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INVESTIGATIONS OF COMPOSTS AS A POTENTIAL SORBENTS OF ALIPHATIC HYDROCARBONS

BADANIA KOMPOSTÓW JAKO POTENCJALNYCH SORBENTÓW WĘGLOWODORÓW ALIFATYCZNYCH

Abstract: Products from crude oil processing are widely used in industry and are used as lubricants and fuels in motor vehicles. Due to the pipeline failure, lost of substances on the loading stations area and traffic crashes, petroleum products moves to different components of environment. The high costs of removal of oil spills to the soil and ground, forces to search for low-cost and effective methods which can reduce spread of these substances. There are professional sorbents on the market for quick and effective removal petroleum products from ground or water surfaces. The aim of this work was test of two composts and two commercial sorbents. Tests were carried with aliphatic hydrocarbons (heptane, octane and decane) by capillary rise method. Best results were obtained for organic commercial sorbent, worst results were noted for composts with natural humidity and mineral sorbent - mostly used in rescue practices. Obtained results show the real possibility of use composts as cheap petroleum derivatives sorbents.

Keywords: compost, sorption, sorbents, aliphatic hydrocarbons

Introduction

Crude oil products are widely used in industry, and are used as lubricants and fuels in motor vehicles. Due to the pipeline failure, the movement of these substances on the loading stations and traffic crash land, oil products penetrate the various components of the environment. The high costs of liquidation of consequences of oil spills to the soil and ground forces to search for low-cost and effective methods of limiting the spread of these substances. In common use there are sorbents so that a fast way to remove organic liquids from the surface of the land or water [1-3]. In case of organics removal from air stream, organic wastes could be used [4]. In case of manufactured sorbents a lot of primary energy and new raw materials are use - so this is usually much more expensive and environmentally and ethic discussible [5-7]. Using compost derived from municipal waste as a sorbent has numerous advantages: compost is a product that is almost spontaneously created from mixed municipal waste, or can be made from separated biodegradable fraction of municipal waste. Compost is biologically active, and acts to support the natural processes of decomposition organic compounds after use as sorbent. In this study two types of municipal waste composts and two commercial sorbents in order to determine their suitability for the sorption of hydrocarbon chain were tested.

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Material and methods

In this work the wettability of compost from municipal waste and commercial sorbents was tested. Compost K - made of mixed municipal waste, compost Z - made of biodegradable fraction of municipal waste. Commercial organic sorbent (PS) and mineral (ED) have been used as reference sample. Wettability by aliphatic hydrocarbons with chain length C7, C8 and C10, using capillary lift method was tested. Absorbents in an amount of 20 g (8 g in case of PS) filled up to a glass cylinder, and were immersed in the test vessel with the organic liquid. The mass readings started during the start of immersion. Mass of organic liquid in the vessel using the PW-WIN computer program was recorded. The measuring time was 300 s. In this study it was determined the total amount of absorbed fluid and the height of liquid lift. All tested organic liquids were tested separately each on new portion of particular sorbents in duplicates.

Results and discussion

Investigated composts had different chemical composition. One of the most important parameter is organic matter content in tested samples (Table 1). The highest organic matter content has PS sorbent made from peat - over 98.7%. The lowest observed value - according to expected ED sorbent - under 1%. Investigated composts: K and Z had respectively 48.16 and 33.4% of organics, is typical values for these materials made of biodegradable wastes.

Table 1

Characteristic of sorbents used in experiments

| Parameter | ED | PS | K | Z |
|------------------------------|------------|------------|------------|-----------|
| Organic [%] | 0.87±0.01 | 98.73±0.13 | 48.16±4.18 | 33.4±1.38 |
| TOC [% d.m.] | <0.5 | 95.7±0.28 | 24.9±4.1 | 21.4±6.2 |
| pH in H ₂ O | 6.16±0.03 | 3.85±0.02 | 7.95±0.06 | 7.85±0.01 |
| EC [mS/cm] | 0.709±0.11 | 0.09±0.01 | 3.02±0.38 | 1.14±0.08 |
| Gravity [g/dm ³] | 421.8±6.1 | 93.7±3.7 | 185.2±9.6 | 196.4±7.3 |

Table 2

Granulometric composition of investigated sorbents

| Grain size [mm] | ED | PS | K | Z |
|-----------------|------|------|------|------|
| > 4 | 0.0 | 0.4 | 34.8 | 27.4 |
| > 2 | 43.6 | 15.0 | 12.5 | 11.8 |
| > 1 | 54.7 | 10.6 | 20.0 | 18.6 |
| > 0.5 | 1.70 | 17.2 | 13.9 | 11.9 |
| > 0.25 | 0.07 | 22.7 | 16.9 | 19.7 |
| > 0.1 | 0.01 | 20.0 | 5.2 | 8.2 |
| < 0.1 | 0.01 | 9.16 | 1.5 | 2.4 |

Also granulometric composition of tested sorbents (Table 2) was different. Especially high content of fine fraction (< 0.1 mm) was found in organic sorbent PS. Also compost K has characteristic composition with almost 35% content over 4 mm. Granulometric composition suggest that sorbent PS with the fine particles could have the best sorption

properties, however composts K and Z with high organic matter content also could be suitable for organic liquids sorption.

Table 3

Capillary rise of aliphatic hydrocarbons for tested materials [m]

| | ED | PS | K | Z |
|-----|-------|-------|-------|-------|
| C7 | 0.020 | 0.070 | 0.038 | 0.047 |
| C8 | 0.020 | 0.070 | 0.045 | 0.046 |
| C10 | 0.020 | 0.066 | 0.035 | 0.050 |

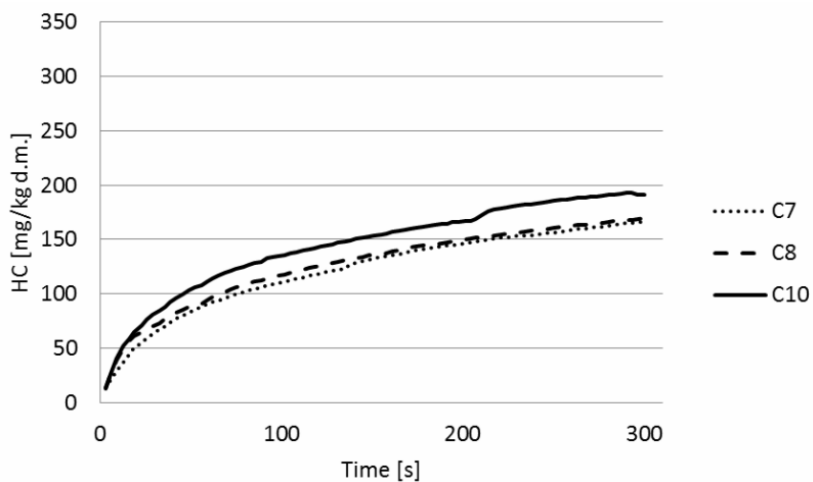


Fig. 1. Capillary rise of aliphatic HC on sorbent EC

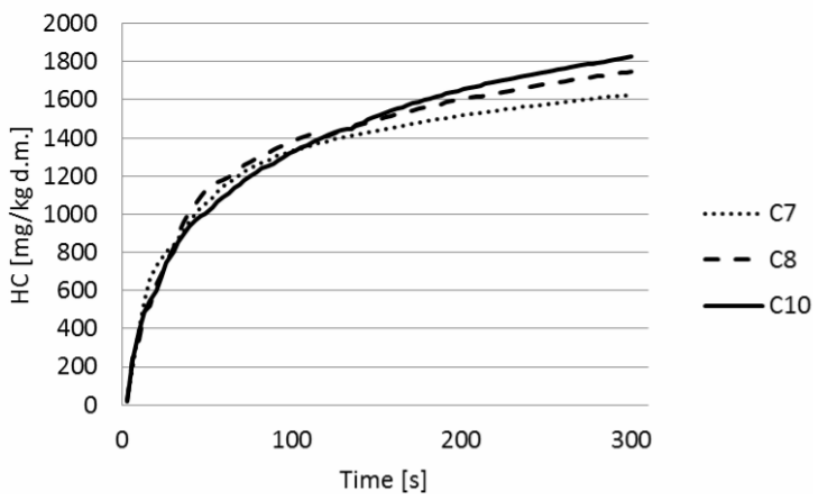


Fig. 2. Capillary rise of aliphatic HC on sorbent PS

The capillary rise of investigated hydrocarbons was different in all tested materials (Table 3). The lowest height was reached by ED commercial sorbent - 0.02 m for all organic liquids. In case of PS sorbent 0.07 m for C7 and C8 and close value for C10. Intermediate values were noted for both tested composts - from 0.035 to 0.05 m confirm good wettability of dry materials. Dynamics of capillary rise of investigated liquids was different for PS and similar for rest tested materials (Figs. 1-4). The worst results - over 125 g/kg d.m. were obtained for decane on compost K material the best - over 1825 g/kg d.m. also for decane on PS sorbent and much better than data obtained for these sorbents used for sorption of n-alkanes from water solution [8].

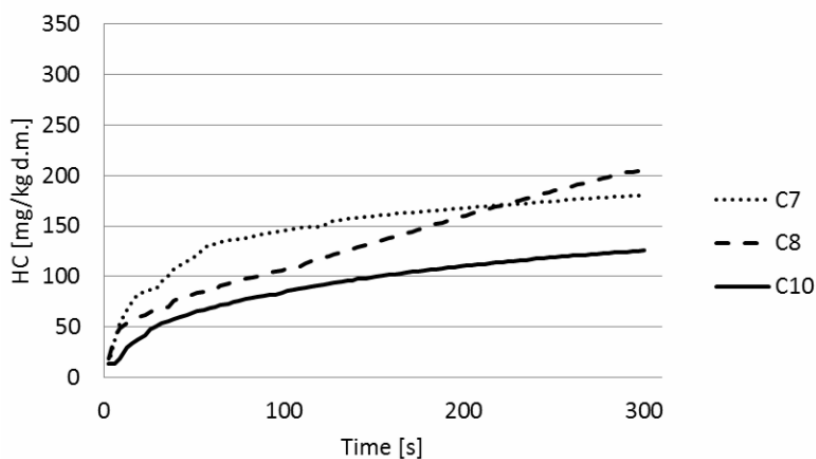


Fig. 3. Capillary rise of aliphatic HC on compost K

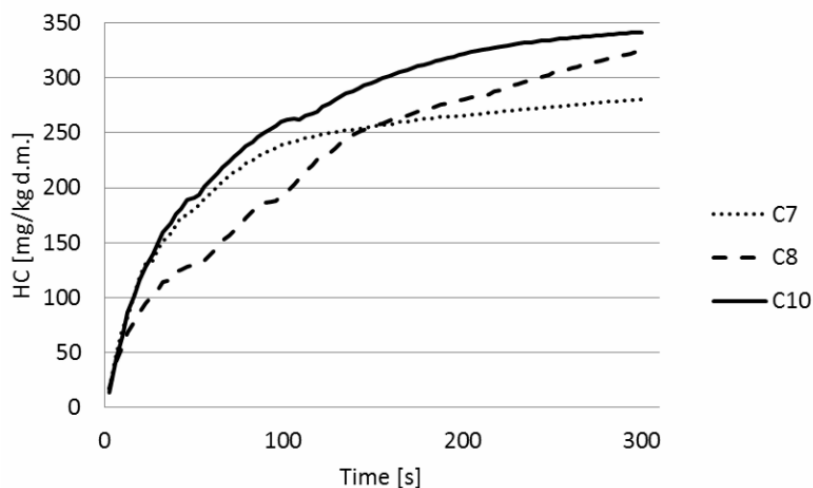


Fig. 4. Capillary rise of aliphatic HC on compost Z

Best sorption results (over 5 times better sorption capacity than tested compost) obtained for organic sorbent show only raw data. But from environmental point of view it is better to use compost made from municipal wastes than this sorbent made from peat. Moreover organic commercial sorbent is about 100 times more expensive than tested composts.

Conclusion

All tested materials were sorbet organic liquids. The best results were obtained for a commercial hydrocarbons sorbent material PS. This was the result of a significant proportion of fine particles and significant organic matter content. Obtained results for compost Z also were good. The best results (more than 340 g/kg d.m.) were obtained in case of this material for decane. Poorer results were obtained for compost K, which, despite considerable content of organic matter sorbet only 205 g/kg d.m. The worst results were obtained for the ED mineral sorbent (190 g/kg d.m. and only 0.02 m of HC liquid rise) as a result of the grain size composition of the tested material. Tested composts can be a cheap and environmentally friendly alternative to commercial hydrocarbons sorbents.

Acknowledgments

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BADANIA KOMPOSTÓW JAKO POTENCJALNYCH SORBENTÓW WĘGLOWODORÓW ALIFATYCZNYCH

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Abstrakt: Produkty przeróbki ropy naftowej znajdują szerokie zastosowanie w przemyśle, a także są wykorzystywane jako środki smarne i pędne w pojazdach mechanicznych. Z uwagi na rozszczenia sieci przesyłowych, obrót tymi substancjami na stacjach przeładunkowych, a także katastrofy w ruchu lądowym produkty ropopochodne przenikają do różnych komponentów środowiska. Wysokie koszty likwidacji skutków wycieków ropopochodnych do gleb i gruntu zmuszają do poszukiwania tanich i efektywnych metod ograniczających rozprzestrzenianie się tych substancji. W powszechnym użyciu znajdują się sorbenty, dzięki którym w szybki sposób można usuwać ciecze organiczne z powierzchni ładu czy wody. W pracy testowano sorbenty i komposty z odpadów w celu określenia ich przydatności do sorpcji węglowodorów łańcuchowych. Zastosowano dwa rodzaje kompostów oraz dwa sorbenty komercyjne. Badano zwilżalność testowanych materiałów węglowodorami alifatycznymi o długości łańcucha C7, C8 i C10 metodą wzniosu kapilarnego. Najlepsze rezultaty osiągnięto dla organicznego sorbentu komercyjnego, najgorsze zaś dla kompostów o naturalnej wilgotności oraz komercyjnego sorbentu mineralnego. Uzyskane wyniki wskazują na możliwość zastosowania kompostów jako tanich sorbentów substancji ropopochodnych.

Słowa kluczowe: komposty, sorpcja, sorbenty, węglowodory alifatyczne