

Development of an American Society of Testing and Materials (ASTM) Stationary Skimmer Test Protocol – Phase 2 Development

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Abstract

The development of a simple and inexpensive standard test protocol to determine a realistic nameplate capacity for oil skimmers is underway within the American Society of Testing and Materials (ASTM); however, there are differing opinions on how these tests should be conducted. A significant point of contention has been whether to test skimmers using oil only or using an oil layer on water. A test protocol using both methods was drafted and the United States Minerals Management Service (MMS) funded a series of experiments to ‘test the tests’ in July and August 2007 at Ohmsett - National Oil Spill Response Test Tank Facility.

The data and results from the Ohmsett tests allowed stakeholders within an ASTM F-20 subcommittee on skimmers to reach a consensus on a general test methodology and the draft protocol is currently being finalized and balloted as a new ASTM standard. This paper discusses the test series that was conducted at Ohmsett during July and August 2007.

1 Introduction

Numerous organizations associated with the oil spill recovery industry are interested in developing a standard test protocol for stationary oil recovery skimmers. Manufacturers currently give their skimmers a nameplate capacity without guidelines from any industry standard. Nameplate capacities are thought to be unrealistic in many cases and the United States Coast Guard (USCG) typically derates the nameplate capacity by 80% or more in estimating a recovery capacity for planning purposes. Without a standard test protocol, one manufacturer’s nameplate capacity is generally not comparable to another manufacturer’s nameplate capacity, making it extremely difficult for prospective skimmer buyers and regulators to accurately gauge, measure or compare skimmer oil recovery performance

Federal and State regulatory agencies and oil spill removal organizations (OSRO) need to have a skimmer’s nameplate capacity reflect the ability of a skimmer, as a system, to recover spilled oil. The system would include the skimmer’s hydraulic power unit (HPU), the skimmer, the offload pump(s), and a modest length of cargo line to transfer the collected oil to a storage tank. The test protocol should be simple and inexpensive making it feasible for the manufacturers to perform, and rigorous enough to deliver reliable, repeatable test results. While the test may represent a ‘best-case’ scenario, it will be a value that is attainable by the

skimmer system and not based on the maximum theoretical capacity of a single component, as is often the case.

An ASTM F-20 subcommittee on skimmers is currently developing a test protocol to determine a realistic nameplate capacity. This development included several test series where they ‘test the test’. Initial testing of the protocol began in the fall of 2004 at Ohmsett – The National Oil Spill Response Test Facility. Five different manufacturers supplied seven oleophilic skimmers (four drum skimmers and three brush skimmers) for use in the tests. The skimmers were tested in Type I and Type III oils in 10mm and/or 25 mm slicks, in calm surface conditions and in waves (Guarino et al., 2007). Using the results of those tests, the draft test protocol underwent further refinement and required testing of the revised draft protocol.

2 Background

In the absence of a standard test protocol, skimmer manufacturers frequently base nameplate capacity solely on the maximum capacity of the skimmer’s offload pump. The offload pump capacity is typically derived from a manufacturer’s optimum pump curve and does not take into account the ability of the skimmer, as a system, to recover oil. The USCG may derate nameplate capacity by 80% or more in calculating an Effective Daily Recovery Capacity (EDRC). EDRC is the capacity of an OSRO to effectively recover oil in a 24-hour period, based on the cumulative EDRC’s of all the individual oil recovery systems in the OSRO’s active inventory. The USCG uses EDRC as a key component in rating and regulating the oil spill response capability of potential responsible parties and oil spill response organizations (OSRO).

The USCG employs two formulae to determine skimmer system EDRC (USCG, 1997). The first:

$$EDRC_1 = T \times 24 \times E \quad (1)$$

Where: $EDRC_1$ is in barrels per day (bbl/day)

T is the throughput rate (or oil recovery rate (ORR)) in bbl/hour (based on the manufacturer’s skimmer nameplate capacity)

24 = hours per day

E = The efficiency factor (typically 0.20) which may vary depending on system and operational limitations

Current U.S. Federal regulations allow for an alternative method to determine EDRC (USCG, 1997). This alternative method allows an OSRO to submit evidence substantiating that a different EDRC applies to a particular oil recovery system. Adequate evidence is defined as verified performance data in an actual spill (as confirmed through USCG review), or submission of third party test data using certain ASTM standards (ASTM, 1997), or an equivalent test approved by the USCG.

The alternative EDRC formula is:

$$EDRC_2 = ORR \times U \quad (2)$$

Where: $EDRC_2$ is in barrels per day (bbl/day)

ORR is the Oil Recovery Rate (bbl/hour) as determined through acceptable alternative means

U = Hours of oil recovery efforts per day, typically 10 hour/day

The factor U is customarily assigned a value of 10 hours/day as an anticipated number of operational hours. The hours of recovery (U) may increase if an OSRO can demonstrate that they have the ability to operate beyond 10 hours/day (USCG, 1997).

$EDRC_2$ provides the opportunity for submission of data from a third party equivalent test as approved by the USCG. Without a standard test protocol, it is difficult to establish baseline values and compare skimmer performance. Additionally, the USCG requires that any alternative test take into account six parameters from ASTM F-631: oil type; oil slick thickness; skimmer position with regard to the slick; interference from debris; air/water temperature and; wave conditions.

A significant point of contention within an ASTM F-20 subcommittee on skimmers has been whether to test skimmers using oil only (i.e., infinite slick thickness) or use an oil layer on water. Using a small test tank filled with oil only would be relatively inexpensive for a manufacturer as they need to dispose of only clean oil after the test. Testing in an oil layer on water introduces the possibility of generating emulsions and introduces the additional expense of disposing of oil that contains water and oil. Testing in an oil layer on water is also more complicated than testing in all-oil as the slick thickness must be carefully monitored during the test. With an all-oil test, one need only ensure that there is an adequate supply of oil to float the skimmer through the entire test.

Despite the simplicity and lower cost of testing in all-oil, a group within the subcommittee had two concerns regarding testing using only oil. First, a test without a water layer would not reflect the realities of a skimmer recovering an increasing amount of water as slick thickness decreased; and second, the recovery rates would be unfairly biased as a result of testing in the presence of unlimited oil. There was consensus that the test was to represent ideal conditions for the skimmer, and that a slick thickness of 50mm (2 inches) or greater should be used to reflect this.

A test was proposed to address these concerns. MMS funded an effort at Ohmsett to test the draft test protocol and determine if there were differences between testing in all-oil and testing in an oil layer on water.

To test the validity of the concerns, three skimmers were used: a low-capacity disc skimmer, a medium-capacity drum skimmer, and a high-capacity weir skimmer. As the test's objective was to test the methodology of the protocol and not the skimmers themselves, the skimmers are identified only as disc, drum, and weir.

3 Test Method

The test method employed was a draft version of ASTM's soon to be balloted *Test Method for Determining Nameplate Recovery Rate of Stationary Oil Skimmer Systems*. This protocol was developed in conjunction with the USCG National Strike

Force (NSF), and complies with the test criteria found in ASTM F-631-99, *Standard guide for collecting Skimmer Performance Data in Controlled Environments* (ASTM, 1997).

4 Test Apparatus

4.1 Test Area

Tests were conducted on the deck of the Ohmsett test tank using a 2.4m x 2.4m x 0.6m portable PVC fabric tank with a capacity of 3800L (1000 gallons). Once the skimmer was placed in the portable tank, a moveable canopy was erected over the tank to minimize test oil heating due to solar radiation.

A portable tank was chosen, in part, to mimic the efforts of a manufacturer to test their skimmer. Testing on the deck also made it easier to adjust the skimmers, accurately measure oil slick thickness, and the close proximity of the test area provided easier monitoring of the test. If a skimmer needed adjustment, it was a simple matter to reach over and quickly make an adjustment. For each test, the portable tank was filled with sufficient fluid to ensure the skimmer was floating for the duration of the test. Per the draft skimmer test protocol, the skimmer was placed in the portable tank and connected to a 15m (50 ft) long oil discharge hose (cargo line), which emptied into recovery tanks located above the deck to meet the protocol's 3m (10 ft) of head requirement. Tests were to be conducted for a period of either three minutes or until 910L (240 gallons) of oil were recovered.

4.2 Test Oils

As oil recovery rates are dependent upon a spilled oil's viscosity, it was planned that two oils would be used: an ASTM Type I oil (Hydrocal 300, which is a hydrotreated, naphthenic lube-stock, with a viscosity of approximately 200 centistoke (cSt) at 20°C); and an ASTM Type III oil (Sundex 8600, a heavy oil which historically has had a viscosity of 20,000 cSt at 20°C and for this test had a viscosity of 13,000 cSt at 20°C). The skimmers had no trouble with the Hydrocal, but the drum skimmer was overwhelmed by the heavier Sundex. The disc skimmer would likely have been overwhelmed with the Sundex. As a result, the Sundex oil was replaced with a lighter oil, Calsol, which is used as a process oil and had a viscosity of approximately 2,100 cSt at 20°C.

4.3 Slick Thickness

A principle objective of this test series was to determine if there was a difference between testing a skimmer in all-oil versus testing in an oil layer on water. For the all-oil tests, the tank was filled with sufficient oil so that as the skimmer recovered and discharged the collected oil, and the oil level within the tank diminished, the skimmer would float throughout the test and not ground on the bottom of the tank.

For the oil layer on water, the tank was evacuated of residual oil from the previous test, filled with approximately 0.5m of water, and then topped with a prescribed thickness of oil. A 50mm thick layer of oil was chosen as a starting point, and to maintain the slick thickness, oil was replenished at the same rate as the skimmer was recovering and discharging oil to the elevated recovery tanks. Envisioning that manufactures would have difficulty precisely metering oil into the tank to maintain slick thickness, subsequent tests used a diminishing slick thickness:

Starting with a slick thickness of 150mm, the skimmer was run continuously and as the oil slick thickness diminished, the recovered oil was diverted to different calibrated recovery tanks at specific intervals: 150mm to 100mm; 100mm to 50mm; and 50mm to 25mm.

To gauge the thickness of the slick, two methods were used. The first method used an 80mm diameter clear acrylic tube, capped and ballasted at the bottom to float vertically in the slick. Using a ruler fastened to the inside surface of the tube, the slick thickness could be estimated. Even with meniscus and parallax effects, the slick thickness could be estimated within about 6mm.

The second method used to measure initial slick thickness was to add water to the portable tank, measure on the outside of the portable tank from the deck up to the water level's shadow line, add the test oil, and read the level of the new shadow line. These levels could be read to within about 3mm. Once the test commenced, this second method could be used to determine only the total height of the oil/water fluid, as it was impossible to distinguish where the oil/water interface was.

4.4 Oil Distribution

Pre-load and replenishment oil was initially distributed from a 5700L (1500 gallon) calibrated storage tank located on the Ohmsett Main Bridge. Oil volumes in the storage tank were carefully measured and metered to the portable test tank. Pre-charging these oil lines eliminated mass balance accounting for residual oil in the lines during transfers. During steady-state tests, oil from the Main Bridge oil tank was carefully metered to the test tank so that oil was replenished at the same rate that the skimmer was recovering and discharging oil to the recovery tanks.

Oil replenishment was only necessary during the steady-state runs. For the all-oil tests, and diminishing slick thickness tests, oil was distributed via the Main Bridge oil storage tank, or from 1100L (300 gallon) Intermediate Bulk Container (IBC) totes.

4.5 Oil Recovery

A series of eight calibrated recovery tanks, located on the Auxiliary Bridge, were used during the test. Each tank has a capacity of approximately 950L (250 gallons). During a test, oil discharged from the skimmer travels through a cargo line, 3m vertically, to a manifold located just above the recovery tanks. Valves attached to the manifold allow the fluid flow to be directed to individual recovery tanks for measurement and decanting of free water.

During low-volume tests, recovered oil was collected in 19L (5-gallon) containers for better measurement resolution. The containers were located at the same height as the recovery tank manifold to ensure the same 3m of head pressure during skimmer discharge.

5 Test Procedure

5.1 Preliminary Tests

Tests typically ran one to three minutes, depending upon skimmer collection rates. The skimmers initially relied on their built-in offload pump to discharge the

recovered oil up to the recovery tanks, but an in-line double-diaphragm pump was used as a booster pump during several of the heavier viscosity tests.

To determine the maximum ORR for the drum and disc skimmers, each was run at different drum/disc speeds until optimum rpm was determined. The weir skimmer was operated at the maximum recommended hydraulic pressure and flow for its offload pump. From this data, oil discharge rates were used to set replenishment rates and maintain a consistent oil slick thickness during the steady-state runs.

5.2 Performance Tests

Test durations were based on each skimmer's estimated recovery rate and were targeted for three minutes of recovery or 910L of fluid recovered, whichever occurred first. The test procedure was similar whether the test was all-oil, steady-state (consistent slick thickness), or diminishing slick thickness. For the oil layer on water tests, approximately 0.5m of fresh water was added to the portable test tank. Oil was then added to reach the correct slick thickness. The skimmer was started and flow was diverted to a 'slop' recovery tank while final adjustments were made. If oil was to be replenished during the run, replenishment began as soon as the skimmer began discharging to 'slop'. Once the system was operating properly, flow was diverted to an empty calibrated recovery tank, the timer was started, and the temperature of oil in the skimmer's collection well was noted. At the end of the collection period, flow was diverted back to the 'slop' tank, the recovery time was noted, and the skimmer and ancillary equipment was stopped. The slick thickness was measured and the recovery tanks were sounded for initial fluid levels. The recovery tanks were allowed to settle for a period of one hour, decanted of free water, and a final sounding was taken. Oil/fluid in the recovery tank was stirred and a representative sample was taken and sent to Ohmsett's lab for analysis.

During the steady-state tests, oil was replenished at (ideally) the same rate that the skimmer was recovering and discharging oil to maintain a consistent slick thickness. During diminishing slick thickness tests, the recovered oil was diverted to different calibrated recovery tanks at specific oil slick thickness intervals: 150mm to 100mm; 100mm to 75mm; 75mm to 50mm; and 50mm to 25mm, as described before. By diverting the flow into separate recovery tanks, individual slick thickness ORR and recovery efficiencies (RE) could be determined, recovery efficiency being the amount of pure oil (fluid minus water) divided by the total volume of fluid recovered.

Each of the eight recovery tanks has a capacity of approximately 950L (250 gallons) and fills at 0.9L/mm (5.8 gallon/inch). Fluid depth is measured using a 1.2m (4 ft) aluminum ruler, and readings are accurate to within 3mm. During some tests, the oil recovery rates and volumes were low enough that oil could be collected into 19L (5-gallon) buckets for better measurement resolution. The 19L (5-gallon) buckets were located at the same height as the calibrated recovery tanks to maintain the same 3m of head pressure.

Once testing with Hydrocal oil was completed, the portable tank was evacuated of all fluid and refilled with 300mm of fresh water (municipal tap water). Sundex oil was added to form a 330mm thick slick. The drum skimmer was placed in the tank and while the drum could collect Sundex oil, it was too viscous for the

skimmer's offload pump and Sundex overflowed the collection well. The drum skimmer was pulled from the tank and replaced by the weir skimmer. Two tests were conducted with the weir skimmer, and although it could collect and pump Sundex, there was no point in continuing since the drum skimmer could not pump Sundex, and it was doubtful the disc skimmer could pump Sundex, either. Sundex oil was replaced with Calsol oil, an intermediate oil with a viscosity between Sundex and Hydrocal.

The test procedure with Calsol was similar to that using Hydrocal. For the next series of tests, the portable tank was filled with pure Calsol (no municipal water) to determine optimum rpm, maximum ORR, and replenishment rates for later tests. For the last series of tests, the tank was evacuated of all fluid and the tank was filled with 300mm to 450mm of fresh water. Calsol was added to the tank to create slicks 50mm to 150mm thick. Tests were conducted under steady-state conditions by replenishing oil at the same rate as the skimmer was recovering and discharging oil.

Diminishing slick thickness tests were performed with Calsol in a similar fashion as they were with Hydrocal.

6 Results and Discussion

The results are shown for ORR and RE. Performance data were calculated from raw data using the following formulae:

$$\text{ORR} = \frac{V_{\text{oil}}}{t} \quad (3)$$

Where: ORR = Oil Recovery Rate, lpm (gpm)
 V_{oil} = Volume of oil recovered, L (gal) (decanted and lab corrected)
 t = Elapsed time of recovery, min

$$\text{RE} = \frac{V_{\text{oil}}}{V_{\text{total fluid}}} \times 100 \quad (4)$$

Where: RE = Recovery Efficiency, %
 $V_{\text{total fluid}}$ = Volume of total fluid (water and oil) recovered

With the diminishing oil slick thickness test, the reported value for slick thickness is the midpoint between the starting and ending thickness. For the oil only tests (infinite slick thickness), the oil depth was sufficient to float each skimmer for the duration of the test and the depth is shown in the figures as 254mm (10 inches) for convenience in graphing. Results for the disc skimmer in Calsol oil are not presented as there appears to be an anomaly in the data that remains to be resolved.

6.1 Weir Skimmer

The weir skimmer was run at maximum output throughout its tests. With the oil layer on water tests, the oil slick thickness was assumed to be consistent

throughout the test tank. In reality, there was a gradient due to the recovery of oil over a relatively small area of the test tank and the gradient increased as viscosity and/or recovery rate increased. The gradient was pronounced in thin slicks of heavy oil, especially while recovering at relatively high rates of fluids, as in the case of the weir skimmer. As the slick thickness dropped below 50mm, patches of near zero thickness (visible water surface) were observed and the skimmer began ingesting water along with the oil, which diminished RE and in turn, ORR. Above 50mm, the effects of the gradient were negligible and the figure shows that between 254mm (infinite slick thickness) and 50mm, the RE and ORR remain relatively consistent.

During the diminishing slick thickness tests, the test tank was filled with approximately 300mm of water and oil was transferred into the tank until the slick was approximately 180mm thick. The skimmer began recovering oil into a 'slop' tank while the skimmer came up to speed and the cargo line was purged. When the slick was 150mm thick, flow was diverted into a calibrated recovery tank and the timer was started. When the slick thickness reached 100mm, flow was diverted to a second recovery tank, and the time was noted. When the slick thickness reached 65mm, flow was diverted to the next recovery tank and time was noted, and when the slick diminished to 40mm, flow was directed back to the slop tank. For purposes of graphing, the slick thickness between 150mm to 100mm was shown as the approximate (due to conversion from US to metric) midpoint, or 127mm; 100mm to 65mm was shown as 83mm; 65mm to 40mm was shown as 51mm.

The cargo line from the skimmer was connected to a 100mm diameter manifold that ran the length of the recovery tanks. Valves tapped into the manifold control the flow into the individual recovery tanks. When the valve was swung from 'slop' to the individual recovery tank, oil must travel down the manifold before it spills into the recovery tank. At the end of the test, whatever oil was in the manifold drained into the most recently used recovery tank, in this case the tank that collected the oil as the oil slick diminished from 65mm to 40mm, artificially increasing its value at the expense of the first collection tank, which collected the oil as the slick diminished from 150mm to 100mm. Oil from the first interval was used to partially fill the manifold (at these flow rates, the 100mm pipe was not filled to capacity), and the reported ORR for the 127mm value was slightly less than actual, while the value for the 51mm value was slightly more, as evident throughout the figures.

When the slick thickness dropped to 40mm (1½ inches) during the weir skimmer test, the viscosity of the oil, combined with the thinness of the slick, created a sufficient gradient and allowed the skimmer to ingest water along with the recovered oil. Recovery efficiency fell off and this in turn affected ORR. This was only noticeable with the weir skimmer heavy oil tests as shown in Figure 1 Oil Recovery Rate, Weir skimmer in Calsol.

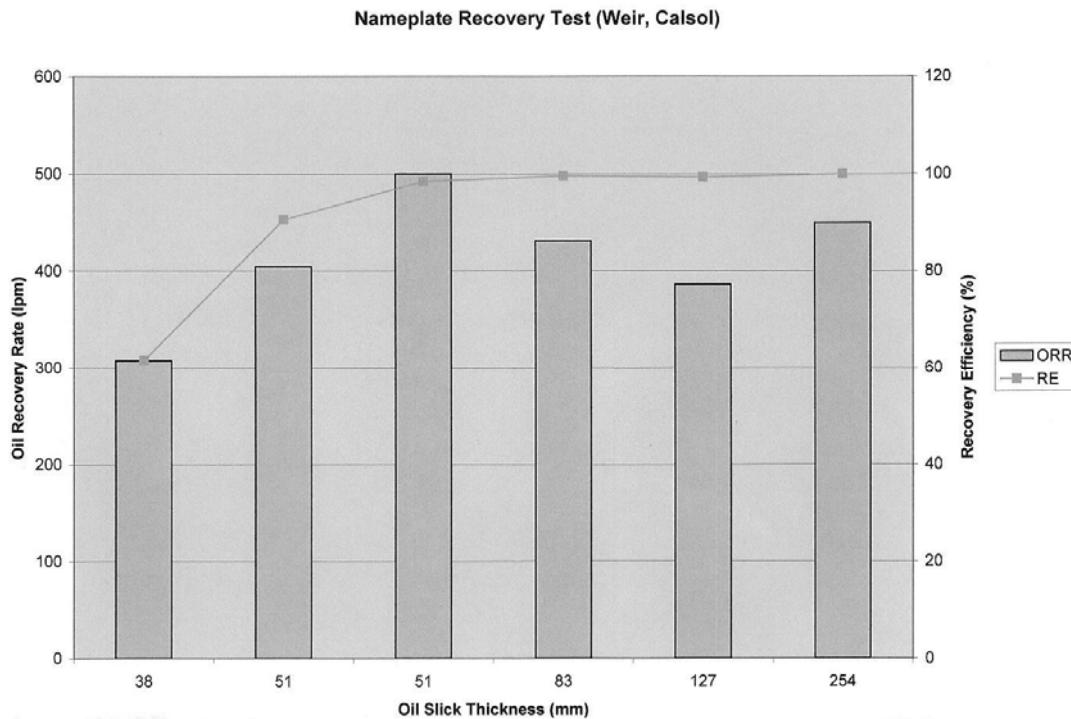


Figure 1 Oil Recovery Rate, Weir Skimmer in Calsol

When the weir skimmer was tested in the lighter Hydrocal oil (Figure 2 Oil Recovery Rate, Weir Skimmer in Hydrocal), there was no observable oil slick thickness gradient, which is reflected in the RE being consistent across all the slick thicknesses. There was, however, the same first tank (represented at 111 mm) and last tank (represented at 44mm) skewing due to filling and draining the manifold. The value at an oil slick thickness of 111mm was shorted, and the value at 44mm thick slick was increased by almost equal values. Allowing for those corrections, ORR is virtually constant from a slick thickness of 44mm to 254mm (infinite slick thickness).

6.2 Disc Skimmer

Unlike the weir skimmer, which was run at maximum output throughout its test, the disc and drum skimmer were tested as various speeds to find the rpm with optimal ORR. With the disc skimmer, the flow values were low enough that recovered oil was collected into 19L (5-gallon) buckets for better measurement resolution. During the diminishing slickness test, the skimmer was set at 70 rpm for its first series and flow was diverted into ‘slop’ until the oil slick thickness dropped to 89mm. When the slick was 89mm thick, flow was diverted into a 19L (5-gallon) bucket and timing ensued. When the bucket was filled, flow was diverted to ‘slop’ until the slick diminished to 76mm, then another 19L (5-gallon) bucket was filled, and so on. As the discharge hose was handheld, the manifold was not used and there was no skewing of data between the first recovery and the last recovery. The ORR is

consistent for oil slick thickness from 89mm down to 51mm, and although the values are somewhat lower than the 254mm thick slick, RE is near 100% throughout the test. The test with the disc skimmer was repeated and the rpm was changed from 70 rpm (Figure 3 Oil Recovery Rate, Disc Skimmer in Hydrocal at 70 rpm) to 58 rpm (Figure 4 Oil Recovery Rate, Disc Skimmer in Hydrocal at 58 rpm). Again, RE is consistent and near 100% through the test. The values when the slick was 50mm through 89mm thick are within 15% of the values at 254mm, and slick thickness appears to have minimal affect on ORR.

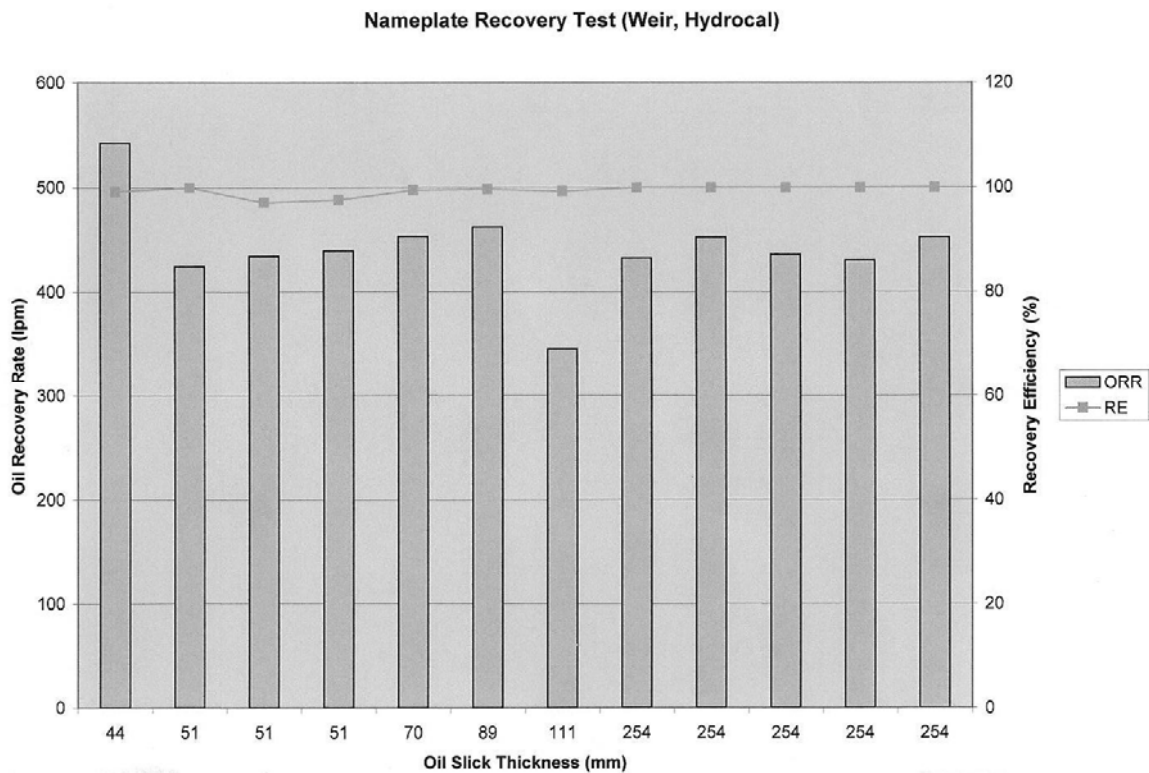


Figure 2 Oil Recovery Rate, Weir Skimmer in Hydrocal

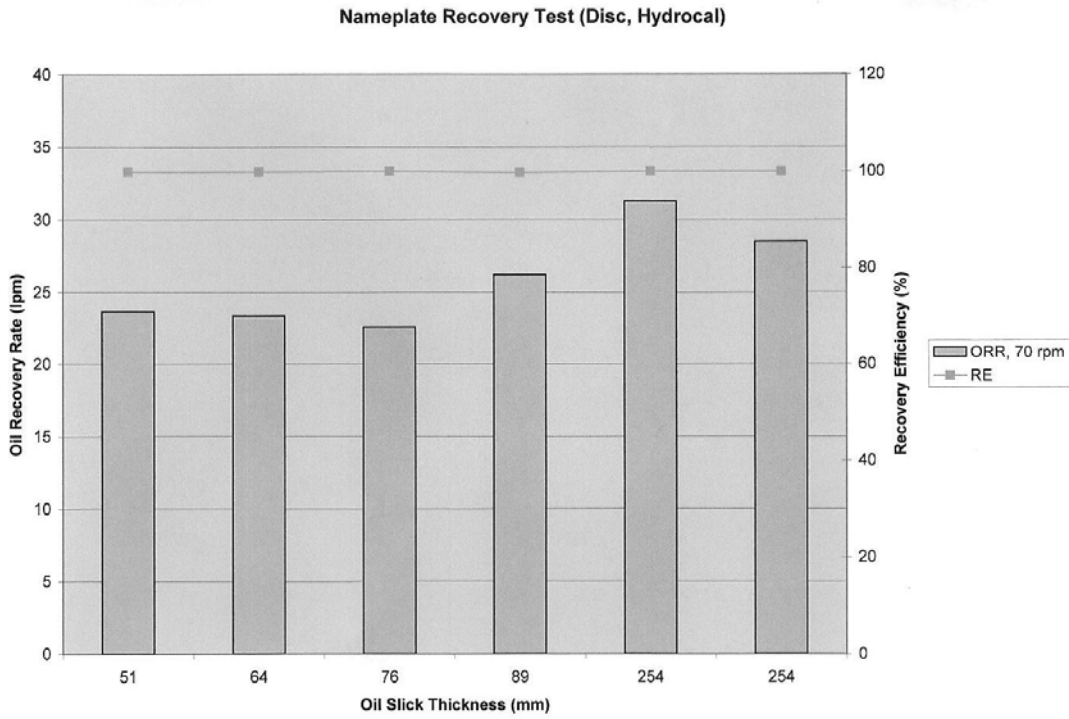


Figure 3 Oil Recovery Rate, Disc Skimmer in Hydrocal at 70 rpm

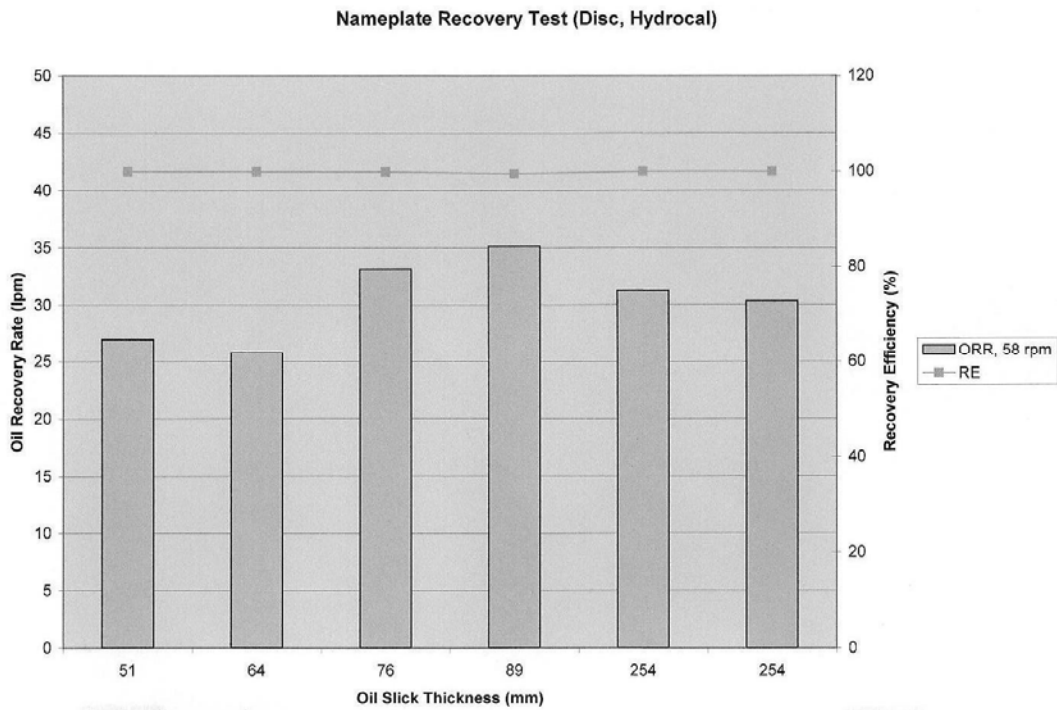


Figure 4 Oil Recovery Rate, Disc Skimmer in Hydrocal at 58 rpm

6.3 Drum Skimmer

As with the disc skimmer, the drum skimmer was also tested at various speeds to determine optimal rpm. When the skimmer was tested at 62 rpm using the diminishing slick method, ORR was within 20% of the infinitely thick slick, and RE was better than 95% for all slick thickness of Hydrocal, as seen in Figure 5 Oil Recovery Rate, Drum Skimmer in Hydrocal at 62 rpm. Again, a slight decrease in ORR was noted for the first interval in the recovery series, at a mean slick thickness of 114mm, and there appears to be a slight boost in ORR at the last interval in the series, at a slick thickness of 25mm, due to the effects of the recovery tank manifold filling and draining.

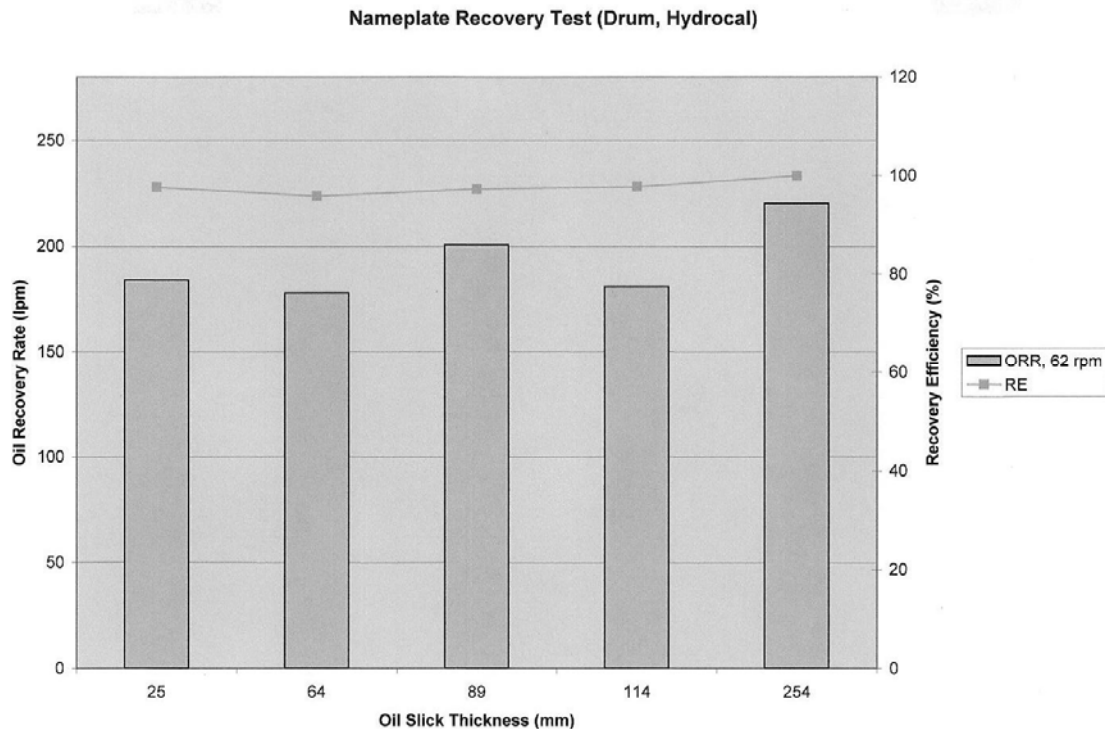


Figure 5 Oil Recovery Rate, Drum Skimmer in Hydrocal at 62 rpm

The drum skimmer was retested at 67 rpm in a diminishing slick thickness. While RE was above 95% for all slick thicknesses, there was a drop in ORR as the slick became thinner, even disallowing the first and last intervals where the oil in the manifold slightly skews the data, as seen in Figure 6 Oil Recovery Rate, Drum Skimmer in Hydrocal at 67 rpm. While this is the only graph where this trend is evident, there is not sufficient evidence to say whether this decrease is simply randomness or if it is a true trend. The value at the next to last interval in the diminishing slick test, shown as a slick thickness of 38mm and chosen to eliminate the boost from the oil in the manifold, is 63% of the value at 254mm (infinite slick thickness).

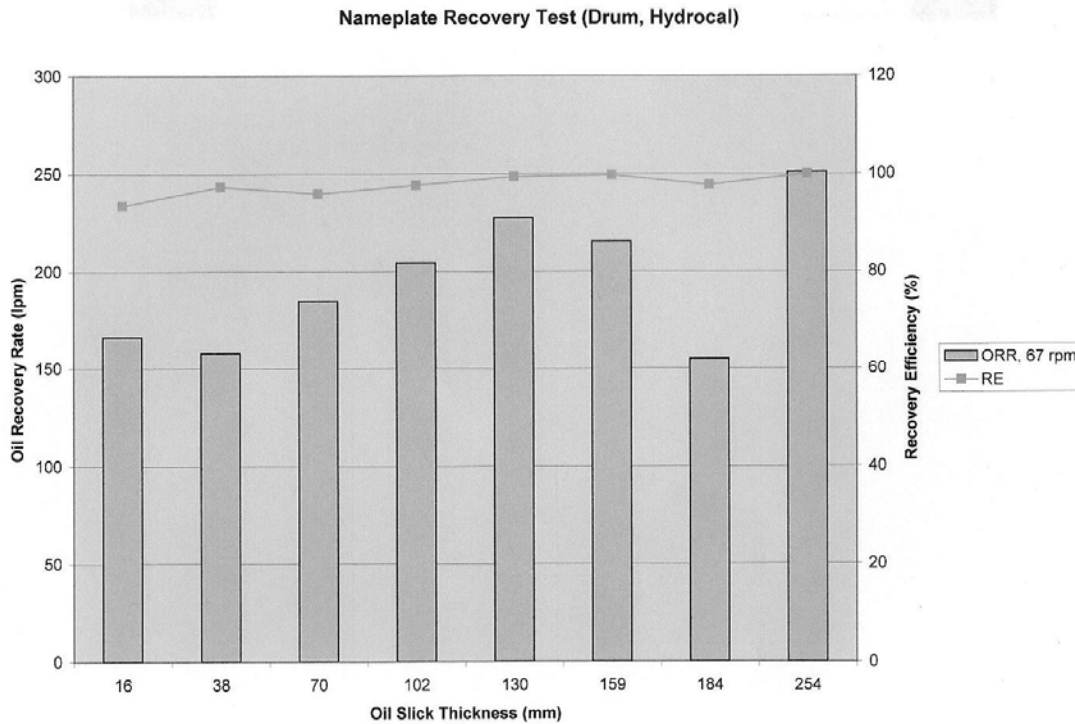


Figure 6 Oil Recovery Rate, Drum Skimmer in Hydrocal at 67 rpm

The drum skimmer was also tested in heavier oil, Calsol. The drum speed had to be slowed considerable due to the drum collecting oil faster than its offload pump could discharge, and the drum was run at 29 rpm in a diminishing slick test. As seen in Figure 7 Oil Recovery Rate, Drum Skimmer in Calsol at 29 rpm, RE remained above 97% through the test and ORR with the diminishing slick was within 25% of the infinite slick thickness. A double-diaphragm booster pump was plumbed in the cargo discharge line and run in series with the skimmer's built-in offload pump. This helped, but did not eliminate the overloading condition, but again, the test is to test the protocol, not the skimmer.

With the double-diaphragm pump assisting the skimmer's offload pump, the skimmer was run at 29 rpm and then at 43 rpm. RE remained above 95% for all tests (Figure 8 Oil Recovery Rate, Drum Skimmer with booster pump in Calsol). There was no all-oil test that used the double-diaphragm pump, and no comparison could be made. For both the 29 rpm and 43 rpm tests, ORR appears to actually increase as the slick thickness decreases. This is most likely due to the oil holdup in the manifold, as it is consistent for both tests and the deficit (from the average ORR) at the 127mm slick thickness matches the surplus at the 51mm slick thickness value.

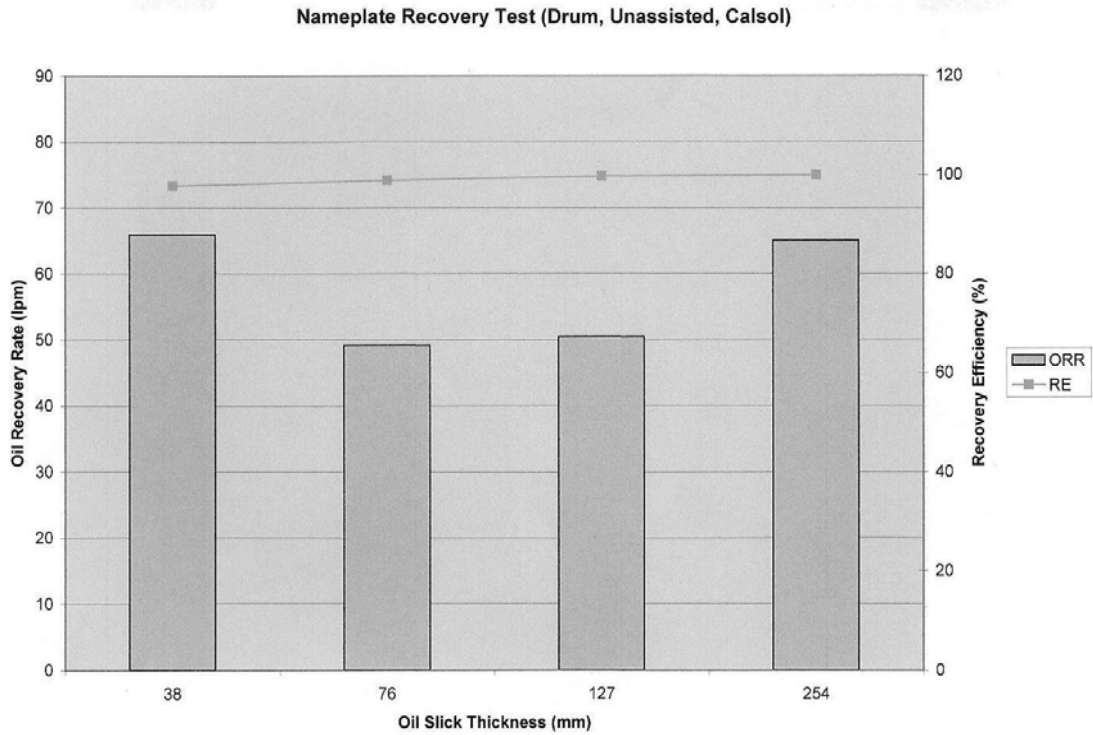


Figure 7 Oil Recovery Rate, Drum Skimmer in Calsol at 29 rpm

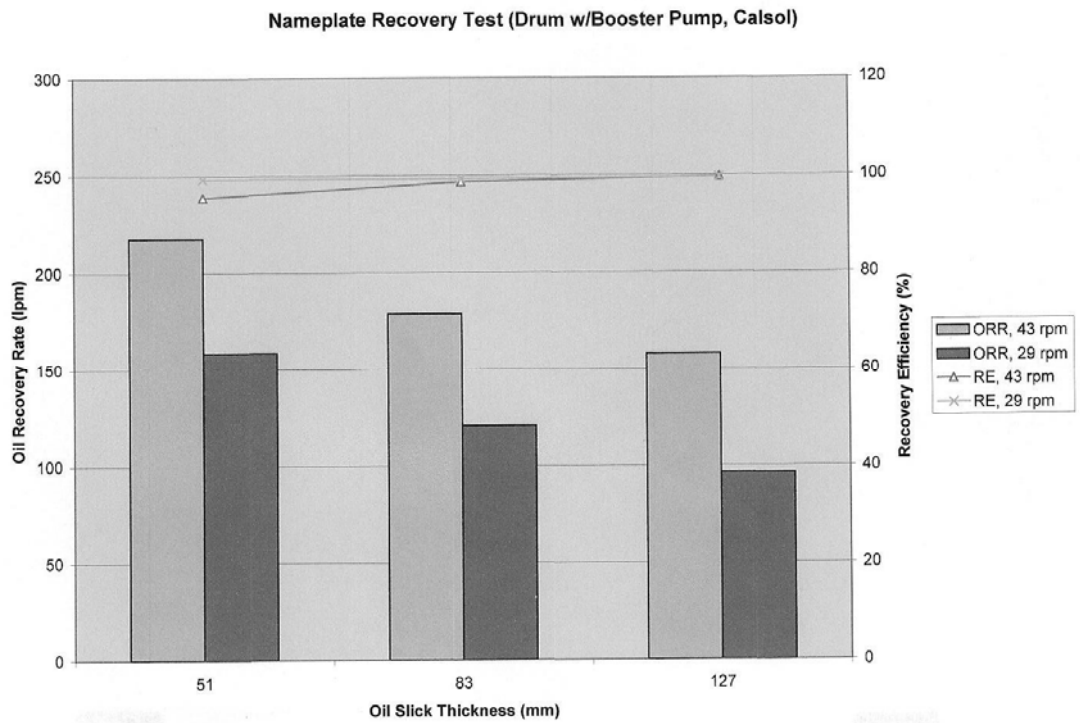


Figure 8 Oil Recovery Rate, Drum Skimmer with Booster Pump in Calsol

6.4 Discussion

The primary objective of the standard is to encourage testing using real oil to establish baseline performance values for skimming systems. The scope of the standard is intended to provide ideal recovery conditions, allowing the skimmer system to operate and collect oil at its maximum possible recovery rate.

The objective of the tests was to "try them out", varying independent test parameters and evaluating the methodologies for ease of performing and ability to achieve repeatable test results. The outcomes were quantitatively assessed in terms of ORR and RE. Repeatability was generally within the protocol's target of 20% for a three-test series and was impacted by the oil hold-up in the collection tank manifold. The evaluation of ease of implementation was purely qualitative by the participating engineers who, collectively, have over thirty years of hands-on test experience.

7 Conclusions

The MMS wanted the ASTM F-20 subcommittee on oil skimmers to have sufficient scientific data to reach a decision on which test to include in the new test protocol. In July and August 2007, three different skimmers (disc, drum, and weir) were tested in all-oil conditions (infinite slick thickness), as well as oil-on-water conditions. A primary difference was that in the latter condition, the disc and drum skimmers had to rotate through the oil/water interface. With the weir skimmer, the oil/water interface became significant in thin slicks of viscous oil. As the slick became thin, there were portions on the surface that had significant thickness of oil, perhaps as much as 25mm, while other portions of the tank had zero thickness (visible water surface). Despite oil being replenished in multiple locations (for a more consistent slick), a slick thickness gradient persisted within the test tank with the heavy oil, thin slick condition.

All three skimmers were able to pump the lightest oil, Hydrocal. While the weir skimmer could pump Sundex, the drum skimmer could not and it is doubtful that the disc skimmer would have been able to pump it as well. All three were able to pump Calsol, but the disc and drum skimmers had difficulty, so an in-line double-diaphragm pump was used to assist the skimmer's integral pump. Further experiments are needed to match test oil viscosity to each skimmer.

As expected, it was far easier to test with all-oil than with an oil/water interface. Getting an accurate oil slick thickness measurement became more difficult as viscosity increased, particularly if there was an oil slick thickness gradient within the tank. While the oil/water interface test more accurately models real-world conditions, the results indicate the presence of water beneath the 51mm (2 inch) thick oil slick did not significantly degrade the skimmer performance, with the exception of the drum skimmer in Hydrocal.

The data and results from the Ohmsett tests allowed the stakeholders to reach a consensus on a general test methodology and the draft protocol is currently being finalized and balloted as a new ASTM standard.

8 Acknowledgements

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