

Automotive Lubricating Oil Degradation as an Electric Power Generator using *Geobacter Sulfurreducens*

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Abstract— Electricity is the basis for the development of all humanity, moving the economy and being part of our daily life, unbridled consumption of electricity around the world, ends up making the continuous use of natural resources, making them increasingly scarce. This situation has led to numerous studies and research into finding alternatives for sustainability and clean energy generation. The objective was to highlight the use of microbial fuel cells in bacteria such as *Geobacter sulfurreducens* and *Bacillus Subtilis* with automotive lubricating oil as a way to generate clean electrical energy. The methodology used was the quantitative and qualitative bibliographic research in the main platforms of scientific journals, having as a selection criterion the period from 2015 to 2019. It can be concluded that studies involving these possibilities are capable of bringing great impacts, especially in the case respect for the preservation of the environment and the reduction of the use of natural resources.

Keywords— Sustainability, Clean energy, Bacteria, Disposable waste.

I. INTRODUCTION

The search for electricity generation from renewable sources has become one of the most commented agenda today, given its need for human life. Moreover, in the technological age, many products and machinery need electricity to function and to move the entire economy of society, focused on the use of electricity.

However, what persists is the use of water as a source of energy to supply the industrial community and for the operation of an entire city, involving the consumption of energy through hydroelectric dams, so the misuse of natural resources has caused the water can reach its critical state, especially in Brazil's hydroelectric reservoirs.

However, there are several other ways to generate energy in a clean and renewable manner, through conscious use of sustainable energy sources, such as the sun, wind, waves, waste and sewage, and in this particular case use of contaminated oils, such as automotive lubricating oil, which is often used and is discarded without proper treatment, causing irreparable damage to the environment.

In the mid-1970s, clean energy became the target of many countries, when oil scarcity caused many parts of

the world to invest heavily to adopt new technologies aimed at reducing dependence on energy imports [1].

Thus, the search for clean technologies is increasing, as a way to avoid and prevent serious environmental problems that affect the whole society, avoiding that several gases are emitted causing pollution of the environment. Therefore, clean energy is focused on the use of natural and fully renewable means [2].

According to [3] renewable energy sources are of various types: hydro, solar, wind, geothermal, waves and tides, alcohol, natural gas and vegetable oils. Each uses a natural resource for transformation into energy. These alternatives draw from nature resources that do not bring scarcity, such as wind, sunbeams, tidal waves, which are not continuous and have a certain propensity to become extinct in the world.

Clean energy is about renewable strategies focused on sustainability, because to keep the natural resources active in society, it is not enough to spend more than what can be obtained, turning to this idea energy needs to be clean for it to be renewable and sustainable. resources do not become scarce over time for all mankind [4].

Clean energy sources are called this because they are the least polluting energy in the environment, slowly abandoning the excessive consumption of electricity, the

creation of the tariff flag, where the consumer assigns the surcharge values related to the cost of kWh as a function of the cost attributed to electricity generation [5].

The other forms of clean energy still correspond to about 29% of the sources of electric energy, characterizing Brazil as a country dependent on the available electric energy (hydro and thermal).

This fact has raised interest in conducting research to use clean and renewable energy as the main alternative for the generation of electricity in Brazil, causing no generation of polluting agents and no significant environmental impacts. From a global point of view, there is still a significant dependence on power generation for thermal sources, coal and the like, which allows a small comparison of world dependence compared to Brazil (Figure 1).

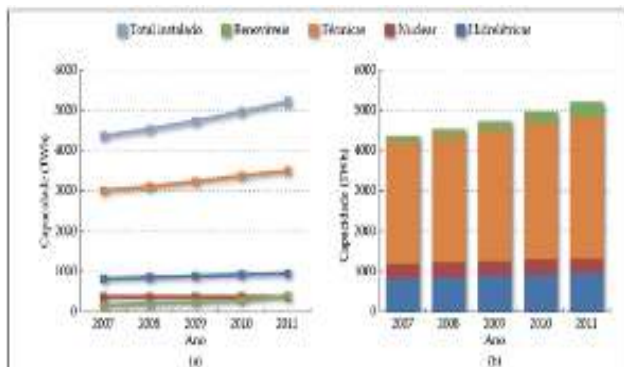


Fig 1: Installed capacity of worldwide installed power sources.

Source: Authors (2019).

Thus, the microbial fuel cell (MFC) is considered as a bioreactor capable of transforming chemical energy into electrical energy, becoming an alternative for energy generation due to catalytic reactions from within microorganisms [6].

For [7] cells can be called “electrochemical devices capable of converting chemical energy into electrical energy” with a considered high efficiency and small pollutant emissions, and can generate electric current being a good option for generating small scale energy.

According to [8], the microbial fuel cell is in alliance with sustainability, aiming at society's well-being through water quality, because microbial fuel cells are geared to operate as biosensors and can therefore be to determine the biochemical oxygen demand (BOD) in the sewage.

As a result, fuel cells start to draw attention for their ability to use bacteria to generate electricity. Starting from the premise that every living being has electrical energy, with this, the idea of generating energy from biodiesel as fuel for cells arises, however oxygen must be present otherwise the reaction becomes incomplete [9].

In a research carried out there is evidence of current measurements directed to the bacterium *Geobacter Sulfurreducens* DL 1, elucidating the factors involving the maximum capacity produced by a microbial fuel cell, where it was possible to observe the quantized current output of $92 (\pm 33)$, and $196 (\pm 20)$, fA are produced from well-isolated microelectrode parts [10].

In another study, it was found that these bacteria move electrons in their “breath”, causing the movement of microorganisms, where it generates electricity in the same way as other energy generators that use nanotechnology, in the case of bacteria. *Geobacter Sulfurreducens*, its existence occurs within the earth, where the existence of oxygen is zero, and its survival is caused by the exchange of energy with the other organisms that live around it [11].

Another bacterium is *Bacillus Subtilis*, occupying the soil, where it becomes composed of prokaryotic and also eukaryotic microorganisms. However, turning to the field prokaryotes may be in distinct parts like plants, multiplying in internal tissues, thus surviving from the rest of the native microflora [12].

These genera of bacteria are recognized for their ability to provide biological control of plant diseases and their use allows the monitoring of phytopathogens, where producers may have dominance in pathologies. In a recent discovery they also realized that this bacterium can be used to develop new ways of generating energy through moisture in the air, with a technique called hydroscopy-powered artificial muscles that takes advantage of the ability of some microorganisms to remove from the environment moisture, at this time using the bacterium *bacillus subtilis* enters a dormant state and becomes a spore, which when in contact with water removes all liquid from it, causing its volume to increase by 6% [13] (Figure 2).

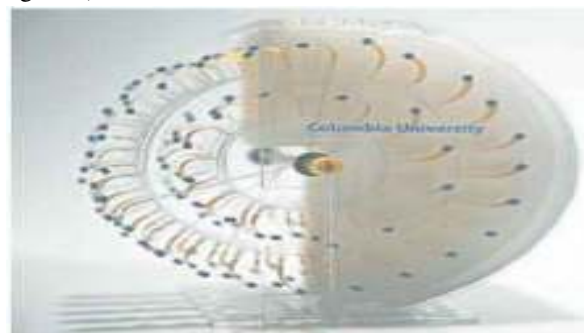


Fig 2: Hydra system demonstration prototype using *Bacillus subtilis*.

Source: Machado (2015).

This article aims to describe the use of bacteria *geobacter sulfurreducens* in consortium with *bacillus*

subtilis in a microbial fuel cell using automotive lubricating oil as a way to generate clean energy, that is, emitting less pollutants, and renewable, without compromising the future existence of existing natural resources.

II. MATERIALS AND METHODS

For the development of this article, bibliographic researches were carried out in the main platforms of journals, being, therefore, a qualitative study, for research focused on the generation of electricity using microbial fuel cell and the use of bacteria or microorganisms that can generate renewable electric energy.

As inclusion criteria were used articles published from 2015 to 2019, linked to research conducted with the cited bacteria or used in the junction of all cited items.

III. RESULTS AND DISCUSSION

By applying the inclusion and exclusion criteria, it was possible to obtain the results shown in table 1, which indicates the comparative use of microbial cells for fuel cell generator use.

Table 1: List of articles consulted.

Author s	Title	goal	Analysis Factors
[17] Fug, 2016.	Optimization of energy generation in a microbial fuel cell with Escherichia coli using polypyrrole electrodeposition modified electrode.	Construct a dual-chamber CCN for power generation from glucose degradation by Escherichia coli.	Two types of electrodes were analyzed: graphite and graphite modified by polypyrrole electrodeposition.
[15] Silveira Duarte et al. 2016	Microbial fuel cell used for electricity generation from sewage sludge and anionic surfactants.	To evaluate the influence of an anionic surfactant on membrane and membrane-free CCN.	Graphite rod electrodes were used and the MCC were fed with synthetic substrate and kept at room temperature.
[18] Felipe et al. 2017	Microbial fuel cell power generation	Achieve microbial fuel cell performance	An Escherichia coli strain was used in a 5 ml B.H.I broth

		e by varying some factors in search of new results.	test tube.
[19] Galera et al. 2018	Microbial Fuel Cell: Teaching Material for Microbiology Teaching	Use CCM as didactic material in the teaching of Microbiology, Chemistry and Physics for the secondary, technical and higher levels.	Materials such as 40 mm 10 cm pvc pipes were used; pipe connectors; iron and solder for the construction of a microbial fuel cell.
[16] Oliveira, 2019.	Alternative sources of energy with microbial origin: fuel cells and supercapacity nanostructures	Analyze the development of yeast-based microbial cells.	Dibasic potassium phosphate (K ₂ HPO ₄) and Saccharomyces cerevisiae, strain 1026 were used.
[14] Otonari et al. 2018	Synthetic vinasse biotreatment and electricity generation using a microbial fuel cell.	To evaluate the use of a dual chamber CCM in the treatment of synthetic vinasse.	Reactor power was analyzed by CCM technology.

Source: Authors (2019).

The relevance of using microbial fuel cells together with other microorganisms for the development of renewable electric energy was observed. Within this view, in the study by [14], tests were made with vinasse, it is a residue that comes from the production of ethanol, which in turn has a high concentration of oxygen or Biochemical Oxygen Demand (BOD₅), a pH low and in contrast, an abundance of mineral and organic substances, this junction causes a discharge into the soil. For this study a prototype of a microbial fuel cell was needed to insert the synthetic vinasse and inoculate with pure culture of red cell sulfate bacteria (BRS-IPT 032).

In the study by [15], an analysis of this energy conversion was made, but now using the microorganisms found in the sewage sludge in conjunction with anionic surfactants, after 35 days of monitoring, it was observed in the experience that the addition of Sulphonated linear alkylbenzene (LAS) positively corroborated with the electric power generation, and within the membrane-free CCM had a current of 7.5mA / m², for the membrane-based CCM the current was 37.3 mA / m².

In the study by [16] the use of yeast for microbial fuel cell power generation, where it was prepared using two Teflon cylindrical tubes, resulted in the efficiency of the lowest cost yeast-based fuel cell. according to the combination of the proton exchange membrane and current collectors.

Thus, in the study by [17] it was possible to find an increase in coulombin efficiency in the system containing polypyrrol (17.18%) compared to the system that did not have (7.31%), which causes a better use of electrons that can be converted into electrical energy.

For [18] microbial cells are considered as a method of generating energy with the degradation of a certain organic material, in the study the materials used were not enough to generate energy on a larger scale, for this the author suggests that further studies be done to find more cost effective electrodes.

Thus, [19] showed that in his study, CCM goes beyond an analysis involving Biology, Physics and Chemistry, where it was observed that it is easy to build a low cost CCM, therefore to generate energy, it is understood that costs can be low if a way of generating this energy on a larger scale is created.

With the largest consumption of electricity in the world, several losses to the use of natural resources have been faced mainly regarding the use of water as a source of electricity in the metropolises. Therefore, exploring new ways of generating energy in a clean or renewable manner allows it to preserve the main natural resources, which, however, may become scarce for all humanity in the future.

Thus, further studies should be done frequently to expand more possibilities, making it possible to generate energy using items that are harmful to the environment and that are discarded. Sharing scientific knowledge about this innovation not only contributes to the advancement of humanity, but also to its own preservation through the natural factors and effects that have been present over the years in nature.

IV. CONCLUSION

The microbial fuel cell is what makes it possible to generate electricity using bacteria or microorganisms of its own nature or in agreement with other elements that are also continuously discarded, such as automotive oils, sludge, solid waste, yeast, vinasse and many others. Combinations capable of causing the chemical reaction of the combination of these microorganisms and bacteria to generate electricity continuously.

Studies involving these possibilities are capable of having major impacts, especially for the preservation of the environment and natural resources, making electricity more accessible, cheaper and renewable, that is, something that is used inexhaustible source of nature, and therefore its use causes neither scarcity nor wear and tear over the years.

Incorrect use of oils that are disposed of in rivers or garbage can contribute to environmental pollution, and can also be a source of food for microorganisms capable of degrading them, so they can be used in conjunction with the microbial fuel cell, subject to chemical changes and which can generate electrical current.

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