Optimized filtration mesh for ballast water management systems

Perfectly designed filtration media and filtration packages to meet increasing demands

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For maritime shipping, ballast water is a necessary evil. It is used as compensation for missing or shifted cargo and empty fuel tanks to maintain the required draught of the vessel and ensure the stability required for safe passage across the world's oceans. According to the World Wide Fund For Nature (WWF), up to 7,000 different organisms are drawn on board with ballast water and discharged into new habitats at the port of destination. There, they may cause massive damage to the economy, the ecology and to human health. To put an effective stop to these unwanted hitchhikers, in 2004 the International Maritime Organization (IMO), a sub-organization of the UNO, agreed on a globally applicable Ballast Water Management Convention. Regulation D-2 of the convention prescribes the treatment required on every ship during intake and discharge of ballast water. One of the stages of effective treatment is fine filtration in the 10 to 50 µm range, and this is where Optimized Dutch Weaves (ODW) and Reversed Plain Dutch Weaves (RPDW) made by GKD – GEBR. KUFFERATH AG play a key role.

In a globalized world economy, shipping is the most important mode of transport. Two thirds of all goods are transported by sea, with an upward trend. Ships are getting bigger and, with speeds of 25 nautical miles

(approx. 50 km/h), faster, too. Docking times for offloading and loading are getting shorter, and the frequency of port calls is increasing constantly. According to the UNO, this implies an increase in one of the four major threats to the marine environment: the infiltration of ecosystems with alien organisms through ballast water. The WWF estimates that ten to twelve billion tons of ballast water a year are transported across the oceans and discharged in ports of destination during the loading of new cargo. Countless alien animal and plant organisms are released along with the ballast water. Without natural enemies they spread rapidly in their new habitat, doing irreversible damage to the local aquatic flora and fauna. This leads to considerable economic losses through destruction of fish stocks, damage to harbor installations and blocking of industrial conduits. The WWF puts the value of the documented damage worldwide at more than 11 billion euro per year. Cholera bacteria and toxin deposits in common mussels pose a direct threat to human health. To protect against these dangers, the IMO laid down strict regulations in its BWM convention in 2004 for control and treatment of ballast water in ships with over 400 gross tonnage. This so-called D-2 standard will apply from 2016 at the latest to around 50,000 ships in the world's merchant fleet. In the USA, the IMO limit values, in a lot more stringent form, have been law since 2012. In their territorial waters, ships are only allowed to operate if they have been certified by the US Coast Guard (USCG).

Two-stage treatment

To comply with the D-2 standard, manufacturers of onboard ballast water treatment systems use a two-stage approach consisting of mechanical separation followed by chemical or physical disinfection. After preliminary removal of larger organisms using a hydrocyclone, a fine filtration stage removes all organisms with sizes in the range of 10 to 50 µm. A subsequent stage of chemical disinfection is performed either with chlorine

produced from the seawater by electrolysis, through addition of biocides like peracetic acid or hydrogen peroxide, or with ozone produced directly on site. The options for physical disinfection are heat treatment, ultrasound or UV irradiation. The expectations ship operators have on these extremely expensive ballast water treatment systems are correspondingly high. In addition to high throughput rates to ensure fast deballasting times in harbors, they want the systems to have small footprints, low operating costs, easy handling and retrofitting, long service life and low maintenance requirements. Reliable treatment of different water qualities, e.g. seawater, freshwater, brackish water, without environmental impact through chemical residues rounds out the high performance profile the ship operators expect these systems to deliver.

High demands on filter media

For the separation of organisms and particles > 50 µm, ballast water treatment systems usually employ filter cartridges and discs with pore sizes between 10 and 50 µm. Depending on the manufacturer, they are cleaned automatically via back-flushing, back-pulsing , scraping or suction, so the filter media have to have lasting mechanical strength. This application also calls for filter media that combine the required fineness with high throughput rates and long service life, have a low tendency to clog, and are easy to clean. Another crucial requirement for operational reliability is an absolutely dependable filtration rate. However, in practice, it appears that not all filter media available on the market meet these diverse requirements. With their Optimized Dutch Weaves and Reversed Plain Dutch Weaves, GKD offers a solution that fits the bill in all respects. To meet the customer's specific requirements, GKD has a range of mesh constructions (laid, wrapped or sintered) and seam designs (welded, folded or clamped) available. Aggressive seawater and the type of disinfection

stage used in the system pu demands on the filter media materials. With Super Duplex (1.4410), Hastelloy (2.4602), Monel 400 (2.4360), SS 904L (1.4539) or SS 316L (1.4404), GKD has a wide range of materials to cover all needs. This allows perfect tailoring of the filter media materials to the particular system in terms of resistance to corrosion, chloride ions and heat, as well as non-stick and anti-fouling properties. Optimized Dutch Weaves and Reversed Plain Dutch Weaves owe their outstandingly high performance to the special design of the stainless steel wire mesh. The slot-shaped pore geometries on the mesh surface are smaller than the pores inside the mesh. This design ensures that particles of the specified separation range are reliably separated on the surface of the wire mesh, while smaller particles pass through the larger internal pores without clogging them up. The slight pressure increase at a constant contamination level makes for a higher dirt-holding capacity than other mesh constructions of the same fineness. In practice, this means longer filtration times without having to regenerate the filter media.

Precise design and layout through simulations

Woven wire meshes as filter media in ballast water treatment have an edge over other media, for example higher throughput rates at defined pore sizes, depending on the weave pattern used. To maintain this lead, the focus of research and development activities at GKD is firmly on continuous optimization of mesh geometries and filter package layouts. Single-layer and multi-layer wire meshes are constantly being analyzed to improve their permeability and mechanical strength. In the process, experimental and computational simulation methods like the Finite Element Method (FEM) or Computational Fluid Dynamics (CFD) are used. FEM enables GKD to localize critical weak points inside the woven wire meshes or filter elements. Filtration tests in GKD's own laboratory allow exact specification

of retention rates for particles and organisms of defined sizes – including for soft or elastic particles – as well as prognoses of flow rates under various operational pressures. In this way, GKD defines the absolute mesh openings needed to guarantee the required cut-point accuracy. In the specific example shown here, particle measurement of a sample of seawater containing artemia was carried out, before and after filtration, according to the ISO 13319 standard. Analysis and measurement confirmed that all particles > 49µm were retained. In addition to selecting the appropriate filter media with defined absolute pore sizes, GKD also determines the optimal layout of the various layers inside the filter package. Options are constructions with or without woven wire drainage mesh between the perforated base plate and the fine filtration mesh. Integrating a layer of drainage mesh increases the flow rate. GKD also uses CFD simulations to provide recommendations the best way to clean the filter media, for example through back-flushing or back-pulsing.

Thanks to their sophisticated construction and customized design, Optimized Dutch Weaves and Reversed Plain Dutch Weaves by GKD are a key factor in the full compliance of ballast water treatment with the strict regulations of the IMO convention. Compared to other filter media on the market, they offer the advantage of substantially higher flow rates, absolutely precise separation and reliable efficiency in a demanding physical environment. For this reason, they are already in use in the filter discs and cartridges of numerous ballast water treatment systems, with great success.

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WORLD WIDE WEAVE

GKD – WORLD WIDE WEAVE

As a privately owned technical weaver, GKD - Gebr. Kufferath AG is the world market leader in metal, synthetic and spiral mesh solutions. Four independent business divisions bundle their expertise under one roof: Industrial Mesh (woven metal mesh and filter solutions), Process Belts (belts made of mesh and spirals), Architectural meshes (façades, safety and interior design made of metal fabrics) and Mediamesh® (Transparent media façades). With its headquarter in Germany and five other facilities in the US, South Africa, China, India and Chile – as well as its branches in France, Spain, Dubai and worldwide representatives, GKD is close to markets anywhere in the world.

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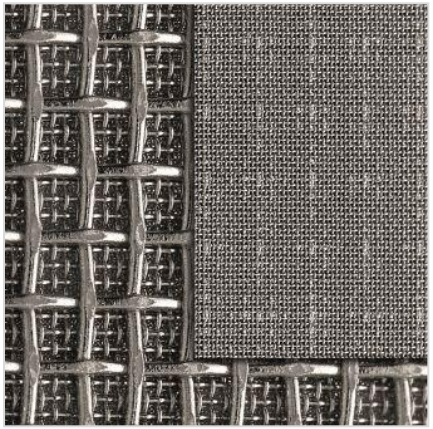
Picture 1: According to WWF about twelve billion tons of ballast water a year are transported across the oceans and discharged in ports of destination.



Picture 2: Multi-layer Dutch Weaves made by GKD ensure efficient treatment of ballast water.

Pictures 3-4: For the separation of particles > 50 µm, ballast water treatment systems employ filter catridges and discs.

Picture 1 © Nickolay Khoroshkov – Fotolia.com

Pictures 2-7 © GKD

We will be happy to send you the desired images in printable resolution by e-mail.

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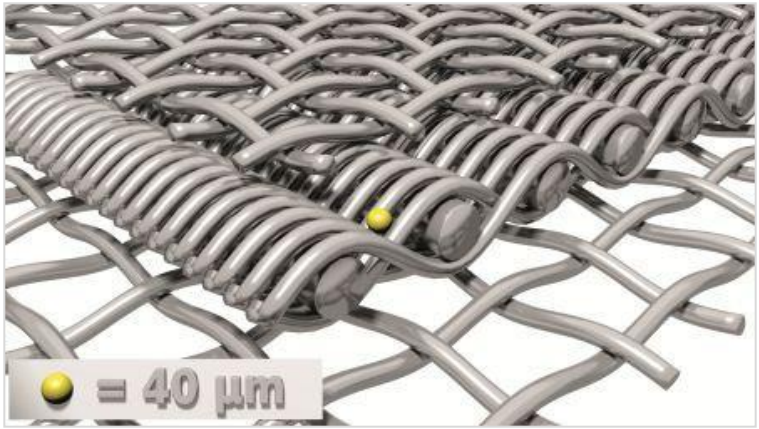
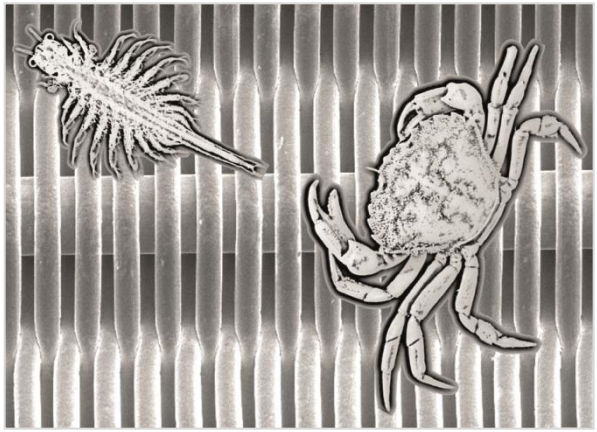
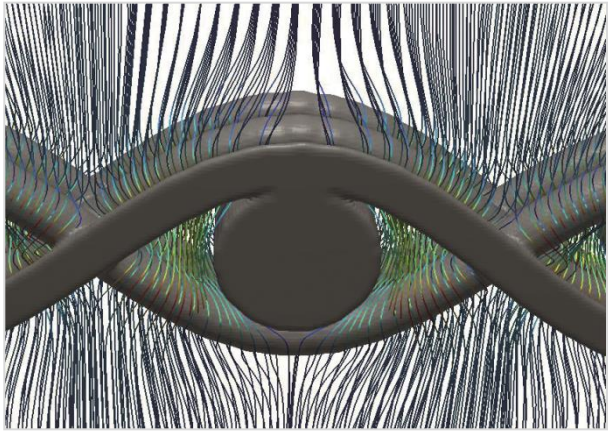


Picture 5: The multi-layer filters usually have pore sizes between 10 and 50 µm.



Picture 6: After removal of larger organisms, a fine filtration stage removes particles with sizes in the range of 10 to 50 µm.



Picture 7: CFD-simulation of an Optimized Dutch Weave made by GKD – Gebr. Kufferath AG.

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