ethanol and eliminate the inhibitory effect of the product, the produced ethanol is simultaneously separated from the fermentation process by the pervaporation method. In experiments, a PDMS membrane with a thickness of 10 μm used. The initial concentration of sugar reported to be around 50 gl^{-1} and the fermentation period was around 72 hours [48-50].

The dominant technologies posed for ethanol generation of beet molasses are called non-stop culturing, fermentation by cell recycling, and vacuum distillation by cell recycling [50-52]. The cell recycling reactor has been investigated with the presence of a dense culture of fermenters and recycling of cells has been carried out using membrane accommodation inside the bioreactor. The cell bleeding enhanced and improved via dilution and bypass channel of excess cell removal efficiently. This process posed to be constructed in the industrial scale-up. Also, gas or steam stripping via distillation and vacuum distillatory units resulted to enrich and pure ethanol generation along with other product outcomes. By the way, the inhibitory effects of ethanol concentration can be reduced and the system goes towards the efficient generation of products. The exploitation of the following systems can also rise the product quality and quantity in an enhanced form of generation such as liquid-liquid extraction, adsorption, perstraction, integrated methods of fermentation, integration of fermentation process with chemical treatment, oxidation, and catalytic systems, and reverse osmosis.

The recombinant DNA technology in genetic engineering creates novel and nascent fermenters which can generate efficient product without waste stream loss [53-54]. But there are some drawbacks to handling and controlling the newly developed microorganisms because of damages conducted towards human exposures and environmental issues [55-59].

Gasification and valorization of waste materials with the aim of producing gaseous products will facilitate ethanol generation in the presence of water concentration. Using the plasma reactors will also enhance the generation of gaseous products and consequently, the alcohol generation will escalate efficiently especially using multi-reformers [60-62]. The plasmatron reactor equipped with molecular sieves for producing enhanced ethanol is getting high popularity recently. Other types of plasma reactors are also encouraged to be used by stakeholders according to recent developments. The merits of these technologies get back to employing reactors for integrated product outcomes depend on the circumstances of run the reactor and material stream injection [63-65].

The widespread application of nanotechnology expanded to be employed in ethanol generation of beet molasses and nanomaterials used in this field encompasses the nanoparticles of Hematite, Pd, Silver, Cu, Nickel, Iron oxide, Magnetite, etc. Using FexOy nanoparticles and Ni^{+2} additives led to a significant rise in H_2 generation. The zerovalent Fe and Ni verses, Fe^{+2}, and Ni^{+2} nanoparticles also resulted in the culmination of biohydrogen generation in the presence of glucose, temperature shock, in the anaerobic treatment of sludge. So, they can be used for the pretreatment of complex compounds introduced into the reactor of ethanol generation of beet molasses.

Dark fermentation (containing a temperature of 60°C [48]) and Photo-fermentation also can be an alternative technology for ethanol generation in the fermentation reactor. The wavelengths of 522, 805, and 850 nm of sunlight are also able to rise the hydrogen generation in this regard [66].

The Co-cultivations of microorganism species in experimental ambient for generating ethanol have not been noticed widely. The recent studies revealed that exploiting both common microorganisms of yeast and bacterium species on an industrial scale-up, resulted in enhancing the growth and fermentation activity of yeasts. On the contrary, the wild or antagonistic species of bacterium species were detrimental to fermentation efficiency in Co-cultivations reactors in ethanol generation plants [67-70].

7. Global ethanol generation

The purpose of ethanol generation in various nations is different from each other as mentioned above [71]. But the global ethanol generation has generally been estimated according to Table 3. Table 3 denotes the global generation of ethanol of agricultural wastes. Globally the annual generation of ethanol of agricultural feedstocks reached around 10×10^7 m^3 in 2017 [59].

Table 3. Global ethanol generation from sugarcane in million gallons by 2018 [3].

Country	Quantity	Percentage
Brazil	7950	28%
USA	16100	56%
EU	1430	5%
China	1180	4%
Canada	480	2%
Thailand	390	1%
India	330	1%
Argentina	290	1%
Rest of world	550	2%

8. Recent Applications of Beet Molasses and Its Distillery Stillage

Concerning wide cultivation of sugar beet in countries of Russian Federation, Ukraine, United States of America, Germany, France, Turkey, China, Poland, Egypt, United Kingdom, Iran (the Islamic Republic), Belarus, Netherlands, Italy, and Belgium, and European Union the beet molasses generated is outlined to be employed in a variety of novel applications [72-73]. In the international levels use of beet molasses as additives (bulking powders) of some food materials recently declared but it depends on the quantity of sugar in the molasses [74]. The use of molasses in producing value-added gaseous products even bioplastics and lots of other applications has been recognized in a variety of studies [75].

The recent studies confirmed the way for the valorization of distillery stillage of ethanol generation plant to recover and extract the volatile fatty acids, natural antioxidants, and polyphenols. The enhanced and advanced valorization techniques assigned to utilize the eutectic solvents for extracting valuable compounds with minimal disposal of waste streams [76].

9. Conclusion

The difficulties discovered on the way of the economic prosperity of Iranian industries get back to the bereavement of access and discern of new technologies and developments with regard to this fact that the Iranian industries actually are a mimic of each other by stockholders with old-fashionable processes. The Iranian ethanol generation industries of beet molasses can update the information in order to attract investment and stakeholders' benefits. Then technologies can be compared to each other for selecting the efficient and economic option. The collection of data is a notice of recent developments and the Iranian industry's current situation in this regard. In the present study, we emphasize the attention towards the application of plasmatron reactor as cost-benefit technology posed. The future research direction can be taken into attention economic estimation of ethanol generation industries of beet molasses using the content of the table of requirements of the project. Also, the efficiency of industries can be estimated by the same data of the table of the requirement of the project via data envelopment analysis.

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Conflict of interest

There is no conflict of interest.

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