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Technical Note – April 2006

‘The Oily Water Separator and the Oil Content Meter’

IMO resolutions stipulate that no bilge water pumped overboard at sea may contain more than 15ppm (parts/million) of oil. How can the conscientious chief engineer ensure this limit is not breached?

Machinery space bilge water is usually pumped through the Oily Water Separator (OWS). There are several types and many designs of OWS. But most rely on the difference in density between water at 1,000—1,025kg/m³ and oil at about 850—990kg/m³. Unless agitated, a mixture of oil and water will, usually, separate spontaneously, the oil rising to float above the water. The separation process may be accelerated by warming the mixture and/or by artificially increasing the gravitational force by designing the OWS as a centrifuge. Makers of marine OWS claim that, if properly operated, their equipment will remove all but a trace of oil and they will at least comply with the 15ppm IMO upper limit. But it is not sufficient to rely on the intrinsic capability of any type of OWS. As with any machinery, the OWS can under perform because of defect or unskilled use.

Figure 1 - Typical OWS – does it work? Is the discharge less than 15ppm?

An Oil Content Meter (OCM) is a mandatory feature of all OWS systems. As its name implies, the OCM continuously monitors the concentration of oil in the stream of ‘clean’ water leaving the OWS. If the oil content rises above 15ppm the instrument sounds an alarm within 5s and within 20s operates a valve to divert the unsatisfactory effluent from the overboard discharge and return it to the bilge pump suction. From the point of view of adhering to anti-pollution regulations the OCM is the most important part of the OWS system and may be all that stands between the chief engineer and criminal prosecution. The latest IMO Marine Environment Protection Committee Resolution, MEPC.107(49), requires the OWS to be capable of dealing with an oil/water emulsion but it focuses more on improvements to the OCM than to the OWS. Now, the OCM must not only monitor the discharge, it must record the date and time of alarms and store the data for at least eighteen months. Also, these data must be accessible to official inspection by way of printout or display.

How does the OCM work and how can the Chief Engineer be sure it is working correctly? Most instruments of this type depend on transmission of a beam of light. A sample of water leaving the OWS is drawn off automatically and passed through a detector cell. A low power light shines a beam through a window in the side of the detector. This is transmitted through the water sample and picked up by a detector on the far side of the cell. Pure water will only have a slight attenuating effect on the beam, whereas, oil will absorb the light, reducing the intensity reaching the detector and causing the OCM to sound the alarm. But soot, rust and other non-oil contaminants of the bilge water will also have their affect on the light beam. As each solid particle acts as a minute mirror such material may cause false alarms. The alarms will be recorded and to an official examining the OCM record they will be indistinguishable from the real thing. This is where a little science can help.

Mie theory provides solutions to the problem of calculating the degree to which a beam of light will be scattered (diffused) while passing through liquid containing a concentration of finely divided particles, such as soot or rust. Oil tends to absorb light rather than scatter it. By judicious design, the difference between light scatter by rust/soot and absorption by oil can be accounted for and the OCM can be relied on to react to oil but not to solid contaminants. Figure 2 Illustrates the principle. Normally the un-attenuated light beam will pass directly to the ‘transmit’ photocell. Oil droplets in the water will absorb light and diminish the beam reaching the transmit photocell, thus sounding the alarm. But when the beam is scattered by solid particles rather than absorbed by oil, light will simultaneously reach the ‘occluded’ or ‘scatter’ photocell and be diminished at the transmit photocell. The alarm will not sound for this situation, except when the software incorporated into the system detects the simultaneous presence of oil and solid particles because of a mismatch between the degree to which light diminishes at the transmit cell and increases at the scatter cell.

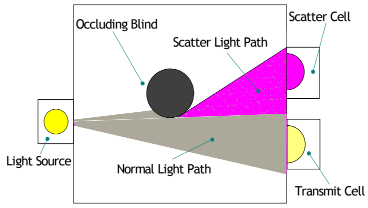

Figure 2 - Schematic of OCM working according to Mie theory. Light only enters the red band because of scattering by solid particles.

The OCM is calibrated by the manufacturer and is not to be opened by the ship’s crew. Indeed, the new IMO regulations require that the OCM is to be sealed. The accuracy of the detector cell may be calibrated at IOPP Certificate renewal but only by the manufacturer or a person authorized by the manufacturer. Alternatively, and what will probably become the norm, a replacement detector cell may be fitted. A simple onboard means is also to be provided to check indicator instrument drift in between calibrations.

Much more can be said about the OWS and the OCM than can be accommodated in this short note. No mention has been made here of the problems of dealing with oil/water emulsions or of the effect of bilge cleaning detergents. These are important complicating issues and they add significantly to the difficulties faced by shipowners and chief engineers in ensuring they protect the environment and stay on the right side of the law.

This series of occasional Technical Notes is intended as a service to the enlightened lay reader and to explain marine engineering issues which are topical or which appear from time to time as issues in maritime disputes.

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