

ABSTRACT

Title of Document: USING ENZYMATIC COMBINATIONS TO REDUCE ASPHALTENE AGGREGATION

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Team BACTERIA's research aims to determine an optimal mixture of enzymes produced by fungi that would effectively reduce asphaltene aggregation in heavy crude oil, also known as bitumen. One of the biggest challenges associated with handling heavy crude oil is the asphaltene aggregation, which leads to a spontaneous flocculation that causes clogging of the pipelines. The key to impede the flocculation is preventing the formation of the asphaltene nanoaggregation by reducing the polycyclic aromatic hydrocarbons (PAHs) within the asphaltene. Conventional methods of asphaltene de-flocculation utilize chemicals that are both energy-intensive and expensive, while a biological method can improve the sustainability of heavy crude oil refinement. In this study, extensive experiments were conducted to determine whether the enzymes laccase and chloroperoxidase reduced flocculation by oxygenation, thereby reducing PAHs and increasing the oxygen-containing functional groups. A combination of these enzymes was also tested to determine whether the combination of enzymes would be more effective at degrading asphaltene than the individual enzymes. Enzymatic treatment of asphaltene demonstrated a significant reduction in flocculation when compared to untreated asphaltene, but the combination of laccase and chloroperoxidase did not exhibit

a significant reduction in flocculation when compared to the individual enzymes. Based on the results of the flocculation tests and FTIR analysis, the team provided for the first time an example mechanism of the chemical pathways of such enzyme-mediated asphaltene degradation. This research, therefore, offers possibly the first comprehensive and systematic investigation of the technique of enzyme-mediated asphaltene oxygenation and degradation.