# UTILIZATION OF $CO_2$ SIMULTANEOUSLY WITH $H_2$ GENERATION BY ANAEROBIC CORROSION OF ZERO-VALENT IRON AT TEMPERATURE NEAR ROOM TEMPERATURE

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## ABSTRACT

Hydrogen ($H_2$) is considered as a clean, sustainable fuel, and it is promised to deliver a future with zero net emissions. Presently, nearly 96% of $H_2$ is produced from non-renewable sources (e.g., natural gas, coal, etc.) through a polluting method called the steam reforming process and the remaining 4% by electrolysis of water[1]. Meanwhile, researchers are interested in an old commercial method: the iron-water process under mild hydrothermal conditions, where metallic iron $Fe^0$ is oxidized in the presence of water steam, producing $H_2$ and iron oxide. It is also suggested that the presence of carbon dioxide ($CO_2$) performs a catalytic role and enhances $H_2$ generation[2]. $CO_2$ is the primary anthropogenic greenhouse gas that contributes to significant environmental problems and global warming; consequently, the European Commission proposed to reduce GHG emissions by at least 55% by 2030 compared to 1990[3]. However, the iron-water process requires high temperatures and pressures, leading to increased energy consumption and high cost. Therefore, from the perspective of energy and cost savings, the generation of $H_2$ through the oxidation of $Fe^0$ at a significantly lower temperature would be desirable.

Herein, a sustainable, cost-effective method for reducing $CO_2$ and producing $H_2$ with metallic iron under anaerobic conditions at 33°C is presented. This research shows that zero-valent iron ($Fe^0$) is reacted with bicarbonate solution and $CO_2$ and generates 96% $H_2$ after five days and siderite ($FeCO_3$), which is created in the outer surface of the metallic iron. Noteworthy, siderite can be used as a raw material in the cement or steel industry[4]. Moreover, scrap iron pre-treated with citric acid was assessed for $H_2$ generation under the conditions mentioned above. The present work has investigated the effect of metallic iron and bicarbonate concentrations on $H_2$ production and has developed the rate law of the reaction based on the experimental data obtained. Furthermore, different temperatures in the range of 4-50°C were examined for $H_2$ generation.

**KEYWORDS:** hydrogen generation, iron, carbon dioxide, reaction rate

## REFERENCES

[1] Yukesh Kannah, R., Kavitha, S., Preethi, Parthiba Karthikeyan, O., Gopalakrishnan Kumar, Dai-Viet, N. Vo., & Rajesh Banu, J. (2021). *Bioresour. Technol.* 319:124175.

[2] Duo, J., Jin, F., Wang, Y., Zhong, H., Lyu, L., Yao, G., & Huo, Z. (2016). *Chem. Commun.* 52(16):3316-3319.

[3] European Commission. https://ec.europa.eu/clima/eu-action/european-green-deal/2030-climate-target-plan [accessed 05 Jan 2022].

[4] Mora Mendoza, E.Y., Sarmiento Santos, A., Vera Lopez, E., Drozd, V., Durygin, A., Chen, J., & K Saxena, S. (2019). *J. Mater. Res. Technol.* 8(3):2944-2956.