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LABORATORY STUDY OF EFFECTIVENESS OF SORBENTS INTENDED FOR OIL SPILL COMBATING

Włodzimierz Kończewicz, Natalia Walaszkowska, Dawid Lachowicz, Zbigniew Otremba

Gdynia Maritime University
Faculty of Marine Engineering, Department of Physics
Morska Street 81-87, 81-225 Gdynia, Poland
tel.:+48 58 6901504, fax: +48 58 6206701
e-mail: zotremba@am.gdynia.pl

Abstract

While various floating objects driven by combustion engines are exploited, unintentional oil spill might be done (caused by fuel, lubricant or gear leaks). So arisen undesirable pollution is usually removed from water environment using various types of booms, pumps and skimmers as well as by various oil-sorption materials. Sometimes oil spills are dispersed into bulk of water (only in water-areas that are rich with oil-consumption bacteria). The reason for undertaking investigations described in this paper was a real problem with oil pollution in narrow spaces of port and shipyard basins, marines and inland shipping routes. The paper describes study on sorptivity of chosen materials proposed as measures to combat oil spills on the water surface. Natural, synthetic and mineral materials were investigated at laboratory conditions, which was based on contacting those materials with, on the one hand, only water and – on the second hand – with oil in two ways, namely: with oil only and with oil as a film on the water surface. The authors presents in graphical form dependencies of sorptivity on a type of sorbent and on the time. In addition, air temperature, oxygen content in the water, density and viscosity oil are registered. The data obtained from the measurements play a role input data to establish procedure for usefulness of defines sorbent-materials in define conditions of application.

Keywords: *fuels, lubricant oil, maritime engineering, environmental protection*

1. Introduction

A numerous materials have been used to remove various oil substances from both hard substrates and from water surface. Following examples may be mentioned: polyester, polyethylene, polyprophylene, polyuretane (synthetic), peat moss, straw, vegetable fibre, bird, feathers, bark or wood fibre (natural organic), clay, pearylite, vermiculite (natural inorganic, mineral). Sorbents are material that incepted oil through either absorption or adsorption and can be of natural or synthetic origin.

Various types of sorbents were tested and descriptive data were published [1-5] but there are still low number of effective tests for parametrically express usefulness of defines sorbent during oil spills removing process.

This paper consists of report of laboratory tests on sorptivity of mineral, synthetic and natural sorbents, made within the Student Scientific Society „Nautica“ (at Faculty of Marine Engineering of the Gdynia Maritime University).

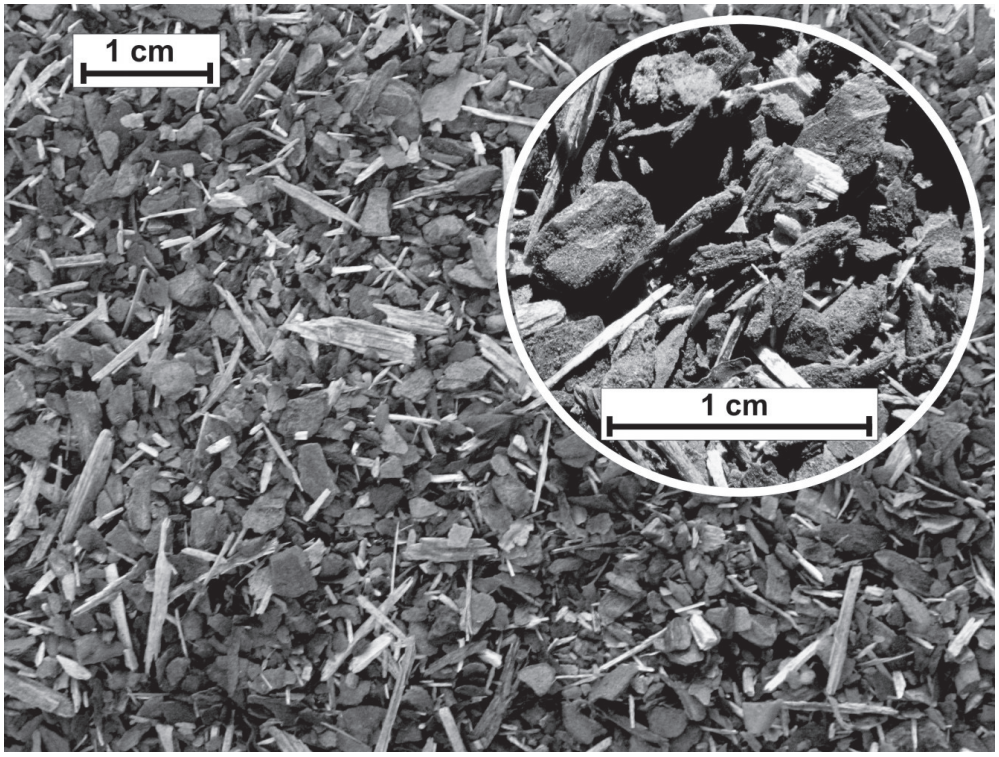
2. Material and methods

There were four types of sorbent used, namely two organic: *Ecobark* (bark) and *Spill-Sorb* (peat), mineral – *Wermikulit* and synthetic – nonwoven *WS 0.50/50* (used as sheets). The experiment consisted of tracking of absorption of oil by the sorbent lying separately: on the surface of oil and on the surface of water. Two types of oil were used, namely: lubricate oil *Marinol RG 1240* (previously used in vessel engine 3 AL 25/30) and fuel oil *Eurodiesel – winter version*. Tests

were carried out in transparent containers, cube box like, made of plexiglass with a side of dimensions 100×100×100 mm. Every test was prepared in three containers to analyse results after three different times of contact of absorbent with defined liquid (lubricant, fuel, water).

Figure 1 presents enlarged photos of studied sorbents. The nonwoven was used in the form of quadratic sheets (side dimension 100 mm).

Ecobark



Spill-Sorb

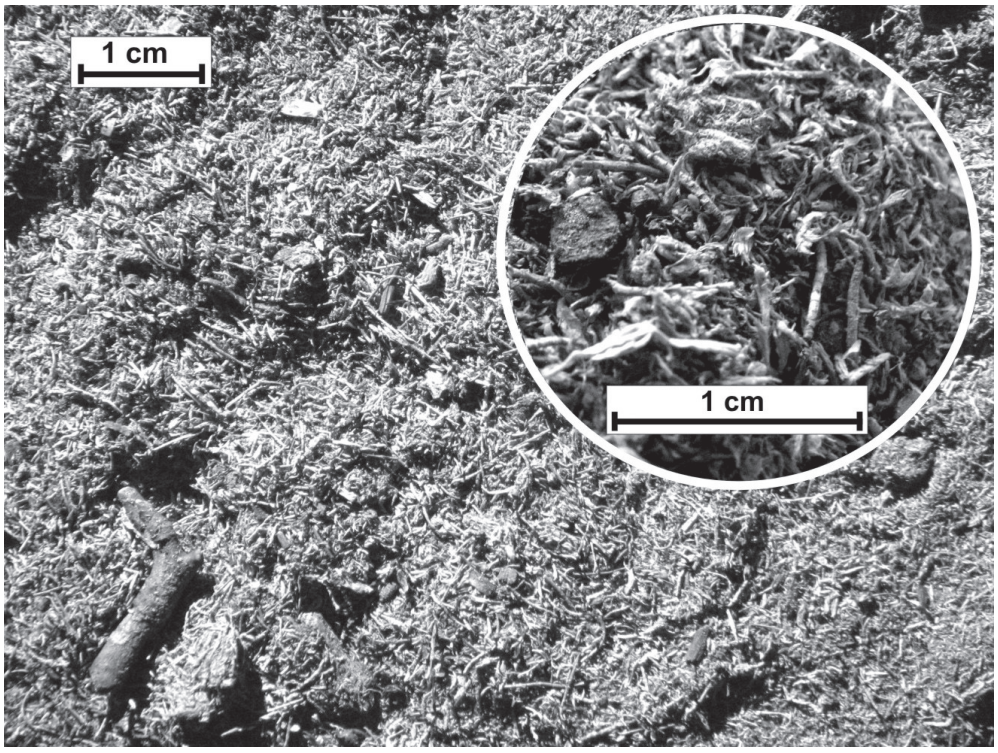
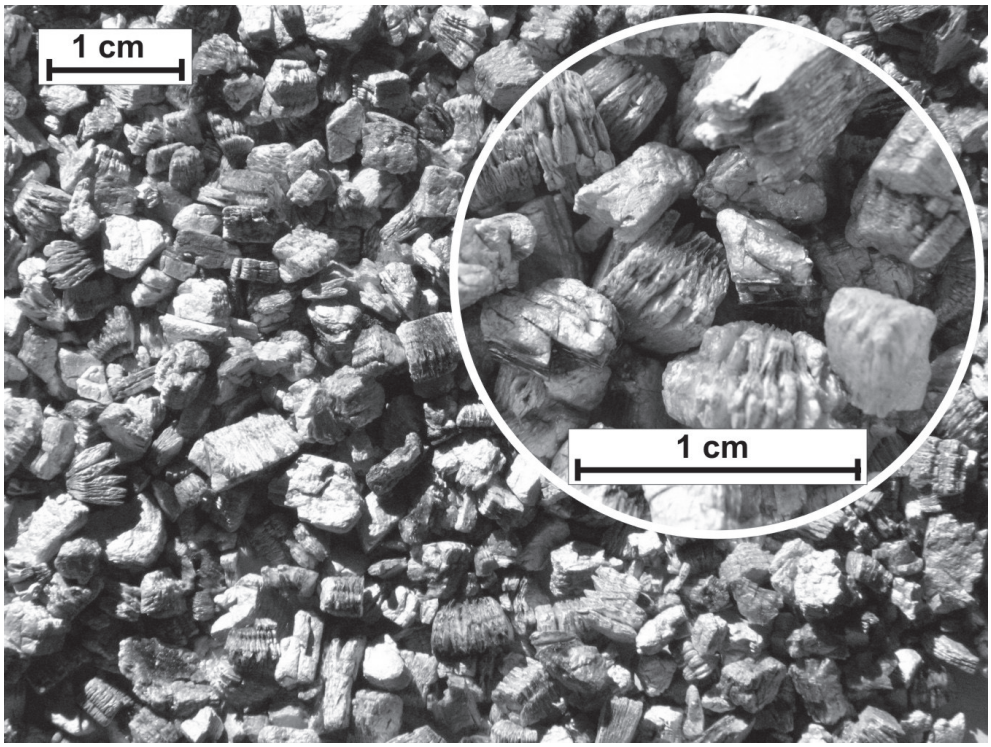


Fig. 1. Pictures of sorbents – first portion (invert for the second portion) Wermikulit



Nonwoven

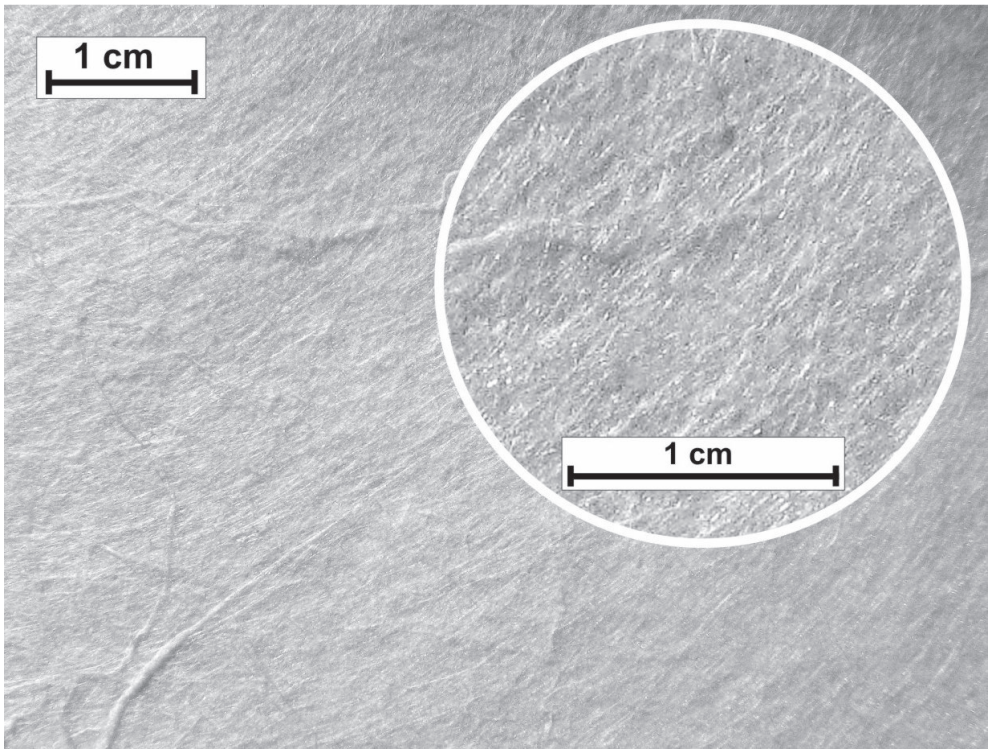


Fig. 1. Pictures of sorbents (continued)

In every test, 200 ml of oil and 200 ml of sorbent were used. Only in the case of nonwoven, the quadratic sheets were placed on the surface of oil or water. Fig. 2 demonstrates behaviour of sorbent during the first 3 minutes of contact with oil. The same in the case of contact with water is demonstrated. Due to nonwoven sheet is in Fig. 2 and 3 poorly visible, in the Fig. 4 downward view of oil absorption is shown. The time-period of particular sorbent contact with liquids was 300 s, 600 s and 900 s. After those periods, the sorbents were removed and heightened.

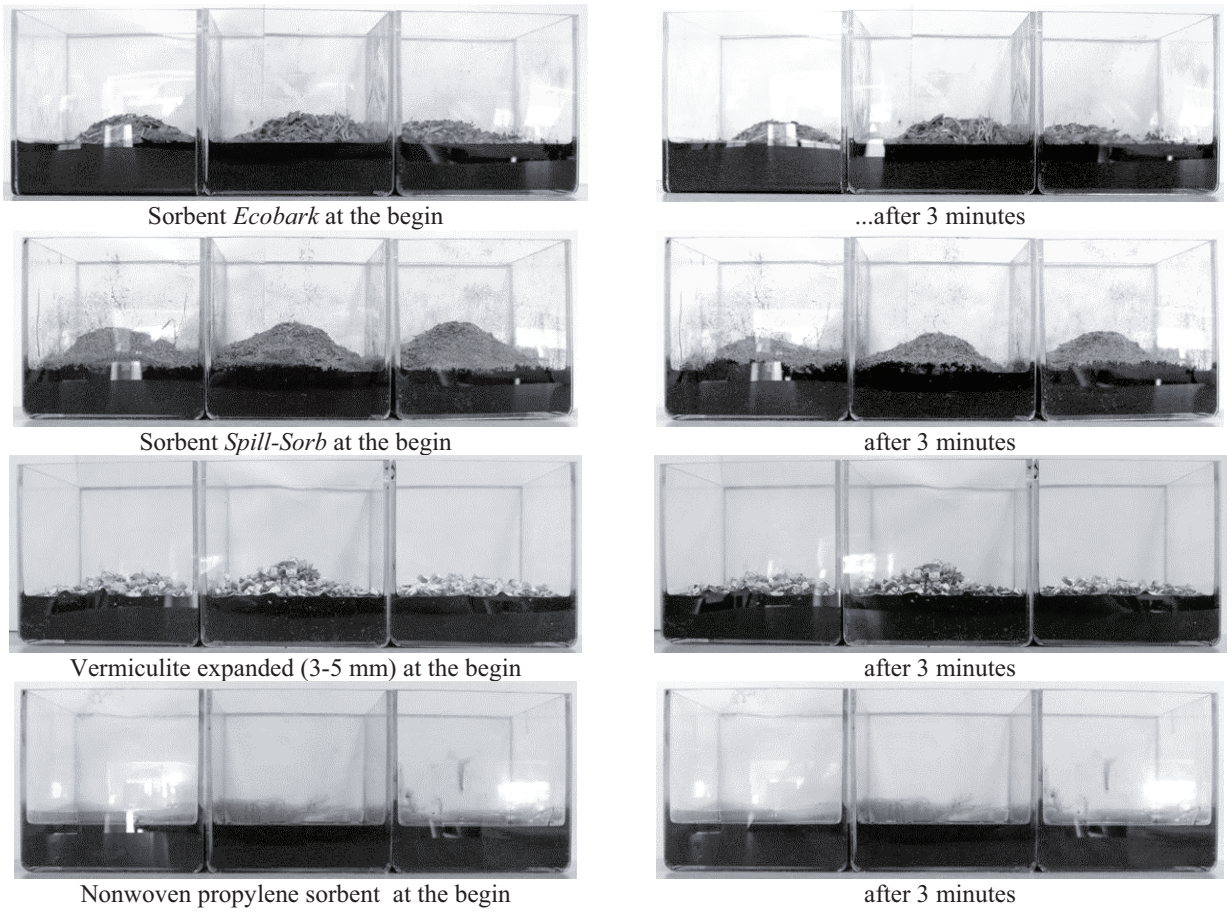


Fig. 2. Oil absorbents floating on the oil surface

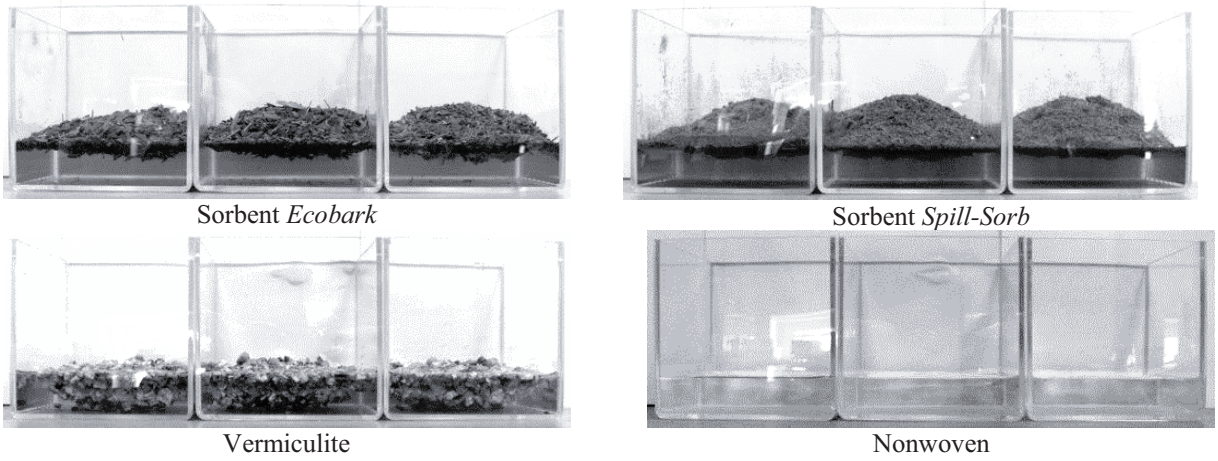


Fig. 3. Oil absorbents floating on the water surface

3. Results

Sorptivity *s(t)* of specified sorbent expressed as the relative mass increase of sorbent after contact with water (relation 1) is presented in Fig. 5, whereas after contact with oil – in Fig. 6 (lubricate oil) and Fig. 7 (fuel oil) is shown.

$$s(t) = (m(t) - m_o) / m_o , \tag{1}$$

where:
$m(t)$ – mass of sorbent after time t of contact with liquid,
m_o – mass of sorbent at the beginning.

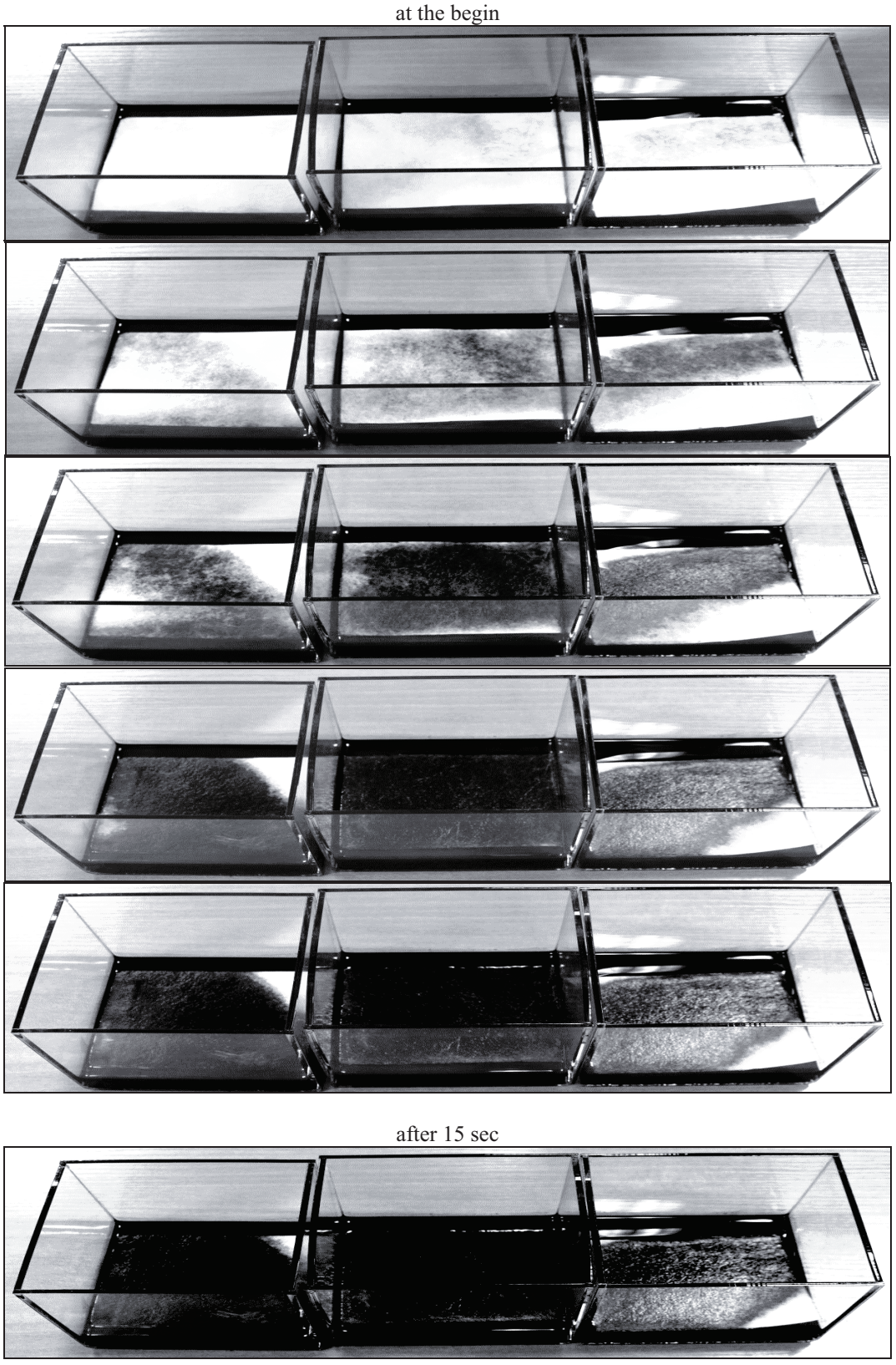


Fig. 4. Oil absorption of the nonwoven patch

Sorptivity of water appears lowest for nonwoven (0.05-0.2), whereas greatest – for *Spill-Sorb* (1.1-2.75). At the same time sorptivity of lubricate oil is greatest for nonwoven (28-34), lowest – for vermiculite (2). Similar phenomenon is observed for fuel oil, but then sorptivity of nonwoven is two times lower than for lubricate oil.

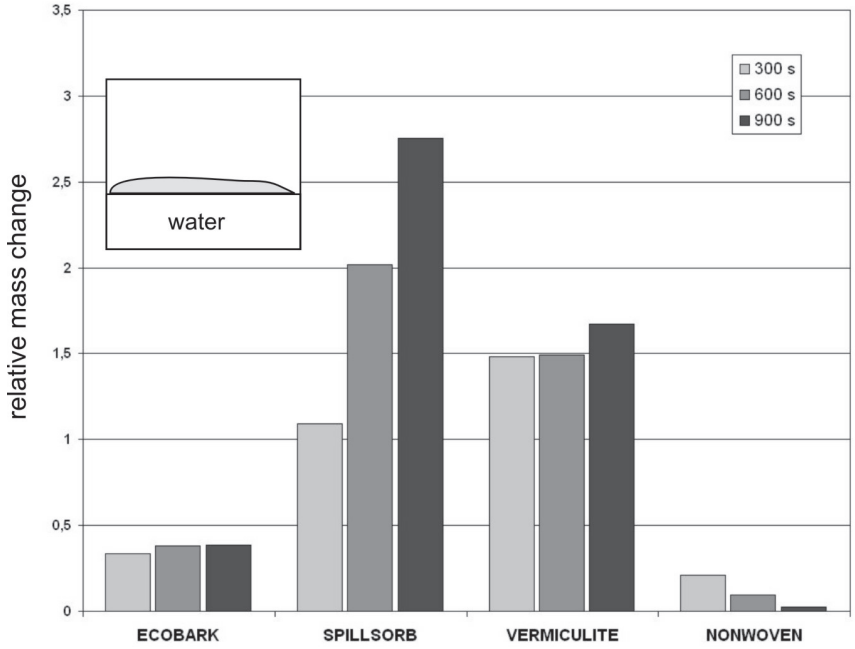


Fig. 5. Relative mass of sorbent changes after various times of contact with water

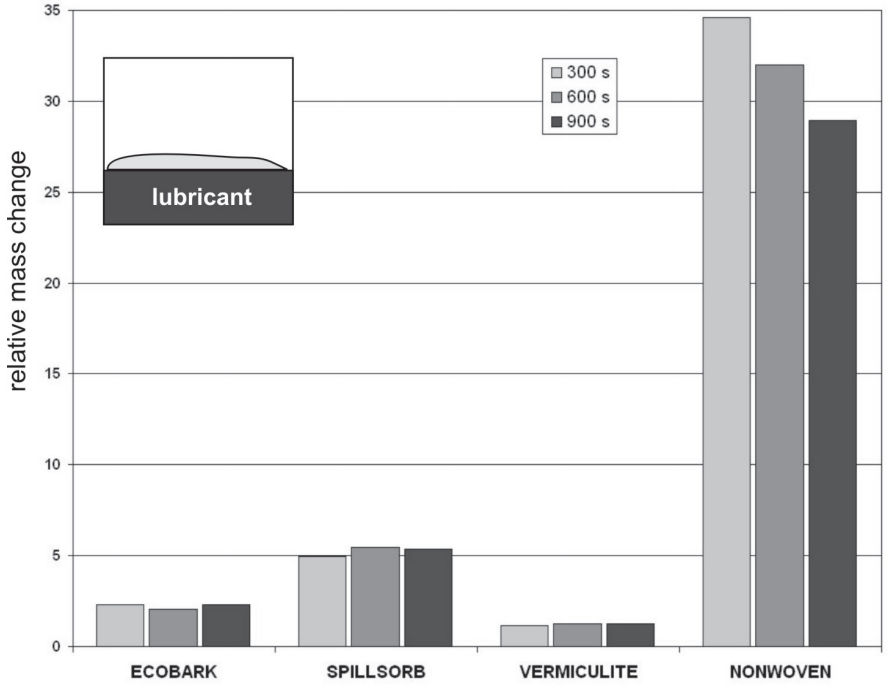


Fig. 6. Relative mass of sorbent changes after various times of contact with lubricate oil. It is worth to notice, that the scale is 10 time greater than in Fig. 5

If the analyse of Fig. 6,7 is carried out, one can notice that sorptivity of nonwoven material decreases with the time of contact with oil. Namely, it seems that inner structure of sorbent varies under the influence of absorption of the liquid for both water and oil. This change of structure has negative impact on sorption process. Optimal time of sorbent contact with oil is less than 300 s. Evolution of appearance of nonwoven sheet in Fig. 4 suggests that this time is close to several seconds, but it should be a subject of more insightful investigations in the future rather. Various nonwovens as relatively effective oil sorbents are indicated yet in literature [6-8]. It should be mentioned that various types of nonwovens should be tested, especially other than synthetic ones here used.

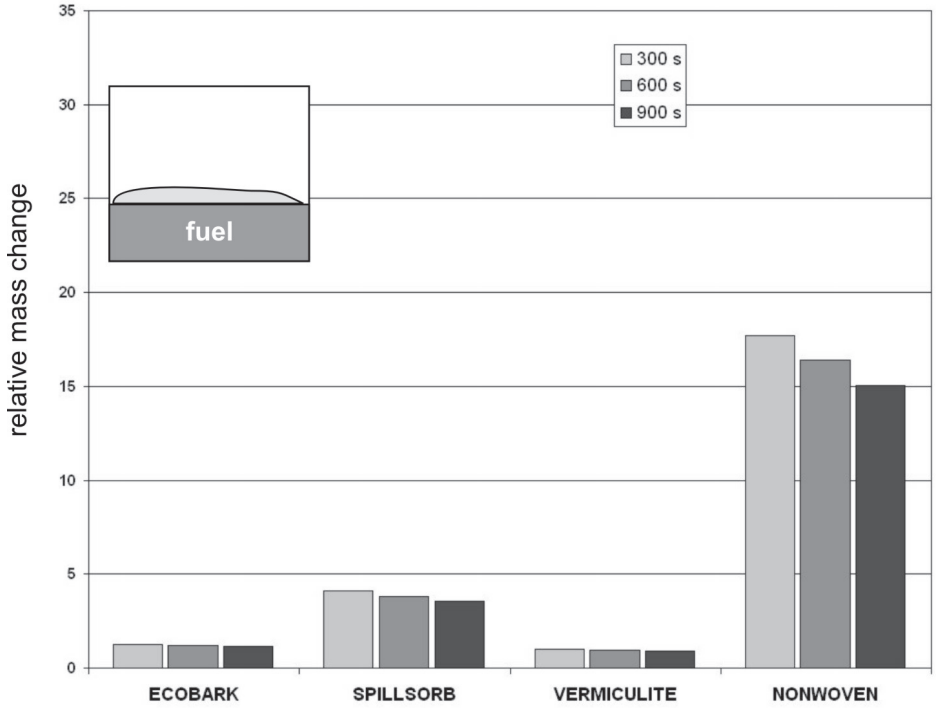


Fig. 7. Relative mass of sorbent changes after various times of contact with fuel oil

4. Conclusions

Methodology based on weight of sorbent measuring used in this paper for sorptivity determination seems be effective. Obtained results of tests carried out allow saying, that among tested sorbents, sorptivity of nonwoven is several times higher than other ones. There is optimal time of contact of sorbent with oil. Therefore, every type of sorbent should be tested for the optimal time of contact with oil.

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