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Dielectric Barrier Discharge Plasma Analysis and Application for Processing Palm oil mill effluent (POME)

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Abstract

Analysis of dielectric barrier discharge (DBD) plasma reactor electrically has been done. DBD as low-temperature plasma was used on liquid wastewater palm oil mill effluent (POME) treatment. The dielectric barrier discharge plasma reactor consists of electrodes in the stainless made of screw rod with a length of 40 cm and diameter of 1.84 cm and outer electrode as winding coil with a diameter of 2.25 cm. The outer electrode was made of copper wire windings with a diameter of 0.87 mm that was wrapped in a Pyrex tube with 0.25 cm thick, with a 20 mm inner diameter and tube length of 30 cm. Plasma reactor purged with argon gas discharge flow at 4 L/min which was connected to an AC voltage of 4 kV and frequency of 15 kHz. POME was inserted into the reactor by the time variation of 0, 30, and 60 minutes. The most optimal results in 60 minutes with a Chemical Oxygen Demand (COD) value of 115.62 mg/L or still 18 % compare with an initial and TSS value of 1018 mg /L or rest 85 %. We also determined the charges carrier mobility by using modified Robinson Equation, and we found that average mobility with samples is always high than average mobility without samples.

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Keywords: Dielectric Barrier Discharge, palm oil, liquid waste treatment, COD, TS, charge carrier mobility

1. Introduction

Plasma generator by using Dielectric Barrier Discharge Reactor has been done for many areas of research and applications. DBD is one of low-temperature plasma that can be applied in several areas, among others, the environment, ozone generator, and much more [1,2,3]. DBD's application on the environment has been carried out among others for removal of NOx [4], for the production of biodiesel from fatty acids from food industry waste [5], for upgrading heavy oil in a conventional thermal cracking system under atmospheric pressure [6]. Palm oil mill effluent (POME) is the wastewater of palm oil production process that is not only extremely damaging environment (especially soil and water bodies) but also disrupts the aesthetics of the environment. Chemically, POME is a colloidal suspension containing 95-96 % water, 0.6- 0.7 % oil and 4-5 % total solids including 2-4 % solids suspended. Levels of Biological Oxygen Demand (BOD) LCS is located between 25 000 and 65714 mg/L. Meanwhile, levels of Chemical Oxygen Demand (COD) of POME is between 44300 and 102696 mg/L. Treatment of POME should be done by a combination of several methods. The treatment via up-flow anaerobic sludge blanket–hollow centred packed bed (UASB–HCPB) reactor [7], for thermophilic (POME) [8]. There is some research for POME treatment by

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using non-thermal plasma. Treatment of POME by a combined sand filtration-DBD system for a preliminary study has been done [9].

This paper discusses the analysis of DBD Plasma screw rod - spiral configuration and separates by a dielectric of pyrex tube. This paper also discusses on macroscopic electrical such as voltage-current characteristics and microscopic concerning the mobility of the charge carriers. Furthermore, this paper explains the application on DBD Plasma for a treatment of wastewater used for processing oil palm that is often called palm oil mill effluent (POME).

2. The object of the study

The object this study was developing dielectric barrier discharge plasma that will be used for the treatment of palm oil mill effluent (POME). This research includes characterization of DBD plasma with spiral- screw electrodes; POME treatment and analysing.

3. Methods

3.1. Experimental set up

Figure 1 shows the experimental setup of this research. Dielectric barrier discharge plasma was constructed by an active electrode that was made of stainless steel screw with a diameter of 8 mm, Pyrex pipe with a diameter of 20 mm and an outer diameter of 22.5 mm as barrier and the outer electrode was made of copper wire with a diameter of 1.83 mm and its wrapped around the pipe as much as 54 windings. This DBDP was generated by AC high voltage. Electrical parameters of DBDP determined through a voltage divider (HV Probe DC Voltage DC Max 40 kV; 28 kV AC EC code number 1010, En G1010). The electrical signal from the probe detected by an Oscilloscope GOS-653, 50 MHz. The electric current, that was generated in the reactor was measured by using a multimeter (Sunwa TRXn 360) and ammeters (Kyoritsu, AC/DC Digital Clamp Meter). Argon gas as the industrial gas (Ar, 99.95%) was inserted into the reactor by regulating the gas flow rate in the range of 1-10 L/min. Voltage and electronic signals are generated can be observed using an oscilloscope. Gas flow rate was measured using a flow meter (Koploc Kojima Model RK 1600 R). Pome together with an argon gas introduced into the DBD reactor. Plasma generated in the reactor. Capacitive current measured as an average current of charge carriers. For measurement of total suspended solids (TTS), standard test methods for filterable matter (Total Dissolved Solids) and nonfilterable matter (Total Suspended Solids) in water has been exploited. For COD, we used Standard Test Methods for Chemical Oxygen Demand (Dichromate Oxygen Demand) of water.

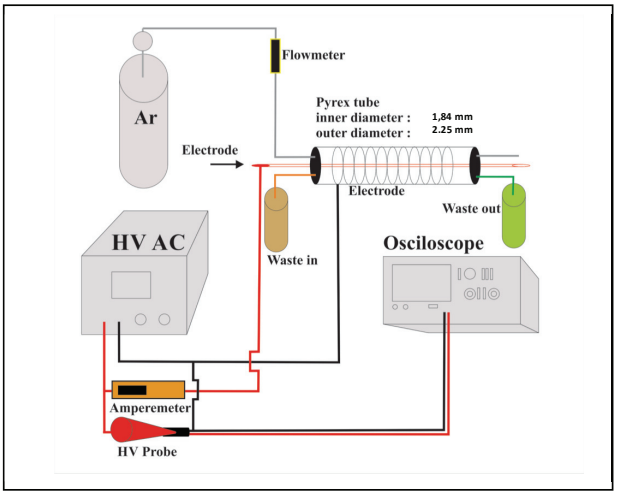

Fig. 1. Experimental set up .