Comparative analyze of different kinds of sorbents for cleaning water surfaces from oil spills: evaluation of environmental and economical benefits

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Using of sorbents is one of the most effective methods for oil and petroleum spills cleanup operations, because of its high cleaning degree (more than 99%). Another advantage of sorbents is that they does not contaminate environment, like chemical or thermal methods. Sorbents used as main method for cleanup of small spills or for final cleanup of large spills.

Sorbents can be synthetic materials such as plastic, organic materials such as peat moss, or inorganic materials such as clay. The main demands to them are:

1. High sorption capacities;
2. Oleophilic (oil-attracting) and hydrophobic (water-repelling) settings - the ability of the material to preferentially absorb oil rather than water.
3. Ability for regeneration and reuse;
4. Simple technology for spreading on spill surface and extracting of saturated sorbent;
5. Low cost.

The aim of present work was to investigate sorption capacities of different kinds of sorbents that are commonly used during oil spills cleanup operations in Ukraine.

The next five types of sorbents were investigated:

6. Activated fossil carbon;
7. Exfoliated graphite. Exfoliated graphite is preparing from thin graphite flakes by oxidation with sulphuric acid and thermal treatment at temperatures of 800 – 1200 °C.
8. Expanded perlite. Perlite is the name of class of natural silicate rocks that has volcanic origin. During fast heating at 900 – 1100 °C its increase his volume 20 times and transform into white porous granules with size of 1 – 10 mm and density 75 – 150 kg/m^3. Expanded perlite has a high porosity which increases sorption capacity. To increase sorption selectiveness perlite additionally treated with polysilicone.
9. "Ecolan". This sorbent belongs to biodegradable sorbents. Prepared from pyrolized wood it localizes oil spills and destroy adsorbed oil with microorganisms which use hydrocarbons as source of energy.
10. Polypropylene. This sorbent belongs to synthetic sorbents and created from polypropylene sheets. The distinction from other sorbents is that porous and capillary structure represented by chemical fibers.

During investigations two different types of oil transported through the territory of Ukraine by oil pipelines "Druzhba" were involved:

- Caspian CTC (Caspian Transport Consortium) – this oil transported from countries of Caspian region and belongs to light oils with high content of volatile compounds, has petroleum odour and yellow-brown colour;
- Russian URALS (United Russian Oils) – this oil transported from Western Siberia region and belongs to heavy oils with significant content of non-volatile compounds, has dark-brown colour.

The results of investigations represented in table 1.

Table 1

Sorbent type	Sorption capacity of URALS, kg/kg	Sorption capacity of CTC, kg/kg
Exfoliated graphite	***22,71***	***20,75***
"Ecolan"	***1,76***	***1,63***
Activated fossil carbon	***1,0***	***1,2***
Expanded perlite	***3,8***	***2,9***
Polypropylene	***12,12***	***11,33***

We can see that the best sorption capacity has exfoliated graphite and polypropylene. Moreover, they have quite high potential for recovering and reuse, especially in case of polypropylene. Oil can be extracted by simple pressing without considerable loosing of sorption capacities and changes in oil composition.

From ***economical point of view*** sorbents implementation can bring significantly reduce amounts of payment that should be paid for oil and petroleum contamination. According to Ukrainian legislation for every kilogram of oil spilled on water surface should be paid **329 USD.** To calculate economical benefit we have compare sorbents expenditures for extracting one ton of spilled oil with payments for contamination. The results are listed in table 2.

Table 2

Sorbent type	Sorption capacity, kg/kg	Price, USD/kg	Expenditures for collection 1 ton of oil, USD	Payments for 1 ton of spilled oil, USD
Exfoliated graphite	***22,71***	***12***	***528***	***329 000***
"Ecolan"	***1,76***	***2,05***	***1 164***	
Activated fossil carbon	***1,0***	***1,4***	***1 400***	
Expanded perlite	***3,8***	***0,57***	***150***	
Polypropylene	***12,12***	***15***	***1 237***	

So, we can consider that sorbents implementation is profitable not only from environmental but also from economical side. In case of polypropylene and exfoliated graphite additional benefit can be obtained from oil extracting. Extracted oil can be used in the same way that origin one.