Dynamic Positioning in Ice Conditions, Challenges and Opportunities

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Dynamic Positioning in ice conditions, challenges and opportunities

by
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Aker Arctic Technology Inc.
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River magic
The cold covers all the water with ice, channels are needed
Frequent traffic freezes the channels to be reopened
Ice fields are very dynamic
Winter is cold and dark
Towards easier winters in the polar regions?

August Ice Extent

Year

Extent (million sq km)

Image courtesy: National Snow and Ice Data Center

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Hi-tech for ICY and COLD MARINE environment
Now our surroundings are finally in shape, the Vuosaari Marine Business Park however not yet – Wärtsilä is our next neighbour.
Shareholders:

- STX Finland Oy 71.4%
- ABB Oy 14.3%
- Aker Engineering & Technology AS 14.3%

24 Arctic dry cargo ships, 25 polar tankers, 9 Polar icebreakers
2 Nuclear icebreaker, 15 River icebreakers
# Activities/services

## Field research
- Ice conditions/properties
- Route selection
- Design basis development

## Concept development
- Feasibility studies
- Performance predictions
- Transit simulations
- Ship concepts

## Testing in model and full scale
- Ships
- Structures
- Offloading operations
- Rescue and evacuation

## Ship designs
- Basic design
- Tender packages
- Aker ARC standard designs

## Other
- License agreements
- Project executions
- Operation training

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Important developments took place even the market was ”dead”
Technology lead by Aker Arctic

- forerunner in diesel-electric icebreakers (1939)
- first four-screw icebreakers
- first polar icebreakers
- first shallow-draught river icebreakers
- first shallow-draught polar icebreakers
- first AC-AC drives in icebreaker application
- first air bubbling systems
- first ice resistant paint (INERTA 160, Teknos)
- first stainless steel icebelts installed
- first cathodic corrosion protection system (SAVCOR)
- first Azipod developed
- first double-acting ship developed
- first oblique vessel developed
- first Arctic containerships
DP In Ice
Challenges

- Forces acting on the vessel
- Forces caused by ice dynamics
- Turning Yaw moment
- Changes in ice movement direction
- Predictability of ice load behaviour
- New type of thruster control allocation
- Forbidden or required sectors for ice flow management
- Specific methods to lower ice loads
- Ice management and operational risk control
Operational aspects

Events:

- Transit to location
- Drilling at location
- Transit to next location
- Supply activity

Fleet requirements:

1. Transit performance, alone/assisted
2. Ice management operations, what kind of icebreakers are needed.
3. Supply philosophy, will the drilling vessel be resupplied by separate fleet or go itself off the operation area to be resupplied
Ice forces/dynamics

Ice forces:

- Quality of ice; level ice, ridges, multi-year ice,
- Thickness of ice
- Ice concentration
- Size of ice floes
- Speed of ice; impact speed

Oscillating forces
Rapid changes
Ice forces/dynamics

vessel aligned to ice flow
Ice forces/dynamics

vessel aligned to ice flow

Mz
Role of ice management

Intensity of Ice Management

Severity of ice conditions

Ice Management

DP capability of the vessel

Output of Ice Management

Distance from the DP vessel

The ice Technology Partner

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Ice management practices
# Ice management requirements

<table>
<thead>
<tr>
<th>Ice thickness</th>
<th>Maximum diameter of the managed ice floe</th>
<th>Minimum width of IM track</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2 m</td>
<td>50 m</td>
<td>400 m</td>
</tr>
<tr>
<td>0.2 m</td>
<td>20 m</td>
<td>200 m</td>
</tr>
<tr>
<td>0.4 m</td>
<td>30 m</td>
<td>300 m</td>
</tr>
<tr>
<td>0.4 m</td>
<td>10 m</td>
<td>150 m</td>
</tr>
</tbody>
</table>

For a 40 m wide DP vessel
Ice management practices
Ice management – using azimuth thrusters
Alternative ways:

- Model fixed to towing carriage, variable ice drift angle,
- Model fixed to towing carriage, variable ice drift angle, model free to heel, heave and pitch,
- Model anchored, model free to move to any direction,
- Model anchored, restoring force/offset to be measured

The above are done with or without propulsion

- Manual DP where the model is kept at location controlling manually the thrusters.
DP in ice model testing

- Model fixed to towing carriage, variable ice drift angle,
DP in ice model testing

- Model fixed to towing carriage, variable ice drift angle, model free to heel, heave and pitch,
• Model anchored, model free to move to any direction,
• Model anchored, restoring force/offset to be measured
Manual DP where the model is kept at location controlling manually the thrusters.
Propulsion

Manual DP where the model is kept at location controlling manually the thrusters.
Challenges

- Algorithms can be made
- Predicting loads is hard
- Machinery response to be on sufficient level
  - engine power adjustment time
  - turning time of thrusters
  - etc.

Creative thinking is needed!!!!!!
Conclusion

• It is preferred to have the vessel heading within ±15 degrees to the incoming ice direction

• DP needs to cope with turning forces

• Ice management is a must

• Don’t forget the transit operation

• Model testing is quite good way to get an idea about the force levels
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