

Production of Photosolubilized Carbon in the Presence of Dispersant

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Introduction

Petroleum enters the aquatic environment in many ways, two of which are natural oil seeps and oil spills. Petroleum is susceptible to both biotic and abiotic degradation. Here, we are interested in the abiotic process of photodegradation. Previous studies have shown photosolubilized carbon (PSC) products are formed when oil is subjected to sunlight. Over time, the composition of PSC begins to show more "natural" dissolved organic matter-like characteristics. Following the Deepwater Horizon (DWH) oil spill on April 22, 2010, 2.1 million gallons of the chemical dispersant, Corexit, was applied to facilitate dissolution of the oil. Approximately 1.4 million gallons of dispersant was spread across the surface and 0.77 million gallons was infused at the wellhead. The active ingredient in Corexit is a surfactant called dioctyl sodium sulfonate (DOSS). DOSS reduces the surface tension at the oil/water interface, emulsifying the oil. In this experiment, the effect of dispersant on the photodegradation of MC252 crude oil was investigated.

Methods

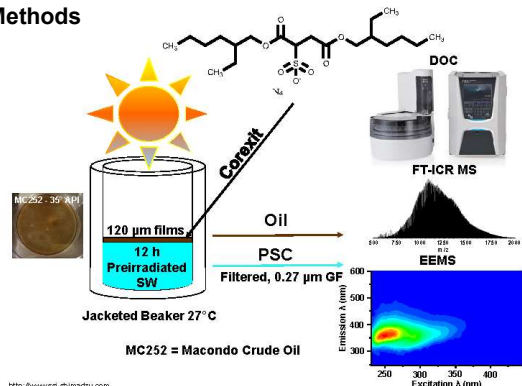


Figure 1. A schematic of the experimental procedure. A CPS+ solar simulator was used for irradiation.

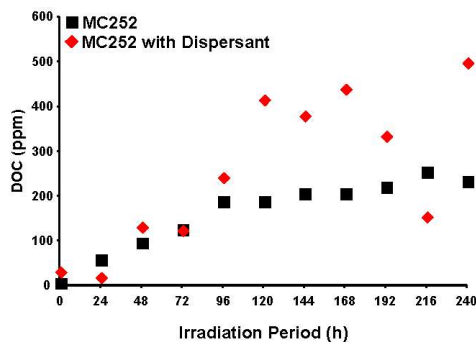


Figure 2. Dissolved organic carbon (DOC) as a function of irradiation period.

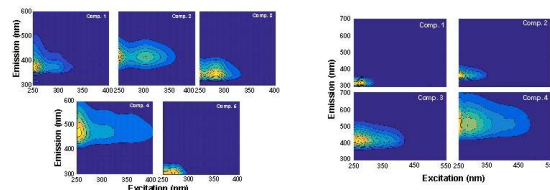


Figure 3. Components of a PARAFAC model fit from EEMS for PSC (left) and oil (right).

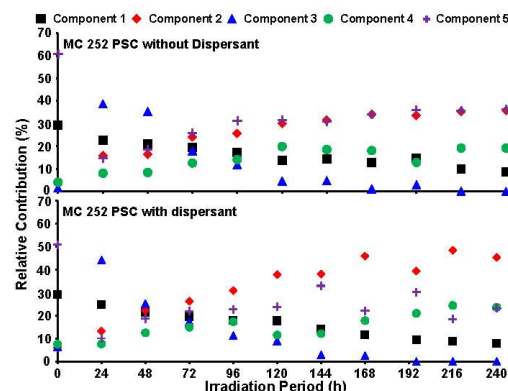


Figure 4. Comparison of the % relative contribution as a function of irradiation period derived from the PARAFAC model for PSC produced from MC252 with and without dispersant.

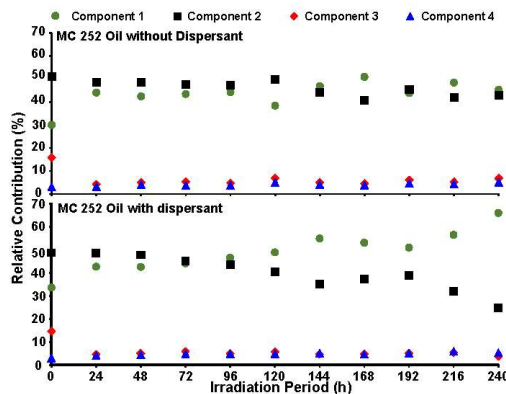


Figure 5. Comparison of the % relative contribution as a function of irradiation period derived from the PARAFAC model for photooxidized MC252 oil with and without dispersant.

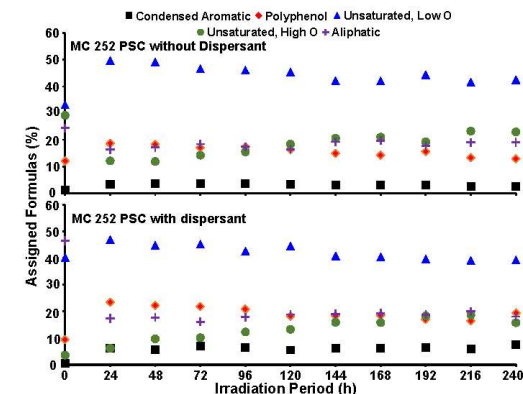


Figure 6. % formulas assigned to each specific class of compounds for the PSC produced as a function of irradiation period by (-) ESI FT-ICR MS.

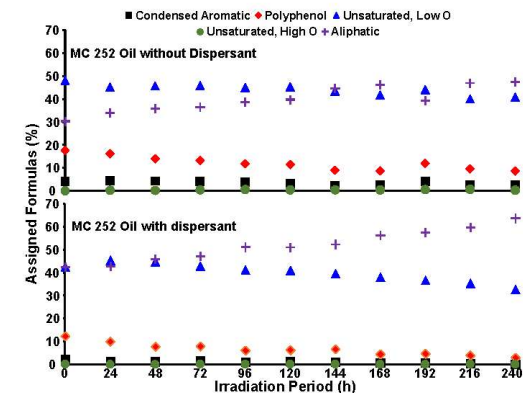


Figure 7. % formulas assigned to each specific class of compounds for the oil as a function of irradiation period by (-) ESI FT-ICR MS.

Conclusions

The data from this study infer that the composition of petroleum-derived PSC is similar in the presence or absence of dispersant. However, a more dramatic change in the composition of the oil was observed in the presence of dispersant. The optical properties obtained by EEMS show an enhanced blue shift in the presence of dispersant which is indicative of the degradation of aromatic rings to more aliphatic-like compounds. The molecular level information obtained through FT-ICR MS corroborates the EEMS data by showing a decrease in the unsaturated low oxygen with a corresponding increase in the aliphatic-like compounds. These preliminary results indicate that Corexit enhances photodegradation of Macondo crude oil.

Acknowledgments

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