Circular Economy in Food Industry Waste Management (BIVALIA Workshop2 - 2026)

Editors: Elena Diaz Nieto; Francisco Heras Muñoz; Juan Antonio Melero Hernández; Manuel Gertrudix
Madrid, BIVALIA, UAM-URJC, 2026
DOI: 10.5281/zenodo.22206833 · CC BY 4.0
Full volume: https://books.ciberimaginario.cloud/libro/bivalia-w2-2026

P.I.10 — Anodic polarization drives the trade-off between organic conversion and bioproduct formation in PPB photo-MECs

V. Galve[1,2*], D. Puyol[1,2], R. Molina[1,2], A. Prado[1]

1: Department of Chemical and Environmental Technology, Universidad Rey Juan Carlos, Madrid, Spain | 2: Instituto de Investigación de Tecnologías para la Sostenibilidad, Universidad Rey Juan Carlos, Madrid, Spain

Purple phototrophic bacteria; Wet air oxidation; Photo-bioelectrochemistry; Refinery sludge; Carotenoids

HOW TO CITE THIS CONTRIBUTION

V. Galve, D. Puyol, R. Molina, A. Prado. (2026). P.I.10 — Anodic polarization drives the trade-off between organic conversion and bioproduct formation in PPB photo-MECs. In: Diaz Nieto, E., Heras Muñoz, F., Melero Hernández, J. A., Gertrudix, M. (Eds.), Circular Economy in Food Industry Waste Management (BIVALIA Workshop2 - 2026), p. 47. BIVALIA, UAM-URJC. https://doi.org/10.5281/zenodo.22206833

Poster Presentations #26

P.I.10 — Anodic polarization drives the trade-off between organic conversion and bioproduct formation in PPB photo-MECs

V. Galve[1,2], D. Puyol[1,2], R. Molina[1,2], A. Prado[1]*

[1] Department of Chemical and Environmental Technology, Universidad Rey Juan Carlos, Madrid, Spain | [2] Instituto de Investigación de Tecnologías para la Sostenibilidad, Universidad Rey Juan Carlos, Madrid, Spain

**Correspondence: victor.galve@urjc.es*

Keywords: *Purple phototrophic bacteria; Wet air oxidation; Photo-bioelectrochemistry; Refinery sludge; Carotenoids*

The valorization of refinery oily sludge remains challenging due to its hazardous nature, high organic load and complex hydrocarbon-rich composition. In this work, purple phototrophic bacteria (PPB) were integrated with wet air oxidation (WAO) and photo-bioelectrochemical operation to evaluate whether anodic polarization can steer the conversion of refinery sludge-derived organics towards treatment- or valorization-oriented outputs.

WAO was first used to oxidize and solubilize high molecular weight hydrocarbons from refinery oily sludge, generating an aqueous phase suitable for PPB cultivation. This WAO effluent contained high soluble chemical oxygen demand (SCOD ≈11.4 g L^{-1}) and ammonium concentration (NH_4^+ ≈0.84 g L^{-1}) and was diluted to 33% (v/v) to reduce microbial inhibition while preserving substrate availability. The diluted stream was treated in H-type photo-microbial electrolysis cells inoculated with an enriched natural PPB culture. Graphite anodes were poised at +0.2, +0.4, +0.6 and +0.8 V vs Ag/AgCl, using platinized titanium mesh cathodes and infrared illumination. Open circuit potencial reactors (OCP) were operated as non-polarized controls.

Electrode polarization clearly modified the fate of the soluble organic fraction. After four days, SCOD removal increased from 22% in OCP to 35–43% under polarized operation. The +0.8 V condition showed the highest removal at this stage and reached the maximum overall SCOD removal of the assay at the end of the experiment (52%). In addition, final residual SCOD under polarization was 21–32% lower than in OCP, while polarized reactors maintained measurable late-stage activity after the control approached near-zero consumption. Ammonium removal was also enhanced, increasing from 12% in OCP to 27–34% under polarized conditions.

However, the potential that maximized organic conversion was not the one that maximized valorization products. Planktonic biomass reached its highest value at +0.4 V (800 ± 100 mg VSS L^{-1}), while it decreased to 660 ± 50 mg VSS L^{-1} at +0.8 V. Apparent biomass yield was 12% higher than OCP at +0.4 V but 32% lower at +0.8 V, indicating a shift from biomass formation to electrode respiration at more oxidizing potentials. Biofilm development and the carotenoid production were highest at +0.2 V.

Overall, anodic potential acted as a key operational lever in PPB photo-bioelectrochemical systems: +0.8 V promoted organic conversion and ammonium removal, whereas +0.2–+0.4 V favoured biomass formation, biofilm development and pigment-oriented valorization.

Acknowledgements

This work was supported by COST Action PurpleGain (CA21146), supported by COST, by the project SLUDG4MAT&WATER (PID2021-122883OB-I00), and by the project Purple4Life (grant agreement No. 101212806).

© 2026 BIVALIA-CM (TEC-2024/BIO-177) · CC BY 4.0 · DOI: 10.5281/zenodo.22206833