Oil-Spill Mitigation over Waterways- A New Approach

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Abstract: *Oil spillage in rivers, sea and ocean is very common and creates serious environmental problems. There are a number of ways available to tackle this problem. This study proposes few methods which are economically viable, chemical free, readily available around us and may be used to solve the problem of oil spills- A concept to have an automatic collection of oil through oil spill retention boats [OSRB] having innovative means of magnetism and polymer interaction, particularly for inland water navigation would be a novel exercise for Fresh water related pollution incidence, where zero tolerance is needed- as oil spill pollution of any kind has been a health risk factor and also a determinant for soil health ;if agrarian economy and demography habitat across Inland waterways or coastal waters are in perspective ..*

Keywords: Oil spillage, rivers, polymer, magnetite

1. INTRODUCTION

Oil spillage is the issue not only in the oceans but also found in the rivers and lakes. This is considered to be very serious particularly when we are going in the river navigation and inland water ways. Most of the time livelihood of mankind depends upon the rivers. With increase in inland water transport in India, there is going to be incremental possibility of oil-spillage issue in the rivers, lakes and inland water bodies. These point sources through floods, rainwater lead to pollution of seas as well.

It is very difficult to handle such issues with limited resources and non-availability of equipments. We are proposing few easier solutions to handle oil-spillage issues in the smaller areas such as rivers, canal and lakes. This paper described more practical approach to handle oil-spill issues with easily available materials than the theory.

2. EXPERIMENTAL

Following materials are used in the experiment.

The PVC polymer powder obtained from PVC door after grinding and filtering it out. Carbon black powder is obtained from tyre by grinding and filtering. Magnetite or small iron power collected from sand and from workshop. Cotton used for the experiment is absorbent cotton wool, I.P obtained from local market.

In the first experiment we used fine powder of PVC door. It usually contains polyvinyl chloride [1]. These materials repel water and get stuck to oil surface, which forms a semi-solid layer of oil and material over the water surface. After some time the whole slice of oil can easily be taken out from the water either by floats or simply be fisherman's net. Photographs below from 1 to 6 depict the oil collection by PVC powder.

Figure 1. Clean Water

Figure 2. Oil Layer With PVC Powder

Figure 3. Oil Layer Being Removed

Figure 4. Oil Slab Collected

Figure 5. Removing Oil Slab With Nylon Mesh

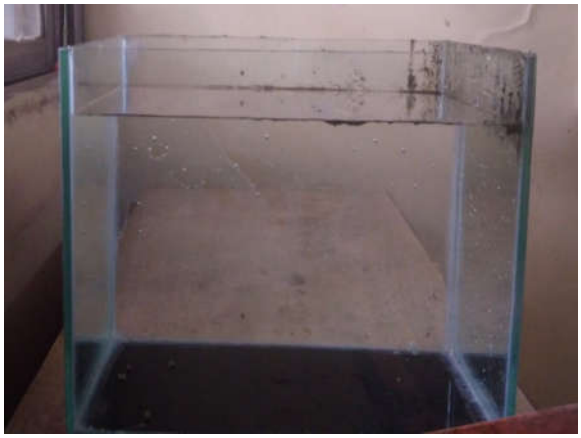


Figure 6. Oil Removed From Water

In the second experiment we used tyre material powder which is composed of natural rubber, synthetic rubber and carbon black [2]. Such powder spread over oil-spilled surface. After some time, it was observed that whole surface of oil became a semi-solid. Such semi-solid surface can easily be removed by floats or suitable material just to pull it out as shown in the following images, figures 7 to 11.

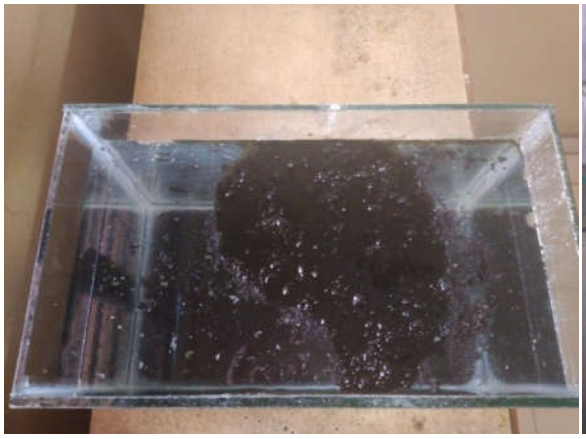


Figure 7.Carbon Black Over Oil Surface

Figure 8. Carbon Back Over Water

Figure 9. Carbon -Oil Being Removed

Figure 10. Oil Slab Removed From Water

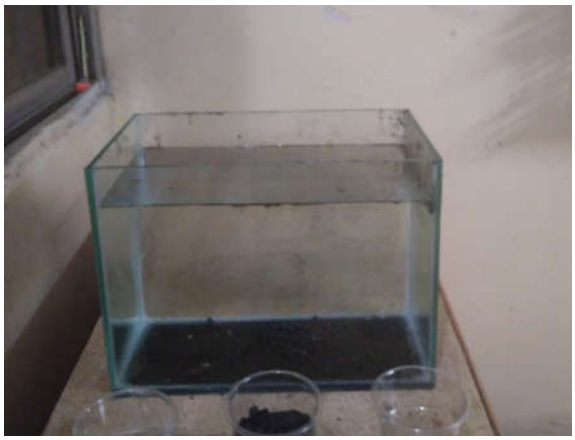


Figure 11.Oil Removed Completely.

One more experiment was performed with the combination of PVC powder and normal cotton. In this experiment, the PVC powder was poured on the oil surface, as it is demonstrated in Figures 1 to 6- we have spread cotton layer over the surface. The Cotton started absorbing water and oil along with PVC powder quickly; once absorbed fully, whole cotton soaked with oil and PVC powder reached at the bottom of the container, and settled at the bottom. This may be due to cotton becomes heavier and more dense due to absorption of water and oil-PVC powder combination. Here most of the oil gets absorbed and settled at the bottom of the container. This is illustrated in the Figures 12 to 17 below.

Figure 12. Clean Water

Figure 13. PVC Powder Over Oil surface

Figure 14. Cotton Over The Surface

Figure 15. Cotton And Mix Settling Down.

Figure 16. Oil Removed From The Bottom

Figure 17. Oil Removed Completely

These experiments also carried out at 10^0C to understand the other effect of lower temperature. But we did not observe any significant change. This is illustrated at Figures 18 to 22. This confirms that the methods proposed for oil spillage are effective at lower temperature also.

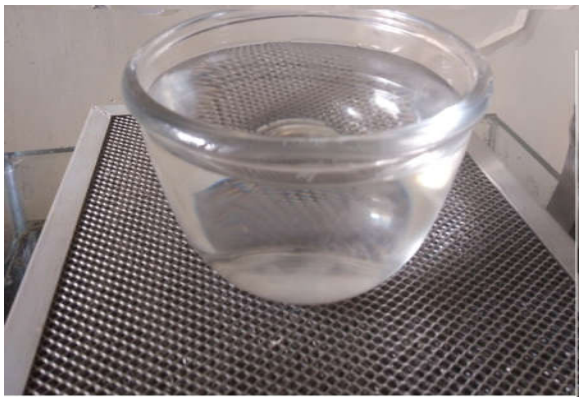


Figure18. Clean Water

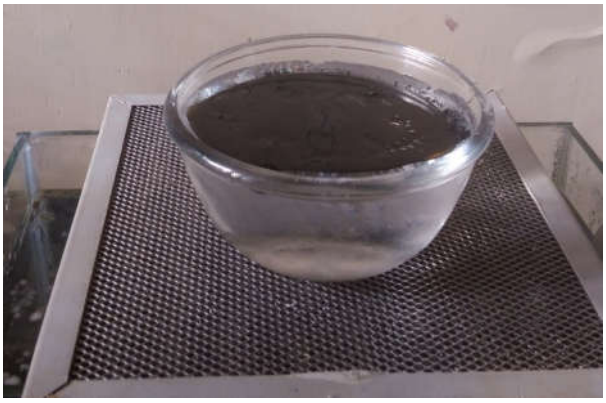


Figure19. Carbon Black over oil

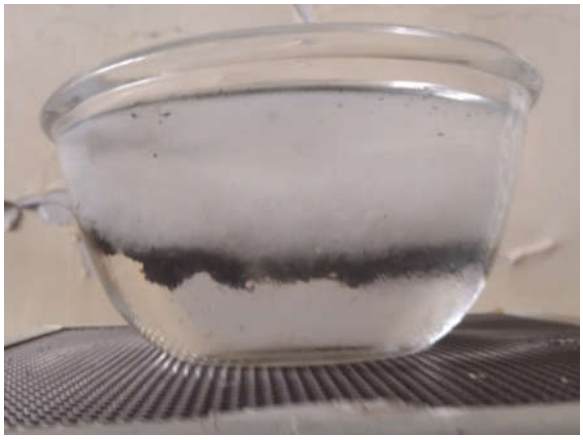


Figure 20. Cotton And Oil Setting At the Bottom

Figure 21. Oil Removed

Figure 22. Clean Water After Removing of Oil.

The fourth experiment is performed with strong neodymium magnets which are attached at the outer side of a boat's hull near the draft or at water level. Then it is experimented with spraying very fine magnetite particles; small iron particles over the oil surface as much as possible As these are very fine and lightweight, the tiny particles float on the oil surface and stick to oil. Then boat is brought in oil spill affected area. It is observed that most of the oil starts getting attracted towards the magnets which is attached to the boat's outer shell. This may be due to attraction of magnetite particles along with the oil surface towards the magnets and eventually oil gets pulled towards the boat and stuck to the outer surface near magnets.

Once magnetite-oil gathered around the boat then it is easy to scoop or pump the oil by some other devices and collect in the container or slop like tanks. The experimental images are shown in the Figure 23 to 26.

Figure 23. Boat With Magnet Attached.

Figure 24. Boat In Oil Affected Area

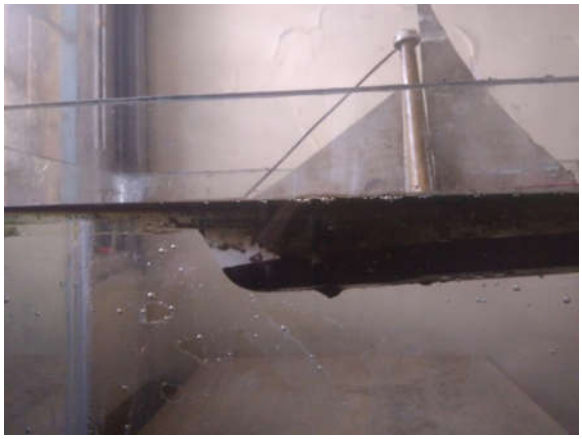


Figure 25. Magnetite over oil attracts to magnet. Figure 26. Magnetite and Oil Sticks to Magnet.

A new design is under preparation in which oil automatically gets collected through the pipes into a barrel already kept inside the boat.

3. OBSERVATIONS

The experimental results of oil recovered or removed by the above methods are tabulated in the Table 1 below.

Table 1. Record of Oil before spill and recovered by the above methods.

Sr.No	Method	Oil before spill	Approximate Oil recovered	% oil recovered
1	Magnet-Magnetite method	50 ml	32 ml	64
2.	Carbon black tyre powder-cotton	50 ml	40 ml	80
3.	PVC powder over oil	50 ml	45 ml	90
4.	PVC powder-cotton	50 ml	48 ml	96

Following figures confirms the experimental results for tyre powder, PVC powder and cotton combination.

Figure 27. 50 ml Oil in Beaker Before Spill

Figure 28. Cotton -Tyre Powder Pushes Oil Down

Figure 27 depicts 50 ml of oil taken for spill demonstration. Figure 28 shows how oil-black tyre powder setteing down to the bottom after addition of cotton. After some time whole mass of cotton-oil-tyre powder is taken out and squeezed into beaker to see how much amount of oil recovered. It is found that almost 96% oil spilled recovered from the water surface as it can be seen in Figure 29 below.

Figure 29. Oil Recovered in Beaker by Squeezing the Cotton, confirm maximum collection of Oil.

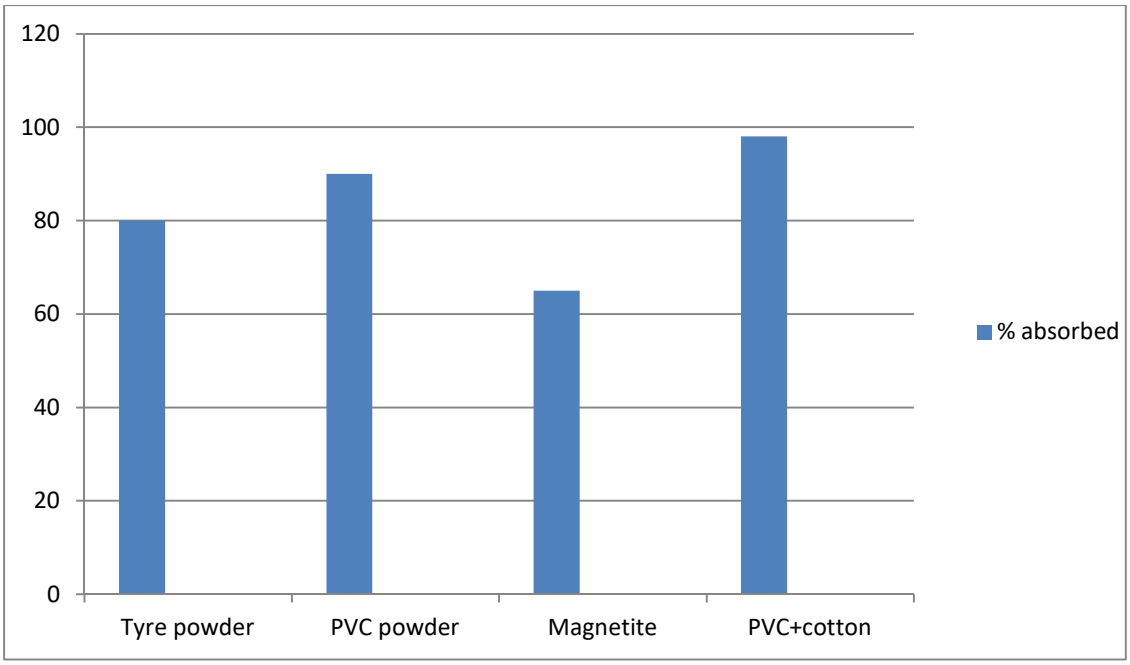
Figure 30 to 31 confirms amount of oil removed or recovered by the method of PVC powder-Cotton combination. It is observed from the figure 31 that almost 96% oil recovered after squeezing the cotton, leaving hardly any oil in the experimental glass tub.

Figure 30. Beaker showing 50 ml Oil before spill.

Figure 31. PVC-Cotton brings Oil Down.

Figure 31. Squeezed cotton releases absorbed oil in to beaker shows over 90 % removed.

All the experimental results are summarized graphically in the following bar graph. It manifests itself that experiment with PVC and cotton produced best results as it has absorbed almost 98% oil from the water surface.



4. RESULTS AND DISCUSSIONS

The result of the fourth experiment shows that the oil collection by magnets is such that the oil gets stuck to the outer surface of boat, but is not easy to remove completely from shell area. New design may help in solving this issue.

However, in previous experiments of PVC powder and tyre powder or carbon black power and after adding cotton layer into PVC powder, it has been very easy to pull out entire oil slab without any difficulty. Almost over 80 % oil can easily removed from the water.

The particles of PVC material and carbon black are derived from raw material of petroleum oil and hydrocarbon products [3][4]. Such particles are hydro-phobic in nature and therefore, forms some kind of bonding with oil surface and gets stuck to the oil molecules.

Detailed study is still required to confirm observation considering various parameters such as temperature, density and environmental conditions. It would be therefore necessary to study the effectiveness of the method for flowing water such as river, salt water and ponds etc. Extremely fine powder of the sample of PVC or Carbon black is essential to form polymeric structure of oil surface over water so that it can be easily and completely taken out from the water.

5. CONCLUSION

This study unlocks the pollution related problems across waterways and provides easier and economic solutions for marine pollutions as well as river and ponds. Pollution of oil contributes to reasonable quantification as a factor, not only as impediment to trade, supply chain, agrarian based economy; but also to the livelihood of fisherman community as the fish-haul/marine species gets affected. Moreover the human health of community which is entirely dependent on water gets a setback due to medical problems. All living beings could suffer due to waterborne chronic diseases that are deprived of knowledge and facilities and habituating across coastal belt may be ameliorated if zero tolerance is achieved against oil-spill related pollution over waterways.

Acknowledgements.

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