ACCIDENTAL OIL SPILL DUE TO OIL-SEPARATOR'S MALFUNCTION

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INTRODUCTION

It became a common sight in Brest to see a ship putting into port because it has been intercepted by the Navy and accused of voluntary pollution. A glittering wake has been observed, and a photograph taken of the ship's wake. The Tribunal, with only this proof and with the plane's pilot as the only witness, decides to release the ship on bail in the order of 200,000 / 400,000 Euros. The shipmaster, more often than not, admits the spill and attributes the spill to a faulty separator. The requested sum is paid and the ship leaves Brest, not without delay; PSC has its role to play and there may be a week-end.

The procedure seems to us questionable for several reasons.

- The only proof is a photograph. That phosphorescent wake may not be an oil spill and, if it is, may be attributed to another ship, as, in the vicinity of the TSS they follow each other closely.

- The oil spill cannot be but small. A reported phosphorescent wake, say 15 or 20m wide, 5 or 10km long, less than 1mm thick, means a quantity of a few hundreds litres of oil, in some cases less than 100 litres. This rather symbolic pollution disappears rapidly.

- The responsibility of an eventual oil-separator's malfunction should not be attributed to the shipmaster alone. Other bodies should be held responsible for that, chief engineer, manufacturer, supplier, various inspectors and surveyors including the PSC Inspector. In other fields of transport, air, rail and road, a technical malfunction is not automatically attributed to the pilot or conductor.

  The installation of separators aboard ships dates from about 1970 and became compulsory recently under IMO rules. It is, then, relatively recent equipment. This is why our colleague Georges Verdier, Chief Engineer, presents hereunder a short description of this piece of machinery and the way it functions.

- One final point. Why does the shipmaster so often admit the spill? One can admit, à-priori, that the captain does not knowingly throw oil polluted water overboard, otherwise he would do it at night or farther from the shore. Is he incited to admit the spill by his employer? It may be that admitting the spill and paying the required deposit will shorten the judicial procedure and allow the ship to leave earlier. A disturbed ship's schedule means a considerable loss of money.

OILY WATER SEPARATOR (OWS)

Oil/water separators installed on board ships must conform to the requirements of the Resolution MEPC60(33) amended by MEPC107(49) of 18th July 2003. Their use is compulsory as specified in MARPOL, Rule 10.

GENERAL

Densities of oil and water are different. Consequently, in the vast majority of cases, Water/Oil separators installed on board merchant vessel separate water and oil on the principle of their densities.

Oily bilge-water is pumped into the device by an adjustable pump either from the bilges direct or from a retention tank. After the treatment oil is collected at the top and clean water at the bottom of the device. This pump must have a regular output, type approved, avoiding any kind of turbulences causing additional emulsion and mixing effects which would compromise the O/W separation on the principle of gravity.

An oil concentration detector measures the quantity of oil in water, which must not exceed 15 PPM (part per million). If that limit is exceeded, an automatic monitoring device should stop the separator and activate an alarm.

Usually, in the vast majority of cases, a separator is designed as follows:

- A first rough separation is achieved on the principle of different densities, as soon as the oily water enters into the separator.
- The liquid passes then through a system of baffles, change of direction and acceleration followed by a resting zone in view to regroup all droplets of oil in suspension.
- The process also makes use of centrifugal force.
- A built-in coalescer which is a sort of very open porous type strainer with a oleophilic surface separates the smallest droplets of oil.

COALESCENCE

When 2 different liquids are mixed, the droplets of each of them have a tendency to join each other in order to form an assembly of 2 separate liquids.

The coalescer or filter-coalescer can contain a metallic mesh or granules. If granules, they may be made of oleophilic and hydrophobic propylenes (Advanced Pollution Control Technology) or of ceramics containing oleophilic amines.

Oil separated from water accumulates at the top of the separator and either flows out continuously as in what is called “vases of Florence”, or is detected by level sensors and the backwashing is started. This not only drains off all remaining droplets of oil and sludge to the bilges but also washes the coalescer and its strainers with inverse flow of water.

To create this backwash, the separator is equipped with a set of electrically controlled valves to stop the input of oily water as well as the output of clean water and to open a drain-cock for a drain-tank to receive oil. Another valve is activated to receive clean water for the backwash through the same opening as the clean water output.

The counter-current may be started manually or automatically. Oil detected by level sensors may be evacuated, on option, without stopping the separator.

N.B. There are generally 2 level sensors placed at the top of the separator, one lower than the other. The lower-one activates the drain-cock and the higher-one closes it. Of course, the lower-one should not be placed lower than the input of oily water.

In some models, to improve the first rough separation, the oily water is pumped in tangentially. This makes the liquid spin around and, consequently pushes the water to the periphery, the oil staying near the centre.

There are also separators using the centrifugal force only. Oily water is pumped in tangentially, spinning around with a force which may be as high as 1,000 x gravity. Water is pushed hard against the sides while descending. Oil is collected at the top and drained off to the drain-tank.

Some installations have an additional oleophilic strainer placed beyond the level sensors in view to reduce even more the quantity of oil in the output before pumping it overboard. In some yachts that are not equipped with 15 ppm separators, oleophilic strainers are mounted directly on the output of bilge pumps. (Docs Vulkan)

PUMPS

They are mainly volumetric, positive displacement, self-priming pumps, in order to assure a steady throughput without undue turbulence or additional emulsion.

Volumetric pumps may be of several types:

- Diaphragm
- Peristaltic
- Eccentric screw

Diaphragm pumps

Two parallel diaphragms are driven by the same shaft. While one side of each diaphragm receives the liquid to be pumped, the other side is sealed with air which alternatively, as the membrane moves, flows from behind one diaphragm to behind the other through a set of non-return valves.

The liquid to be pumped is, then, drawn in and pushed out by one side of the membranes only. There maybe, however, pumps where the liquid is pumped by both sides of each membrane.

Peristaltic pumps

The liquid to be pumped is contained within a flexible tube fitted inside a circular casing. A rotor with a number of rollers, shoes or wipers turns and compresses the tube forcing the liquid to move through the tube. As the tube opens to its natural state after the passing of the cam, fluid flow is induced to the pump. This process is called PERISTALSIS.

Eccentric screw pumps

A rotor, in steel, rotates in a stator, in elastomer. The centres of these two bodies are offset, creating eccentricity. Extensible vanes fitted to the rotor create cavities of variable volumes causing flow of the liquid through input and output holes on the stator's casing.

If the liquid to be pumped contains abrasive particles or elastomer hostile chemical elements, the stator will wear away quickly. In that case, a centrifugal pump is preferable..

Principle of PPM measurement

This measurement works on the scattered light method. Clean water is a good light conductor and doesn't cause any refraction. If there are some oil or other opaque particles mixed with water, the light is scattered proportionally to the number of those particles. However, light may be scattered also by turbulence.

A sample water of the separator's output passes through a glass tube. A light beam is emitted from one side of the tube and received on the other side by a photocell, both positioned on a straight line passing through the centre of the tube. In case of clean water, the quantities of light emitted and received are identical. In case of water mixed with oil or other opaque elements, not all light emitted will be received. A calculator, if working properly, translates this difference in PPM (Parts per million).

This system has a drawback and that is, the light is scattered not only by hydrocarbons but also by any other solid elements in suspension in water, or by air bubbles if there is turbulence in the output. An improvement is achieved by placing a second photocell, out of line by "alpha" degrees with the first photocell and which receives light deviated by air bubbles. Light received, then, by both photocells should be equal to light emitted. There still remains the problem of solid particles other than hydrocarbons; light is scattered the same way as with hydrocarbons.

This may be obviated by installing more cells and an occulting device. Oil droplets deviate light as a prism does. Consequently, it is possible to collect deviated beams of light by an additional photocell, 160° from the emitting cell. With this device, solid particles in suspension in water are appreciably detected and the separator's efficiency improved. (Docs Inventive Systems Inc).

Value in PPM of the output is permanently displayed on separator's control panel but it is not recorded on a printout.

In some installations 2 pumps are used, one for the input of oil polluted water and the other for the output of treated water. The throughput of the latter one diminishes as oleophilic strainers get clogged with oil. The loss of suction power is measured by a vacuum gauge. The constructor considers that for a given vacuum value, the output reaches 15 PPM. With this system there is no possibility to visualize permanently the output value in PPM.

If the value of 15 PPM is exceeded, the intake is stopped automatically or a by-pass valve is activated to stop the output to the sea and redirect it to the retention tank, if there is one, or back to the separator. An alarm is also activated, both visual and audible. On some well equipped ships, an alarm is recorded on the engine room computer.

There is no way, onboard, to check the validity of the PPM value indicated. Once a year, at least, a sample of treated water is sent ashore for analysis and the PPM value found by the laboratory is compared to that which has been indicated by the separator. Last analysis results are usually displayed on the separator.

It may happen, then, that the concentration of oil in treated water exceeds 15 PPM without any alarm or indication. Therefore, a rough visual check of the output should be made to avoid, as much as possible, the discharge of polluted water overboard.

MAINTENANCE AND REPAIRS

Maintenance of the separator falls on the ship and should be scheduled as for any other “critical” piece of equipment. Its output pipe, for pumping overboard, should be well marked and safely locked outside of operating periods.

The inside of the separator requires little care, except thorough cleaning when it is possible. If necessary, cleaning or replacement of ceramic oleophilic strainers, all other filters and of level detection probes.

Pumps are mechanical devices with moving parts which wear and must be replaced. There should be, then, on board a sufficient stock of spare parts. Pumps must be in perfect condition if the separator has to work properly.

Oil concentration detector (PPM) is an electronic device and requires little maintenance, mainly cleaning the glass tube in which water flows to be analysed. There should be on board, some spare parts, light emitter, glass tube, gaskets.

There should also be spare coils for electrically controlled valves, fuses, lamps.

Functioning of the alarm and of the by-pass valve should be checked before making use of the separator and at least once per week. The test should be entered in the log; it is required by the USCG, and eventually by PSC.

DISCUSSION

The Shipmaster is in command of the whole ship; he is then responsible also for the Chief Engineer.

Every pumping of the bilge water, whether to the retention tank or over-board (if PPM is OK) is entered by the Chief Engineer in his log. If use is made of the separator, it should be entered in the log, starting and closing time, ship’s position and quantity of water pumped. In case of a faulty functioning it is easy to trace the beginning of the pollution and in case of a normal functioning it is easier to defend oneself.

The best method is to pump water from the bilges to a retention tank, if there is one, and to let it decant. When this retention tank is full, it can be partially emptied through the separator. In this manner, water to be treated contains less hydrocarbons in suspension.

The sludge at the bottom of the retention tank will be pumped ashore, in the next port, if it is equipped properly.

This method, however, is not feasible for VLCCs. They are most of the time moored on buoys and the problem of getting rid of ship’s sediments is very difficult to solve.

Another problem concerns the pump for pumping those sediments ashore. Often one makes use of the separator's output pump. Its throughput is low, say 1 to 2 m^3 /hour on a VLCC it will take 20 hours to empty a retention tank of 40 m^3 in theory. In reality, there will be some counter-pressure due to the length of the pipes and their diameter. Throughput of the pump will be probably 500 litres/hour and the tank's emptying will last 80 hours. As a ship's stay in port doesn't exceed 24 hours, there are some problems. A solution might be to use a special powerful transfer pump with large diameter pipes.