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Unravelling the chemistry behind the toxic effects of refining wastewater: Characterization and remediation

Angela Pinzon-Espinosa and **Rakesh Kanda**
Brunel University London, UK

Refining transforms crude oil into marketable products with high commercial value, providing a third of the global energy requirements and numerous raw materials. The process, however, emits vast amounts of wastewater that can have harmful effects on wildlife and human health but the link between chemistry and observed toxicity is fragile because little progress has been made in determining causative agents. Consequently, current treatment technologies are not targeting key toxicants nor providing safe effluents. Here we show that naphthenic acids are important components of refining wastewater, resulting from the processing of heavy crude oil, and that they have an important contribution to the toxic effects exerted by these effluents. Furthermore, we found that their chemical stability makes them highly resistant to remediation using bacteria and Fe-TAML/H_2O_2 systems under laboratory conditions, and only sequential aliquots of Fe-TAML catalysts and H_2O_2 showed to degrade naphthenic acids (50 ppm) within 72 hours. We anticipate our results to be a starting point for better environmental regulations relevant to refining wastewater resulting from heavy crude oil, as naphthenic acids are not currently considered in the effluent guidelines for the refining sector. Furthermore, the degradation of naphthenic acids under mild conditions using Fe-TAML/H_2O_2 systems indicates that these catalysts hold promise for the remediation of refining wastewater in real-life scenarios.

Figure: Analysis of petroleum refining effluents conducted to identify contaminants causing toxicity towards luminescent bacteria (Vibrio fischeri), and subsequent evaluation of bacteria (Pseudomonas putida) and synthetic enzymes (Fe-TAML activators) as low-cost clean-up technologies to provide high-quality effluents suitable for recycling or safe discharge.

Recent Publications

1. Pinzón-Espinosa A, Martinez-Matamoros D, Castellanos L, Duque C, Rodríguez J, Jiménez C, Ramos F (2017) Cereusitin A, a cyclic tetrapeptide from a Bacillus cereus strain isolated from the soft coral Antillogorgia (syn. Pseudopterogorgia) elisabethae. Tetrahedron Letters, 58(7), 634 – 637.
2. Gutiérrez V, Pinzón-Espinosa A, Casas J, Martínez M (2008) Determination of cellulolytic activity in soil from Stevia rebaudiana Bertoni crops. Agronomía Colombiana, 26(3), 497 – 504.

Biography

Angela Pinzon-Espinosa is a Water Scientist working at the interface between Microbiology and Chemistry. Her research interests are directed towards the link between water quality, health, environment, and the different strategies to tackle water pollution. Her current research focuses on the detection and identification of toxic chemicals in industrial effluents using luminescent bacteria, and the development of low-cost clean-up technologies targeting refining chemicals. She is particularly interested in the science behind pollution control and the use of science for regulatory purposes, but keen on expanding her expertise to environmental management aiming to provide clean and safe water.

angela.pinzonespinosa@brunel.ac.uk