Technical Developments in the Salvage Business

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SYNOPSIS: The paper considers five examples of technologies that have found an application in the world of salvage. The Smit cutting wire, a container firefighting tool, pre-fitted transfer connectors to cargo and or bunker tanks, water injection - for more effective pumping and a wastewater treatment system. Each application, in its own right, can have a crucial influence on the outcome of a salvage.

There are three main drivers for innovation in salvage. The first seeks greater efficiency in the performance of salvage. The second addresses new challenges in salvage, particularly those arising from the rapid evolution of ship design and the prospect of ever larger and more complex vessels. The third (and perhaps the single most important stimulus) is public concern for the marine environment. Here, salvors understand the importance of innovation in the context of growing public expectations.

In the first category, greater efficiency, are developments such as Smit’s cutting wire – first used with complete success to sever the bow of the Russian nuclear submarine Kursk – and the Smit Aqualub water injection system, for efficient pumping of heavy fuel oils. This was used recently to recover fuel from the stern section of the Malaysian vessel Selendang Ayu, which broke up in Alaskan waters (Fig 1).

ENHANCING SALVAGE EFFICIENCY

Chain-cutting with a sheerlegs is the traditional way of cutting a wreck into manageable sections. This is difficult and laborious, with the heavy shock loads very punishing for the equipment used.

Over the past decade we have worked closely with TNO, the Delft-based technical university, to develop a new and more efficient alternative, the cutting wire. This is a steel wire mounted with bushes coated with a special abrasive material including tungsten carbide fragments. Trials soon demonstrated a superior cutting performance. Around 60 per cent of the total energy input is utilised for cutting, a figure far exceeding that of cutting chains. There are no punishing shock loads. The trials also demonstrated this solution’s greater flexibility. Using a cutting wire, it is possible to cut from the top down, as well as from the bottom up. Furthermore, the cutting wire can accept a curved surface, such as a propeller shaft (Fig. 2).

Figure 1: Pollutants were removed from the sunken stern section of the Selendang Ayu.

In the second category – the issues raised by larger and more complex vessels – Smit is developing new systems for fighting fires on board a new generation of gigantic container ships. We have also a number of R&D projects concerned with the salvage of double-hulled tankers.

In the third category, environmental protection, we continue with our pioneering work on systems for the cost-effective assessment of pollution threats and the diverless recovery of pollutants from sunken vessels. Other innovations include Smit’s concept for a mobile, high capacity system for the treatment of salvage wastewaters. In addition, we have already introduced a pre-installed connector system, known as fast oil recovery (FOR), which allows rapid connection for ship-to-ship transfers and the pump-out of pollutants from sunken vessels.

There are many challenges, of course, which have yet to be addressed comprehensively. They include, as already mentioned, the problems associated with the salvage of double-hulled vessels and huge container ships of 12,000 TEU – which will require special equipment for the efficient discharge of cargo in an emergency situation.

Figure 2: The Smit cutting wire was used to cut the wreck of the vehicle carrier Tricolor into nine sections.

Greater efficiency was also the driver in our development of the Smit Aqualub water injection system, used for the first time to remove heavy fuel oil from Selendang Ayu. This oil,
at 380 Cstokes in an Alaskan water temperature of 3 deg. C, presented a real challenge. A very slow pumping rate would have put the oil recovery operation at greater risk due to longer exposure to the prevailing hostile weather.

Water injection was effective in reducing viscosity. Our team recovered 400 tonnes of HFO and 100 tonnes of diesel. Without water injection, it will have been like trying to pump asphalt! The initial projections of 2.5m³/hr recovery rate were transformed by water injection (Fig 3).

The injected water forms an annular film around the oil in the line and this had a dramatic lubricating effect. We achieved rates of up to 42m³/hr, using a 4-inch, 100m line. The friction loss was just 0.9 Bar.

Until recently container ships were major users of very heavy fuels, of up to 720 Cstokes. This practice is now much reduced following the introduction of MARPOL atmospheric emission regulations and the move towards low sulphur fuels. Nevertheless, water injection remains an important salvage technique for the recovery of pollutants, due to the difficulties of pumping heavy oils in low temperature conditions.

**BIGGER SHIPS ... BIGGER CHALLENGES**

The recent revolution in ship design will have a profound impact on salvage practice in the years ahead. Container ships with beams of over 45m and deck stacks eight tiers high present a daunting challenge to any salvor. The part-discharge of cargo in an emergency situation poses extraordinary difficulties. These problems can only increase as the 12,000 TEU plus giants enter service.

Should a very large, heavily laden container ship go aground and require lightering, the salvage master will need a large flat-top barge with an unusually high deck and equipped with an extremely large crane. The ‘ideal equipment’ for such situations simply does not exist. The crane, for example, would have to have a very impressive outreach to access centreline stacks. This task is far beyond the equipment likely to be readily available to the salvor in an emergency.

The extreme beam and height of these giants also raises a number of fire-fighting issues. Fires in 4,000 TEU vessels already present difficulties, even with the special, clip-on ladders we now use. Reaching a fire deep in a container stack is always a problem, but it would be child’s play compared to the challenge of fire-fighting deep in an eight tier deck stack. The problem of access, of course, is always aggravated by dense smoke, chemical fumes and the fierce radiated heat.

Containers are highly effective heat transmitters. This is why vast quantities of cooling water are required when fighting a container ship fire. Water barriers are required, to cool and prevent fire spread caused by the intense thermal radiation. This is why we are now developing special water curtain equipment. This will allow firefighting teams to rig water curtains shielding sound cargo from the main fire areas (Fig 4).

![Figure 3: Water injection reduces friction when pumping heavy oils in cold environments.](image1)

There is always a risk of re-ignition when the main fires are out. Every smouldering container must be entered. This is unpleasant and dangerous work. When doors are opened oxygen enters and a smouldering fire can turn into a fierce blaze within seconds.

We now have a new tool which transforms our close-quarters fire-fighting capabilities. This is ‘Cobra’ – a system combining abrasive jet cutting and water misting. Cobra was successfully trialled in the first quarter of this year and it is now ready for operational use. Cobra is a lightweight system which can be hand-held or platform-mounted, for high work over a container stack. It also has a good potential for remote control. This would further reduce risks to fire-fighting personnel (Fig 5).

Cobra’s high pressure abrasive jet can swiftly cut into a smouldering container. On penetration the supply of abrasive ceases and the water stream becomes a cooling agent. When the water vaporises it chokes the fire. Temperatures drop dramatically in a very short time. Just four to eight litres of water spray entering a 40-ft. container will reduce the temperature from 500 deg. C to less than 100 deg. C in around 10 seconds.

There are important benefits. Fire teams do not enter containers until the hazards have been much reduced.
Furthermore, Cobra uses very little water and this minimises consequential property damage. In addition, Cobra can also be used for safe cold-cutting in an explosive environment. The system can be used to remove flammable or explosive gases from flame-heated tanks.

ENVIRONMENTAL SALVAGE
Smit invests heavily in R&D directed at broadening and enhancing our range of environmental services. The major projects include the production of wreck survey and pollutant recovery systems. These new systems take account of the need for rapid intervention when a ship sinks and carries pollutants to the seabed. Equally, these technologies also look to the future, when shore authorities will have regional and national programmes addressing the threat of persistent or catastrophic release from wrecks which have been on the seabed for decades.

Our survey tool is known as POLSCAN. This is a non-intrusive means of detecting liquids and gases within sunken vessels. POLSCAN’s neutron backscattering device was developed by Shell Global Solutions. This provides accurate data on the locations and volumes of water/oils/chemicals/gases within the fuel tanks and cargo spaces. It functions by detecting interfaces through the determination of changes in hydrogen density. The system can be used in conjunction with a pulse eddy current device. This provides data on hull plate thickness and detects frames or other obstacles attached to the inner shell plating. Plate thickness is a key indicator of a wreck’s condition and its potential for leakage. A POLSCAN survey provides essential data for a comprehensive environmental risk assessment of wrecks in inshore waters. It will identify those which require priority attention due to the volume of pollutants remaining in tanks and/or the poor condition of the hull (Fig 6).

When it is necessary to recover pollutants from a wreck, our POLREC system offers a cost-effective option. This was developed by Smit and Norwegian pumping specialists Frank Mohn Flatøy AS. Its primary role is the diver-less recovery of pollutants from wrecks located beyond the 50m air diving zone.

POLREC utilises Frank Mohn’s ROLS (remote-operated offloading system). The ROV-guided POLREC unit is equipped with a hot-tap machine capable of pollution-free penetration of the wreck’s tanks. It also has a powerful pump.

Each tank is penetrated at two locations. One station is used to pump pollutants to the surface; the other, lower station allows seawater to enter, to replace the oils or chemicals. The pulse eddy current device, developed in association with Shell Global Systems, is used to detect frames and bulkheads, so ensuring that the hot-tap base plates are positioned correctly (Fig 7).

POLREC has been used successfully for a number of oil recovery operations. It was also used in 2001 to recover styrene from the wreck of the chemical tanker _Ievoli Sun_, which was lost in a storm off the Channel Islands. This vessel went down in 95m of water and settled on the seabed in an almost inverted condition.

A POLREC team recovered more than 3,000 tonnes of styrene over a seven-week period. The average recovery rate was 30 tonnes/hr. Nine tanks were emptied, the styrene being pumped to a reception barge mounted on the main deck of an offshore installations vessel. An all-weather platform was required for winter working.

This ROLS unit included a ‘double bottom tool’. The variant deployed for _Ievoli Sun_ operation featured side and vertical thrusters, new cutting heads, a fail-safe closure system activated on disconnection, chemical resistant seals and, of course, the double bottom tool. The latter provides for a two-phase operation. The system docks into a base plate installed on the outer hull, then mills and pumps through an extension pipe engaging with the inner hull (Fig. 8).
POLREC has one disadvantage in an acute emergency. It takes time to survey a newly sunken vessel, locate the best positions for hot-tap penetrations of each tank and then install the base plates before pumping can begin. This led to the development of FOR – the fast oil recovery system – which can be fitted to newbuildings or easily retrofitted to ships in service. Pollutant recovery can start immediately if the vessel has pre-installed FOR connectors. This applies to ship-to-ship cargo transfer and the pump-out of pollutants from a sunken vessel (Fig. 9).

If the vessel is submerged, divers or an ROV can be used to connect up the recovery hose and open the lower FOR access port to the tank. Seawater flows into the open port as oil is pumped to the surface. Given the significant advantages for environmental protection, perhaps the International Maritime Organization should mandate FOR for all oil and chemical tanker newbuildings?

Effective monitoring is essential, to ensure that contaminant levels remain within permitted limits. Furthermore, each LDS module will be capable of stand-alone function, or it can be coupled to others, to treat a range of contaminants or achieve a higher flow rate. The treatment technologies include pre-screening and sieving, centrifugal oil-water separation, sedimentation, mechanical filtration, coalescing, activated carbon absorption and ion exchange (for heavy metals recovery). Each LDS process unit will be accommodated in a pallet suitable for air and sea transport. This will allow our teams to work to the highest environmental standards at very remote locations.

In conclusion, it is important that salvage techniques continue to keep pace with changing operational needs. New challenges will certainly emerge in future years. Some are already apparent. One obvious example is the double-hulled tanker. Statistics suggest that around one in six collisions involving double-hulled tankers result in a fire. Oil may flow into the double side, promoting the spread of fire. There are also the explosion risks. Tank coatings can break down and initiate corrosion and pitting in tank bottoms. This process is often accelerated by sulphuric acid and biological matter in the bottom water layer. High temperatures inside a double-hull can heat cargo and the situation can be further aggravated by elastic deformation of the inner bottom plate and crystalline modification of steel in the way of welding butts and seams.

Within just three or four years pitting can eat through half the bottom plate. The plate could split and allow oil to fill the double bottom. In one case several void spaces in a 10-year-old double-hulled tanker were found to be in an explosive condition. Cargo residues had entered the spaces. Should an explosion occur in a double bottom, the blast will tend to expand forward and aft, rather than sideways and up the narrow double sides. This means it will blow into the pump room and engine room.

As the issue of double-hulls and salvage suggests, we anticipate plenty of challenges in future years. The salvor will require all his ingenuity to find effective and efficient solutions which protect lives, property and the marine environment.
Figure 10: The Legal Discharge System is a solution to the need for portable, high capacity treatment systems.
Well, I think you have to look at it from both sides. From the Bert Kleijwegt foresight should be rewarded. some quite interesting submissions by salvors and shipowner’s hadn’t had the system fitted in the first place. This could lead to that the size of your reward is reduced accordingly than if you You are able to do the job much more quickly . You may find FOR system can have the cargo removed much more rapidly . in the event of an LOF salvage, that a vessel fitted with the There could be quite an interesting situation, which might arise in the event of a similar system located on their vessels. Maybe when you look a little bit further in the future, maybe the FOR system is one of the items which will be recommended or maybe imposed by IMO to be installed. That’s a possibility.

Bert Kleijwegt Well, as we used it on the Kursk, it was of course, also for us. It was a pilot project as a matter of fact, and there we used a different type of bushes which we later used for the Tricolor. During the cutting of the bow section of the Kursk, of course, we learned a lot about the complete system and we also found out that when you use the cutting wire, let’s say, for a period of time for over 40 hours effective cutting, then the cob and metal which is mounted onto the bushes, is becoming very, very slim. Then the amount of steel material which you are really taking away is becoming less and less. So it all depends of course on the size of the vessel which you have to cut and also, how much material you have to remove to cut it through. So that’s a matter of calculation. But in general, you can say when you use a cutting wire for 48 hours, then it’s time to replace the bushes.

Mike Allen How much is it likely to cost the shipowner to install the FOR system? I appreciate that it depends on the size of the vessel, but can you give us some rough indication of how much that would be?

Bert Kleijwegt A number of shipping companies have made a calculation in that respect and we also did, together with ship building companies. When you take a new building vessel, you come to a figure of let’s say, 7% of the new building cost. So actually, it’s not a big amount of money when you look at the total investment on a new building vessel. When you look at the retrofits, then the amount of money to be invested is more or less the same, but then you are talking about US$250,000-300,000.

Mike Allen There could be quite an interesting situation, which might arise in the event of an LOF salvage, that a vessel fitted with the FOR system can have the cargo removed much more rapidly. You are able to do the job much more quickly. You may find that the size of your reward is reduced accordingly than if you hadn’t had the system fitted in the first place. This could lead to some quite interesting submissions by salvors and shipowner’s counsel and cargo’s counsel to the tribunal on how your foresight should be rewarded.

Bert Kleijwegt Well, I think you have to look at it from both sides. From the salvor’s point of view, rewards under Article 13 are based on the salved value of ship and cargo, so as such, it does not make too much difference. But when you look at the P & I Club exposure, I think it will be cheaper for them when salvors have to work on a vessel which is properly equipped with a similar fast oil recovery system. Because there, we can save fines, there we can save money. Also, when you look back at the Aqualub system which we utilised on the transfer of heavy fuel oil from the Selendeng Ayu, also there by using the system, we saved around seven days of working time. So there we saved also a lot of money for the P & I Club, who were eventually paying the bill.

Mike Allen That’s a very interesting point, and I’m sure that the Club representatives here in the audience will be thinking about that in terms of future calls from their members and what the risk may be for the vessels that they are covering.

Mike Lacey This is to do with the fitting of equipment to vessels in anticipation of salvage needs. It’s not at the front-end of technology, but many years ago, the tongue bracket was created and fitted to the bow and stern of many ships. It facilitates the easiest establishment of a towing connection to a ship which has been disabled. It’s commonly known as the SMIT bracket, and I wonder in your experience nowadays, are you finding that these are fitted to new buildings or does that not happen?

Bert Kleijwegt Well, at least all tankers above 20,000 tonnes are obliged to have a so-called SMIT bracket at the forward and after-end of the vessels. It was patented many, many years ago, but I don’t know whether it’s still the same. But I know that they have a similar system located on their vessels. Maybe when you look a little bit further in the future, maybe the FOR system is one of the items which will be recommended or maybe imposed by IMO to be installed. That’s a possibility.

Mike Allen Jim Shirley spoke this morning about salvage of LNG vessels. How would SMIT be prepared if there were a major LNG casualty off Europort right now?

Bert Kleijwegt Well, I am not so sure how they will react here in the Rotterdam port to be very frank, but I can tell you one story from my own experience, which happened in Italy a number of years ago. There was a 7,000 tonne LNG carrier, which had an explosion in the bunker. It was starting off for a discharge for its cargo. She was alongside the LNG berth at that particular time. The fire brigade said, well, it’s impossible to extinguish that fire because it’s a burning bomb. Public exposure, of course, and all the people around it said to the Harbourmaster, you have to remove this vessel as quickly as possible because it will explode. It will destroy my LNG terminal. So the Harbourmaster towed the vessel, which was still a little bit on fire, to outside of the port, and then we became involved. We assessed the situation and said to the responsible people and also to the owner, we can easily extinguish the fire. But he said no, because the Italian Fire Brigade said that it was impossible. So we had to use explosives to open up all the other cargo tanks as a matter of fact to get all the contents burned at sea, and then afterwards, we sank the vessel in 1,000m of water. Because of the public opinion, they didn’t want to hear about that vessel anymore. So there was no control from the owner; it was controlled from the politicians, and they decided what to do with it. So unfortunately, we had to sink that vessel. So here in the Rotterdam port, I don’t know whether there is anybody present from the Rotterdam port at the moment; I don’t know how they would consider something like that.

Mike Allen As ever, the political element.