극지해역에서의 환경오염 방지 기술 및 IMO 동향

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Prevention Technologies of environmental contamination and IMO action in Arctic Ice-covered Waters

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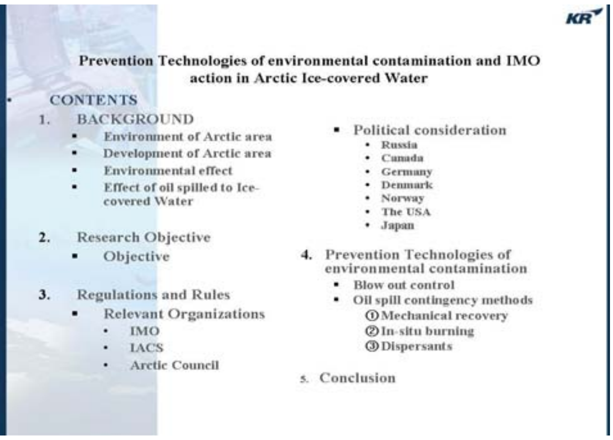
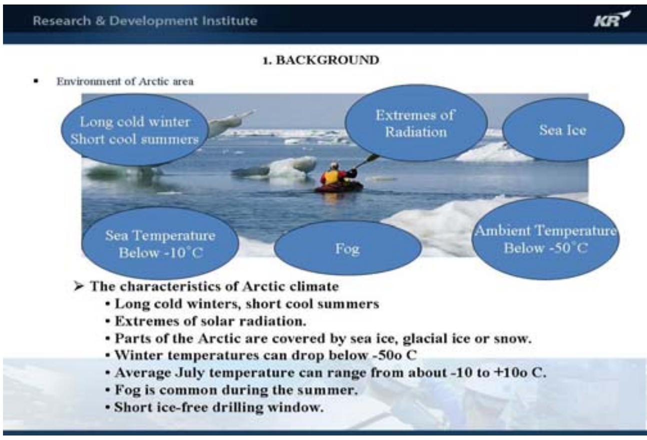
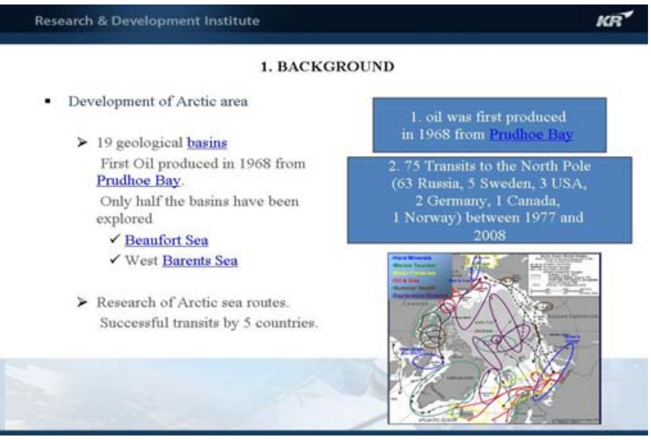
Abstract : 최근 국제해사기구(International Maritime Organization, IMO)는 “극지를 운항하는 선박에 대한 안전기준(Polar Code)"를 제정하여 결정하기로 하였으며, 2012년까지 완료하여 법제화하기로 하였다. 이는 최근의 극해 지역의 연속적인 사고의 심각성에 대한 대비책의 일환이다. 2004년도에 알라스카 앞바다에 침몰한 *Selendang Ayu* 는 6600만 톤의 콩, 170만 리터의 연료유와 55,564 리터의 MDO 및 다른 오염물질을 바다에 유출하였다. 이는 주변의 동물들에게 심각한 영향을 끼쳤고, 아직까지도 유출되어진 오염물질들을 완전히 처리하지 못한 상태이다(Arctic marine shipping assessment, Arctic council 2009.). 즉, 기름이 유출을 하면 방재시설이 다른 육상에서 오기 전까지는 상당히 오랜 시간 동안, 사고 지역 주변을 오염시키게 되며, 유빙이나 극한의 온도는 방재 작업을 더욱 힘들게 한다. 본 연구에서는 극해와 같은 해역에서 기름이 유출 하였을 때에 대응하는 방법, 즉 현존하는 기계적인 복구 방식, 점화식 처리 방식 과 유처리제 방식을 소개하고, 그에 대한 국제규정 및 기술 발전 동향에 대해서도 설명한다.

Key words : IMO(국제해사기구), Arctic(북극의), Pack ice(유빙), mechanical recovery(기계적인 복구), in-situ burning(점화식 처리), chemical dispersants(유처리제 방식) and Environmental pollution(환경오염).







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1. BACKGROUND

- Environmental effect
  - ➢ Air pollution or Arctic Haze
    - ✓ Tiny particles(Dust, Paticulate matter)
    - ✓ Nitrogen oxides and volatile organic compounds(precursors to ozone).
    - ✓ Dirty deposits that fall on snow and ice.
  - ➢ Noise
    - ✓ More frequent vessel traffic,
    - ✓ Seismic testing for oil and gas, and other industrial activities
  - ➢ Invasive Species
    - ✓ Discharging Ballast water at new ports
    - ✓ Introducing any potential species picked up in their port of origin
  - ➢ Ship Strikes
    - ✓ Whales' migratory routes can correspond with shipping routes,
    - ✓ Slow-Large mammals are often the victims of ship strikes
  - ➢ Ocean Garbage and Sewage
    - ✓ More and more ships, including cruise lines,
    - ✓ Using Northwest Passage and the Arctic

1. BACKGROUND

- **Effect of oil spilled to Ice-covered Water**
  - ➢ **Several weathering processes in water may take place.**
  - ➢ **In ice conditions, different of weathering processes**
  - ✓ **Spilled oil may not spread as far in the presence of ice floes**
  - ✓ **Irregularities in the ice surface because the ice may create natural barricades to oil movement (Evers *et al.* 2004).**
  - ✓ **Oil can move hundreds of kilometers from the spill site if it is trapped under or within a piece of ice.**
  - ✓ **Trapped oil may not be released until complete melting takes place**

Process	Open Water	Ice or Extreme Cold
Spreading and Dispersion	A thick layer of oil grows thinner and covers a larger area of water (depending on the oil).	Ice acts as physical barrier (drift ice) or retardant (grease ice); oil does not spread or disperse as fast, and ends up in a thicker layer.
Drift	Oil moves with wind/current.	Oil will drift separately from the ice at less than 30% ice coverage, and with the ice at 60-70% (or greater) coverage. Unpredictable in dynamic drift ice conditions.
Evaporation	Relatively fast (thin oil films)	Slower where oil spills are thickened
Emulsification	Higher in areas with breaking waves. Rate of emulsification, total water uptake, and stability of emulsion depend on type of oil.	Total water uptake and rate of uptake may be reduced due to dampening of wave activity by presence of ice.

Weathering processes impacted by sea ice (adapted from Evers *et al.* 2004)

2. Research Objective

- Research Objective
  - ➢ **Take into consideration of Prevention Technologies of environmental contamination and IMO action in Arctic Ice-covered Water.**
  - ➢ Various activities comprising oil and gas, shipping and fishing and their possible impacts on the marine environment and its living resources
  - ➢ Prevention Technologies of environmental contamination is so broad.
  - ➢ **Explain about oil spill Response in Dynamic Ice conditions.**

3. Regulations and Rules

- **Relevant Organization**
- **IMO**
  - ➢ **IMO Guidelines for Ships Operating in Arctic Ice-covered Waters are analyzed and discussed. (FNI-rapport 2/2007, Øystein Jensen)**
  - ➢ **MSC/Circ.1056 and MEPC/Circ.399 – Refer to IMO Guidelines**
  - ➢ **IMO Polar code (Mandatory to 2012) – This code will be mandatory until 2012**
- **IACS**
  - ➢ **The IACS Unified Requirements for Polar Ships apply to ships constructed of steel and intended for navigation in ice-infested polar waters, except ice breakers (IACS UR1)**
- **Arctic Council**
  - ➢ **PAME (Protection of the Arctic Marine Environment) – Sub-group of Arctic council consisting with specialists in terms of Arctic(185 members).**
  - ➢ **Arctic Marine Shipping Assessment 2009 Report – 4years report (Arctic problems and conclusion)**

3. Regulations and Rules

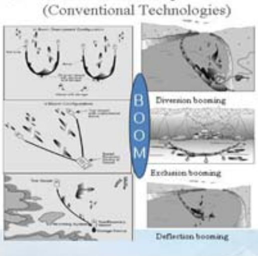
- Political consideration
  - **Russia**
    - ➢ Murmansk Initiatives (1987) – Russia report about arctic sea route
    - ➢ INSROP (International Northern Sea Route Program) – Research group(Norway, Japan and Russia)
  - **Canada**
    - ➢ Ottawa unveils Arctic campaign (Mapping, Construction & etc.) – Canada report the construction plan and mapping cooperation with the other countries
  - **Germany**
    - ➢ HSVA – Germany has made Weather forecasting system with several researches
  - **Denmark**
    - ➢ Arctic military command and task force (2009)
  - **Norway**
    - ➢ FNI (Fridtjof Nansen Institute) -Researching Sea Route in Arctic area (INSROP)
    - ➢ Arctic offshore rules and technologies on DNV rules
  - **The USA**
    - ➢ CRREL (Cold Region Research Engineering Laboratory) - Research of navigation methods in Arctic area(Northern Sea Route Transit Model)
  - **Japan**
    - ➢ SOF (Ship & Ocean Foundation) - Conducting Sea Route research in Arctic area (INSROP)
    - ➢ JANSROP – Research group conducting Sea Route research in Arctic area (JANSROP)

4. Prevention Technologies of environmental contamination

- **Blow out control**
  - ➢ **Well Capping – BOP (Blow out prevention system)**
    1. **Blowout prevention (BOP) system – First equipment to block blow out oil**
    2. **Uncontrolled blowout state, well capping may be used to control the well at the surface.**
    3. **Substantial amount of water is sprayed on the rig structure,**
    4. **Containment booms around the work area.**
    5. **Cutting away massive steel debris on large land rigs or offshore structures,**
    6. **Once the debris is removed, a new wellhead must be installed to control the well.**
  - ➢ **Voluntary Well ignition**
    - ✓ **Detecting toxic component to the released hydrocarbons.**
    - ✓ **The explosive limit of differing blowout flows varies with chemical composition.**
  - ➢ **Relief Well**
    - ✓ **No bridge off naturally**
    - ✓ **Uncontrolled by well ignition or well capping**

4. Prevention Technologies of environmental contamination

- Oil spill contingency methods
  - ① Mechanical recovery (Conventional Technologies)



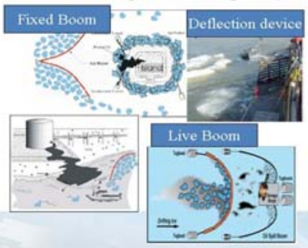
- **Containment booming** is a fixed-booming tactic where boom is positioned around the spill source to prevent spreading and concentrate the oil for removal with a skimmer.
- **Diversion booming** redirects oil to a specific location for recovery.
- **Exclusion booming** may be used to prevent oil from entering a sensitive area.
- **Deflection booming** is used to direct oil away from a location or to change the course of an oil slick.

4. Prevention Technologies of environmental contamination

- **Weir skimmers** draw liquid from the surface by creating a sump in the water into which oil and water pour. The captured liquid is pumped from the sump to storage.
- **Oleophilic skimmers** pick up oil adhered to a collection surface, leaving most of the water behind. The oil is then scraped from the collection surface and pumped to a storage device.
- **Bucket skimmers** are a variation of a weir or oleophilic brush skimmer that can be used in either mode.
- **Suction skimmers** use a vacuum to lift oil from the surface of the water. These skimmers require a vacuum pump or air conveyor system.

4. Prevention Technologies of environmental contamination

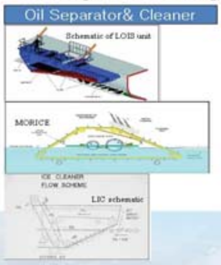
- Oil spill contingency methods
  ① Mechanical recovery (New technologies – Ice Management)



- *Fixed Boom*
  Ice booms are affixed permanently in some locations to exclude sea or river ice from areas, facilitate navigation, or protect facilities or infrastructure.
  Ice booms may be used to exclude ice from an area, or to concentrate ice to accelerate the formation of a stable ice cover.
- *Live boom*
  Keep ice away from areas where oil recovery is occurring.
- *Deflection Devices*
  A metal grate positioned in front of a skimmer to deflect small pieces of ice away from the skimmer.

4. Prevention Technologies of environmental contamination

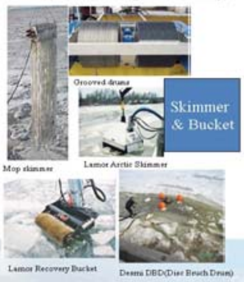
- Oil spill contingency methods
  ① Mechanical recovery (New technologies – Ice Processing)



- ***Schematic of LOIS unit***
  Installed on the side of a dedicated response vessel.
  An oscillating ice grid on the forward side of the LOIS separates ice chunks and washes the oil from ice chunks as they move along the grid.
  When the vessel advances, oil and crushed ice pieces are pushed against the ice grid and forced deeper into the water as they proceed aft.
- ***LIC schematic***
  Two sets of brushes and water-spraying nozzles
  The unit works in two stages: The first stage cleans the ice and the second stage separates the oil from ice and collects the oil for recovery
- ***MORICE***
  Two different recovery systems, separating ice from oil, and deflecting large pieces of ice to allow the unit to function.

4. Prevention Technologies of environmental contamination

- Oil spill contingency methods
  ① Mechanical recovery
  (New technologies – Recovery)



- ***Mop skimmer***
  Easily deployed from vessels in many positions and can be readily positioned in ice
- ***The Lamor recovery bucket (LRB)***
  The brush wheel can be lifted to allow the bucket to be used to scoop and dump heavy oil sludge and solid materials, and to move large ice chunks at sea.
- ***The Lamor Arctic Skimmer (LAS 125)***
  The brush wheel discs revolve in the same direction as the flow of the oily water passing through the skimmer, and the revolving brush forces oil under the water surface, where it then migrates upward and adheres to the brushes.
- ***Desrni DBD(Disc Brush Drum)***
  Oil is recovered from the water as it adheres to the surface. As the discs or drum brushes are rotated through the skimmer head, oil is collected in the central sump on a continuous basis.
- ***Gooveed drums (University of California Santa Babara)***
  The tests found that the use of a grooved surface could increase recovery up to 200%.

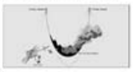
4. Prevention Technologies of environmental contamination

- Oil spill contingency methods
  ① Mechanical recovery (New technologies – Vessel & Pump)

- ***Vessel maneuver and Fire monitor wash***
  Using the props and bow thrusters to walk the vessel sideways creates a lead on the downstream side of the vessel. Oil may pool in this lead allowing recovery by skimmers.
  A fire monitor is also used to wash oil to the skimmer and wash small pieces of ice away from the skimmer.
- ***New ice processing and recovery operation***
  Within the boomed area, one or more work boats use a bow sweeper to corral the oil and ice and move it toward the recovery unit.
- ***The Desmi screw auger pumps***
  High capacity, and capable of processing ice slush and debris up to 2 inches in diameter. Hydraulically driven.
  Steam or water into the oil being pumped and facilitate handling of heavy oils by reducing backpressure in the discharge hose.

4. Prevention Technologies of environmental contamination

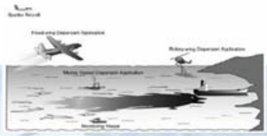
- **Oil spill contingency methods**
  ② In-situ burning
  - **In-situ burning requires the containment of an oil slick to a sufficient thickness, ignition of the slick in a controlled burn, and removal of any remaining burn residue.**



  - **The condition for In-situ burning**
    - **The oil slick must be thick enough to ignite;**
    - **Wind and wave conditions must be moderate;**
    - **The oil must not have significantly emulsified; and**
    - **The downwind emissions must be below threshold concentrations for sensitive populations.**
  - **In broken and pack ice provide an opportunity to burn.**
  - **In-situ burning oils in sea ice proposes efficiency rates in the 33% to 50% range**

4. Prevention Technologies of environmental contamination

- **Oil spill contingency methods**
  ③ Dispersants
  - **Accelerate the process of natural dispersion.**
  - **Reduce the amount of floating oil to minimize damage to shorelines, wildlife, and other sensitive resources.**
  - **Three components: surfactants, solvents, and additives.**
  - **Surfactants are molecules with an affinity for two distinct liquids that do not mix, acting as an interface between them.**
  - **Dispersants are not a proven technology for use in most sea ice conditions**



5. Conclusion

- **Challenges of Spill Response in Ice-infested Waters**
  - **There are significant challenges in Arctic area**
    - ✓ **Extreme seasonal ecological sensitivity variations**
    - ✓ **Seasonal ice conditions**
    - ✓ **Slower weathering and longer persistence of spilled oil**
    - ✓ **Remote logistical support**
    - ✓ **Need to improvise response using available means**
    - ✓ **Low visibility due to fog and snow**
    - ✓ **Frequency of storms and adverse weather**
    - ✓ **Cold temperature effects on the efficiency of equipment and personnel**
    - ✓ **Limited boat operations in ice-infested waters**
    - ✓ **Seasonal daylight variability**
  - **Need to make robust oil spill planning and response infrastructure in Arctic area**
    - ✓ **Industry and government should take into consideration it**
    - ✓ **Need Global cooperation**
  - **Need to make suitable rules and regulation in Arctic area**
    - ✓ **IMO & IACS should be leading organization to make rules and regulation**
    - ✓ **Need Strong Verification**

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