Dispersants and Related Oil Spill Technologies – at the Nanoscale!

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Funding: Gulf of Mexico Research Initiative

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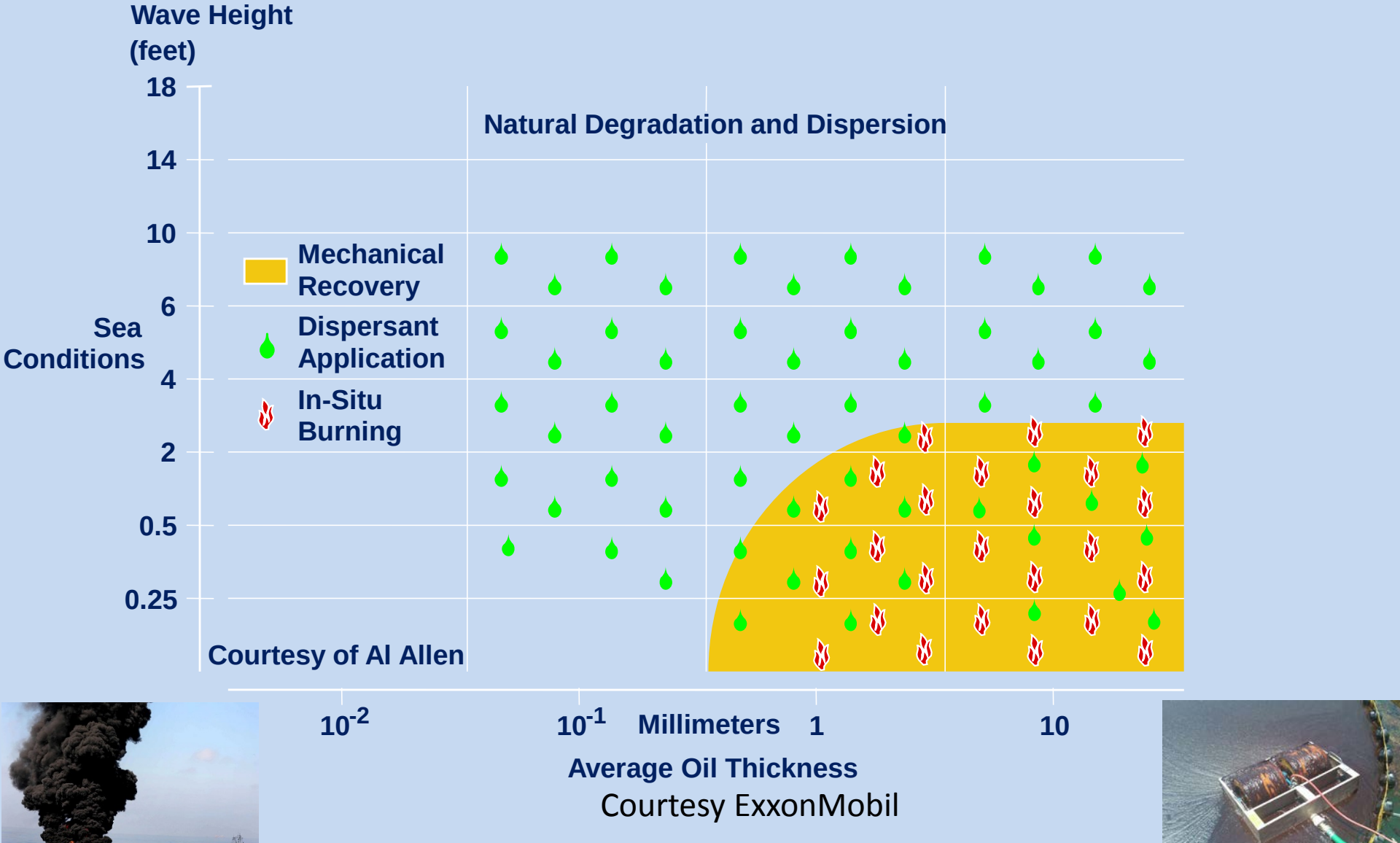
Spill Conditions Limit Response Options



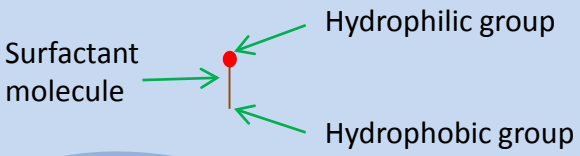
Courtesy ExxonMobil

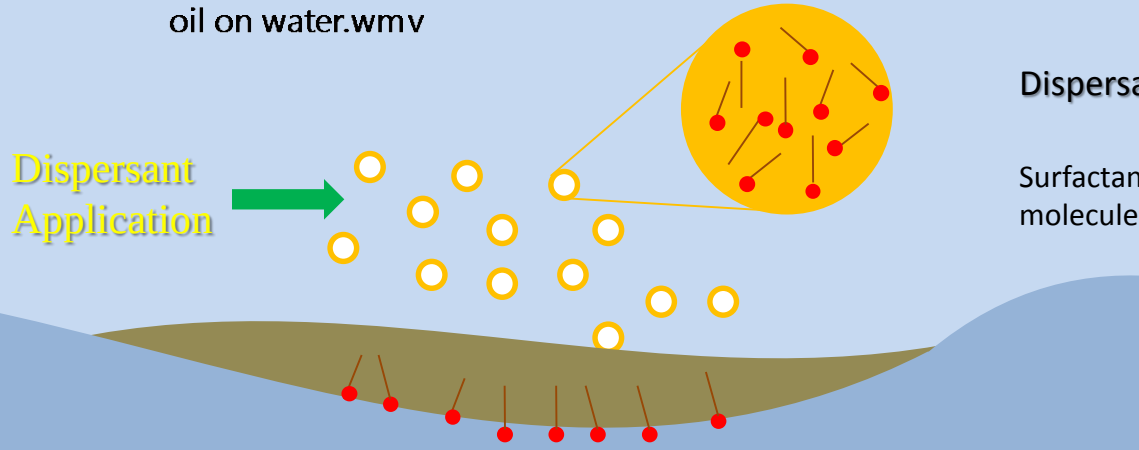
The use of dispersants is an important oil spill response strategy.

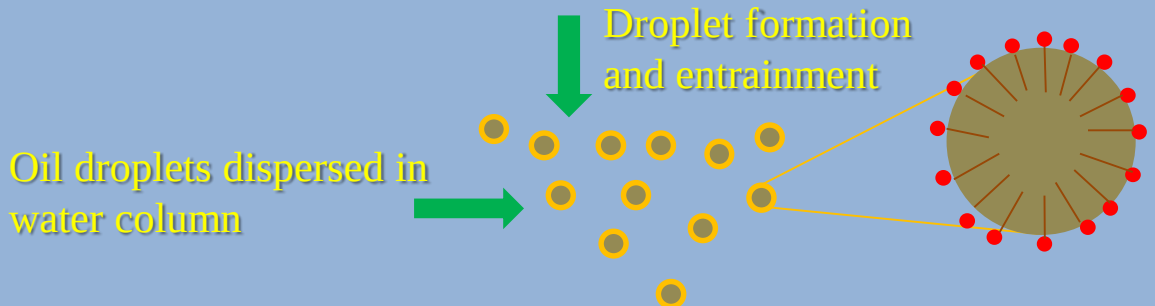
oil on water.wmv

Image courtesy Exxon Mobil

Dispersant is a mixture of surfactants and solvents.







A Simple Dispersant Formulation with Food Grade Surfactants.

Motivation: Current dispersants used to remediate oil spills, (e.g., Corexits), contain synthetic, non-food-grade surfactants.

Overall Goal: To develop new dispersants for oil spills using nontoxic, food-grade amphiphiles. The dispersant should be comparable (or better) in its effectiveness compared to the Corexits.

Our Main Result

Zwitterionic, 2-tailed phospholipid: Used as emulsifier in mayonnaise, chocolate etc.

+

Tween 80

Nonionic, 1-tailed surfactant: Used as emulsifier in many foods, especially ice cream.

=

Effective dispersant of crude oil in sea water at 60:40 lecithin:T80 (comparable to Corexit).

Lecithin+Tween 80: Emulsifying Crude Oil

Lecithin (60%) + Tween 80 (40%)

Initial

After 30 min

Observations: Emulsions remain homogenous and stable

Corexit

Initial

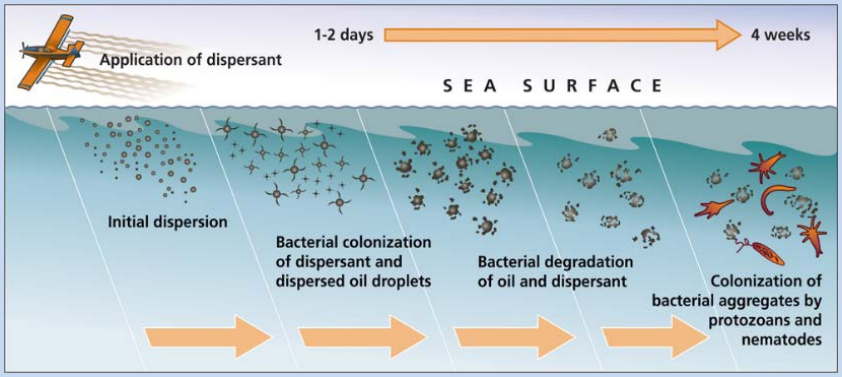
After 30 min

Observations: Emulsions became unstable within about 5 minutes.

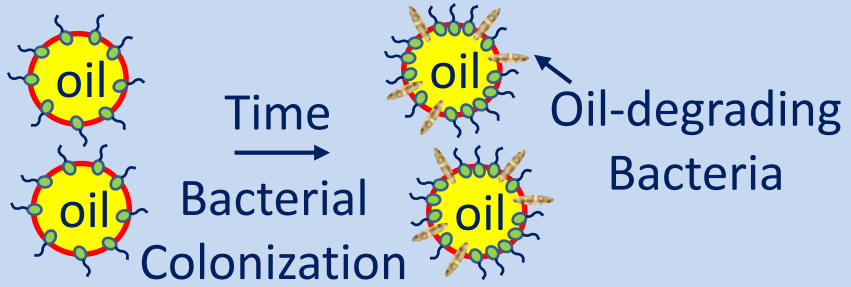
Athas, J. C., Jun, K., McCafferty, C., Owoseni, O., John, V. T., & Raghavan, S. R. (2014). An Effective Dispersant for Oil Spills Based on Food-Grade Amphiphiles. *Langmuir*, **30** (31), 9285-9294.

Oil Spill Remediation: Gel Dispersants

Dispersion by ocean waves and Biodegradation



http://ehp.niehs.nih.gov/118-a338/



Biodegradation of suspended oil droplets

- Dispersants: surfactant blends dissolved in a **hydrocarbon solvent** applied to **reduce oil-water interfacial tension.**
- **Liquid dispersants** - suffer from spray drift, gets washed off by ocean currents when applied onto heavy or weathered oils and pose health risk to responders
- **Gel based dispersants - potential advantages include (a) adherence to weathered oil (b) increased contact time with oil due to buoyancy (c) minimal solvent use (d) high surfactant concentrations**

Lessard, R.; Demarco, G. The significance of oil spill dispersants. Spill Sci Technol B 2000, 6 (1), 59-68.
Nedwed T. New dispersant delivered as a gel IOSC 2008; 121

Gel Buoyancy and Oil Dispersion Characteristics

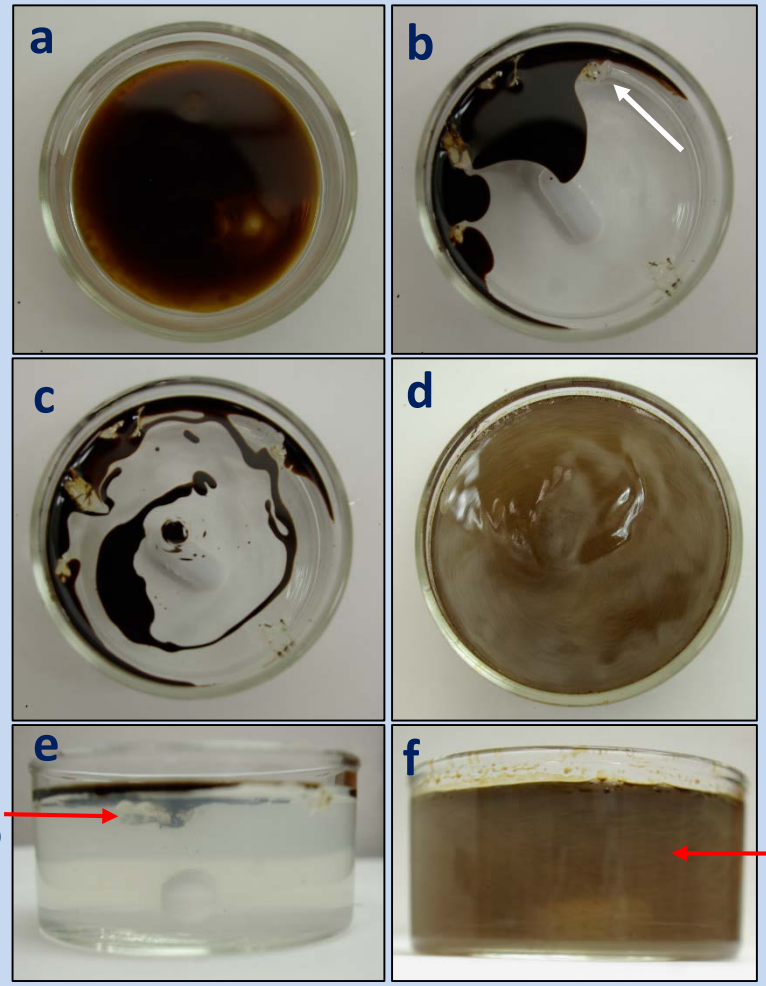


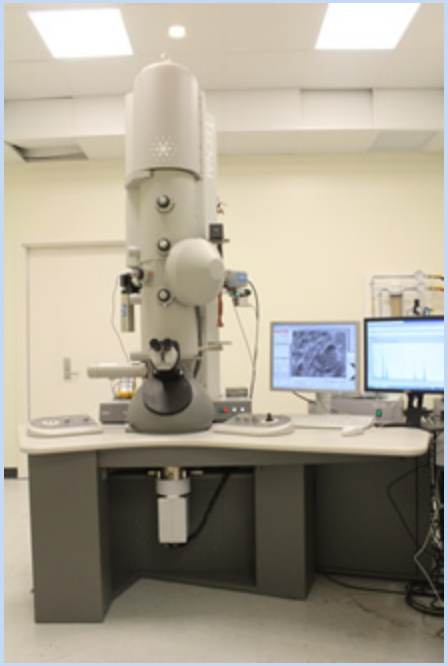
Figure: Buoyancy and oil dispersion mechanism of PC/DOSS/Tween 80 gel
(a) Oil is added to water surface (b) Dispersant gel is added to oil layer (c) the system is mixed gently with a stirrer (d) The oil is dispersed when the mixing speed is increased (e) Side-view of photograph in c (f) Side-view of photograph in d.

Buoyant gel anchors to oil

Oil is dispersed into droplets suspended in the water column by gel dispersant

The DOSS/PC/Tween 80 gel anchors to the surface oil layer and disperses the oil into droplets suspended in the water column

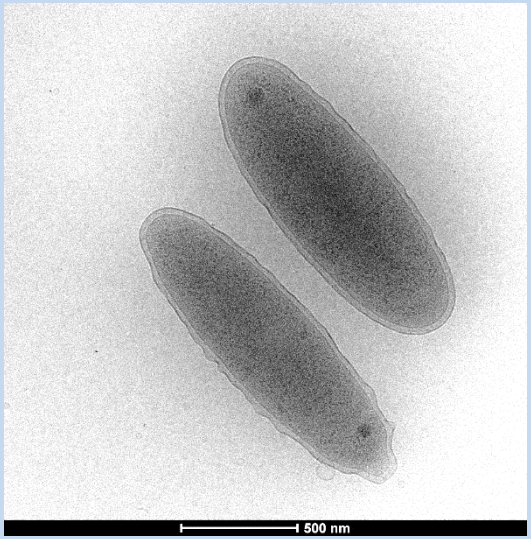
Seeing phenomena at the micro and nanoscale using optical and electron microscopy

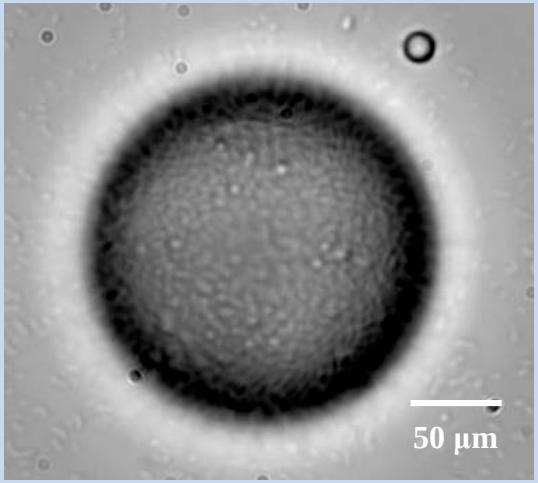


Transmission Electron Microscope

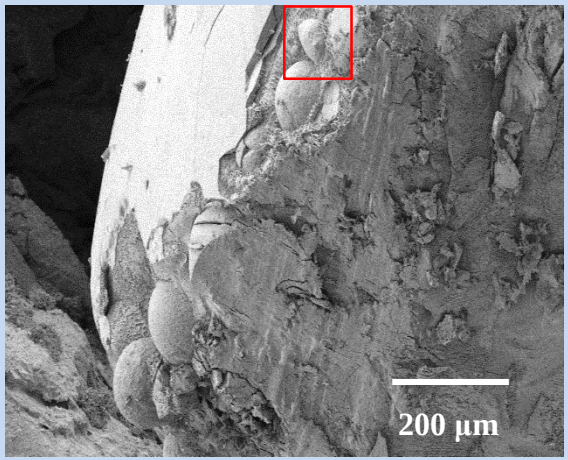
Scanning Electron Microscope

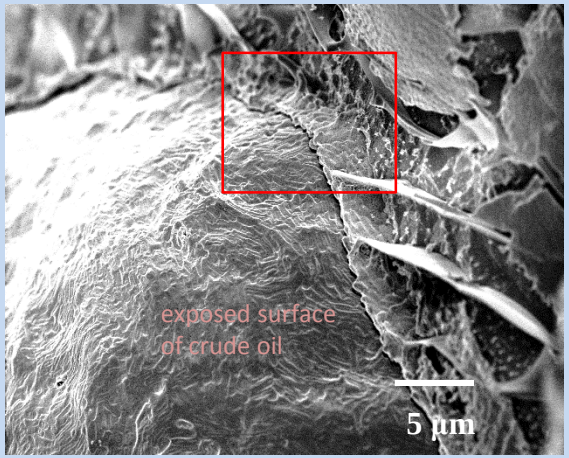
Cryo-Electron Microscopy to visually observe attachment of bacteria on oil droplet and exopolymer formed when the emulsion is formed by *A.borkumensis* bacterial culture

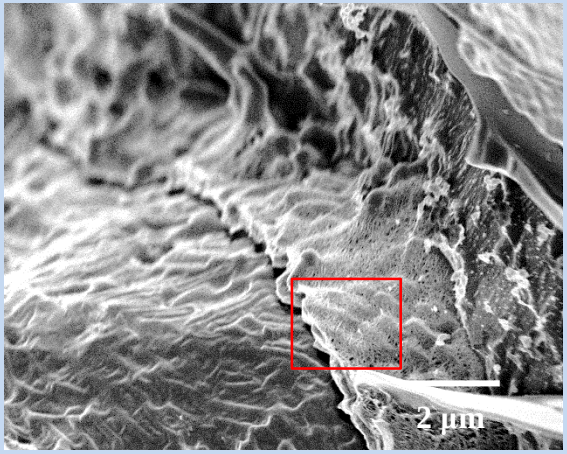


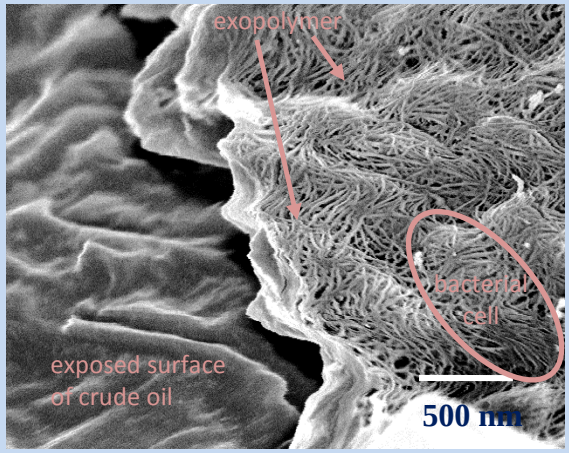


A.borkumensis populating a hexadecane droplet



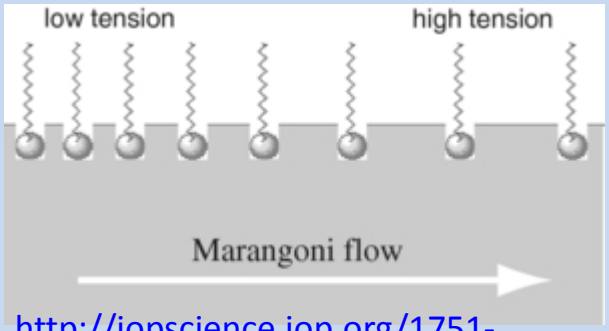






A.borkumensis interconnected by exopolymer on the surface of Anadarko crude oil

Chemical Herding and In-Situ Burning



http://iopscience.iop.org/1751-8121/43/24/242001/fulltext/

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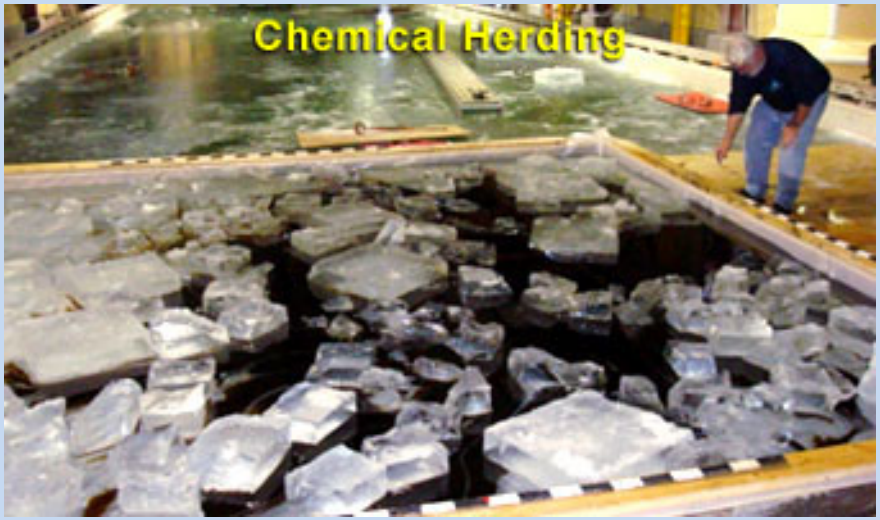

www.ohmsett.com
BSEE- Bureau of Safety and Environmental Enforcement

Using surfactants to thicken surface oil slicks "chemical herding"
http://www.crrel.usace.army.mil/innovations/oil_spill_research/mitigation.html

Thank you!