HARNESSING CO_2 IN HYDROGEN GENERATION USING GREEN TEA AND SCRAP IRON FROM THE PYROLYSIS OF TIRES

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ABSTRACT

In Europe, an estimated 350 million tires are discarded annually, representing a fraction of the global total of 1 billion tires reaching the end of their lifecycle worldwide [1]. The management of tires through the pyrolysis process necessitates the removal of steel fibres, which constitute approximately 10-25% of the tire's total weight, prior to the commencement of the pyrolysis procedure. The current study focuses on the production of H_2 by reusing the steel fibres resulting from the waste tire pyrolysis process. Pyrolysis is the thermochemical breakdown of substances in an oxygen-free, inert atmosphere, and it yields a variety of carbon and hydrocarbon compounds [2]. The reaction of scrap iron with CO_2 and $NaHCO_3$ results in the production of $FeCO_3$, H_2 and NaOH. During the reaction, siderite is generated as a passivation layer on the scrap iron preventing it from reacting further. A study conducted by Constantinou et al. (2023), identified that citric acid was the most suitable acid in removing the siderite layer under anaerobic mild aquatic conditions. However, a more cost-effective solution needed to be found [3]. Consequently, rather than utilizing citric acid, green tea was incorporated into the system (consisting of steel fibres from tires and $NaHCO_3$) to interact with the siderite on the steel surface, thereby enhancing the reaction yield. Several parameters were tested to find the most suitable conditions for higher hydrogen generation. Experiments were conducted in 125 mL serum bottles, featuring a working volume of 80 mL, a headspace of 45 mL and 20 g/L $NaHCO_3$. The influence of temperatures (4°C, 25°C, 50°C, 80°C) with 50 g/L Fe was studied and found that 50°C was the most effective temperature, producing 10 mL of H_2 after 17 hours at a rate of 2.8% daily. Various concentrations of green tea (5 g/L, 25 g/L, 50 g/L) were investigated. The findings showed that 5 g/L generated 29.8 mL hydrogen on day 1, indicating a daily production rate of 18.7%. Similarly, concentrations of $NaHCO_3$ (0 g/L, 5 g/L, 10 g/L, 20 g/L) were examined, which resulted that 0 g/L produced the highest volume of 28.4 mL with a rate of 4% daily.

KEYWORDS: CO_2 usage, Green Tea, Hydrogen generation, Scrap iron, Siderite removal

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