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Environmental pollution

EFFECT OF THE DBS DETERGENT* ON OXYGEN CONCENTRATION IN WATER

WPŁYW DETERGENTU DBS* NA ZAWARTOŚĆ TLENU W WODZIE

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Effect of DBS detergent on oxygen diffusion out of and into water with no or 9°/ NaCl was tested. Concentrations of detergent used were 5; 50 and 250 mg/l SA. Oxygen content was measured after 24 h by the Winkler’s method; in observations up to 10 days oxygen pressure was measured with Plastomed 305 apparatus. There was no direct effect of detergent present in water on its oxygen content no matter it there were carp juveniles or no fish at all.

INTRODUCTION

According to many communications it is quite clear for detergents to be toxic to organisms living in waters (Bardach, et al. 1965; Cronin and Flemer, 1967; Eisler, 1965; George, 1970; Grønno, 1971; Abel, 1974). A toxic effect of detergents on fishes was noted during surveys on fish behaviour (Bardach et al., 1965; Korpela, 1969 as well as surveys of tissue enzymes e.g. in gills, serum or brain (Jurkowski 1977; Lundhal, a Cabridence 1978; Jurkowski et al., 1979).

Aside its toxic effect on organisms living in water, detergents are irreplaceable as cleansers in households, industry (Anastasiu and Jelescu, 1973) and also for crude oil licence removal (Smith, 1968) although some of detergents are more toxic for animals, than crude oil is (George, 1970).

High amounts of surface-active agents get, from rivers, into gulf’s waters, presenting a serious risk for inhabiting organisms (Drobwa et al. 1975; Grønno, 1971; Žmudziński,

* Sodium dodecylbenzenesulphonate (DBS)
Although recently production of detergents less toxic for water organism has been started (Swedmark et al., 1973) nevertheless "traditional" ones are to be used for many years, yet.

Among many data concentrating the toxic effect of surfactants, there are only few dealing with effect of physical agents on detergents toxicity; with few elder data suggesting detergents to decrease the oxygen content in water (Cronin and Flemer, 1967; Korpela, 1969). Our earlier results (Jurkowski, 1979) conducted on the perch fry, suggested the above to be a false statement, however it was found purposefull to test an effect of detergent on diffusion of oxygen into "fresh" and saline waters with and without organisms within these water.

Scheme of the experiment

A

- distilled water with normal oxygen content
  - control water
  - water + DBS 5 mg/l

results in table 1

B

- distilled water with decreased oxygen content
  - control water
  - water + DBS 5 mg/l

results in table 2

C

- oxygenated tap water
  - control water
  - water + DBS 5 mg/l
  + fish (6 individuals)

results in table 2

D

- distilled water its initial oxygen pressure
  - pure water
  - water + NaCl (90/0)
  - DBS 50 mg
  - DBS 250 mg
  - control
  - DBS 50 mg
  - DBS 250 mg

results in table 3

results in table 4

Fig. 1. Scheme of the experiment
A rather common substrate for production of many washing preparations in Poland is sodium dodecylbenzenesulphonate (DBS), toxic effect of which is well known (Jurkowski, 1977, Jurkowski et al. 1979), that was why that detergent was chosen for the experiment.

MATERIAL AND METHODS

The experimental scheme is presented on Fig. 1. The DBS detergent was obtained from the Chemical Plant in Gdańsk. Fry of carp used had 20 to 50 g of weight. Oxygen concentration was measured by the Winkler's method (experiments including fishes as well as 24-h experiments with no fish). In the ten 24-hour experiments pressure of oxygen in water was measured with Plastomed 305 apparatus. All the reagents used were produced by the Polish Chemicals — pure for analysis. Experimental vessels were either 21 in volume and 154 cm$^2$ in diameter (experiments with no fish in it) or 51 in volume and 576 cm$^2$ in diameter (experiments with fishes).

Fish fry was kept in settled, oxygenated tap water (Fig. 10), while other experiments were carried on in settled, distilled water (Fig. 1A and D) distilled water partially oxygen free (Fig. 1B) or in distilled water with 9g NaCl/l. Following concentrations of detergent were applied:

- 5 mg/l SA — for fish and 24-hours experiments and
- 50 mg/l and 250 mg/l Sa — in ten — 24-hours observations.

Measures were taken after collecting water samples from the bottom, in three repetitions. Results presented represent average value ± standard deviations.
RESULTS AND DISCUSSION

According to Korpela's results (1969) there was 13.4 mg of various detergents/l of Helsinki municipal sewages, of which, after purification, 2 mg/l got into marine waters. In 1956, contamination of the USA rivers with detergents ranged from $0.1 \times 10^{-3}$ to $0.5 \times 10^{-3}$ kg/m$^3$ (Bardach et al., 1965) reaching $40 \times 10^{-3}$ kg/m$^3$ in 1974 (Abel, 1974). Due to the data for the Dead Vistula River, there were seasonal fluctuations in detergent contents; for example in 1975, noted differences oscillated between $1.69 \times 10^{-3}$ and $2.64 \times 10^{-3}$ kg/m$^3$ (Drewa et al., 1975) Although there were no, more actual, data available, presumably since then, concentration of detergents haven’t decreased, that was why doses of detergent applied in the experiments were relatively high and equal to 50 and 250 mg/l SA. Testing relations between an oxygen concentration and oil impurities in waters, Otremba and Kaniewski (1983) proved there to be one between oxygen content and an air-water contact surface with the oxygen decreasing rate being particularly fast within the first 10 days of the experiment (decrease in initial oxygen content by 50%).

In the present experiments, beside the 24-hours ones (Tab. 1 and 2) the ten-days experiments were conducted, however, according to results (Tab. 3 and Tab. 4) no essential changes in an oxygen pressure were observed in waters, both, with and without NaCl. Experiments were conducted in containers with a small air-water contact surface, as to get thicker layer of detergent on the surface, just to make an oxygen diffusion more difficult.

### Table 1

| Time (hours) | Oxygen content (mg/l) |
|--------------|-----------------------|
|              | control | detergent |
| 0            | 11.6±0.7 | 11.6±0.7 |
| 6            | 11.9±0.8 | 12.2±0.8 |
| 24           | 11.5±1.2 | 11.8±0.7 |

### Table 2

| Time (hours) | Oxygen content (mg/l) |
|--------------|-----------------------|
|              | control | detergent |
| 0            | 8.0±1.0  | 8.0±1.0   |
| 24           | 10.7±1.1 | 11.5±0.7 |
### Table 3

| Time (hours) | Oxygen pressure (mm Hg) |
|--------------|-------------------------|
|              | control | detergent |
|              |         | 50 mg/l SA | 250 mg/l SA |
| 0            | 153 ± 5.2 | 153 ± 5.2 | 153 ± 5.2 |
| 24           | 148 ± 2.3 | 149 ± 5.0 | 149 ± 1.1 |
| 48           | 146 ± 1.1 | 140 ± 5.4 | 143 ± 3.9 |
| 96           | 149 ± 4.7 | 150 ± 2.2 | 142 ± 5.7 |
| 168          | 153 ± 4.8 | 155 ± 1.1 | 144 ± 8.3 |
| 216          | 146 ± 2.8 | 152 ± 4.3 | 144 ± 7.5 |
| 240          | 147 ± 3.7 | 142 ± 4.6 | 138 ± 7.6 |

### Table 4

**Effect detergent on oxygen content in saline water (9g NaCl/l)**

| Time (other) | Oxygen pressure (mm Hg) |
|--------------|-------------------------|
|              | control | detergent |
|              |         | 50 mg/l SA | 250 mg/l SA |
| 0            | 147 ± 2.6 | 154 ± 5.5 | 152 ± 3.2 |
| 24           | 145 ± 1.7 | 152 ± 4.2 | 150 ± 4.3 |
| 48           | 138 ± 5.3 | 145 ± 3.7 | 122 ± 6.8 |
| 96           | 150 ± 2.8 | 150 ± 5.2 | 136 ± 5.6 |
| 168          | 154 ± 2.3 | 151 ± 2.2 | 143 ± 5.7 |
| 216          | 146 ± 3.7 | 151 ± 4.3 | 144 ± 3.9 |
| 240          | 135 ± 3.2 | 147 ± 5.4 | 130 ± 6.9 |
Sensitivity of fishes and other water organisms towards detergents depends, in between, on type of detergent, its concentration and organism species (Thatcher, 1966, George, 1970, Swedemark et al., 1971) itself. Toxicity of detergents depends, to a high degree, on its chemical structure, water pH and hardness, oxygen concentration and temperature of water (Eisler, 1965; Hohanson and Smith, 1971). In the experiments with fishes, oxygen decreasing rate, in both containers was alike (Fig. 2), however fishes within the control container survived while these within the container with detergent started to die. (Experiment ended when three fishes died in water with detergent. Obtained results indicated the direct cause of the fishes death was other then lack of oxygen in the water. Simmilar results were obtained in experiments with no fish. Yet indirect effect of detergent on oxygen concentration in water, through eutrophication process, for example, can't be excluded. (Cronin and Flemer, 1967; Zbytniewski et al., 1975). Observations of Kaniewski and Otremba (1983), however, concerning pollution with oil-derivatives, proved there to be an increase in oxygen concentration in polluted waters.

According to the obtained results it can be stated the tested detergent has no direct effect on the oxygen concentration in water.

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REFERENCES

Abel P.D., 1974: Toxicity of synthetic detergents to fish and aquatic invertobrates. J. Fish. Biol. 6: 279–298.
Anastasiu S., E. Jei&ecu, 1973: Šrodki powierzchniowe czynne. Surfactants W.N.T., Warszawa: 11–20.
Bardach J.E., M. Fujia, A. Holl, 1965: Detergents effects on the chemical senses of the fish Ictalurus natalis (Le Sueur). Science 148: 1605–1607.
Cronin L.E., D.A. Flemer, 1967: Energy transfer and pollution in Pollution and marine ecology. Ed. Olson T.A., and Burges F.J., Interscience Publishers, New York-London-Sydney: 171–192.
Drewa G., Z. Zbytniewski, F. Pautsch, 1975: Seasonal changes in the level of detergents in the brackish water of the Dead Vistula and Bay of Gdańsk. Morentutkimuslait Julk. (Harforskininsints Skr.) 239: 105–108.
Eisler R., 1965: Some effects of a synthetic detergent on estuarine fishes. Trans. Am. Fish. Soc. 94: 26–31.
George J.D., 1979: Sublethal effects on living organisms. Mar. Pollut. Bull. 27: 107–109.
Granmo A., 1971: Biological effects of surface active agents on marine animals. Mar. Biol. 9: 183–201.
Hokanson K.E.F., L.L. Smith, 1971: Some factors influencing the toxicity of linear alkylbenzene sulphonate (LAS) to the blugill. Trans. Am. Fish. Soc. 100: 1–12.
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Jurkowski M.K., 1977: Effect of DBS detergent on activity of some enzymes of young carp brain, gills and serum. Acta Ichthyol. Pisc. VII. Fasc. 2: 47–53.

Jurkowski M.K., M. Stachowiak, J.W. Białowąs, 1979: Effects of certain stress situations and DBS on acetylcholintransferase acetylcholinesterase and monoaminoxidase activitites in various regions of brain of juvenile carp. Acta Ichthyol. Pisc. IX. Fasc. 2: 21–29.

Jurkowski M.K., 1979: The effect of DBS on survival of juvenile perch in relation to certain physical factors. Acta Ichthyol. Pisc. IX. Fasc. 2: 55–61.

Kaniewski E., Z. Otremba, 1983: The effect of seasonal changes of oil pollution on the oxygen concentration in water of the Gulf of Gdańsk. Studia i Materiały Oceanolog. 41: 167–180.

Korpela T., 1969: The effect of synthetic detergents on fish stock. Eripainos Vesitalous 5: 1–4.

Lundhal P., R. Cabridence, 1978: Molecular structure-biological properties relationship in anionic active agents. Wat. Res. 12: 25–30.

Otremba Z., E. Kaniewski, 1983: Wpływ wielkości powierzchni kontaktu olej-woda na szybkość zmiany stężenia tlenu w wodzie zanieczyszczonej zemulgowanym olejem. Effect of the oil-water contact surface size on the changes rate in oxygen concentration, in waters polluted with emulsified oil. Studia i Materiały Oceanolog. 41: 153–166.

Smith J.E., 1968: "Torrey Canyon" pollution and marine life. Mar. Biol. Ass. of U.K., Cambridge Univ. Press. Ed Gen. Smith J.E.

Swedemark M., B. Braaten, E. Emmanuelsson, A. Granmo, 1971: Biological effects of surface active agents on marine animals. Mar. Biol 9: 183–201.

Swedemark M., A. Granmo, S. Kollberg, 1973: Effects of oil dispersants and oil emulsions on marine animals. Wat. Res. 7: 1649–1672.

Thatcher T.O., 1966: The comparative lethal toxicity of a mixture of hard ABS detergent products to eleven species of fishes. Air Wat. Pollut. Int. J. 10: 585–590.

Zbytniewski Z., G. Drewa, F. Pautsch, 1975: Effect of detergents and phosphogypsum on the oxygen and chlorophyl A levels and on the dry weight of the residue of brackish water under laboratory conditions. Merentutkimuslait Julk. (Harsforskininginst Skr.) 293: 100–104.

Zmudzinski L., 1983: Pollution problems of Baltic Sea. Pol. Ecol Stud. 9: 397–415.

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WPŁYW DETERGENTU DBS* NA ZAWARTOŚĆ TLENU W WODZIE

STRESZCZENIE

Wykonano oznaczenie tlenu metodą Winklera w wodzie z dodatkiem detergentu DBS po 24 godzinach, w eksperyencie z narybką karpia oraz bez ryb. Użyto detergent w stężeniu 5 mg/l SA. Stwierdzono brak różnicy w zawartości tlenu w wodzie bez detergentu i z detergentem, jakkolwiek w tej ostatniej ryby zaczęły snać po 5 godzinach doświadczania. Wykonano również eksperymenty bez ryb z dużymi stężeniami detergentu 50 i 250 mg/l SA prowadząc pomiary prędkości tlenu aparatem Plastomed 305 do 10 dób w wodzie bez soli i zasolonej w ilości 9‰. Także w tych doświadczeniach nie stwierdzono istotnych różnic w zawartości tlenu w badanej wodzie.

Uzyskane rezultaty pozwalają stwierdzić, iż obecność detergentu w wodzie nie wpływa w sposób bezpośredni na zawartość w niej tlenu.

* dodecylobezenosulfonian sodowy
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