Proposal of Optimal Sorbent Use Through Natural Sorbent Research
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With frequent oil spills in today’s natural water bodies around the world, society is obligated to put forth strenuous efforts to remediate and restore what was harmed. There are up to 20-2000 tons of crude oil spilled into Baltic Sea alone (Paulauskienė, 2014) each year. Oil releases occur due to production, transport, energy source use, accidents, and illegal disposal (Dashti, 2015). Oil spilled into a marine environment is subject to many weathering processes such as, spreading, drifting, evaporation, dissolution, dispersion, photochemical oxidation, biodegradation, adsorption onto suspended materials, and formation of water-oil emulsions (Palauskiene 2014). Because weathering can be rapid and difficult to accommodate, application of fast-acting sorbents can contribute to significant maritime recovery. While it is crucial to emphasize the need for improvements in prevention of oil deposits, another common reaction is to remediate with sorbents specifically. A sorbent is a substance that has the property of collecting molecules of another substance by sorption. Sorption with sorbents is only one of many methods used to remediate harmed waters. The category of sorbents is broad and offers many types of remediation methods. Sorbents are categorized as being either synthetic, natural with chemical enhancements, and natural. My intention is to learn about natural sorbents because they are environmentally safe, cheap, and easy to create compared to synthetic sorbents. In order to propose further research that has not yet been done, one must have an understanding of existing research in the field.
The following researchers focus on the second two types of sorbents (natural and natural with chemical enhancements); some do not fail to observe all of them at some point in their experiments. Much of the work intends to discover information about natural sorbents and learn which ones were most effective and why. A successful sorbents has a low lignin/high cellulose concentration, optimal bulk density, cost effectiveness, buoyancy, and environmentally friendly characteristics (Palauskiene, 2014). From reading and learning the details about natural sorbents, further questions form after individual project analysis.

One of the natural sorbents studied by Dashti (2015) is olive pomace. Pomace is the pulp residue from when a fruit is crushed to extract juice. The idea here is to maximize the use of olives during their production and processing. The remaining olive skin and seed have potential to naturally absorb oil. Natural sorbents are rich in lignin and cellulose. In olive pomace, research showed that the lignin in the sorbent harbored communities of hydrocarbonoclastic bacteria. One of their major ideas concluded that olive pomace functioned as a functional sorbent, but also as a biological source of hydrocarbonoclastic bacteria based on consumed nitrogen (Dashti, 2015). A sorbent with this capability brings two means of reversing oil spill damage, to the advantage of this specific natural sorbent. The absorbency helps remove oil, while the bacteria helps break down harmful chemicals via bioremediation processes. Compared to other natural sorbents, olive pomace absorption takes place over a longer period of time. After an 8-month span, 44% of oil was absorbed within the lab experiment. Other popular natural sorbents function within an hour; there are pros and cons of each kind. Dashti (2015) also makes a point that synthetic (polypropylene) remediates work thoroughly, but are not
biodegradable, and physical dispersants are flammable. There is no doubt that natural sorbents offer attributes of sustainability. As long as they are not pretreated, the natural sorbents can harbor unwanted oils for disposal and then biodegrade.

Another closely studied natural sorbent is rice husk. Rice husk differs from olive pomace because it is cheaper and easier harvest. Wang (2015) focuses on the differences in natural sorbent function, acetylated or natural. Acetylated rice husks outperform non-acetylated husks because the chemical addition alters the composition of the husk. Normally, rice husk is made of 25-35% cellulose, which is fine, but for maximized function delignification must take place. Chemical pretreatments were placed on husks to cause delignification and increase oleophilic trends and hydrophobic capacity. The acetylation chemicals can react with hydroxyl groups and improve water repellence of cellulose. Changing the sorbent to match this process makes it more marketable because it traps oil quicker and absorbs oil with less reaction time. It is ironic that chemical treatments are used to improve sorbent function when pretreatments cause other harmful environmental issues. Fortunately, biological methods were also tested to reveal they are an environmentally sound way of increasing absorption, although this is less effective than using chemical treatments. Biological treatments reduced lignin 50.65%, while chemical treatments reduced lignin by 70.31% (Wang, 2015). In the end, both methods somehow help to make rice husk a desirable product.

Coir was found to be another successful sorbent based on research of biomaterials. Teli (2015) gains insight (like the rice husk research) about how modifying lignocellulosic materials can improve its performance by changing the basic chemistry of the cell wall polymers (Teli, 2015). Coir is fiber found on the outside husk of a coconut,
and was studied because of its biodegradable, environment-friendly, and inexpensive nature. The experiment observed the function of the coir as a sorbent with chemical changes from oleic acid and sulfuric acid to name a few. The chemical treatment (acetylation) once again relayed hydrophobic properties into the fiber. Coir’s affinity for oil and not water makes it a suitable sorbent material.

Natural sorbents include almost any organic product that has the ability to absorb oil. Particular plant remnants are used more than others due to their standout qualities. Palauskiene (2015) observed a variety of popular natural sorbents in order to compare their strengths and weaknesses. The purpose of this research transitions to its application in the market. Peat, wool, moss and straw were used as variables. This study proved that wool carried the maximum sorption capacity with crude oil, and peat was the best for diesel fuel (Palauskiene, 2015). The study did not focus on why these differences exist. Even though wool and peat have the highest absorbance in specific oil types, the straw-peat (25-75%) combination is the recommended composite for spilled oil cleanup because of its ability to maximize the absorbance of both crude oil and diesel. A caveat of this composite warns to use the sorbent for no longer than 60 minutes. As water sorption intensifies, the composite would sink to no avail. This study helped reveal that there are very specific adjustments to be made for the optimization of a sorbent’s function. Natural sorbents function well to an extent, but being able to better understand the sorption could maximize its activity and narrow the knowledge gap between synthetic and natural sorbents.

Searching for the best features in natural sorbents was the main inspiration behind Palauskiene’s previous research project (2014). This time, sawdust was included in the
study. The focus behind Palauskiene’s (2014) research looked for the best sorbent to be used in the Lithuanian Baltic Sea coastline and the Curonian lagoon (Palauskiene 2014). The results discuss details about bulk densities, sorption capacities and salinity of the water being absorbed. They also compare the sorption capacity to synthetic sorbents and compare its value to the lower competitors. Straw holds the next highest bulk density at 15% lower than the synthetic (Palauskiene 2014). Similar results occurred in 2014 as they did in 2015; peat had the maximum sorption capacity for diesel, while wool had the highest for crude oil. It would seem logical that the less dense the sorbent, the higher the sorption capacity. The results indicate that bulk density is only one of many parameters affecting the overall sorption capacity, such as sorbent surface area, oleophilic properties, hydrophobicity ratio, and buoyancy (Palauskiene 2014). For example, wool has beneficial buoyancy properties, so mixing with peat maximizes its function. Not only is it crucial to observe the absorbance of oil, but also absorbance of water. A sorbent resistant to water will outperform a sorbent lacking hydrophobicity. As another example, peat and moss have weak hydrophobic properties; their water sorption abilities will interfere with oil sorption causing it to sink easily. This is a case when sawdust may join composite like wool to blend their individual strengths into one treatment.

The previous research modified and reformed the practices of oil spill remediation. For the most part the products are environmentally healthy. The purpose of the research was to evaluate characteristics of the natural products and learn how to optimize their use, whether that includes mixing or enhancing with chemicals. While a multitude of questions were answered, further questioning persists. The knowledge
learned by researchers give the ability to ask questions and address research topics that would have been difficult to solve before.

After familiarizing with the characteristics, pros, and cons of natural sorbents, many questions remain about what negative impacts they could instill. Natural sorbents are biodegradable, but to what extent will that benefit surpass the function of synthetic sorbents? Is all the effort to perfectly blend and modify sorbents in vain if its function cannot keep up with its synthetic competitors? The disposal of natural sorbents is less challenging, but if the function of other sorbents greatly surpasses, will the benefit of cleaner waters outweigh the sustainability factor? Some sorbents have weak hydrophobic properties; can too much absorption of water be harmful for the marine ecosystem? Surely, there is potential to absorb large amounts of water and microorganisms that are necessary for aquatic life. Are there constituents like cations, minerals, and organisms being absorbed that are necessary to remain in the water? Does this removal even make a difference? Also, the risks of emulsification require heavy monitoring to prevent sinking. If absorbed oil sinks, new challenges are created that could have easily been avoided.

While learning about information, it is essential to question what is being stated, along with what is not being stated.

I would propose to research the effect of water (and all that is in the water) removal and observe differences in the ecosystem, perhaps on a small laboratory scale. It would also be interesting to research the harms of disposing polypropylene sorbents and compare that to its heightened performance of oil removal. Current methods further pollute water and air. Any recovered oil in natural sorbents still generates a hefty amount of solid and liquid waste, in the form of tons of soiled boom. This recovered oil is treated
as industrial waste and buried in designated dumps (Teli). Looking into long term affects of synthetic sorbents verses natural ones could reveal prioritization of environmental protection. Prioritization should go to either sustainability or haste of oil spill remediation (marine health). This requires further research of ocean ecosystems, and environmental impacts of hazardous waste. I would like to examine opposing sides of the previous research by hypothesizing that it is more environmentally sound to utilize synthetic sorbents for reasons of functionality. At this point with current scientific abilities, almost all methods of environmental work will have some negative impacts. The challenge becomes, how can we optimize those practices to leave the smallest footprint? The attempt to solve this balance issue would sustain the new research.
Research Citations:


Notes:

5-8 pages
Known-unknown-challenge-action-assessment
Formulate a hypothesis that is falsifiable-can be tested
Focus on use of literature and reasoning, strong scientific argument
Don’t be wordy, concise, including all key points of literature