

Comparative photocatalytic performance of asphaltenes tuned photocatalyst and Pd/g-C₃N₄ for degradation of 2,5-dichlorophenol

Ammar Haider(1), Grzegorz Boczkaj(1)

1. Department of Sanitary Engineering, Faculty of Civil and Environmental Engineering, Gdansk University of Technology, Poland.
ammar.haider@pg.edu.pl, grzegorz.boczkaj@pg.edu.pl

INTRODUCTION & AIM

Introduction

- ❖ Halogenated organic compounds such as 2,5-dichlorophenol are toxic, persistent and considered as pollutant of priority concerns.
- ❖ Conventional water treatment methods are inefficient and generate secondary pollutants.
- ❖ Photocatalysis emerges out to be very effective for degradation of such toxic pollutants.
- ❖ Graphitic carbon nitride is very stable, low cost and metal free photocatalytic material but suffers from rapid charge recombination.
- ❖ Modification strategies such as Pd loading improve charge separation but involve high cost.
- ❖ Asphaltenes, carbon rich waste materials, offer a low-cost alternative for tuning photocatalytic properties by enhancing light absorption and electron transfer.

Aim

- ❖ To compare the photocatalytic performance of asphaltene-tuned photocatalyst and Pd/g-C₃N₄ for degradation of 2,5-DCP under different light sources.
- ❖ To evaluate degradation efficiency and kinetics under identical conditions.
- ❖ To understand the mechanism behind their performance differences.

METHOD

Catalyst Preparation

Two photocatalysts Pd/g-C₃N₄ and Asp/g-C₃N₄ were synthesized by using the method as explained in below diagrams

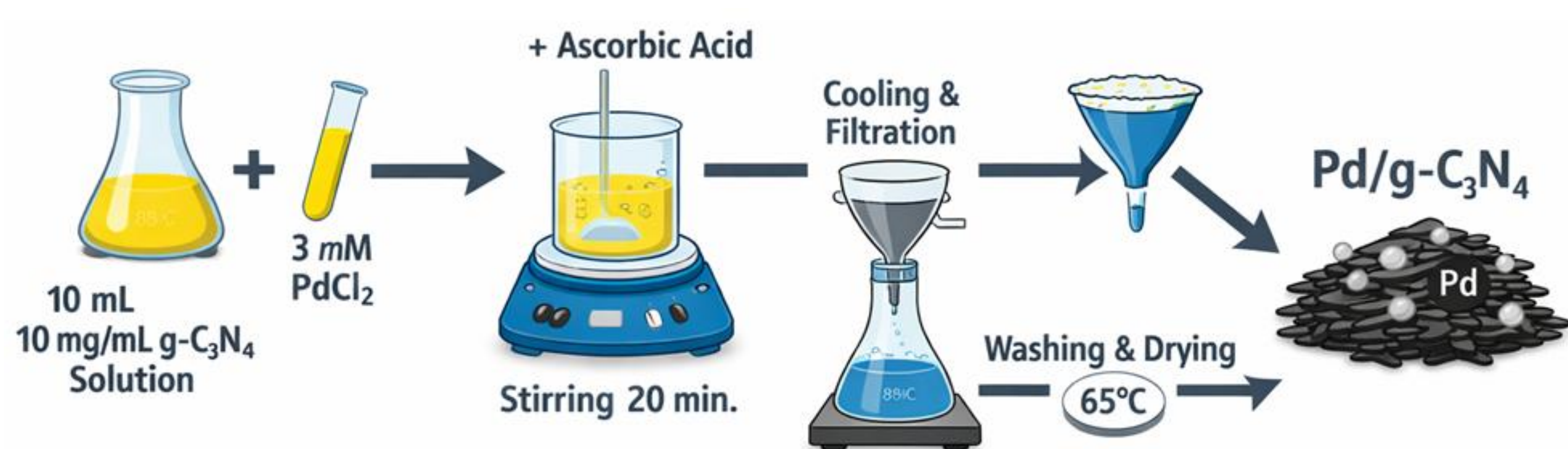


Fig. 1 Synthesis of Pd loaded graphitic Carbon Nitride

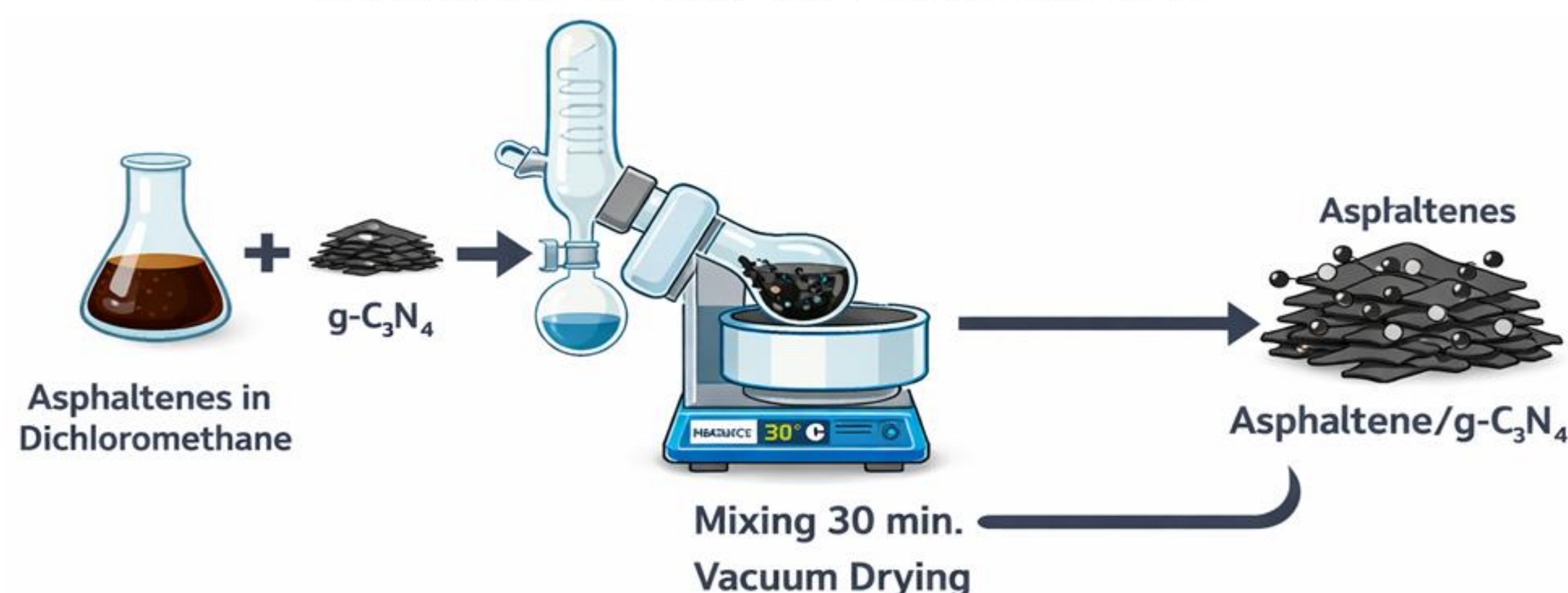


Fig. 2 Synthesis of Asphaltenes loaded graphitic Carbon Nitride

Photocatalytic experiments

Degradation experiments were conducted under hydrogen atmosphere in a photochemical reactor under two different light sources

UV light: Low pressure Hg lamp

Visible light: Xe lamp

Analytical Techniques

HPLC: used to monitor the degradation of contaminant

IC: used to measure the dehalogenation

GC-MS: used to identify reaction intermediates and pathway of degradation.

Optimization of parameters: Different parameters including loading of asphaltenes, dose of catalyst, pH were also optimized. TBA was used to confirm the degradation followed reductive pathway.

RESULTS & DISCUSSION

Photocatalytic performance

Xe lamp showed superior activity due to broader spectrum and higher intensity as shown in Fig 3.

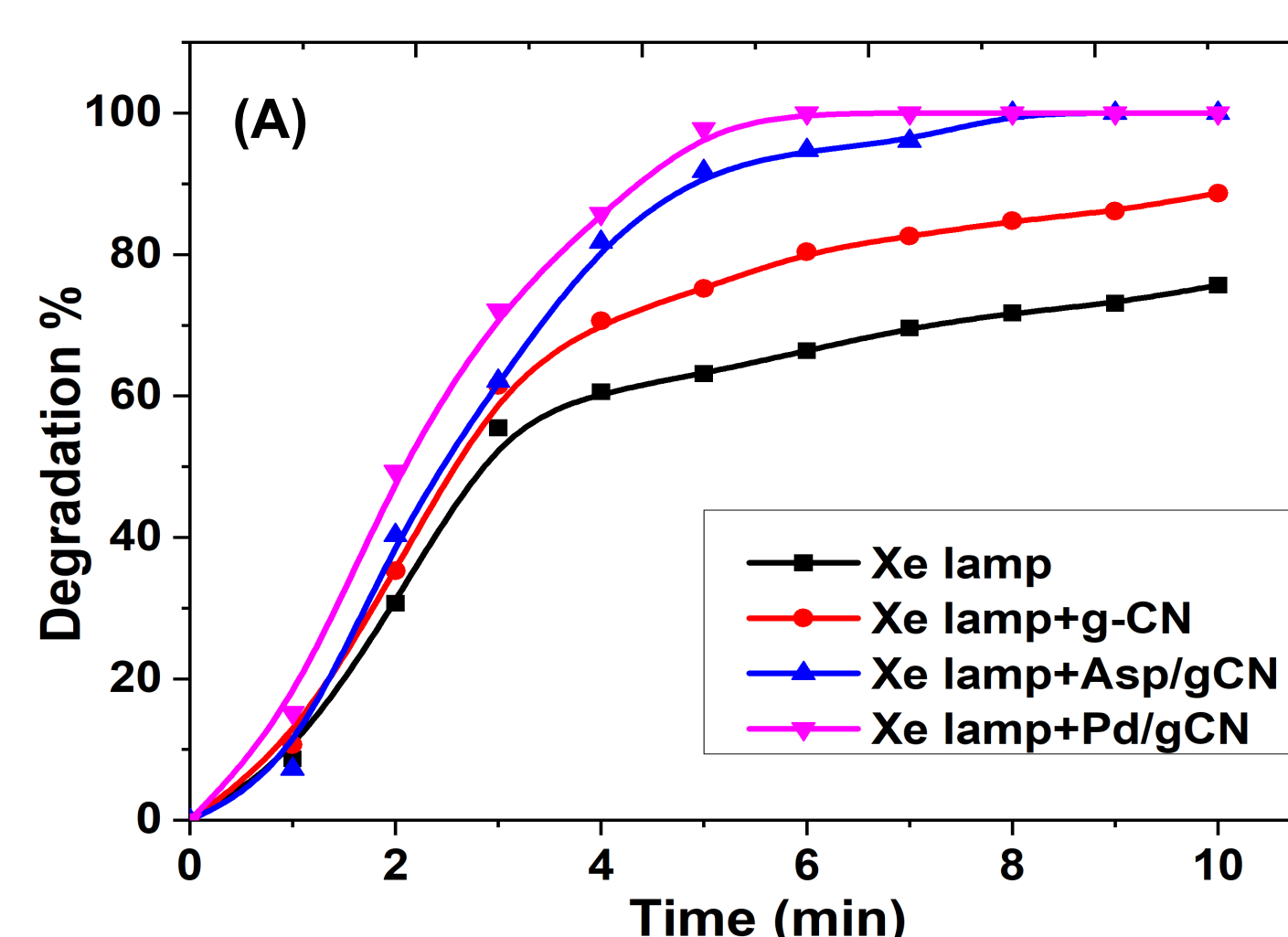


Fig. (A) Degradation under Xe lamp

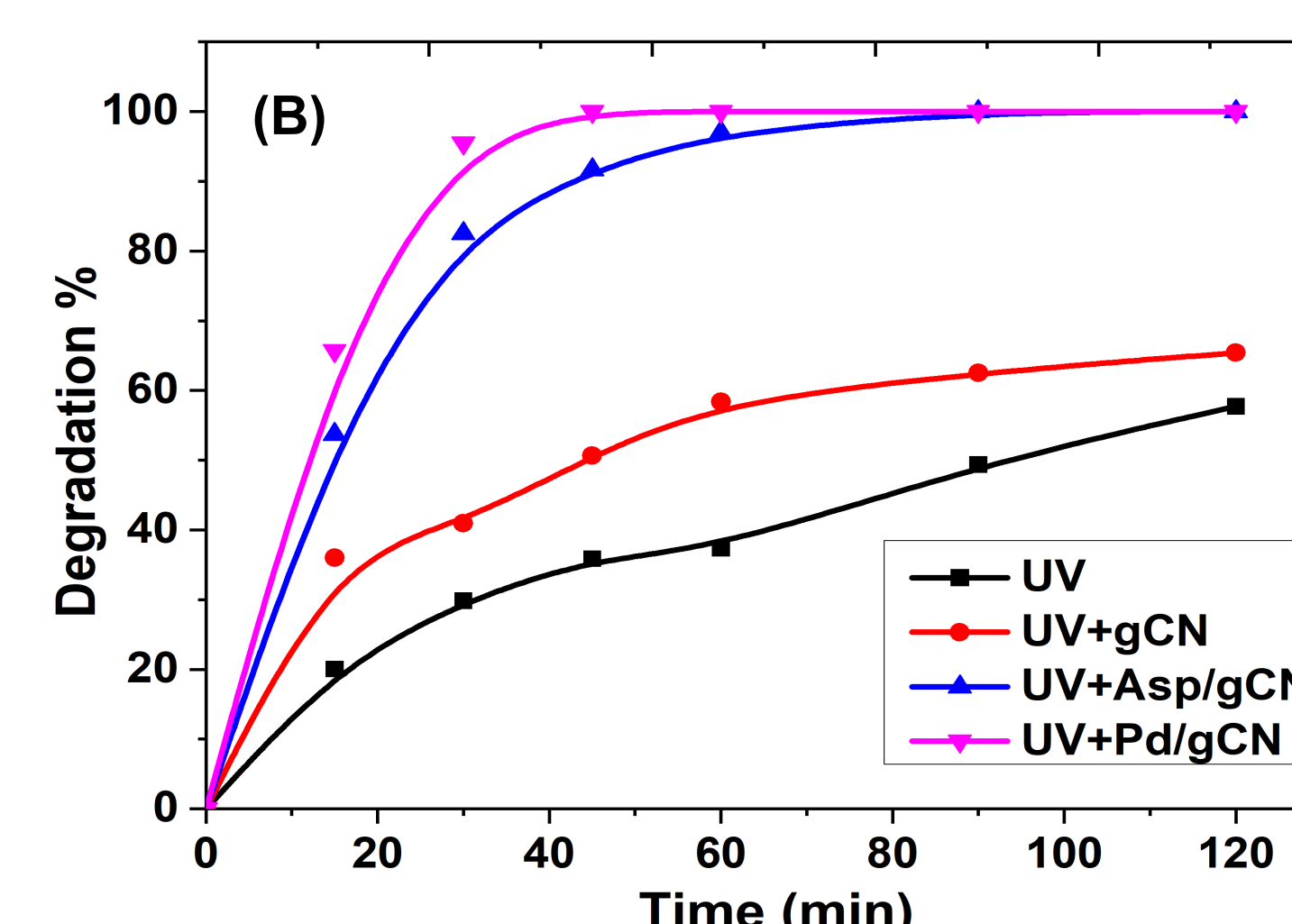


Fig. (B) Degradation under UV lamp

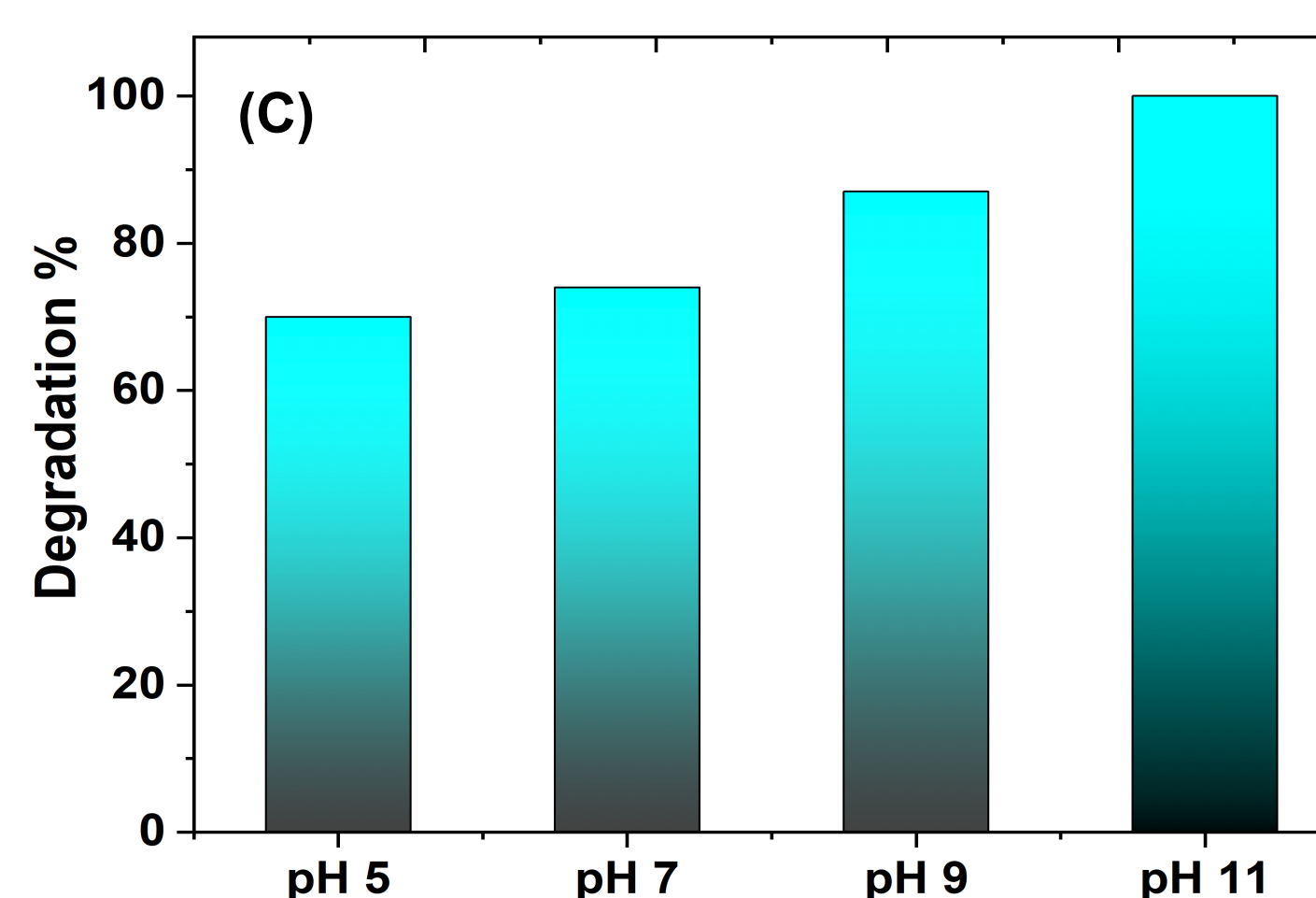


Fig. (C) Effect of pH on degradation

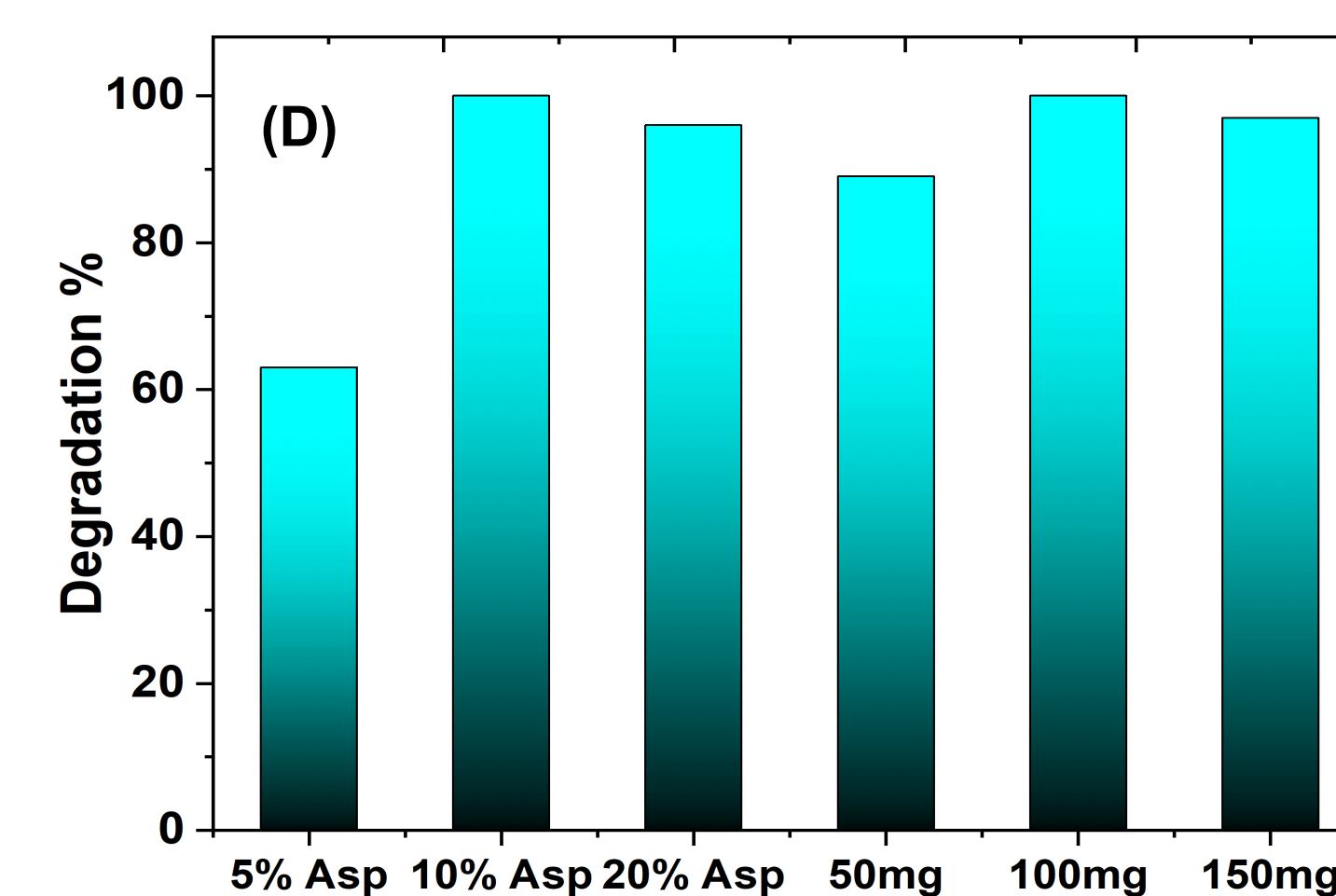


Fig. (D) Effect of Asphaltenes loading and dose

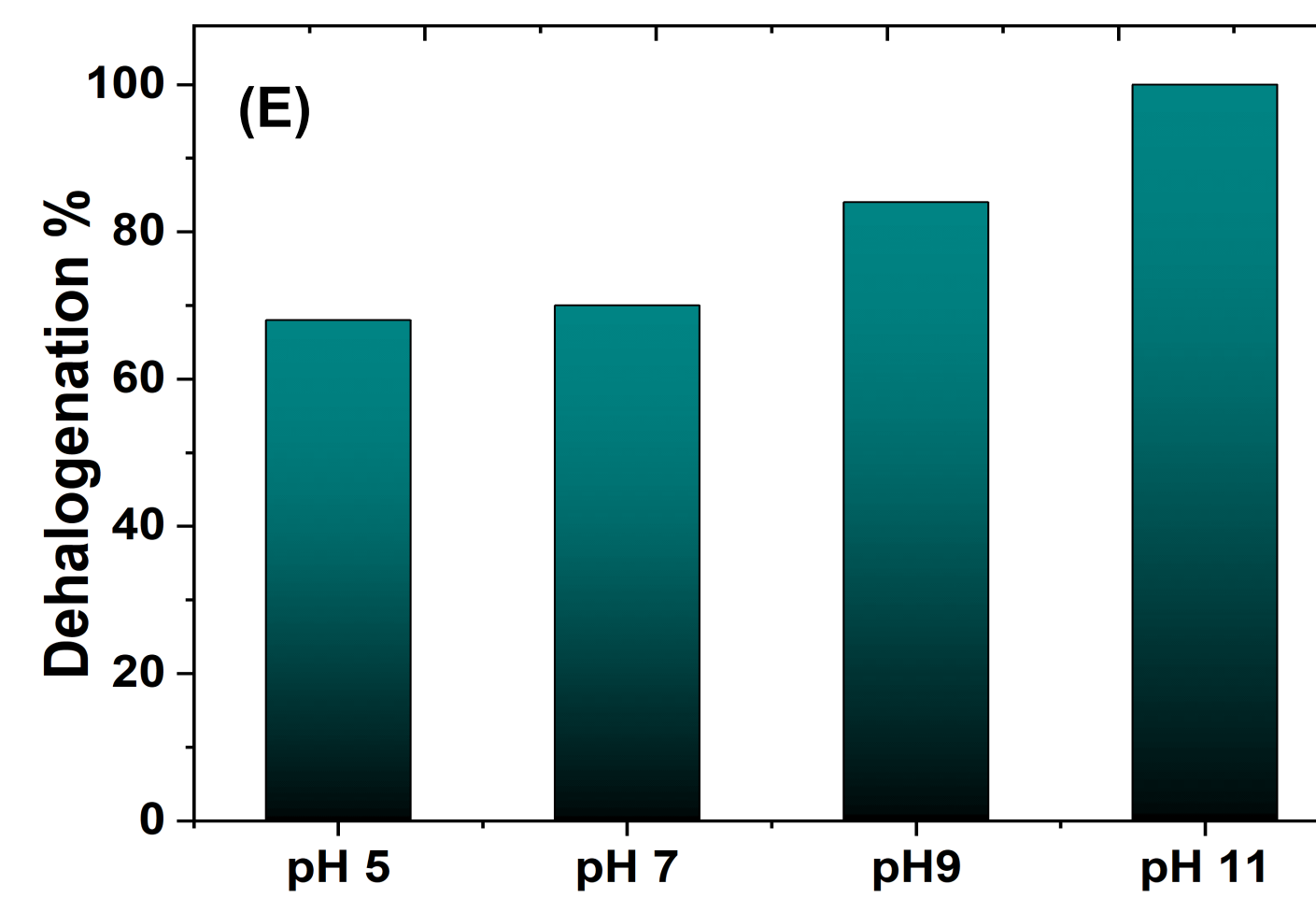


Fig. (E) Effect of pH on dehalogenation

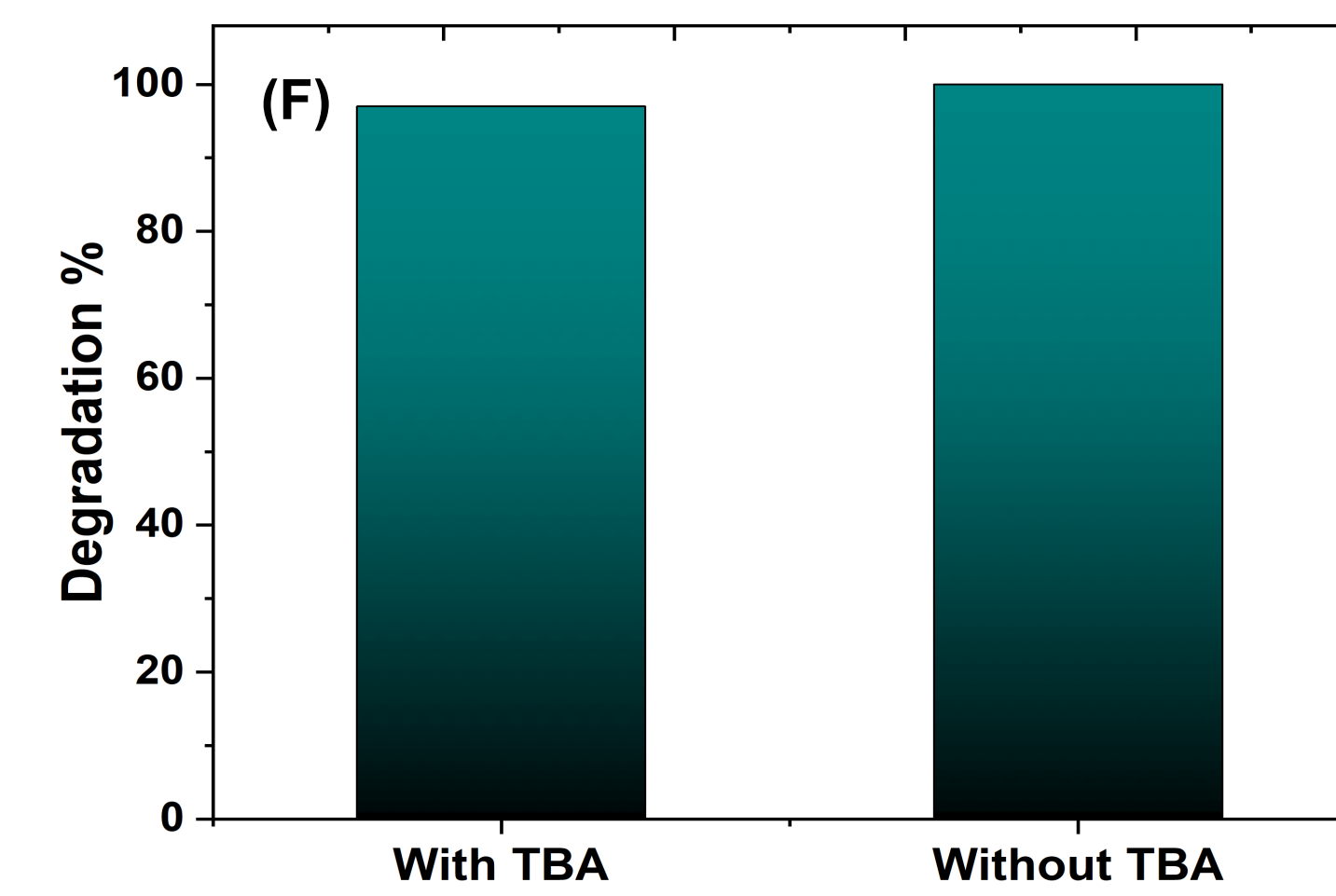


Fig. (F) Effect of TBA on degradation

Loading of Pd and Asphaltenes on g-C₃N₄ reduced charge recombination, improved absorption of light and transfer of electron. Asp/g-C₃N₄ showed competitive performance in low cost. Degradation followed pseudo-first order kinetics. Highest degradation rate was observed at pH 11 due to enhanced availability of electrons and improved surface interactions. Optimal loading of Asphaltenes was 10% and dose of Asp/g-C₃N₄ was 100mg/L, higher loading and dose reduced efficiency due to scattering of light and aggregations. Maximum dechlorination was achieved at pH 11 consistent with degradation results. Addition of TBA did not affect the degradation process confirming reductive degradation of contaminant.

CONCLUSION

- ❖ Pd and Asphaltenes loading on graphitic carbon nitride improved the photocatalytic activity of g-C₃N₄.
- ❖ Degradation followed pseudo-first order kinetics and reductive pathway for degradation.
- ❖ Efficient dechlorination confirmed C-Cl bond cleavage, indicating complete pollutant transformation.
- ❖ Asp/g-C₃N₄ exhibited a promising photocatalytic activity, demonstrating its potential as a cost-effective alternative to noble metal catalysts.

ACKNOWLEDGEMENT

❖ The authors gratefully acknowledge financial support from National Science Centre, Warsaw, Poland for Project OPUS nr UMO-2021/41/B/ST8/01575.