White paper

Muddy waters and filter clogging in ballast water treatment

Securing filter performance in ballast water treatment systems

September 2017

Overview

With the implementation of ballast water treatment regulations, first in United States waters and now worldwide, many of the treatment systems installed over the past 10 years are being put into regular use. As a result, practical challenges that may not have been evident previously are coming to light. One of these is the issue of filter clogging, which has been noted by customers with ballast water treatment systems operating in muddy waters, such as those of Mumbai, India or the Yangtze River.

The tendency of filters to clog relates primarily to filter design, although smaller mesh sizes also play a role. While low-end filter solutions may clog or experience excessive backflushing in muddy waters, there are high-end filter solutions with enhanced cleaning that perform reliably and efficiently, even with small mesh sizes.

Two recent studies, performed using Alfa Laval PureBallast 3.1 and Filtrex filters with enhanced cleaning, show that ballast water treatment systems can indeed perform well in muddy waters. The first, conducted for dredging contractor Van Oord at Dutch research facility Marine Eco Analytics (MEA-nl), demonstrated the ability to handle 250 mg/L of sediment, which is equivalent to samples taken by the Van Oord in the very muddy waters of Mumbai. The second study, an onboard comparison performed on a large container ship, established that the Filtrex basket filter with enhanced cleaning has 10 times greater backflushing efficiency than a standard filter.

From these studies, it can be concluded that filter clogging is an avoidable problem. When selecting ballast water treatment systems, customers should prioritize those systems that make use of high-end filters with enhanced cleaning.

Filters in ballast water treatment

Filtration is the most common method of pre-treatment employed by ballast water treatment systems. Nearly all ballast water treatment systems, regardless of technology, use fixed-screen filters to remove larger particles and organisms prior to main treatment. When finer mesh sizes are used, they also reduce sediment accumulation at the bottom of the ballast water tanks, which lowers operator costs for sediment removal.

It is important to note that the filter of UV-based treatment systems does not have a substantial impact on UV transmittance, i.e. the ability of UV light to pass through the water. UV transmittance is the result of many different factors, on which the effect of the filter is negligible.

The role of backflushing

While there are different types of filters available on the market, almost all employ an automatic cleaning procedure called backflushing. During this procedure, which is automatically initiated by an increase in differential pressure between the filter inlet and outlet, water flows in the reverse direction – from the outside of the filter to the inside – and clears the filter weave. Because the impurities have collected in the filter element during ballast water uptake, the backflush water can be discharged overboard into the same local area.

As the filter weave becomes finer, the need for backflushing increases along with the amount of impurities filtered out. If the backflushing is ineffective, it will impede ballast water operations and cause a substantial amount of pumping energy to go to waste. In a worst-case scenario, if the filter cannot clean itself properly, it will clog completely after a time. This will necessitate lengthy manual cleaning that brings ballast water operations, and in many cases cargo loading and unloading, to a stop.

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The challenge of muddy waters

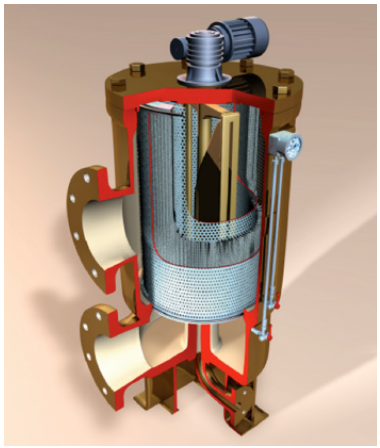
For ballast water treatment systems whose filters have a small mesh size, certain waters present a greater risk of filter clogging than others. The waters of Mumbai, India, for example, or the Yangtze and Mississippi Rivers, can contain high amounts of suspended solids – especially mud and dirt – that pose difficulties for finer filter weaves. If the organic content is also high, the challenge becomes even greater.

In recent years, some vessels have experienced significant clogging when operating their ballast water treatment systems in muddy waters. Regardless of filter type, the problems have been tied to low-end filters with simpler backflushing procedures.

Filters with enhanced cleaning

There are major differences between low-end and high-end filters when it comes to preventing clogging. High-end filters, such as the basket filters produced by Filtrex, have enhanced cleaning mechanisms that speed up the backflushing process while using a reduced flow of water. This not only improves backflushing efficiency, but also increases overall filter effectiveness by producing a higher net capacity.

In Filtrex basket filters, a rotating arm with a slot mechanism passes over the filter interior during backflushing. Underpressure draws clean water in through the weave, carrying the accumulated impurities with it into the slot. The water and reject then passes into a pipe for discharge overboard. (See image below.)



The enhanced cleaning mechanism of a Filtrex basket filter. Image courtesy of Filtrex Srl.

Two recent studies confirm the ability of such filters to handle muddy waters – even with a 20 µm mesh size. Performed with Filtrex basket filters as a part of Alfa Laval PureBallast 3.1 ballast water treatment systems, the studies show that ballast water treatment systems can avoid clogging issues with the correct choice of filter.

Filter testing for Van Oord at MEA-nl

The first of the two studies was initiated by Van Oord, an international contractor specialized in dredging. By nature of their business, dredging vessels encounter far higher sediment loads during ballast water operations than are specified in the IMO G8 guidelines for type approval. Van Oord thus contacted Dutch research facility Marine Eco Analytics (MEA-nl) to evaluate different filtration set-ups for ballast water treatment.

In November 2016, MEA-nl performed tests using an Alfa Laval PureBallast 3.1 ballast water treatment system with a Filtrex basket filter. Over the course of the testing programme, the system and filter were subjected to a variety of sediment concentrations in excess of the 50 mg/L required for IMO type approval. Using natural sediment from the Den Oever area of the nearby Wadden Sea, loads of 50, 75, 100, 125 and 150 mg/L were targeted, to be followed by a final load of 250 mg/L.

The sediment concentrations were chosen to correspond with field samples taken by Van Oord in dredging projects all over the world. The final target of 250 mg/L was set based on actual sediment levels measured during operations in the muddy waters of Mumbai. While technical difficulties with the chosen set-up prevented a consistent load of 250 mg/L over time, the system and filter experienced loads over 200 mg/L at several points, including a maximum load of 400 mg/L.

During testing, samples were taken once stable conditions were established at each sediment concentration. For each load condition, two samples were taken of each of the following:

- The challenge water, i.e. the ambient water plus added sediment
- Outflow from the ballast water treatment system
- Backflush water from the filter

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When the samples were evaluated, they showed that the Filtrex filter had significantly reduced the sediment content in the challenge water. This was in spite of the fact that most of the sediment particles present were considerably smaller than the mesh size used. As stated previously, the tests included concentrations much higher than those required for IMO type approval.

The MEA-nl samples demonstrated conclusively that the Alfa Laval PureBallast 3.1 system, using a Filtrex filter with enhanced cleaning, could operate reliably at sediment concentrations as high as 250 mg/L. This corresponds to the sediment concentration in the waters of Mumbai, which was the most challenging of the samples Van Oord had collected.

Onboard filter testing on a container ship

The results of the land-based testing at MEA-nl are also supported by onboard testing, performed in April 2017 aboard a large container ship.

During a three-day trial, which was conducted on-route from Aahus, Denmark and in the challenging waters of the Wilhelmshaven, Germany, the container ship performed a direct, side-by-side filter evaluation. Once again, Alfa Laval PureBallast 3.1 systems were used. On the vessel's port side, a ballast water treatment system was equipped with a standard filter. On the starboard side, an identical system was equipped with a Filtrex basket filter with enhanced cleaning.

During the trial, sediment loads of up to 665 mg/L were experienced. When the data from the three days was collected, it showed that the backflushing of the Filtrex filter with enhanced cleaning was 10 times more efficient than that of the standard filter.

Conclusion

In combination, the two studies involving Alfa Laval PureBallast 3.1 and Filtrex filters make clear the importance of filter selection when choosing a ballast water treatment system. Filter clogging when operating in muddy waters can be avoided. However, it requires the selection of a high-end filter technology with enhanced cleaning capabilities.

Ballast water treatment systems sourced from reliable suppliers, who have put substantial effort into researching and testing their system's filters, can be trusted to perform optimally even in the most challenging sediment conditions worldwide.

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