Efficacy of manufactured wood shavings to mitigate marsh land impacts associated with deep water oil spills.

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Use of pine shaving to remove oil from seawater and sandy beaches during spill was evaluated. Two identical microcosms capable of simulating tidal waves were constructed. Shavings were applied in three different spill scenarios; 1): over clean sand before tide, 2): over contaminated sands after tide, and 3): over oil covered sands. Saudi Arabian sweet crude was used for this study. Shavings adsorbed significant amounts of oil in all three cases from oil contaminated water and sands. Shavings spread over the contaminated seawater surface contained the highest amount of oil adsorption from seawater and the least amount of sand contamination. This method of application seems to provide the most efficient and practical approach for quick removal of oil and spent shaving from seawater with minimal contamination of beaches or marshes. The high number of petroleum acclimated bacteria in seawater are able to biodegrade the leftover residual hydrocarbons.

Introduction

Wood shavings have been proposed as a mechanism for preventing environmental damage to marsh grasses and for absorbing oil from the deep water drilling operations. Initial questions associated with the use of wood shavings in this application is the composition of the shavings that would be added to tidal estuaries and would the addition have negative impacts on the food chain in the marshland. If there is not a detrimental impact on the marsh from the addition of shavings to protect marsh grasses, what would be the best management practices associated with application of shavings to 1) protect the soil in an area where oil contamination in eminent, 2) soak up floating oil, and 3) could shavings remove oil from contaminated soil.

This study was designed to collect preliminary data associated with using manufactured shavings as a method of protecting marsh grass and adsorbing oil found in inland bays. The study was designed to formulate initial or best management practices for three scenarios based on small scale tests that may need modification for wide area testing.

The first condition studied, was oil that was adjacent to marsh grass (Figure 1) with enough separation to allow for application of shavings that would sink to the bottom to provide a protective soil barrier. Shavings placed in water that do not contact oil sink but no studies have been done to see if they have the ability to form a protective soil barrier. The probability of success was unknown.

The second condition was represented by floating oil that had appeared in marsh areas behind booms and is adjacent to marsh grass as shown in Figure 1. In pre-study laboratory tests, shavings soaked up multiples of their own weight in used motor oil and once oil was adsorbed, the shavings floated for extended periods (up to 3 months). Therefore, it was believed that the probability of success for this treatment was high.

The third condition was contaminated soil with oil visibly sitting on top (land based). An evaluation of effectiveness of shavings absorbing oil in this condition was made. Figure 2 illustrates condition three at the bottom where there is contaminated soil. Shavings have shown the ability to absorb floating oil so it was believed that some of the oil on contaminated soil would also be removed. The probability of success was rated as high.

A tidal simulator capable of analyzing the three scenarios was constructed and used to study the feasibility of using manufactured shavings to reduce environmental impacts associated with deep water oil spills.

Material and Methods

Seawater was collected by pumping water into 50 gallon containers from Bay St.Louis in south Mississippi (Figure 3).

Southern yellow pine shavings were provided by Sunbelt Shavings in Shuqualak, Mississippi.

The shavings were cut on a Kimber 4488 Quad Head Log Shaver.

Twin identical microcosms to simulate tidal movement were built by cutting a 206 L drum into two identical 103 L test units connected to a seawater reservoir and drain systems (Figure 4). Twenty four Kg of clean sand was spread in the bottom of each unit. Twenty eight L of seawater and 106 g of shaving were used for each of the following tests. Nutrient agar (NA) was used to count for total bacterial population in seawater. The same media amended with 50mg/L of petroleum diesel estimated the petroleum acclimated bacteria (TNA). Dilution plate technique was used for bacterial counts. Fungal population was determined using potato dextrose agar amended with antibiotics (PDAA).

Test I: Shavings were spread over the clean sand in each unit. Seawater (30 L approximately) was allowed to enter into each unit slowly. Forty eight mL of Saudi Arabian crude oil was gently added on the surface of water while the remaining seawater was flowing over the sand covered with shavings. Samples were taken from contaminated water, sands, uncovered sands and wood shavings for total petroleum hydrocarbon (TPH) analysis after seawater was drained from the unit.

Test II: The test units containing sand were filled with seawater and 48 mL of crude oil was put on the water surface as illustrated in Figure 5. One hundred and six grams of shavings were spread over the water surface to adsorb spilled oils. Shaving and water samples were collected after one hour. Sand samples were taken after seawater was drained from the unit.

Test III: This test was performed the same as test II. The only difference was spreading shavings over oily sands after all water was removed from the unit. Shavings, water and sand samples were taken for TPH analysis from this test.

Results

Background seawater results tested by EPA methods for total petroleum hydrocarbons (TPH), salinity, total kjeldahl nitrogen (TKN), chemical oxygen demand (COD), total organic carbon (TOC), and pH are summarized in Table 1. These results showed normal concentration levels common to seawater with no higher than usual concentration of TOC and TPH common to oil spill. No background level of oil was also observed for clean sand and shavings in this study (Table 3). Microbial counts showed a good number of colonies per mL in which most of these colonies were tolerant/acclimated to oil (Table 2).

Total petroleum hydrocarbon (TPH) results for tests I, II, and III are summarized in Table 3. In test I shavings adsorbed most of oil from the surface water during tidal waves with little or no significant amount of oil left in water but some in uncovered, and covered sands,

In test II where shavings were spread over the water surface after spill, shavings adsorbed most of the oil with a much lower sand contamination than test I. However, more oil was recovered in water for this test than test I. Test III where shavings were spread over oil contaminated sands after drainage, shaving adsorbed significantly less oil than test II. Also, significant concentration of oil remained on the sand.

Conclusion

Shavings seem to adsorb significant amount of oil from oil contaminated water and sands. Shavings spread over the contaminated water surface would provide the most efficient and practical approach for quickly removing oil and spent shaving from seawater with minimal contamination of beaches or marshes. The high number of TPH acclimated bacteria in seawater should be able to breakdown the residual oil in the water(Hazen et al.,2010,Horel et al.,2012). While not as technically efficient as collecting oil from water, the use of shavings to prevent or reduce soil contamination from floating crude washing ashore holds promise and should be explored further as a means of reducing the long term impacts associated with the loss of marsh grasses.

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References

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Table 1: Concentrations for Salinity, Total Organic Carbon (TOC), TPH (diesel), pH, Chemical Oxygen Demand (COD), and Total Kjeldahl Nitrogen (TKN) on duplicate seawater samples collected

Sample ID*	Salinity	TOC	TPH	COD	TKN	pH
	SU	---------------------------------- mg/L ---------------------------------				
33385	36	7.5	<100	603	0.14	7.3
33386	36	7.4	<100	350	<0.1	7.7
Method **	2520B	415.1	8015M	8000	351.4	150.1

*Samples 33385 and 33386 are duplicates.

**The tests performed are in accordance with EPA methods for chemical analyses and/or standard methods 20th edition.

Table 2: Bacterial colonies recovered from seawater on selected media*

Microorganism	**Media used**	**Colonies/mL**
Total Fungi	PDAA	0
Total bacteria	NA	10,500
TPH acclimated bacteria	TNA	9500

*Each figure represents an average of three replications

Table3: Total Petroleum Hydrocarbons diesel (TPH) concentrations (ppm) for test I, II, and III of oil spill experiment*

Treatments	Matrices	Concentration (ppm)
Test I	Uncovered sand	68
Test I	Covered sand	1,550
Test I	Oily water	<100
Test I	Oily shaving	66,500
Test II	Oily water	1,100
Test II	Oily shaving	50,000
Test II	Oily sand	373
Test III	Oily water	1,500
Test III	Oily shaving	38,765
Test III	Oily sand	12784
Tests I, II& III	Clean shaving	<50
Tests I, II& III	Clean sand	<50

*EPA method 8015M

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Figure 1. Crude oil from a deep water spill adjacent to marsh grass.

Source: http://www.louisianasportsman.com/lpca/index.php?section=reports&event=view&action=full_report&id=78635&sid=9a888d71d4cbd22eed314cbe112f6400

Figure 2. Intertidal zone with oil contaminated soil at the bottom of the picture and floating in water at the top of the picture.

Source: Dr. Dan Seale

Figure 3. Collection of sea water from Bay of St. Louis in Mississippi.

Source: Dr. Dan Seale

Figure 4. Test 1, (top left) shavings applied over sand, (top right) shavings sink when contacted by water and the oil floats over the top, (bottom left) as the water is removed simulating tidal movement, the oil is deposited on the shavings, (bottom right) the sand is protected as a sample is collected for analysis.

Source: Dr. Dan Seale

Figure 5. Test 2, (top left) oil added to water over sand, (top right) shavings applied over the top of floating oil, (bottom left) shavings sit on the oil for an hour, (bottom right) samples are collected for analysis.

Source: Dr. Dan Seale

Figure 6. Test 3, (left) oil contaminated sand, (right) shavings applied over the top contaminated sand.