FIBROUS-WOOD SORBENT FOR ELIMINATING OIL POLLUTION

S. Nenkova, R. Garvanska, S. Jelev

University of Chemical Technology and Metallurgy, Kl. Ochridski 8, 1756 Sofia, Bulgaria
E-mail: nenkova@uctm.edu

Abstract

In this paper, we examine the possibility of eliminating oil pollution by using fibrous-wood sorbents on the basis of short wool fibres, technical hydrolysis lignin, wood sawdust and barks. The sorption ability of waste fibrous-wood materials has been investigated by determination of Chemical Oxygen Demand (COD). The special sorption patterns by net cover and fibrous-wood compositions as a nucleus have been prepared. The sorbents on the basis of technical hydrolysis lignin (THL) and wool shoddy have high sorption ability to oil pollution.

Keywords:

oil sorbents, oil pollution, waste fibres, sawdusts, barks, lignin.

Introduction

Oil floods downriver, in ports, and in rivers near oil-manufacturing firms are an exceptionally great ecological problem.

Nowadays environmental protection against oil pollution is carried out by different means because of the multiple factors of the problem, as determined by the kind, composition and location of the pollution.

Barrage buildings are used for collecting and concentrating the oil floods on moving water bodies such as the River Danube, which are then collected and taken out.

Some papers in literature [1-3] have examined the use of biological means for cleaning waters, but these methods are not applicable in emergency situations. In such cases the use of highly effective fibrous polymer sorbents is of great importance.

The possibilities of cleaning oil pollution by sorbents on the basis of fibres, polymers and wood products, however, have not yet been sufficiently investigated.

Papers have peen published on the following subjects: high fibrillated fibrous materials for cleaning sewage waters from proteins [4], microfibrous sorbents on the basis of thermoplastic polymers (polyolefin) [5], large-surface woollen fibrous materials for cleaning oil spills in the Persian Gulf in 1990 [6], testing wood sawdusts for cleaning water surfaces from average oil floods, obtaining highly effective sorbents on the basis of fibrous waste from paper production, and using lignin-containing waste for cleaning waters.

On the other hand, a large quantity of waste raw materials with high sorption ability is produced by the manufacture of fibrous and wood materials as well as during their everyday usage. Of special interest in this respect are:

- √ waste wool fibres (wool shoddy) and waste textile raw materials from textile mills and everyday use;
- √ technical hydrolysis lignin (THL), produced during the hydrolysis of wood, and
- √ wood sawdust and barks, produced during the mechanical manufacture of wood.

The materials listed above are suitable for making sorbents because of their well-developed inner and outer surface, macro- and microporous structure, and their varied functional groups. Additional

advantages of these fibrous-wood sorbents include their biodegradability and their lower impact on the ecosystem.

In this light, the aims of the present investigation are as follows:

- √ to study the sorption ability of wool shoddy (WS), wool synthetic waste materials, technical hydrolysis lignin (THL), wood sawdust and barks toward oil pollution, and
- √ to develope highly effective sorbents of suitable form and construction, consisting of a cover and nucleus on the basis of: wool shoddy, non-woven textile materials, technical hydrolysis lignin, wood sawdusts and net fabrics.

Experimental

I. The sorption ability of the following was investigated:

- √ wool shoddy (WS) by tweed production;
- √ mixed wool and chemical fibre materials (waste products), article Druzeta by Nonwotex Ltd,- Sofia, containing wool, synthetic fibres (polyamide, polyacrilonitryle) and cellulose fibres; the main part of which is wool fibres (approximately 60%);
- √ technical hydrolysis lignin (THL);
- √ wood sawdust and barks, representing a blend of beech and oak wood.

The porosity of waste products towards acetone was also investigated. The corresponding valueswere similar: for WS 30.0%, Druzeta 28.6%, THL 27.4 %, and wood sawdust 28.9 % and corresponded to natural products with a porous structure. The wood barks have less porosity (18.9)%.

Oil with 0,85 g/cm^3 specific weight and pH of 7 was used. The sorption ability of materials towards oil in static and dynamic conditions was investigated, with a view to their application on different objects, such as spills in seas and rivers, or waste waters from oil manufacturing mills.

The experiments in static conditions were performed at various concentrations of oil in water and various duration of the interaction between sorption material and oil:

- √ for WS and Druzeta' 102 g/l, 136 g/l, 170 g/l, 255 g/l; at ratios of oil:WS and oil:Druzeta 6:1, 8:1, 10:1, 15:1,
- √ for THL, wood barks and sawdust 17 g/l, 34g/ l, 51g/l, 102 g/l and ratios of: 1:1, 2:1, 3:1, 6:1;
- √ a duration of interaction between sorption material and oil with permanent agitation for 2, 5, 10 and 15 minutes at a permanent hydromodule of 1:50, at room temperature.

After that, filtration through a metal sieve was carried out, and the Chemical Oxygen Demand (COD) of the treated water was determined. The COD was determined by using potassium dichromate, a well known method for assessment of the integral concentration of organic pollution

The sorption ability in dynamic conditions was determined using a column, i.d. internal diameter 25 mm, filled with a corresponding quantity of sorbent, and water with oil 170 g/l for WS and Druzeta; 102 g/l for THL, wool sawdusts and barks. Fractions of 50 ml were collected up to the moment of the sorbent's saturation. The COD of the fractions was then determined.

Experiments for studying the possibility of repeated use of wool shoddy and Druzeta for cleaning the oil-polluted water with 170 g/l were carried out, and the COD was determined.

II. Development of sorbent cylindrical patterns:

Cylindrical patterns with a length of 100 mm and a diameter of 50 mm, consisting of a polyester, polyamide and cotton net cover with holes of 2 to 3 mm diameter, fibrous-wood materials and non-woven materials (NWM) as a nucleus, were prepared.

The sorption ability of model patterns towards oil pollution was investigated on the water surface with a continuous oil layer of 0.045 g/cm^2. The sorption capacity and the remaining of the patterns on the water surface were determined.

Results

The dependence of the COD of water polluted with different quantities of oil and cleared with WS, Druzeta, THL, wool sawdust and bark in static conditions according to the duration of contact is shown in Figures 1-5.

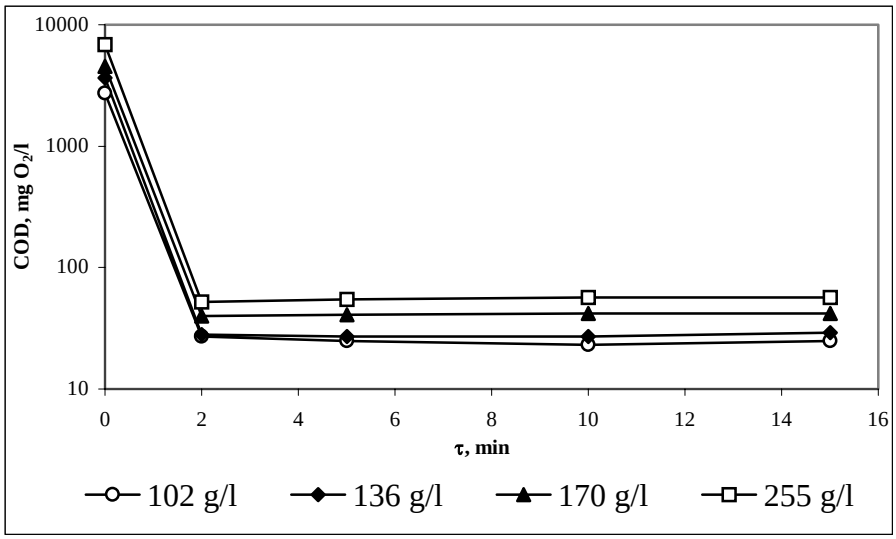

Figure 1. Dependance of COD of water poluted with different oil concentrations by using of wool shoddy sorbent on the duration of the sorbent action

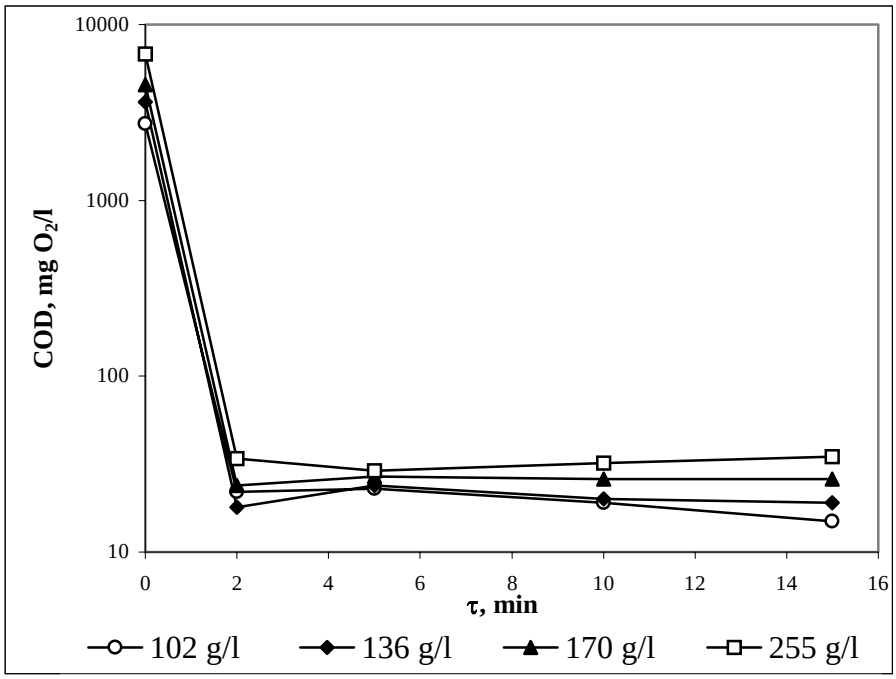

Figure 2. Dependance of COD of water poluted with different oil concentrations by using of art. Druzeta sorbent on the duration of the sorbent action

It is seen from Figures 1 and 2 that in the cases of WS and Druzeta, the COD speedily decreases (over approximately 2 minutes), and a high cleaning extent of water (even with high oil concentration) is reached. An oil spot of 6 to 15 mm thickness (according to the oil quantity) visually fully disappeared.

A high rate of cleaning (over approximately 2 minutes) with THL, wood sawdusts and barks is reached, but at lower oil concentrations (17 to 51 g/l), and an oil to sorbent ratio of 3:1 to 1:1, compared to WS and Druzeta. An optimal result for COD (18-20 g/l) is observed at the correlation 2:1 and 3:1 of oil to sorbent. This correlation is recommended.

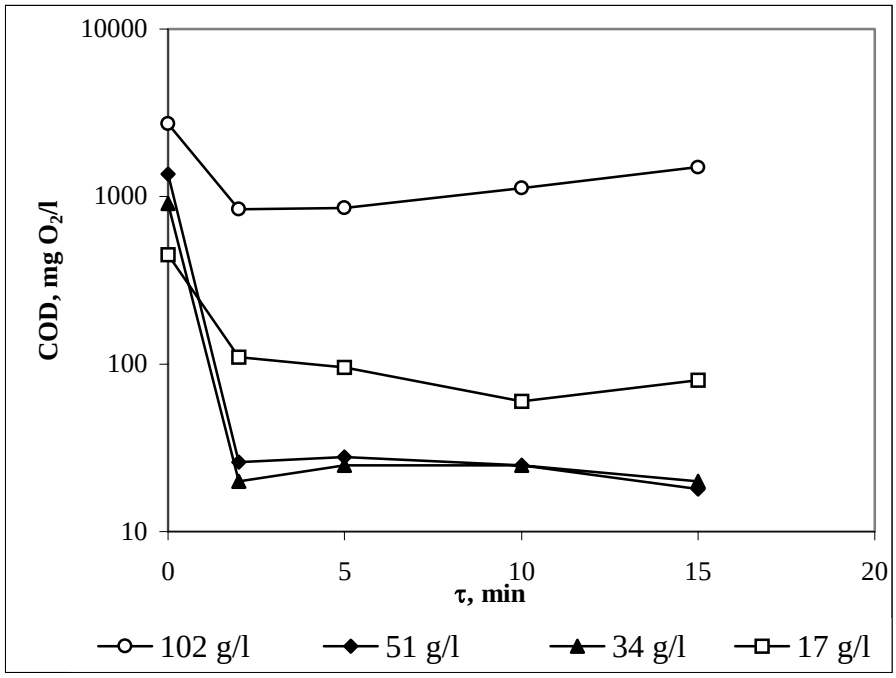

Figure 3. Dependance of COD of water poluted with different oil concentrations by using of THL sorbent on the duration of the sorbent action

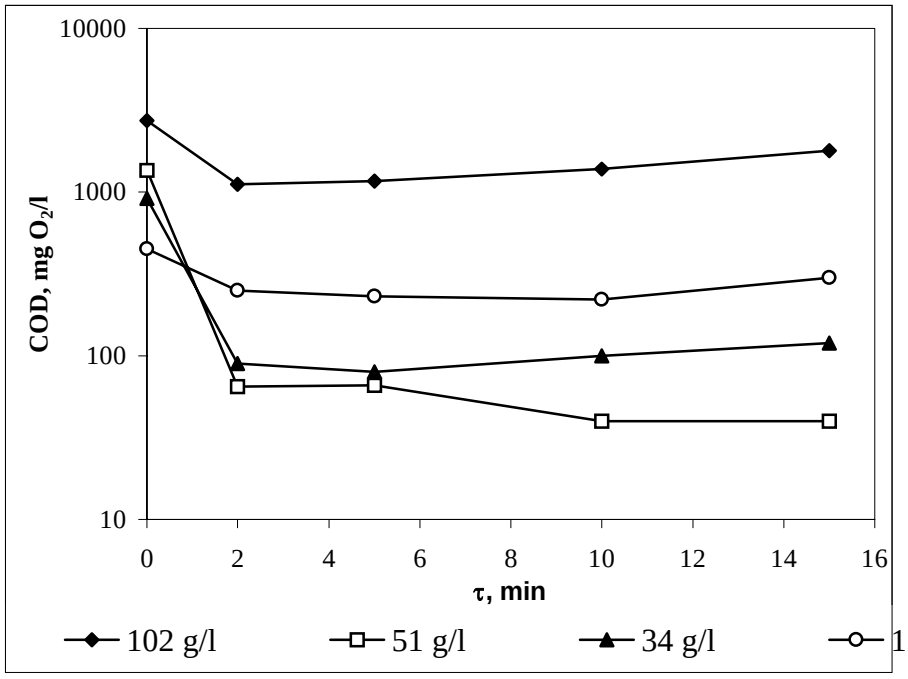

Figure 4. Dependance of COD of water polluted with different oil concentrations by using of wood saw-dusts sorbent on the duration of the sorbent action

It is shown (Figure 6) that a high COD (of the starting solution) of oil-polluted water after cleaning in dynamic conditions is reached after letting through a THL of 250-ml oil-polluted water and 350 ml through WS and Druzeta. After such quantities of are polluted water, COD sharply increased and reached the COD value of the starting solution (over 8000mg O_2/l)

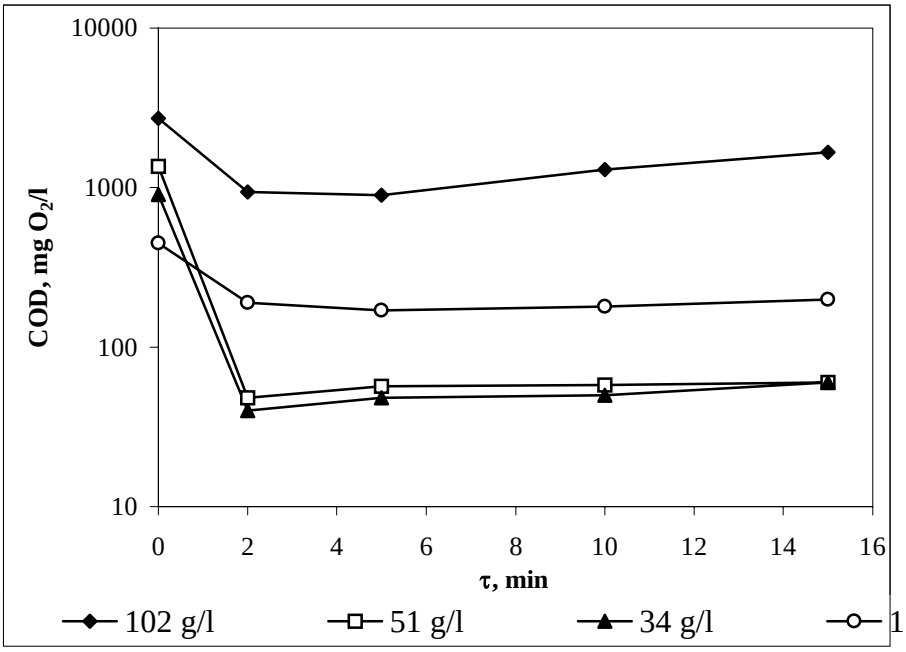

Figure 5. Dependance of COD of water polluted with different oil concentrations by using of wood barks sorbent on the duration of the sorbent action

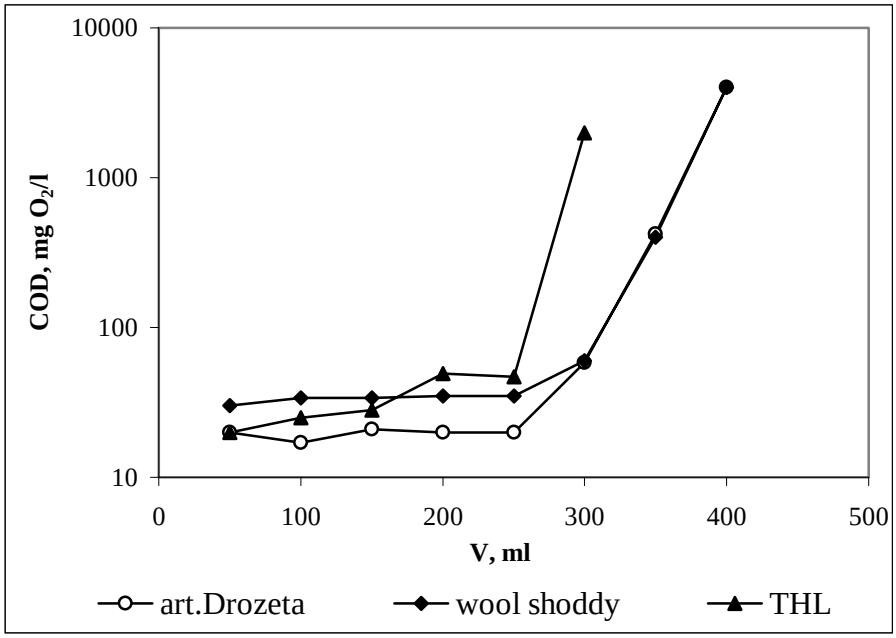

Figure 6. Dependance of COD of water polluted with oil by cleaning with wool shoddy, art. Drozeta and THL at dynamic condition on the volume of liquid

Therefore, the three tested materials possess high sorption ability in dynamic conditions, as the COD is low, corresponding to the standards of treated industrial water.

The results in Table 1 for treated oil-polluted water show that even after using the WS and Druzeta combination six times, the fibrous materials remain effective and the treated water shows a low COD.

The results in Table 2 show that highly effective sorbents for practical application can be prepared on the basis of THL with non-woven textile, or with WS at a correlation from 75:25 to 50:50 as a nucleus and a polyester net cover with holes of 2-3 mm diameter.

Table 1. Results of repetedly using of art. Druzeta and wool shoddy on waters, polluted widh 170 g/l oil

Sorbent	COD (mg O_2/l) for each experiment					
	I	II	III	IV	V	VI
Druzeta	24	36	41	42	42	60
Wool shoddy	40	42	48	50	62	68

Table 2. Sorbent cylindrical patterns

N	Description of sorbent		Sorption capacity, %	Remaining on the water surface, min
	Cover	Nucleus		
1	PE net	THL, Nin woven material /NVM/	100	Not sinking
2	PE net	WS	40	1 min
3	PE net	THL: WS-75:25	100	Not sinking
4	PE net	THL: WS-50:50	100	Not sinking
5	PE net	THL: WS-25:75	80	10 min
6	PE net	Saw-dust, NWM	80	7 min
7	PA net	THL	50	Not sinking
8	PA net	WS	50	20 min
9	Cotton net	THL, NWM	70	5 min
10	Cotton net	WS	70	5 min
11	Cotton net	Saw-dust, NWM	30	1 min

The sorption ability of the materials discussed (WS, Druzeta and THL) is very high compared with the sorption ability of materials hitherto used. The COD value of the cleared water is very low, and is related to the standard values of clean industrial water.

Summary and conclusions

The possibility for using waste fibrous-wood materials such as wool shoddy, wool-synthetic waste raw fibres, technical hydrolysis lignin, wood sawdusts and barks as sorbents for elimination of oil floods were studied.

Our conclusions were as follows:

- √ The tested fibrous-wood materials showed a high rate and degree of purification in static conditions of highly polluted waters, although the COD values are too low. Fibrous materials (WS, Druzeta) and THL have higher sorption than sawdusts and barks. Fibrous-wood materials possess high sorption ability in dynamic conditions; also, the COD value is low and meets the standards of pure industrial waters.
- √ The possibility of achieving a close ecological cycle is proved by the repeated use of fibrous materials, and by the pressing into briquettes and burning of THL, wood sawdust and barks which contain oil. This demonstrates the economic benefit of developing composite sorbents on the basis of WS, THL and waste raw wool-synthetic materials.
- √ The investigations in static and dynamic conditions showed that the method developed for eliminating oil floods is applicable for cleaning both standing and moving waters.
- √ Highly effective sorbents for eliminating oil pollution have been developed. The fibrous-wood sorbents prepared are multi-component articles, consisting of net cover and sorption materials on the basis of THL and WS as a nucleus.

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