Scrubber Technologies

A variety of scrubbers are available to the market for reducing gaseous emissions of sulphur oxides (SOx) and particulate matter (PM) and ensuring compliance with MARPOL Annex VI regulatory requirements.

For the purpose of SOx removal, a number of scrubber technology options are available to ship owners and operators. These are:

• Wet scrubbers with an open- and closed-loop mode.

• Hybrid scrubbers.

• Dry scrubbers.

Table 10 outlines the maximum percentage of SOx and PM emissions that wet and dry scrubbers can remove:

TABLE 10. Emissions Removal By Scrubber Type

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WET SCRUBBERS

A wet scrubber system uses a flue gas desulphurisation process to remove SOx and PM from the exhaust gas.

Wet scrubbers are available in both an open-loop seawater mode and closed-loop chemical mode. The open-loop option uses high seawater alkalinity to remove SOx whereas the closed-loop system uses an aqueous chemical solution to scrub the gas.

Waste discharge varies between the systems. In an open-loop system the washwater is treated and then discharged into the sea. In a closed-loop system the exhaust gas is recirculated, following a regeneration process.

Requirements for treatment, monitoring and discharge of washwater are contained in the IMO MEPC.184(59) Guidelines. See Section 2.2 for further information and guidance on washwater discharge regulation and requirements.

OPEN-LOOP SYSTEMS

The open-loop scrubber system, also known as the ‘seawater scrubber’, uses seawater to remove SOx and PM from gaseous exhaust emissions (see Figure 13).

Open-loop scrubbers function by pumping seawater into the scrubber system in which exhaust gas is sprayed at different stages. The natural salinity of the seawater induces a chemical reaction with the SOx in the exhaust gas, forming sulphuric acid (H2SO4) as a bi-product.

Because the washwater is treated with seawater and no chemicals are used in the process, the washwater discharge from open-loop scrubbers can be discharged back into the sea without recirculation.

Figure 13 illustrates the process of exhaust gas cleaning via an open-loop scrubber system. The seawater is led along the pipes to the scrubber unit where the exhaust gas is sprayed with the water to remove pollutants. After the process is complete, the dirty seawater is taken to the water treatment unit where it is separated from the clean water. The black water is then pumped to the sludge tank and the clean treated washwater is transferred along the pipes and back into the sea.

A research study by Fridell and Salo (2014) demonstrated that for an open-loop wet scrubber system using seawater for SO2 abatement, the abatement of volatilen particles was very high with a 92% removal success rate and a 48% solid fraction reduction. The study also revealed polycyclic aromatic compounds to be reduced significantly in the exhaust. Reduction in PM were analogous to the reductions gained if switching from heavy fuel oil (HFO) to marine gas oil (distillate).

THE WASHWATER

An open-loop scrubber uses centrifugal forces to separate suspended matter from the washwater.

The suspended matter is drained away as sludge and stored in a tank while the remaining washwater is treated and diluted for pH adjustment in preparation for

release into the sea.

The washwater, which is filtered from the sludge using carbon particles and other particulate fuel impurities, is likely to be in the form of a warm acidic jet (this

however depends on variables such as onboard treatment and discharge pipe configuration).

In accordance with Resolution MEPC.184(59), discharged washwater is required to reach a pH greater than 6.5 at a distance of 4m from the point of discharge.

Furthermore, the sludge in the waste water tank should not be released untreated into the sea, but be disposed of at a suitable port.