Arctic Oil Spill Countermeasures: Enhanced Dispersion and Natural Attenuation

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Oil Spill Response Countermeasures

• In light of the recent oil spill incident in the Gulf of Mexico, and the public’s renewed fear of oil spills, regulators and industry stakeholders will adopt more stringent science-based standards and regulations for the assessment of oil spill impacts and remediation.

• Development in the Arctic adds further challenges.

*To establish operational guidelines, research is needed to identify efficiency, operational limits and biological effects of various clean-up strategies.*
Arctic Spill Response Options

Containment and Mechanical Recovery
  • Booming and skimming

Burning
  • In-situ burning

Bioremediation
  • Biostimulation
  • Bioaugmentation

Enhanced dispersion
  • Chemical oil dispersants
  • OMA formation

Natural Attenuation
  • Monitoring natural recovery
Chemical oil Dispersants

Dispersant use following the Gulf of Mexico Oil Spill prevented significant oiling of sensitive shoreline habitats

• SINTEF JIP - Arctic conditions reduce oil weathering and extends the window of opportunity for its use

• New low-toxicity formulations developed for low temperature/Arctic conditions and high viscosity oils

• Methods of application from surface vessels, aircraft and sub-sea injection are being improved
National Research Council (NRC) Committee on Understanding Oil Spill Dispersants: Efficacy and Effects (2005) Identified two major uncertainties regarding dispersant use at sea:

- Dispersant efficacy at different sea states is not clear
- Biological effects of dispersed oils are poorly understood

Factors to be addressed in oil dispersant efficacy studies:

BIO wave tank facility constructed in collaboration with US EPA and co-funded by NRCan, NRC, NOAA, MMS, Cedre, etc.)
Vertical Profiles:
CDOM
SPC
DO
BTEX
UV-Fluorescence

SPC & i340 vs. Distance from Wellhead

SPC: Surface (<10m)

SPC: Bottom (>700m)

i340: Surface (<10m)

i340: Bottom (>700m)

estimated background
Oil Dispersant Research Priorities

- Develop and improve application methods for surface and subsurface (e.g. deepwater blow-out) spill response
- Evaluation of acute/chronic biological effects of oil dispersants on benthic and pelagic biota fish and develop improved Environmental Effects Monitoring (EEM) protocols
- Development of analytical methods for the quantification of chemical dispersants applied at sea
- Monitoring dispersant and oil degradation and habitat recovery
- Evaluation of current and new dispersant formulations in the field
- Develop predictive numerical models to support chemical dispersant applications under Arctic conditions
- Resolve key regulatory issues
Oil-Mineral Aggregate (OMA) Formation

- Naturally produced in high particulate estuarine and near shore waters
- OMA occurs with naturally occurring suspended particles
  - Mineral fines and associated organic fractions
- OMA changes fate and transport and effects of oil
  - Biodegradation rate
  - Horizontal and vertical transport
  - Biological effects
Surf-Washing as an Oil Spill Countermeasure

Development of an oil spill countermeasure for shoreline environments based on “surf washing” (accelerated dispersion of oil stranded within shoreline sediments into the water column by oil-mineral aggregate formation).

Norway (SINTEF)  
Canada (DFO/EC)  
USA (ExxonMobil)
St. Lawrence Estuary Field Trial: DFO Science/CCG

Test effectiveness OMA formation as a oil spill countermeasure

Fill the gap between lab and real-world application

Gain operational experience for larger scale field trails

* Controlled release of oil
## OMA Application and Mixing Treatment

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Modeling the Fate/Risks of OMAs

Risk assessment for the benthic habitat by integration of:

Hydrodynamic model (interactions between waves and currents)

Fate/transport model (advection/diffusion, settling and re-suspension of OMAs)

Biological Effects/risk assessment model

Collaboration with BOEMRE, SINTEF, Akvaplan-Niva
Response estimates expressed as % cumulative volume of oil discharged in the best, expected, and worst cases

Other: Remaining oil is at the surface as light sheen or weathered tar balls, biodegraded, or already came ashore
Natural Attenuation

What’s the environmental impact of the residual fraction that is not accounted for following clean-up operations?

• The interaction of biological, physical and chemical processes are responsible for the progressive lost of these contaminants within the marine environment

• New evidence from advances in biotechnology (e.g. metagenomics) suggest that oil in Arctic waters may be degraded at higher rates by indigenous organisms than previously thought

How clean is clean?

• Development of protocols to monitor operational end-points and assess natural resource damage (NRDA)
The Way Forward

Government of Canada’s Northern Strategy Framework promotes northern science and research, reinforce circumpolar cooperation, strengthen partnerships, and environmental protection

- Most of what we know about oil spill behavior and response to spills in ice comes from laboratory, experimental test tank studies, and a few historical large-scale field experiments

- The operational effectiveness of numerous “new” oil spill clean-up technologies and response strategies is unknown

- Proof-of-concept and operational guidelines must be established before they are accepted by the oil spill response community

- Conclusion of numerous scientific symposia on Arctic oil spill response - Field trials with oil are absolutely essential to make real progress
Socio-economic Benefit from Joint Norway/Canada/US Research Collaboration

- **Reduced Environmental Costs/Footprint:** Reduced environmental effects from exploratory and production activities, oil spill remediation strategies

- **Technology Innovation:** Development of instrumentation, numerical risk assessment models, oil spill countermeasures, process controls

- **Resource Management:** Energy efficiency gains, reduced production costs

- **Educational Funding:** Training of graduate students, leveraged support of university programs

- **Remote Development:** Support of activities that benefit rural and Arctic regions.

- **Support of Private Sector Industry:** Contracting and technology to oceans sector consultants