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Statistical analysis of salinity reduction in Borneo tropical brackish peat water with continuous electrocoagulation treatment system

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ABSTRACT

The coastal peatlands located in Borneo estuaries region have a vast accumulation of brackish peat water. This water source is currently underutilized for domestic application due to the excessive salinity levels that may harm human health. As such, this study aims to conduct statistical analysis of salinity reduction in Borneo tropical brackish peat water with continuous electrocoagulation treatment system. Correspondingly, the study analysed the relationship between salinity percentage, electric current density, and flow rate on salinity reduction efficiency and energy operating cost. Subsequently, this study has developed a statistical model analysis with three level factors of central composite design to study the significant effects of salinity percentage, electric current density, and flow rate in continuous electrocoagulation treatment. The developed model is well fitted to the polynomial mathematical quadratic equations, particularly for salinity reduction efficiency ($R^2 = 0.84$) and energy operating cost ($R^2 = 0.97$). In addition, the analysis of variance (ANOVA) found that the salinity percentage, electric current density, and flow rate have significant effect on the studied parameters due to the p-value is less than 0.05. From the process optimization conducted, the continuous electrocoagulation treatment could achieve maximum salinity reduction efficiency of 91.78% and minimum energy operating cost of Ringgit Malaysia (RM) 0.29 or United States Dollars (USD) 0.06 per metre cubic of treated brackish peat water under optimal 22.22 A/m^2 of electric current density, 1.2 L/min of flow rate, and 30% of salinity percentage. Overall, it is deduced that continuous low electrocoagulation treatment system could be utilized to reduce the salinity levels in brackish peat water.

1. Introduction

Peat water is defined as surface water that contains organic substances, specifically humic acid which is found primarily in peatland areas (Alif et al., 2018; Rahman et al., 2021a; Abdul Rahman et al., 2023). According to Wenten et al. (2020), peat water could be an alternative water source especially for those residing in peatland areas. In addition, some peat water also contains salt ions that are naturally derived from the seawater intrusion into coastal peatlands areas during high tide (Gutekunst et al., 2022). Brackish peat water is categorized as a peat water source that contains both humic acid and salinity levels that ranged from 1000 mg/L to 15,000 mg/L (Grzegorzek and Majewska-Nowak, 2017). According to Gosch et al. (2018), brackish peat water in coastal peatlands is naturally formed due to seawater intrusion into peat water sources during high tides. Martin et al. (2018) reported that the southern Sarawak region particularly in Lundu and Sematan constitutes natural catchment areas that contained both peat water and brackish water. In terms of physical appearance, brackish peat water contains a complex mixture of yellowish-brown to black-coloured amorphous organic matter that is mostly found in estuaries regions (Takahashi et al., 2021; Rahman et al., 2022b). Despite brackish peat water is available abundantly in some rural coastal areas, this water is currently underutilized for domestic consumption due to an excessive salinity level (Zhang et al., 2013).

The membrane-related process is an advanced filtration that separates salts from water sources through microscopic porous membranes derived from polymeric or inorganic films. The performance of membrane process is only suitable with high-quality of feed water conditions despite membrane-related processes could remove salts from saline water sources (Khanzada et al., 2017). According to Qasim et al. (2019), the membrane fouling issue needs to be considered in implementing reverse osmosis due to fast degradation of membranes when the treated water

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