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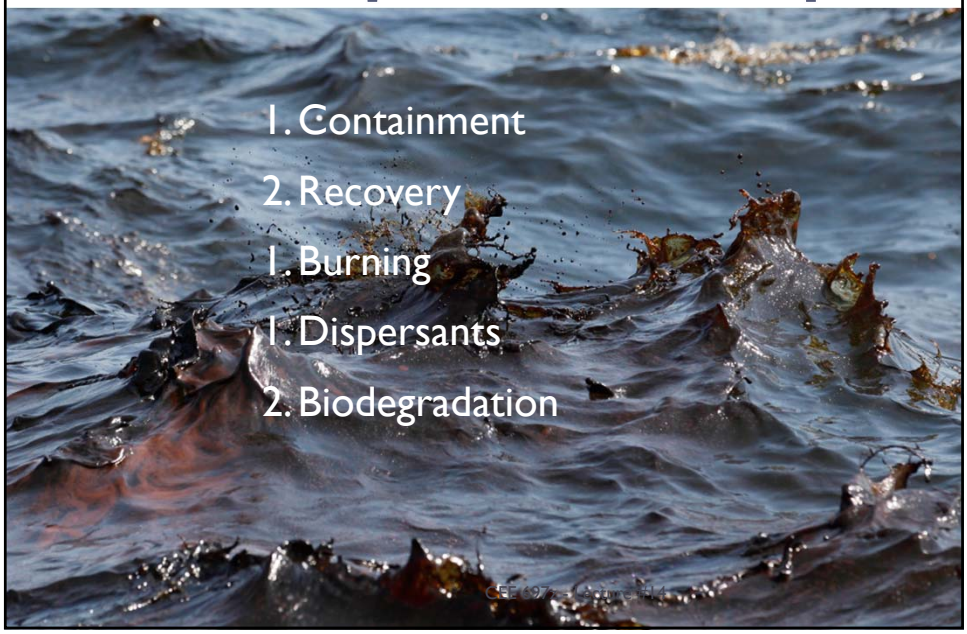
CEE 697z
Organic Compounds in Water and Wastewater

Oil Spill Cleanup and Surfactant Use

Kristie Stauch-White: Lecture #14

Oil Spill Clean Up



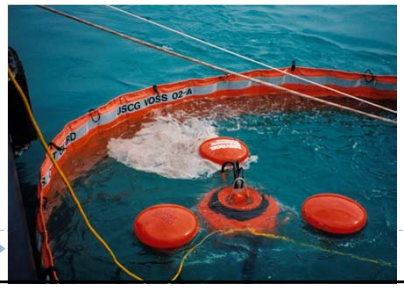
CONTAINMENT:

http://www.federallabs.org/flc/sandlg/state_profile/?state_id=127

Recovery

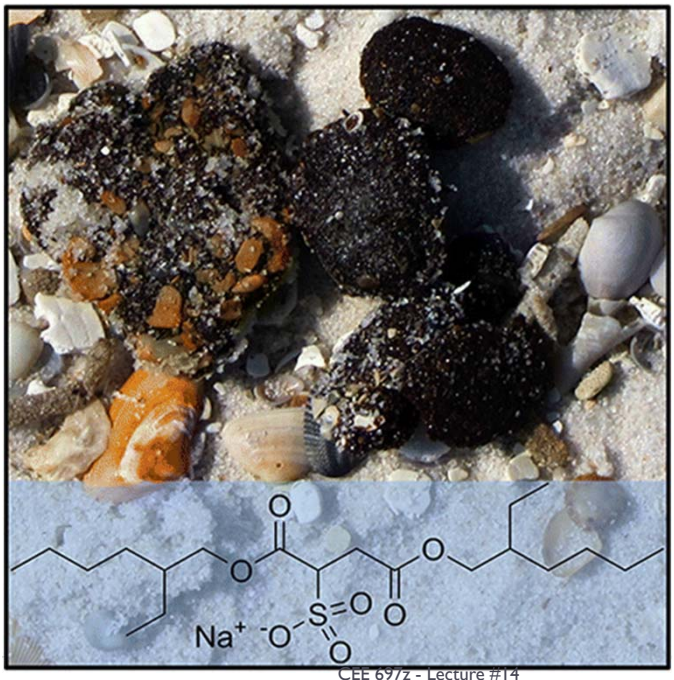
Skimmers and Sorbent materials:

- polyester Fiber Mats
- Super-Hydrophobic Absorbents
  - polyethylene mop-like pads
- Hair Mats
- Hay
- Pine Shavings



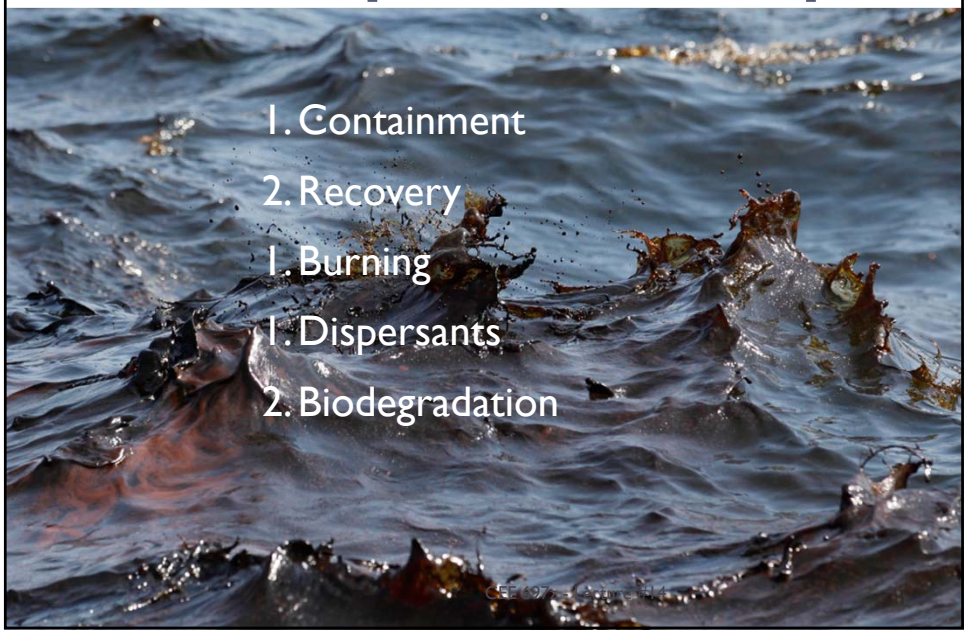
Burning

Department of Defense



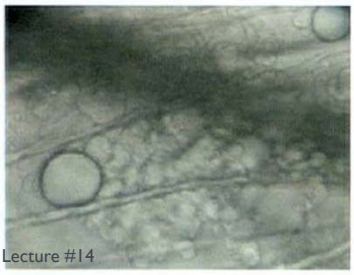
Helen K. White, 2014, Dept. of Chemistry, Haverford College

Oil Spill Clean Up

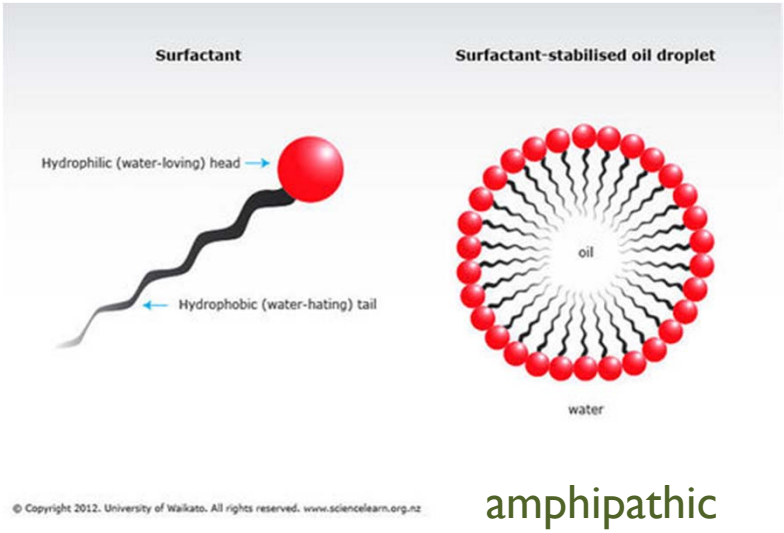


Dispersants

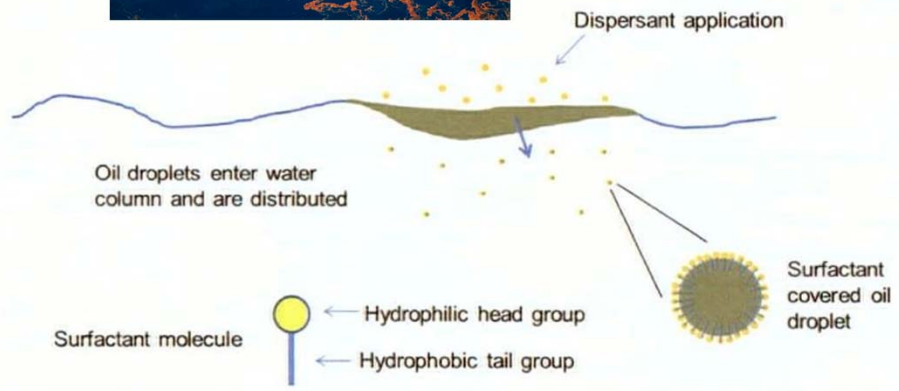
- Solvents – decrease viscosity
- Surfactants – surround and emulsify oil
  - Encourages oil to sink and come into contact with bacteria in the water column
  - Also encourages oil droplets to spread into fur and feathers of marine animals



Surfactants



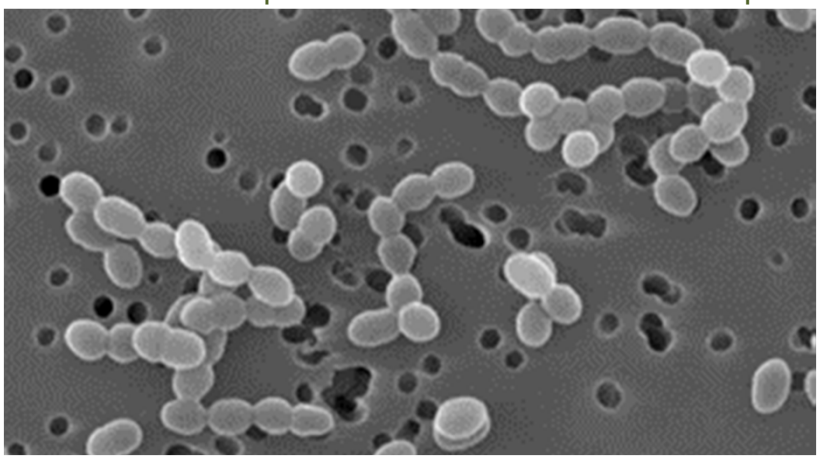
amphipathic



Tiny oil droplets suspended in the water column are more available for biodegradation

odegradation

Direct Interfacial Uptake of Oil/Surfactant Emulsion Droplets



Oil Degrading Bacteria:
- Alcanivorax borkumensis
- Pseudomonas

Symbiotic Bacteria:
- Azotobacter – provides fixed nitrogen
- Cyanobacteria – provides fixed nitrogen and oxygen

ants

- 1.8 million gallons of Corexit 9500 applied at Deep Water Horizon Oil Spill in 2010

Active Ingredients:
dioctyl sodium sulfosuccinate (DOSS)

-Reported to be quickly biodegradable (>90% in 12-19 days)
-Found in Coral Beds 6 months after application
-Found on Coastline 4 years later
-Toxic to Marine Life
-Toxicity increased when mixed with Oil

Clearly, more research is needed to find less toxic and more biodegradable surfactants for Oil Spill Remediation

- Commercial Lecithin & Cellulose Polymer based surfactant – mixture of natural phospholipids in oil

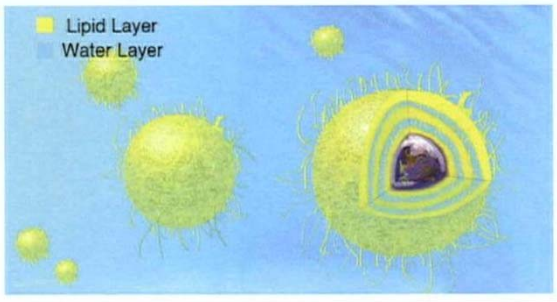
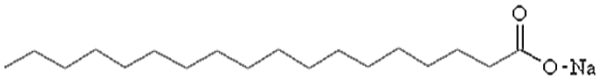


Figure 15—Illustration of the method of encapsulation for antidote-position treatment of oil droplets. The lecithin bilayers form around the oil droplet and anchor the cellulosic polymer in the d-spacing of the bilayers. (Note: illustration not to scale)

Commonly Used Surfactants

Commonly Used Surfactants



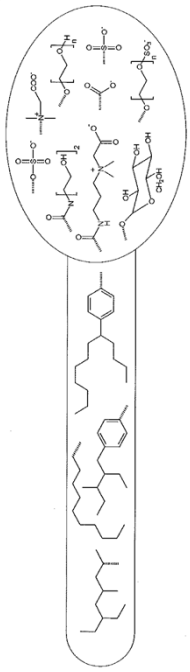
Sodium Stearate

- Soaps
- Detergents
- Household Cleaners
- Foaming Agents
  (sodium lauryl sulfate in toothpaste and shampoo)

Soap – 1st Widely used Surfactant

ABS – Alkylbenzene sulfonates used in laundry products*
- left calcium and magnesium salt precipitates
- foaming in sewage water, treated sewage and river water
- led to ban in Germany and voluntary bans in the U.S.

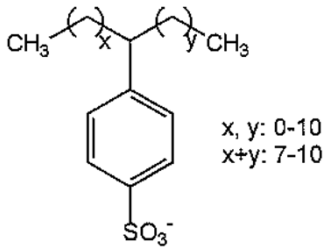
LAS – Linear alkylbenzene sulfonates
- introduced in 1960s
- improved biodegradability
- less foaming
- levels of surfactants in ancestor



Thomas P. Knepper and Peter Eichhorn

asses of Surfactants

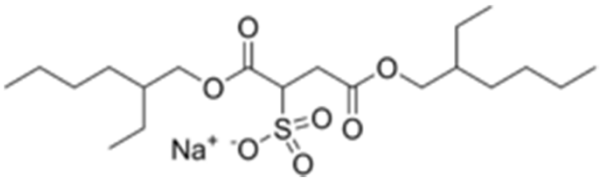
- Anionic
- Cationic
- Non-ionic



General Structure of LAS
(linear alkylbenzene sulfonate)

Knepper & Eichhorn, 2006

Dioctyl Sodium Sulfosuccinate



Anionic Surfactant

Biodegradation of Surfactants

Primary Biodegradation

– minor alterations in chemical structure of surfactant molecule

– may result in loss of surface-active properties, lowering toxicity

Knepper & Eichhorn, 2006

esting for Surfactants

- Anionic Surfactants are methylene blue-active substances (MBAS)
- Non-ionic surfactants are bismuth iodide-active substances (BiAS)

Additional testing required to determine the fate of surfactant molecules after primary degradation

Biodegradation of Surfactants

Organization of Economic Co-Operation and Development (OECD)

- developed International Standard Methodologies for testing the biodegradability of surfactants
  - **Ready Biodegradability** – real environmental conditions (60% CO2 formation or 70% DOC removal within 28 days) *likely to be degraded
  - **Inherent Biodegradability** – ideal conditions *potential to be degraded
  - **Simulation Biodegradability** – WWTP conditions

What happens to Surfactants from household and industrial use?

The majority reach Wastewater Treatment Plants where they are effectively eliminated.

Some persistent compounds and their metabolites are found in raw water that is treated for drinking water.

Additional Research is needed to better understand the fate of these compounds and their metabolites.

Thank you

- To next lecture