A comparison of linear and nonlinear programming for the optimization of ship machinery systems - DTU Orbit (21/08/2019)

A comparison of linear and nonlinear programming for the optimization of ship machinery systems

The selection of a proper machinery system is one of the primary decisions to be taken during the ship design phase. Several machinery system configurations are possible, including the use of mechanical and diesel electric propulsion. Nonetheless, little data is available at the early stages of the design phase, making it challenging to define the optimal configuration to be installed on board. Moreover, the screening of different alternatives is a lengthy process, which is mostly carried out manually by the ship designers.

As a way to support decision making at the earliest stages of the ship design process, an optimization framework was developed. The framework is suitable to perform the screening and the selection of optimal machinery configurations for a predefined ship operational profile, and it includes both linear and nonlinear optimization routines. The linear approach has faster, and more reliable solvers, but requires a relatively high simplification of the behaviour of the machinery system. The nonlinear approach, while more accurately representing the system performance, requires longer computational times. In addition, the latter can be expanded to multi-objective optimizations, where the solver not only tries to reach the minimum fuel consumption for a ship, but also takes into account the required space on board.

The aim of this paper is to compare the results of the linear and the nonlinear approaches, and to provide indications on what conditions are the most suitable for the application of one, or the other approach. Both approaches are tested for two case studies, a bulk carrier and a small cruise ship.

The results show that both the optimization approaches led to the same layout of the machinery system, with the linear optimizer converging in a much shorter time. However, the attained solutions feature slightly different unit scheduling. This suggests that, while the linear approach might be the most suitable for design purposes, it is not appropriate for operational optimization.

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