Ohmsett Test Review Document

Summary

Ohmsett is the National Oil Spill Response Research test facility in Leonardo, New Jersey, and is maintained and operated by the U.S. Department of Interior's Bureau of Safety and Environmental Enforcement (BSEE).

In 2012, EST's 12 m skimmer was tested at Ohmsett using Hydrocal 300 (200 cps) and Calsol (2000 cps) test oils. The goal was to test to failure in order to discover the practical limits of the technology. Throughput Efficiency (TE) rates of 94.4% @ 2 kts in calm conditions and 90.2% @ 1 kt in waves were achieved. Based on lessons learned, EST expects that future performce will be noticeably better, especially in waves. The Ohmsett Report detail reproduced below in Appendices 1-3 (scanned from the official Ohmsett Report) describes the test setup. The test oil was spread evenly in front of the vessel as it proceed down the tank, creating a path of oil approximately 150 m long x 2 m wide. In the above mentioned calm water test the oil slick was approximately 3.17 mm thick based on the fact that 950 litres of test oil was spread during the test. In the above mentioned wave test the oil slick was approximately 2.4 mm thick based on the fact that 713 litres of test oil was spread during the test.

Fig. 1 12 m EST vessel in Ohmsett test tank, Sept 2012

Appendix 1: Ohmsett Report Executive Summary

EXECUTIVE SUMMARY

Testing of the Extreme Spill Technology skimmer vessel.

During the time frame of 9/10/2012 and 9/14/2012, Extreme Spill Technology completed performance testing of their oil recovery skimmer. The skimmer system employs a unique technology which by design demonstrates benefits over other systems. The catamaran style vessel advances to encounter oil slicks and channels the oil between the integrated pontoons. The design utilizes a pumping system to create and maintain a vacuum within the oil collection tower which becomes water filled to an elevation significantly higher than the water line. Once oil reaches the vacuum tower (moon-pool), the oil rises into the water filled tower due to the differential in specific gravities. Oil remains captured and due to the residence time further gravity separation takes place which resultantly increases the recovery efficiency. The vessel's large surface area can be utilized for multiple purposes, it has onboard storage capabilities, allows the operator to visually observe collection and determine when to offload product. A second pump system is employed for the purpose of offloading product once a significant volume is collected.

A total of sixteen tests were performed in relative tow speeds ranging from 0.5 to 4.0 knots in calm and wave conditions and with two oil types. Tests one through nine were performed using Hydrocal 300 test oil with a nominal viscosity of 200 cps at 20c in calm conditions. It was learned during initial testing that a single pump system may perform both functions, create a vacuum to raise the water column into the tower and offload product. The potential to use one pump system may simplify the design and improve the efficiency. Tests ten through fourteen were performed using Hydrocal 300 test oil in two wave conditions. These tests were performed to document behavior of the skimmer in wave conditions. The analyses of the two wave conditions generated are provided within the data binder. Above and below water videos were recorded and logs provided within this binder providing correlation between test numbers and tape count. Additionally, still photos were obtained and documented by picture number to test number.

Test fifteen and sixteen were performed using Calsol test oil, nominal viscosity 2000 cps at 20c. These tests were performed to provide comparison to performance of tests with lower viscosity oil. Actual oil properties are provided in the analyses section of the binder.

The test procedure was as follows;

- A vacuum was established in the oil collection tower raising the water column to the top of the tower. The vacuum measured between 74 and 78 inches of water.
- In the presence of waves; the wave generator was started, a window of data collected prior to and after the run.
- The skimmer was accelerated to the predetermined advancing speed.
- Oil distribution began at a defined rate creating a slick in front of the skimmer.
- Once near the end of the test basin, oil distribution was stopped providing enough time for the skimmer to encounter the entire slick.
- When at test basin end, the system was decelerated to a stop.
- Once stopped, all the recovered oil was offloaded to the Ohmsett recovery tanks for measurement. Offloading continued until no oil was visible in the influent flow thereby evacuating the tower of all oil.
- The recovered fluid was allowed to gravity separate for a minimum of 30 minutes, free water was decanted from the collection tank, a sounding obtained to determine the volume and a representative sample obtained for BS&W analysis.

The actual volume of oil collected was calculated from the final sounding converted to volume then multiplied by the concentration of oil determined from analyzed samples by the laboratory (BS&W).

The primary quantified performance value generated for this test was Throughput Efficiency (TE); a measure of the volume of oil collected relative to the volume of oil encountered by the system. The results with the corresponding test parameters are presented in the "Data analysis" section within the data binder. Noteworthy are the 90+% TE values obtained at the 1.0, 1.5 and 2.0 knot advancing speeds in calm conditions.

Additional testing and evaluations were performed on an autonomous offload control system. Sensors located within the oil collection tower provide signals to initiate and end offload pumping. When fully functional will optimized recovery efficiency.

Appendix 2: Ohmsett Report Test Summary

EXTREME SPILL TECHNOLOGY 9/2012

Test Number	1			2		3		4		5		6		7	
Tow Speed (kts)	1.0			2.0		4.0		3.0		2.5		1.5		1.0	
Surface Condition	Calm			Calm		Calm		Calm		Calm		Calm		Calm	
Test Oil	Hydrocal			Hydrocal		Hydrocal		Hydrocal		Hydrocal		Hydrocal		Hydrocal	
Distribution rate(gpm)		100		70.00		100		100		100		100		75	
Collection Tank	8	1	5	7		6		5		4		3		7	8
Sounding (inches)	20.5	2.0	2.5	16.5		3.3		8.8	0.0	14.3		24.5	0.0	7.8	21.8
Volume of Fluid (gal)	118.9	11.6	14.5	95.7		19.1		50.8	0.0	82.7		142.1	0.0	45.0	126.2
BS&W of Collected Oil (%)	0.4	0.2	0.2	0.4		6.8		1.4	0.0	0.8		1.5	0.0	3.5	3.5
BS&W Initial(in test oil) (%)	1.4	1.4	1.4	1.4		1.4		1.4	0.0	1.4		1.4	0.0	1.4	1.4
Oil Volume / tank	118.4	11.6	14.5	95.3		18.1		50.8	0.0	82.0		142.0	0.0	44.0	123.5
Total Volume collected from surface (gal)	144.5			95.3		18.1		50.8		82.0		142.0		167.5	
Volume of Encountered Oil	225.0			106.0		77.0		92.0		111.0		175.0		183.0	
Volume of Oil Encountered (minus init H2o)	221.9			104.5		75.9		90.7		109.4		172.6		180.4	
Throughput Eff.(%)	65.1			91.2		23.8		55.9		74.9		82.3		92.8	

Wave Analysis (w/ equipment)	Test 10 - 4.5" stroke, 30 cpm	Test 11 - 8" stro
Wave Height (Ave H 1/3)	6.6 inches	10.3 inches
Apparent Average Wave Period	1.98	3.05
Average Wave Length	19.9ft	40.4 ft

8	9	10	11	12	13	14	15	16
1.5	2.0	1.0	2.0	1.5	0.5	0.5	1.0	2.0
Calm	Calm	Wave	Wave	Wave	Wave	Wave	Calm	Calm
Hydrocal	Hydrocal	Hydrocal	Hydrocal	Hydrocal	Hydrocal	Hydrocal	Calsol	Calsol
75	100	75	100	75	40	40	75	75
6	5	4	3	2	1	8	7	2
24.0	18.5	28.3	5.0	23.0	24.0	1.0	14.3	17.3
139.2	107.3	163.9	29.0	133.4	139.2	5.8	82.7	100.1
3.3	1.6	9.9	4.8	3.7	1.0	53.0	67.0	60.0
1.4	1.4	3.2	3.2	3.2	0.5	0.5	55.0	55.0
136.6	107.1	152.9	28.6	132.7	138.5	2.8	27.3	40.0
136.6	107.1	152.9	28.6	132.7	138.5	2.8	27.3	40.0
122.0	115.0	175.0	106.0	178.0	178.0	87.0	188.0	183.0
120.3	113.4	169.4	102.6	172.3	177.1	86.6	84.6	82.4
113.5	94.4	90.2	27.8	77.0	78.2	3.2	32.2	48.6
SEE NOTE								

, 20 cpm

NOTE: Calculated TE value exceeds 100%, possible contributing reasons include;

Residual oil in tower prior to test

Residual oil in cargo line prior to test

Oil trapped along bottom of hull from previous test

Appendix 3: Ohmsett Report Raw Data Sheets

Lab Analysis

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Recovered Oil Analysis: Lab Data Sheet

				BS&W		
Sample Description:	Sample #:	Date:	Tube #:	Water:	Solids:	SUM:
TEST 1 (TANK 8) HYDROCAL 300	516-01	9/13/12	1	0.2	0	0.4% H2O
		11:00	2	0.2	0	
TEST 1 (TANK 1) HYDROCAL 300	516-02	9/13/12	3	0.1	0	0.2% H2O
		11:00	4	0.1	0	
TEST 2 (TANK 7) HYDROCAL 300	516-03	9/13/12	5	0.2	0	0.4% H2O
		11:00	6	0.2	0	
TEST 3 (TANK 6) HYDROCAL 300	516-04	9/13/12	7	3.3	0	6.8% H2O
		11:00	8	3.5	0	
TEST 4 (TANK 5) HYDROCAL 300	516-05	9/13/12	1	0.7	0	1.4% H2O
		11:40	2	0.7	0	
TEST 5 (TANK 4) HYDROCAL 300	516-06	9/13/12	3	0.4	0	0.8% H2O
		11:40	4	0.4	0	
TEST 6 (TANK 3) HYDROCAL 300	516-07	9/13/12	5	0.6	0	1.4% H2O
		11:40	6	0.8	0	
TEST 6 (TANK 3) HYDROCAL 300 DUPLICATE	516-08	9/13/12	7	0.8	0	1.6% H2O
		11:40	8	0.8	0	
TEST 7 (TANK 8) HYDROCAL 300	516-09	9/14/12	1	1.6	0	3.5% H2O
		7:45	2	1.9	0	
TEST 8 (TANK 6) HYDROCAL 300	516-10	9/14/12	3	1.8	0	3.3% H2O
		7:45	4	1.5	0	
TEST 9 (TANK 5) HYDROCAL 300	516-11	9/14/12	5	0.7	0	1.6% H2O
		7:45	6	0.9	0	
TEST 10 (TANK 4) HYDROCAL 300	516-12	9/14/12	7	4.9	0	9.9% H2O
		7:45	8	5	0	

296F-516 EXTREME SPILL TECHNOLOGY

Recovered Oil Analysis: Lab Data Sheet

				BS&W		
Sample Description:	Sample #:	Date:	Tube #:	Water:	Solids:	SUM:
TEST 11 (TANK 3) HYDROCAL 300	516-13	9/17/12	1	1.8	0	4.5% H20
		7:45	2	2.7	0	
TEST 11 (TANK3) HYDROCAL 300 DUPLICATE	516-14	9/17/12	3	2.8	0	5% H20
		7:45	4	2.2	0	
TEST 12 (TANK 2) HYDROCAL 300	516-15	9/17/12	5	1.7	0	3.7% H20
		7:45	6	2	0	
TEST 13 (TANK 1) HYDROCAL 300	516-16	9/17/12	7	0.5	0	1% H20
		7:45	8	0.5	0	
TEST 14 (TANK 8) HYDROCAL 300	516-17	9/17/12	1	25	0	53% H20
		9:00	2	28	0	
TEST 15 (TANK 7) CALSOL	516-18	9/17/12	3	35	0	67% H20
		9:00	4	32	0	
TEST 16 (TANK 6) CALSOL	516-19	9/17/12	5	27	0	60% H20
		9:00	6	33	0	

296F-516 EXTREME SPILL TECHNOLOGY

MAIN BRIDGE PRE TEST OIL ANALYSIS

			BS&W			
SAMPLE DESCRIPTION:	**SAMPLE #:**	**DATE/TIME:**	**TUBE #:**	**WATER:**	**SOLIDS:**	**SUM:**
PRE-TEST 2 HYDROCAL 300 (9/12/2012, 13:07)	**MB-01**	9/17/2012 9:30:00 AM	1	0.7	0	1.4% H2O
			2	0.7	0	
PRE-TEST 5 HYDROCAL 300 (9/12/2012, 14:05)	**MB-02**	9/17/2012 9:30:00 AM	3	0.7	0	1.4% H2O
			4	0.7	0	
PRE-TEST 10 HYDROCAL 300 (9/13/2012)	**MB-03**	9/17/2012 9:30:00 AM	5	1.6	0	3.2% H2O
			6	1.6	0	
PRE-TEST 13 HYDROCAL 300 (9/12/2012,13:00)	**MB-04**	9/17/2012 9:30:00 AM	7	0.2	0	0.5% H2O
			8	0.3	0	
PRE-TEST 16 CALSOL (9/14/2012, 08:30)	**MB-05**	9/17/2012 10:00:00 AM	1	30	0	55% H2O
			2	25	0	

296F-516 EXTREME SPILL TECHNOLOGY

Oil Characterization Analysis: LAB

Sample Description:	Sample #	Date/Time:	INTERFACIAL TENSION	ρ @ Temp (g/ml @ C)	BS&W		
					Water	Solids	Sum
MAIN BRIDGE SAMPLE PRE TEST 5 (HYDROCAL 300)	M.B.516-02	9/20/2012 9:00	13.9 @22C	0.906 @22C	0.7	0	1.4% H2O
					0.7	0	
MAIN BRIDGE SAMPLE PRE TEST 16 (CALSOL)	M.B.516-05	9/20/2012 11:00	20.1 @22C	0.964 @21.9C	27	0	55% H2O
					28	0	

296F-516 EXTREME SPILL TECHNOLOGY

Tank Water (W) Analysis: Lab Data

Sample Description:	Sample #:	Date/Time:	ST (dynes/cm)	ρ @ Temp (g/ml @ C)	Salinity (ppt)	pH
PRE TEST #1 (TANK WATER SAMPLE FROM FILTER)	**W-01**	9/12/2012 14 30	70.8 @ 23.5°C	1.020 @ 24.2°C	26.6 @ 23.8°C	6.71 @ 22.9°C