DHI SOLUTION

SCALING OF BALLAST WATER TREATMENT SYSTEMS

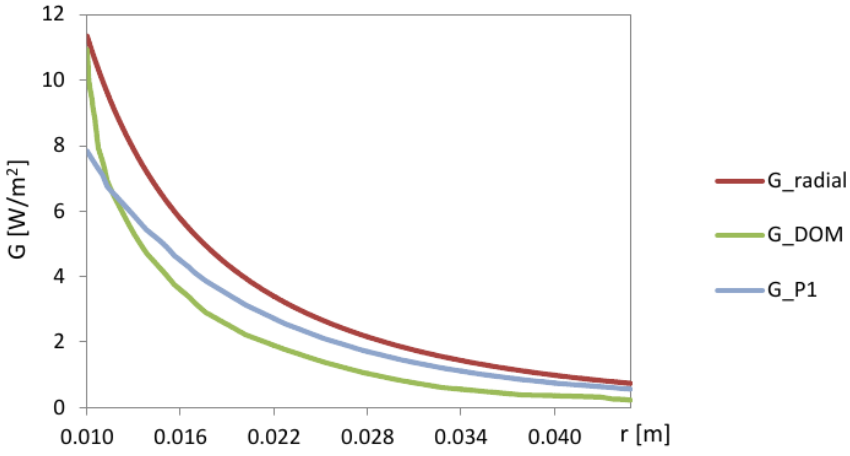
Independent third party validation using Computational Fluid Dynamics

Ballast Water Treatment Systems (BWTS) comprise all the methods, equipment and facilities used to treat ballast water. Whether land-based or on board a ship, BWTS are typically tested for type approval on a smaller scale and tested at a single Treatment Rated Capacity (TRC). The TRC is the maximum permitted continuous ballast water flow rate that the BWTS is approved for. To comply with larger TRCs, the BWTS needs to be physically scaled-up to compensate for the quicker flow rates.

OUR SERVICES FOR BWTS MANUFACTURERS

Ballast water modelling is characterised by many parameters and approximations. A proper selection of these and their evaluation require a broad multidisciplinary knowledge which may not always be available to BWTS manufacturers. With our extensive expertise and knowledge of water environments, we offer two types of services for the evaluation of ballast water systems:

- highly reliable independent verifications of scaled-up Computational Fluid Dynamics (CFD) models (including the use of in-house experimental data)
- optimisation of scaled-up designs to improve performance



Different models for UV intensities produce significant variations in radial UV distribution

SUMMARY

CLIENT

- Developers of ballast water treatment systems
- Classification societies
- Flag states and administrations

CHALLENGE

Need to ensure that scaled-up treatment systems offer a similar or better performance than the system tested in land-based and shipboard tests

SOLUTION

Complex models combining our process knowledge with Computational Fluid Dynamics (CFD)

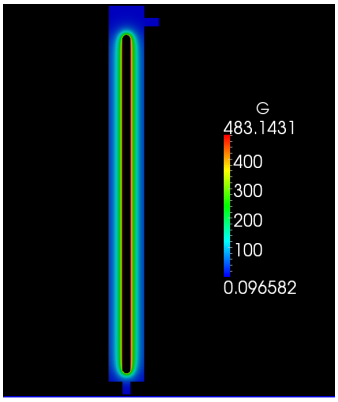
VALUE

- Independent third party validation of scaled up systems
- Reduced costs for type approval
- Confidence of classification societies, administrations and end users in the performance of the scaled-up systems

THE IMO GUIDELINES G8 AND THEIR FRAMEWORK

According to IMO Guidelines G8 relating to the approval of BWTS, computational models of BWTS are acceptable as tools for their scaling. As such, their usage is preferred by the industry as it significantly reduces the speed and cost of type approval. While significant efforts are put in place in Guidelines G8 to describe how different tests are carried out, no further guidelines, specifications or standard protocols exist on the choice and prescribed accuracy of the models used for scaling the systems.

Realistically BWT flows are characterised by a number of physical and chemical variables, such as temperature, sediments, salinity, UV fields and so on. These are generally flow- and geometry - dependent, and all of them impact the survival rate of unwanted microorganisms. Hence, there can be large uncertainties in modelling the survival rates of organisms depending on the level of flow approximations and/or the level of details involved. A sole reliance on results that are not carefully verified could lead to completely wrong assessments of designs.

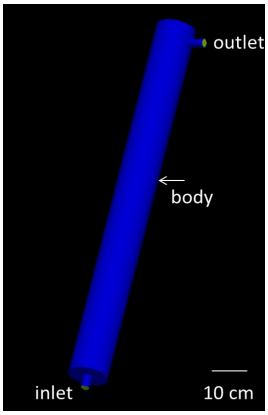


Contours of UV field intensity in a BW reactor with one UV lamp

OUR EXPERTISE HELPS ENSURE PROPER USAGE OF UV SYSTEMS FOR BWTS

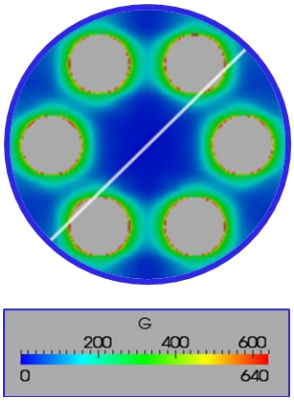
UV systems are now commonly being used for BWTS and they particularly depend on models for scale-up. Measurements of UV fields alone cannot reveal the killing rate of organisms as an integral dose is needed. This depends on the different types of flows. For example, higher flow rates mean lower exposure time and therefore lower inactivation rates. Therefore, UV field measurements alone cannot determine the inactivation rate of UV systems.

For example, in the case of UV systems in scaled-up TRCs, more lamps must be installed to produce larger UV intensities. This is done in order to offset the possible shorter residence times while yielding at least the same inactivation doses. However, this may significantly change the UV-fields as well as the flow fields of the reactor. In cases like these, we can provide independent third party verification related to the scaling up of UV systems in a BWTS.



Single lamp L-reactor

Combining our knowledge on possible variations of ballast water composition, UV technology, organisms inactivation and CFD, we can address the uncertainties faced by BWTS manufacturers. We are also able to carry out uncertainty analyses by running a large number of scenarios. This helps to give our clients a high level of confidence in their scaled up BWTS design before submission of their documentation for type approval.



UV intensity in six-lamp reactor (cross-section)

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