PRODUCTION OF SUSTAINABLE FUEL FROM FOOD WASTEWATER

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ABSTRACT

Nowadays, people are using more and more nonrenewable resources for energy. The world's supply of nonrenewable such as fossil fuels may run out. Other sources must be found to at least partly replace fossil fuels. Hydrogen fuel is seen as a constantly renewable source of energy as well. There are many ways or methods to produce hydrogen. Electrolysis is one of the simplest and easiest way to produce hydrogen. Usually we used blank water to produce hydrogen and oxygen from the electrolysis process. However, from this research the blank water is replaced with food wastewater that was collected from a cafeteria's discharge. The voltage for electrolysis process is fixed to 10V. The ampere is recorded every time the hydrogen is collected. The hydrogen is collected 5 times in 2 hours. The first electrolysis is added with 0.3 molar of catalyst and then the electrolysis is repeated using 0.5 molar of catalyst. The different molar of catalyst is used to determine which molar can produce more hydrogen. The electrolysis process is repeated to characterize the food wastewater in term of COD and BOD. Same with the first electrolysis, 0.3 molar and 0.5 molar of catalyst also added to the wastewater. The electrolysis process is running for two hours. Every 0, 10, 15, 30, 45, 60, 75, 90, 105 and 120 minutes, the sample is taken to characterize for BOD and COD. The raw wastewater which is the wastewater that not undergo the electrolysis process also is characterized in term of BOD and COD. The result of COD and BOD before and after electrolysis is compared.

ABSTRAK

Pada masa kini, kita lebih banyak menggunakan sumber tenaga yang tidak boleh diperbaharui. Bekalan sumber tenaga yang tidak boleh diperbaharui seperti bahan api akan habis. Bekalan sumber tenaga lain mesti dicari untuk menggantikan sumber tenaga yang tidak boleh diperbaharui ini. Bahan api hidrogen adalah salah satu sumber tenaga yang boleh diperbaharui. Terdapat banyak cara atau prosedur untuk menghasilkan hidrogen. Elektrolisis merupakan salah satu cara yang paling mudah dan ringkas untuk menghasilkan hidrogen. Kebiasaannya elektrolisis dilakukan menggunakan air suling atau air biasa. Walaubagaimanapun, dalam kajian ini air biasa digantikan dengan air sisa makanan yang diambl dari kafe. Proses elektrolisis dilakukan dengan menetapkan nilai voltan iaitu 10V. Bacaan elektrik diambil dan direkod setiap kali kuantiti hidrogen dikira. 5 kali kuantiti hidrogen diambil dan direkodkan dalam masa 2 jam elektrolisis. Elektrolisis yang pertama dilakukan dengan memasukkan 0.3 molar pemangkin. Kemudian prosedur yang sama diulang dengan menggunakan 0.5 molar pemangkin. Bilangan molar pemangkin dibezakan untuk menentukan bilangan molar pemangkin yang mana menghasilkan kuantiti hidrogen yang lebih tinggi. Elektrolisis diulang lagi bagi menentukan sifat pada air sisa makanan menggunakan parameter yang telah ditetapkan iaitu BOD dan COD. Elektrolisis dengan menambahkan bilangan molar pemangkin 0.3 dan 0.5 ini dilakukan selama 2 jam. Setiap 0, 10, 15, 30, 45, 60, 75, 90, 105 dan 120 minit , sample air sisa makanan diambil untuk menentukan nilai BOD dan COD. Air sisa makanan yang tidak melalui proses elektrolisis juga ditentukan sifatnya dengan menggunakan parameter kekeruhan, BOD, COD, SS dan PH.

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LIST OF ABBREVIATIONS

BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
SS	Suspended Solid
CO	Carbon Monoxide
CO_2	Carbon Dioxide
TOC	Total Organic Carbon
H_2O	Water
DO	Dissolved Oxygen

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The population of the United States (and the rest of the world) is growing. People are using more and more nonrenewable resources for energy. The world's supply of coal may run out in 130 years. Natural gas may run out in about 60 years, and oil may run out in as little as 40 years. Other sources must be found to at least partly replace fossil fuels. There are a number of reasons why we need alternatives to fossil fuels. Fossil fuels are nonrenewable resources. They took millions of year to form, and there is only a limited supply of them on earth. Once we use up the supply that currently exists, there will not fossil fuels to replace them. Eventually, they will be gone and that time is not far off. Scientist is looking for sources of energy that are plentiful and will not harm the environment. They are looking renewable and sustainable sources. There is a constant supply of these resources or they can be made quickly. Sun, water and wind are examples of renewable resources. They can all be used to produce electricity with little or no harm to the environment. Hydrogen fuel is seen as a constantly renewable source of energy as well. It is very likely that someday, hydrogen fuel might be used to produce electricity on the large scale needed to provide power for homes and business. It can also be used to produce smaller amounts of electricity that can be used as a source of energy

to power transportation vehicles like cars, buses, and planes. The challenge is to find ways to use hydrogen fuel differently than it has been used in the past.

1.2 OBJECTIVES OF THE RESEARCH

a) To determine the effect of catalyst on synthetic fuel production
b) To characterize food wastewater before treatment.
c) To characterize food wastewater after treatment.

1.3 SCOPES OF THE RESEARCH

The student's cafeteria is located between Kolej Kediaman 1 and Kolej Kediaman 3. Figure 1 shows the location of student's cafeteria. Wastewater from the cafeteria is flowing through the traps before its being released to main drain and then directly to the stream.

a) The wastewater released from cafeteria is taken and do the analysis using water quality parameters such as BOD, COD, SS and pH
b) The sample is electrolyzed to collect hydrogen with different mol of catalyst which is 0.3 molar and 0.5 molar
c) Do the analysis using the same water quality parameters to the sample that has been electrolyzed.

1.4 PROBLEM STATEMENT

Burning fossil fuels add pollution to the air we breathe. The pollutants (harmful substance) can cause headaches and breathing problems such as asthma. Burning fossil fuels also creates acid rain, which can harm rivers and lakes, plants and animals and even buildings. In addition, fossil fuels have been linked to global warming. This is the gradual warming of earth's climate, cause by the buildup of carbon dioxide and certain other gases in the atmosphere. Global warming has been linked to a melting of ice in earths' polar regions and therefore, to rise in sea levels around the world. It is not realistic to expect that people will need less energy in the future than they need now. Other than that, fossil fuels are nonrenewable resources. They took millions of year to form, and there is only a limited supply of them on earth. Once we use up the supply that currently exists, there will not fossil fuels to replace them. We are looking for renewable and sustainable sources that are plentiful and will not harm the environment. Besides, we use wastewater to replace the usual water that we use to do electrolysis.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The production of hydrogen is an appropriate environmental solution. Hydrogen is the most abundant element in the universe. It cannot be destroyed unlike hydrocarbons, and it simply changes state from water to hydrogen and back to water during consumption. The pollutants emitted by fossil energy systems (e.g. CO, CO2, CnHm, SOx, NOx, radioactivity, heavy metals, ashes, etc.) are greater and more damaging than those that might be produced by renewable hydrogen energy system. (C.J. Winter)

The renewable energies are solar energy, wind power, hydro power, bio energy, hydrogen energy, geothermal energy, ocean energy, energy efficiency, education menu and others. Energy, economic and political crises as well as the health of humans, animals and plant life are all critical concerns. There is an urgent need to expedite the process of implementing the hydrogen economy. A worldwide conversion from fossil fuels to hydrogen would eliminate many problems and their ramifications. The optimal endpoint for conversion to the hydrogen economy is the substitution of clean hydrogen for the present fossil fuels. The production of hydrogen from non polluting sources (such as solar energy) is the ideal way. (Zweig RM)

2.2 The Properties of Hydrogen

Hydrogen is the simplest element, an atom consisting of only one proton and one electron. It is also the most plentiful element in the universe. Despite its simplicity and abundance, hydrogen does not occur naturally as a gas on the Earth it is always combined with other elements. Water, for example, is a combination of hydrogen and oxygen (H•O). Hydrogen is also found in many organic compounds, notably the "hydrocarbons" that make up many of our fuels such as gasoline, natural gas, methanol and propane.

Hydrogen can be made by separating it from hydrocarbons by applying heat, a process known as "reforming" hydrogen. Currently, most hydrogen is made this way from natural gas. An electrical current can also be used to separate water into its components of oxygen and hydrogen. Some algae and bacteria, using sunlight as their energy source, even give off hydrogen under certain conditions.

Hydrogen is high in energy, an engine that burns pure hydrogen produces almost no pollution. NASA has used liquid hydrogen since the 1970s to propel the space shuttle and other rockets into orbit. Hydrogen fuel cells power the shuttle's electrical systems, producing a clean by-product pure water, which the crew drinks. We can think of a fuel cell as a battery that is constantly replenished by adding fuel to it—it never loses its charge. The vision of building an energy infrastructure that uses hydrogen as an energy carrier, a concept called the " hydrogen economy" is considered the most likely path toward a full commercial application of hydrogen energy technologies.

2.3 Hydrogen research

2.3.1 Developing sustainable technologies for the 21st century

The vision is staggering: a society powered almost entirely by hydrogen, the most abundant element in the universe. In this vision, renewable resources such as biomass, wind, and solar energy are used to extract hydrogen from water. When the hydrogen is used as an energy source, it generates no emissions other than water, which is recycled to make more hydrogen.

2.3.2 Hydrogen and its uses

Hydrogen is a colorless, odorless gas that accounts for 75% of the universe mass. Hydrogen is found on earth only in combination with other elements such as oxygen, carbon and nitrogen. To use hydrogen, it must be separated from these other elements. Today, hydrogen is used primarily in ammonia manufacture, petroleum refinement and synthesis of methanol. It is also used in NASA's space program as fuel for the space shuttles, and in fuel cells that provide heat, electricity and drinking water for astronauts. Fuel cells are devices that directly convert hydrogen into electricity. In the future, hydrogen could be used to fuel vehicles and aircraft, and provide power for our homes and offices.

2.3.3 Benefits of hydrogen

Hydrogen made from renewable energy resources is a virtually inexhaustible, environmentally benign energy source that could meet most of our future energy needs. It is more versatile and has more uses than electricity. These uses include providing energy for businesses, factories, electric utilities, homes, vehicles and airplanes. Hydrogen is also a domestically produced energy source that could help reduce our reliance on foreign oil.

2.3.4 Challenges

Researchers must overcome several obstacles if hydrogen is to become a major energy resource. Hydrogen is currently more expensive than traditional energy sources; the production efficiency (the amount of energy or feedstock used to produce hydrogen) must improve and an infrastructure to efficiently transport and distribute hydrogen must be developed. The reality of an eventual transition from oil to hydrogen becomes more evident when one takes an atomic view of energy history. Since the mid-nineteenth century, the world has been slowly shifting from one form of energy to another from solids to liquids to gases. (Hefner A)

2.4 Hydrogen production

Hydrogen is already being produced in huge volumes and is used in a variety of industries. Current worldwide production is around 500 billion Nm3 per year. Most of the hydrogen produced today is consumed on-site, such as at oil refineries, and is not sold on the market. From large-scale production, hydrogen costs around $0.70/kg if it is consumed on-site. When hydrogen is sold on the market, the cost of liquefying the hydrogen and transporting it to the user adds considerably to the production cost. The fundamental research in hydrogen field is also important. A thermal process for hydrogen generation has been developed using water in the presence of zeolites impregnated with non-noble metals of variable valences and activated in a vacuum (M. Momirlan)

2.5 Future Uses of Hydrogen

New research is showing that hydrogen fuel may be particularly valuable as a safe and clean way to produce the huge amount of electricity people use every day. Hydrogen fuel is also being looked at as an alternative to the gasoline we use to power vehicles large and small. Most of the electricity used in cities and towns today is produced in power plants that burn fossil fuels such as coal and natural gas to generate the electricity. The oil that refined to become gasoline is also a fossil fuel. In the future, hydrogen may serve as the energy for both electricity and vehicle power (Barbara J. Davis 2010)

2.6 WASTEWATER

2.6.1 Definition

Wastewater is a term applied to any type of water that has been utilized in some capacity that negatively impacts the quality of the water. Common examples of wastewater include water that is discharged from households, office and retail buildings, and manufacturing plants. Wastewater may also refer to any water that is utilized in an agricultural facility and is no longer considered fit for human consumption. The most common example of wastewater is liquid sewage. Discharged from homes and businesses alike, sewage usually contains a mixture of human waste, food remnants, water used in washing machines, and any other items that may have found their way into the sewage system.

2.6.2 Sources of wastewater

Most communities generate wastewater from both residential and non-residential sources (Richard Runion)

2.6.2.1 Residential Wastewater or Household Wastewater

Residential wastewater is a combination of excreta, flush water and all types of wastewater generated from every room in a house. It is more commonly known as sewage and is much diluted. There are two types of domestic sewage: black-water or wastewater from toilets, and gray water, which is wastewater from all sources except toilets.

2.6.2.2 Non-Residential Wastewater or Industrial Wastewater

This could be places such as industrial complexes, factories, offices, restaurants, farms and hospitals. Because of the different non-residential wastewater characteristics, communities need to assess each source individually to ensure that adequate treatment is provided. Storm-water is a nonresidential source and carries trash and other pollutants from streets, as well as pesticides and fertilizers from yards and fields. Communities may require these types of nonresidential sources to provide preliminary treatment to protect community systems and public health.

2.6.3 Characteristics of Wastewater

The characteristic of properties of wastewater can be classified under the following three heads which is physical characteristics, chemical characteristics and biological characteristics. The most important physical characteristic of water is its total solids content, consisting of floating matter, matter in suspension, colloidal matter and matter in solution. Other physical characteristics are smell odor, color and temperature.

Important characteristics of sewage are Ph value, chloride content, nitrogen content, fat, grease and oil content, sulphides sulphates and H_2S gas, dissolved oxygen, chemical oxygen demand, and biochemical oxygen demand. Biological characteristics relate to various micro-organism found in wastewater, some of which may be pathogenic. However all bacteria present in wastewater are not harmful; some of these help to treat the wastewater and reduce the cost of treatment plants.

Table 2.1 : Characteristics and Sources of Wastewater

	Characteristic	Source
1	**Physical characteristics**	
	Colour	Domestic and industrial wastes, natural decay of organic materials
	Odour	Decomposing wastewater; industrial wastes
	Solids	Domestic water supply; domestic and industrial wastes; soil erosions;inflow-inflitration
	Temperature	Domestic and industrial wastes
2	**Chemical characteristics**	
a)	*Organic*	
	Carbohydrates	
	Fats, oils and greases	Domestic, commercial and industrial wastes.
	Pesticides	Agricultural wastes
	Phenols	Industrial wastes
	Proteins	Domestic and commercial wastes
	Surfactants	Domestic and industrial wastes
	Others	Natural decay of organic materials
b)	*Inorganic*	
	Alkalinity	Domestic wastes, domestic water supply, ground water infiltration
	Chlorides	Domestic water supply, domestic wastes, groundwater infiltration, water softners
	Heavy metals	Industrial wastes
	Nitrogen	Domestic and agricultural wastes
	Ph	Industrial wastes

	Phosporus	Domestic and industrial wastes, natural runoff.
	Sulfur	Domestic water supply, domestic and industrial wastes.
	Toxic compounds	Industrial wastes
c) Gases		
	Hydrogen sulfide	Decomposition of domestic wastes
	Methane	Decomposition of domestic wastes
	Oxygen	Domestic water supply, surface water infiltration
3	**Biological characteristics**	
	Animals	Open water courses and treatment plants
	Plants	Open water courses and treatment plants
	Protista	Domestic wastes, treatment plants
	Viruses	Domestic wastes

2.6.3.1 Physical characteristic

2.6.3.1.1 Colour

Fresh domestic sewage is grey, somewhat resembling a weak solution of soap. With the passage of time, as putrefaction start, it begins to get black. The colour of septic sewage is more or less black or dark in colour. The colour of industrial wastewater depends upon the chemical process used in industries. Industrial waste water, when mixed with domestic sewage, may also add colour to it.

2.6.3.1.2 Odor

Normal fresh sewage has a musty odor which is normally not offensive, but as it starts to get stale, it begins to give offensive odor. Within 3 or 4 hours, all the oxygen present in the sewage gets exhausted and it starts emitting offensive odors of hydrogen sulphide, gas and other sulphur compounds produced by anaerobic microorganism. Industrial wastewater may contain either process of wastewater treatment. Offensive odors can be harmful in many ways such as reduction in appetite for food, lowering in water consumption, impaired respiration, nausea and vomiting and cause for mental perturbation.

2.6.3.1.3 Temperature

Generally, the temperature of wastewater is higher than that of the water supply, due to addition of warm water from the house holds and from industries. When the wastewater flows in closed circuits, its temperature rises further. This results in the increase in the viscosity of water and also increase in its bacterial activity. Wastewater temperature is commonly higher than water supply because of the addition of warm water from domestic use.

2.6.3.1.4 Turbidity

The turbidity of wastewater depends on the quantity of solid matters present in the suspension state. Turbidity is a measure of light emitting properties of wastewater, and turbidity test is used to indicate the quality of waste discharges with respect to colloidal matter. The turbidity depends upon the strength of sewage or wastewater. The stronger or more concentrated the sewage, the higher is its turbidity.