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Please fill in your abstract title.	The Novel Dissolution of Bitumen by Commercial Enzymes

Please fill in your author name(s) and company affiliation.

Given Name	Surname	Company
Michael	Mislan	U. of Calgary
Ian	Gates	U. of Calgary

Abstract

Objectives/Scope: Recently, at least two abundant and commercially produced enzymes have been discovered which are able to break down bitumen in aerobic, aqueous solution. Visible, physical changes to the bitumen observed after residence times as short as two days and many potentially valuable aqueous bioproducts produced. These results change the way we understand the biogeochemical nature of bitumen and heavy oils, as well as suggest the potential for a new generation of enzyme flood biotechnology.

Methods, Procedures, Process: Enzymes were procured from VWR and used along with additives to produce buffered, aerobic enzyme solutions. Bitumen was then placed in this enzyme solution and fermented in jars, bioreactors and core holders over a large set of pH, temperature and solution compositions for a period of days to months. Degraded bitumen molecular weight distributions were determined by GC Simulation Distillation, bitumen viscosities measured by rheometer and aqueous enzymatic bioproducts characterized by GC-MS. This work was guided by a novel paradigm of bitumen's biogeochemical nature to be discussed. These enzymes have so far been used for other applications.

Results, Observations, Conclusions: Bitumen droplets in enzyme solution break up under agitation but do not fully dissolve as the enzyme reactions appear to quickly become product inhibited. Static tests with bitumen-saturated oil sand corroborate these observations as enzyme-degraded sands demonstrated greatly accelerated bitumen mobilization compared to controls after a period of days. Simulated distillation results suggest the enzymes are breaking down primarily maltene components with an increase in both lighter and heavier molecular weight fractions. As such, rheological results have been mixed and depend heavily on how bitumen is sampled but study is ongoing. Preliminary GC-MS results indicate the production of sugars and fatty acids as a result of bitumen biodegradation, dependent on which enzyme is included in solution and consistent with their expected aqueous bioproducts in the literature. Therefore, the enzymes demonstrate an effect on the bitumen relative to controls which suggests the possibility for application to novel enzyme flood or bioremediative processes.

Novel/Additive Information: While petroleum biotechnology has generally focused on biosurfactants for hydrocarbon mobilization, this study presents new mechanisms and possibilities for the enzyme flooding of heavy oil reservoirs in addition to potential applications in bioremediation. As these results are as of yet unpublished, this is the first time this discovery has been introduced to the global scientific community, not including patents which have been filed to protect this technology.