Continuous H_2O_2 Production via Non-Thermal Plasma (NTP) from O_2 Saturated water

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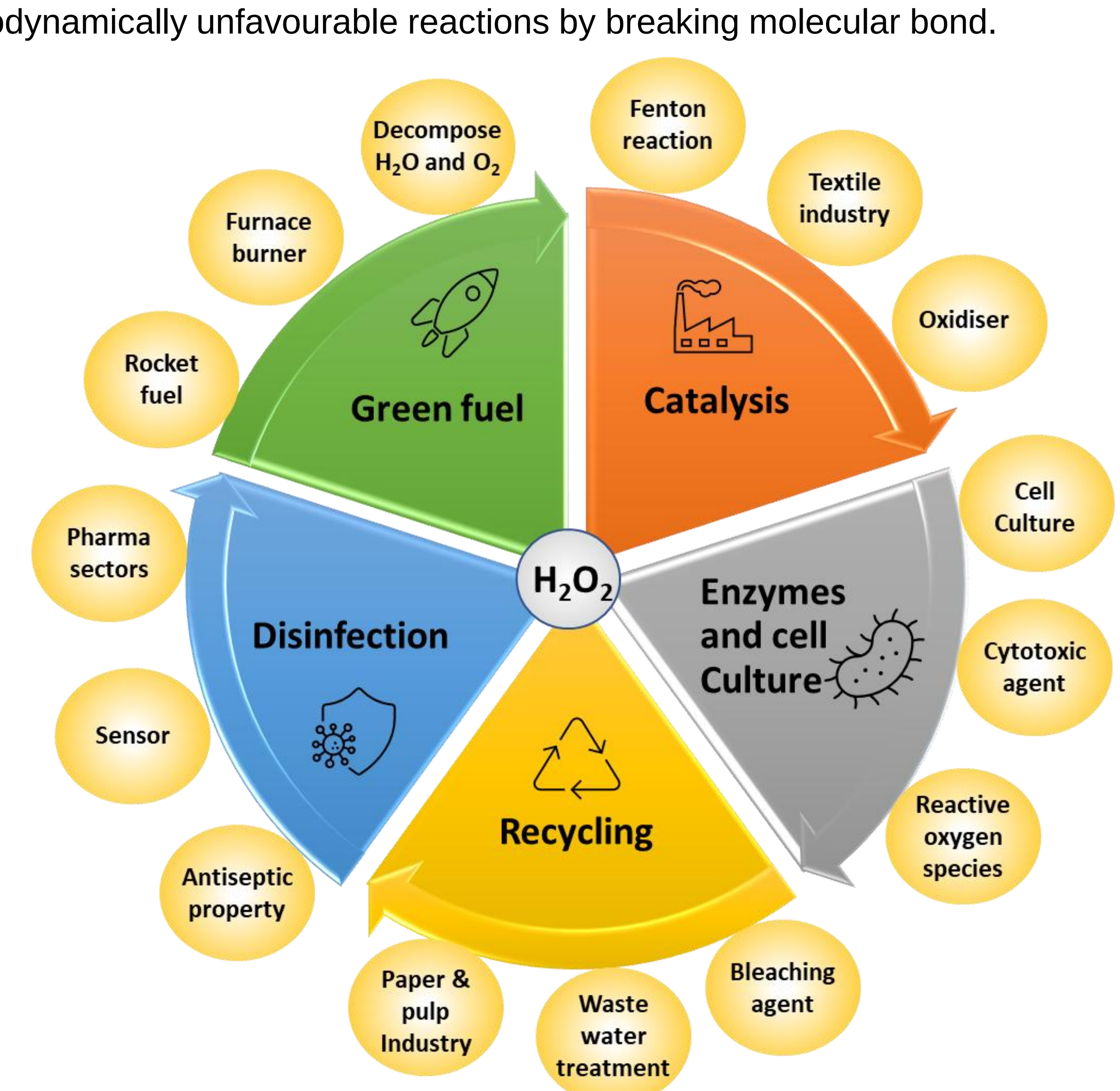
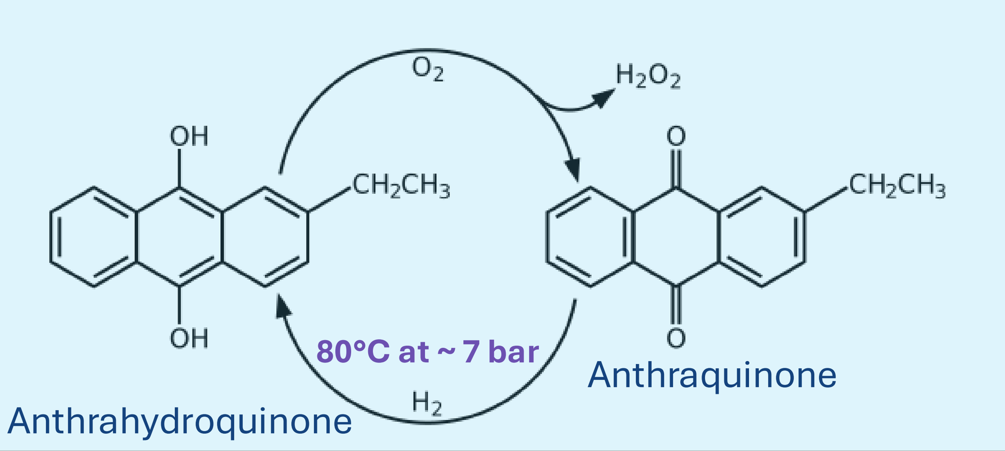
INTRODUCTION & AIM

Conventional methods for hydrogen peroxide (H_2O_2) synthesis, such as heterogeneous catalytic processes, require hydrogen (H_2) and oxygen (O_2) as feedstocks, along with expensive noble metals and organic solvents. Such a method is energy-intensive and hazardous. In contrast, non-thermal plasma (NTP) generated within a dielectric barrier discharge (DBD) coaxial reactor provides 1 to 10 eV energy, sufficient to even drive thermodynamically unfavourable reactions by breaking molecular bond.



This study investigates the direct synthesis of aqueous H_2O_2 by passing oxygen through varying flow rates in the non-thermal plasma reactor. The outlet gas from the plasma reactor is then bubbled into water, facilitating H_2O_2 production. This method relies solely on water, oxygen, gas, and electricity, offering an environmentally friendly alternative to traditional processes. Next, we integrated with photocatalytic process to enhance the product Yield.

Current state of art of H_2O_2 production process:



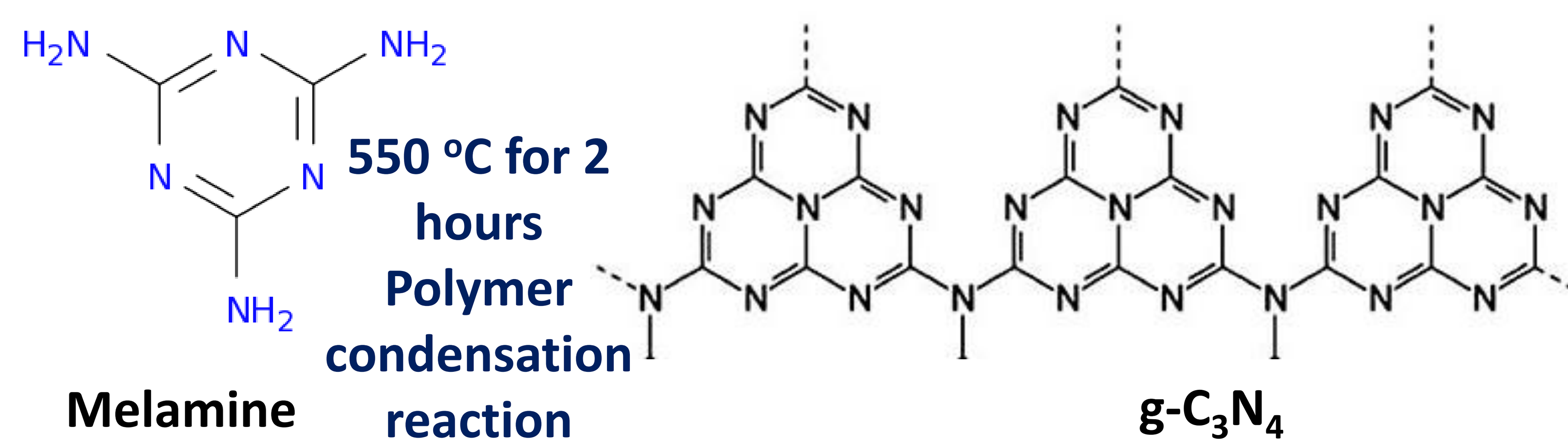
- ✓ Pressurized Storage of H_2 and O_2
- ✓ Can be raise safety concern
- ✓ Usage of rare earth Palladium for hydrogenation reaction

Our proposed H_2O_2 production process:

Sun light + O_2 + Photocatalyst → H_2O_2 at Ambient conditions

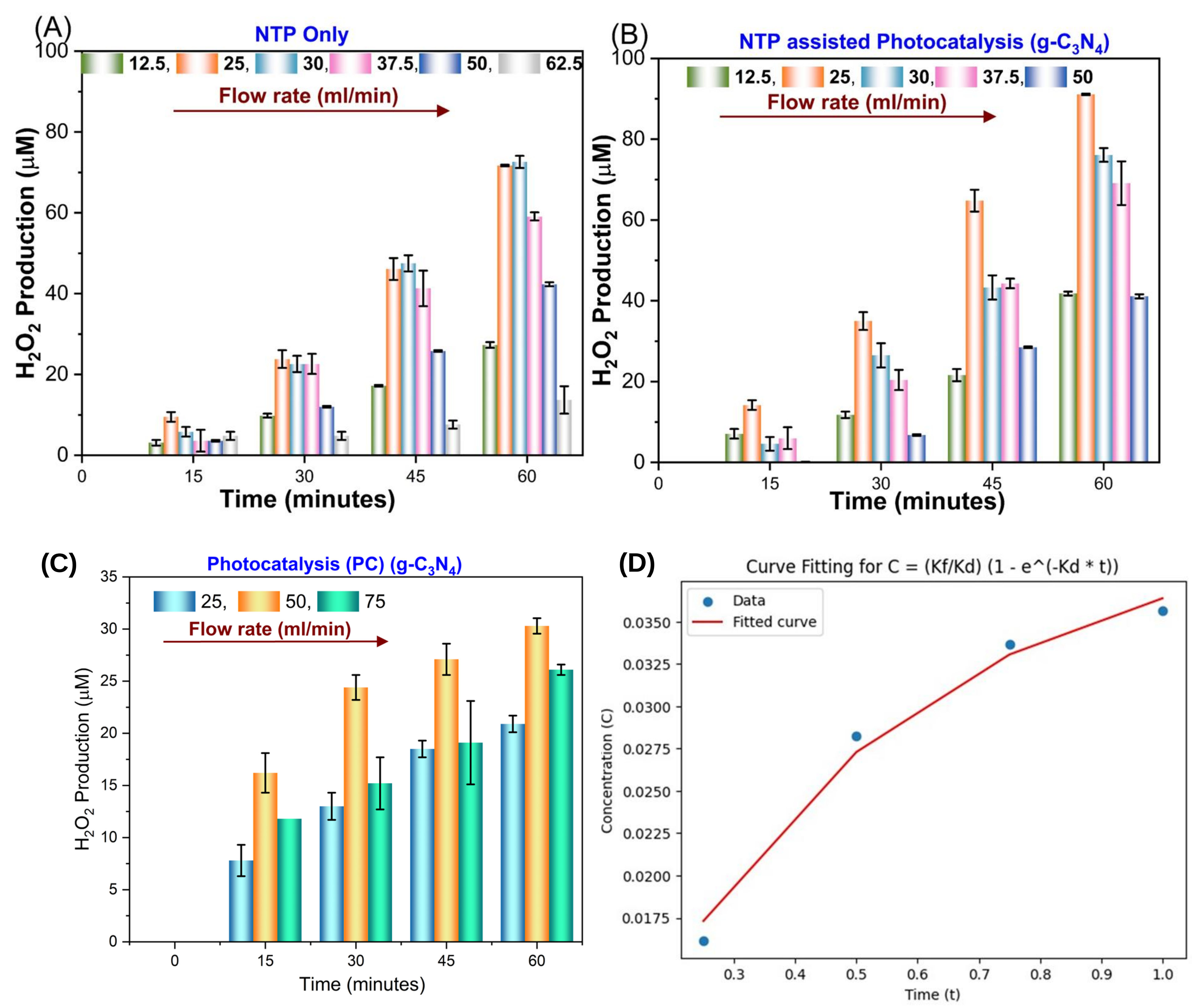
- ✓ No Pressurized Storage of H_2
- ✓ Integration of Renewable energy such as Sunlight
- ✓ Usage of visible light active low-cost catalysts

METHOD



Scheme 1. Pictorial representation of g-C_3N_4 synthesis from the melamine

RESULTS & DISCUSSION



Assuming the formation of H_2O_2 follow zero order reaction with rate constant k_f and the decomposition of H_2O_2 follows first order with rate constant k_d .

$$\frac{dC}{dt} = k_f - k_d C; \quad \frac{dC}{dt} = = k_d \left(\frac{k_f}{k_d} - C\right); \quad \frac{dC}{\frac{k_f}{k_d} - C} = k_d\, dt$$

Integrating on both sides C = H_2O_2 concentration at time t

$$\int_0^c \frac{dC}{\frac{k_f}{k_d} - C} = \int_0^t k_d\, dt; \quad \ln\left(\frac{\frac{k_f}{k_d} - C}{\frac{k_f}{k_d}}\right) = -k_d\, t \ ; \quad C = \frac{k_f}{k_d}\left(1 - e^{k_d * t}\right)$$

CONCLUSION

NTP-assisted photocatalytic reaction provided ~ 3 fold higher H_2O_2 generation than alone photocatalytic reaction in the continuous O_2 supply of 50 ml/min. This study showcase a novel strategy to improve the H_2O_2 production activity using visible light active and low cost g-C_3N_4 . Also, shed light on the nonthermal plasma interaction at different gas flow condition at photocatalyst interface.

ACKNOWLEDGEMENTS / REFERENCES

This research was financially supported by the Department of Science and Technology, INSPIRE faculty program fellowship (Grant DST/INSPIRE/04/2022/002668) by the Indian government.

Ind. Eng. Chem. Res. 2023, 62, 51, 21885.