Title: **Numerical Simulation of Dynamic Positioning in Ice**

Authors: Ivan Metrikin and Sveinung Løset
Norwegian University of Science and Technology (NTNU)
Nils Albert Jenssen, *Kongsberg Maritime*
Sofien Kerkeni *DCNS Research/Sirehna*

Abstract

Numerical simulations have strong potential in a number of applications related to dynamic positioning (DP) in ice-covered waters, such as:

- modeling the effects of the physical ice environment on DP operations, i.e., assessing the feasibility of stationkeeping at a certain location;
- evaluating DP vessel concepts and studying the relationship between hull structures and ice loads;
- evaluating and comparing various DP control schemes—this may lead to, for example, an optimized thrust allocation strategy, reduced fuel consumption and overall greener operations;
- using high-fidelity models to validate simpler models for DP control development;
- using numerical models, integrated with training simulators, to develop operational procedures and educate personnel for Arctic offshore operations;
- analyzing multi-vessel operations, e.g., ice management concepts and strategies, or hydrocarbon offloading to shuttle tankers in icy waters;
- studying safety and reliability, i.e., modeling system failures numerically (e.g., global navigation satellite system failures or thruster failures). Such studies can be useful for risk assessment and DP capability analyses;
- interconnecting numerical simulators, coupled with aerial and underwater surveillance technologies, with onboard support systems for stationkeeping of Arctic offshore floaters;
- studying scale effects and sensitivity with respect to the physical modeling of the ice material, i.e., conducting scientific research.

Currently, numerical simulation of DP in ice is a novel research area. Very few off-the-shelf solutions exist on the market, and it is impossible to name a conventional approach or a standard model. One of the main reasons is that the physical ice environment is difficult to model and simulate. Section 2 of the paper elaborates on this topic and addresses the main challenges associated with numerical ice modeling in relation to DP.

Continued on next page

Despite the challenges, several methodologies have been developed for simulating DP in ice. Section 3 of the paper reviews the state-of-the-art approaches and introduces their classification into three groups: empirical and statistical models, experimental data series methods, and physically based modeling. Each methodology is described and analyzed in terms of its strengths and weaknesses. In addition, recommendations are made for the use of a certain methodology at a particular design stage of a DP system.
This paper also presents a physically based dynamic ice load simulation model coupled with a DP controller. The theoretical and numerical details of the model, along with a series of numerical tests validated against experimental data, are presented in Section 4. Concluding remarks are made in Section 5.

Click below to:

Review the complete paper

Review the presentation

Return to the Session Directory