Threitol Oligomers: Microbe-based Demulsifiers for Oil Extraction

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Water removal through demulsification is a critical step in oil refineries. However, the mass production of conventional chemical demulsifiers is detrimental to public health and the environment for the process relies on toxic and unsustainable raw materials: phenol and formaldehyde. Phenol, a fossil fuel derivative, is a neurotoxin that can lead to paralysis of the central nervous system and cause dysrhythmia, seizures, and coma while formaldehyde is an EPA-classified carcinogen. In order to mitigate health hazards and environmental harms, bio-based demulsifiers were explored as safer alternatives. Threitol, a four-carbon polyol found in edible fungi, can be extracted as monomers and condensed through acid-catalyzed etherification with moderate heating to generate hydrophilic polyol oligomers, alternative demulsifiers for oil extraction that are more sustainable. To investigate the industrial feasibility and optimal process conditions, a simulated pilot plant with key operation units was designed using DWSIM v6.40; process optimization was then performed to maximize both energy efficiency and product yield, which surpassed 98.6%. Recycling over 95% of the unreacted materials and intermediates further minimized waste, reducing environmental pollution. Compared to conventional fossil-fuel-derived demulsifiers, threitol oligomers are more sustainable alternatives generated from benign, bio-available materials. This proposed design takes into consideration socioeconomic implications and provides for human needs while preserving ecosystem services.

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