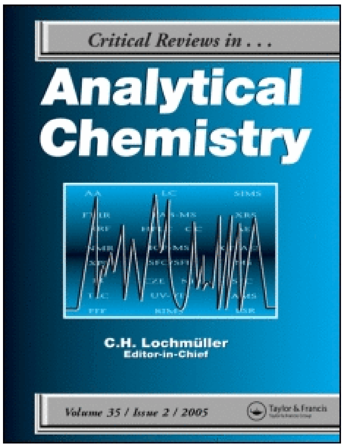

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THE INFLUENCE OF SURFACTANTS ON OXYGEN MASS-TRANSFER THROUGH THE AIR-WATER SURFACE

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INTRODUCTION

The exchange of oxygen between the liquid and gas phases determines the stationary gas content in natural and artificial waterbodies where the oxidation of pollutants is constantly consuming oxygen in waterbodies where the oxidation of pollutants is constantly consuming oxygen in water. Gas exchange between the phases depends to a considerable extent on the state of the interfacial surface between liquid and gas . The adsorption of surface-active compounds in the gas-water boundary decreases the rate of oxygen mass-transfer from the atmosphere to the hydrosphere and therefore the ability of natural waterbodies and water-cleaning systems to decompose the pollutants is declining.

In our work we have investigated the influence of surface-active compounds on the permeability of oxygen through the gas-water surface.

EXPERIMENTAL

The measurements were provided by two methods.

a)In the first method we measured directly the rate of air-oxygen diffusion through gas-water interface. In this method special device with oxygen analyzer was designed (Fig.1).

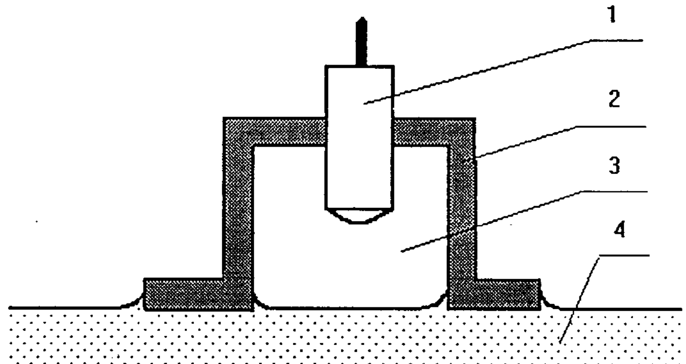

Figure 1. Measuring on water surface.
1-Oxygen sensor
2-Cover fixing gas volume
3-Gas volume
4-Test solution

On the surface of oxygen-free water was put the volume with oxygen sensor. In the beginning of the measurements there is an atmospheric air in this measured volume. After closing a stop-cock, oxygen will diffuse from gas-phase to liquid-phase through gas-water interface. The decline of oxygen content in the gas (air) was measured by oxygen sensor. All the solutions under investigation were deoxygenated with Na_2SO_3 before the measurements. The solutions were thermostated at 20°C.

b)In the second method we measured the rate of oxygenation of deaerated water. The device included oxygen sensor, microcompressor and diffuser (Fig. 2). The solutions were deoxygenated by Argon-gas. The rate of saturation of deoxygenated solutions with air were under investigation. All the solutions were thermostated at 20° C.

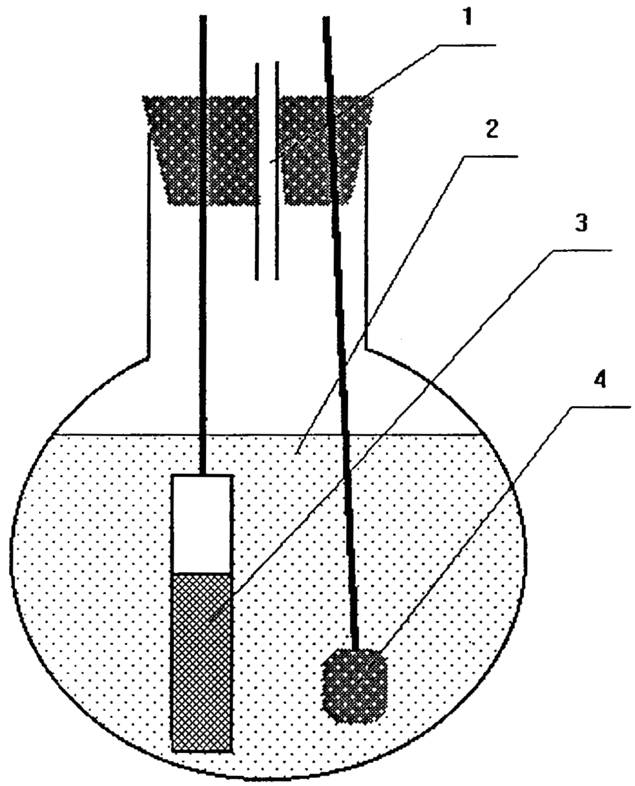

Figure 2. Measuring device for aeration test of surfactant solutions
1-gas outlet
2-solution under investigation
3-oxygen sensor
4-gas diffuser

The test solutions were the solutions of surface active compounds in the bidistilled water, containing surfactants from 0.0005-0.01%.

The reference tests were provided with pure bidistilled water.

The surface active compounds, which were under investigation were alcohols:methanol, 1-propanol, 2-propanol and 1-pentanol. Also some commercial washing powders as Ariel Futur Color, Ariel Futur, Scona, Via Color and Via Total.

RESULTS AND DISCUSSION

a) Direct oxygen (air) diffusion measurements through gas-liquid interface

The rate of oxygen diffusion was found from the slope of the function: oxygen concentration vs. time.(fig.3).

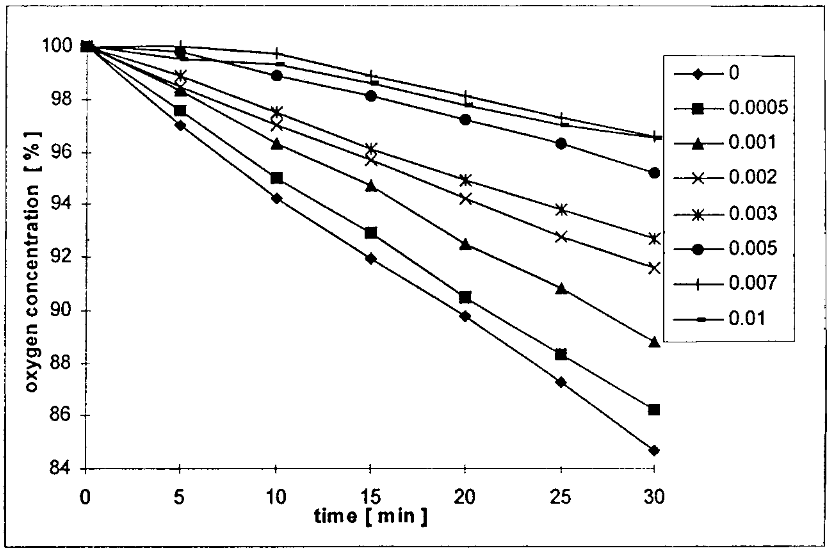

Figure 3. The dependence of the decrese of oxygen concentration in volume V of time : Methanol solutions.

The rates of oxygen diffusion vs.surfactant concentration have expressed on figures 4 ; 5 and 6.

These dependences show the steep rate decline up to surfactant concentrations 0,002 0,003 %. After that occures quite flat region of the function, where rate dependence from surfactant concentration is negligible. Obviously the gas-liquid surface is saturated by quite small ammount and afterwards the increasing of surfactant concentration will give small influence to the rate of oxygen diffusion.

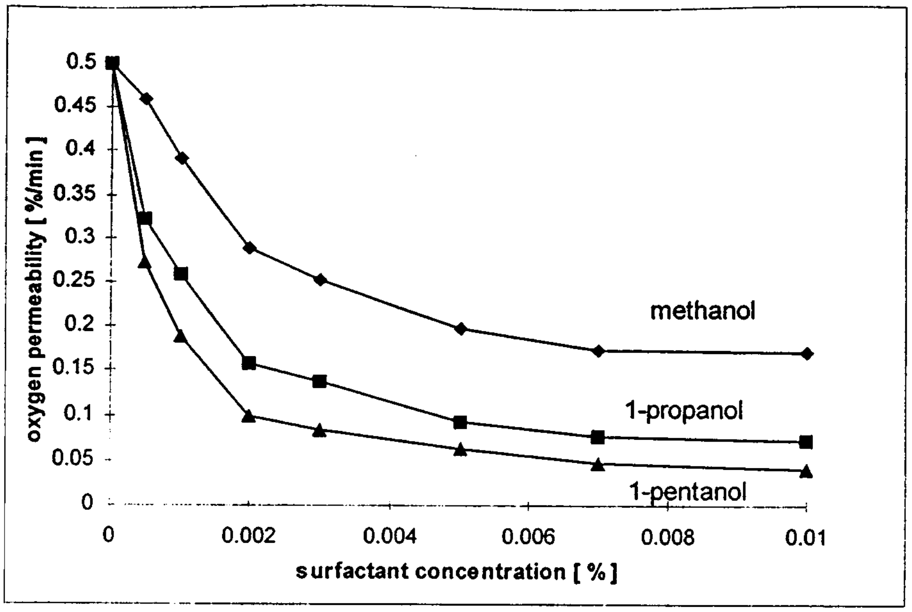

Figure 4. Rate of oxygen mass-transfer through surface of solutions: ethanol, 1-propanol,1-pentanol.

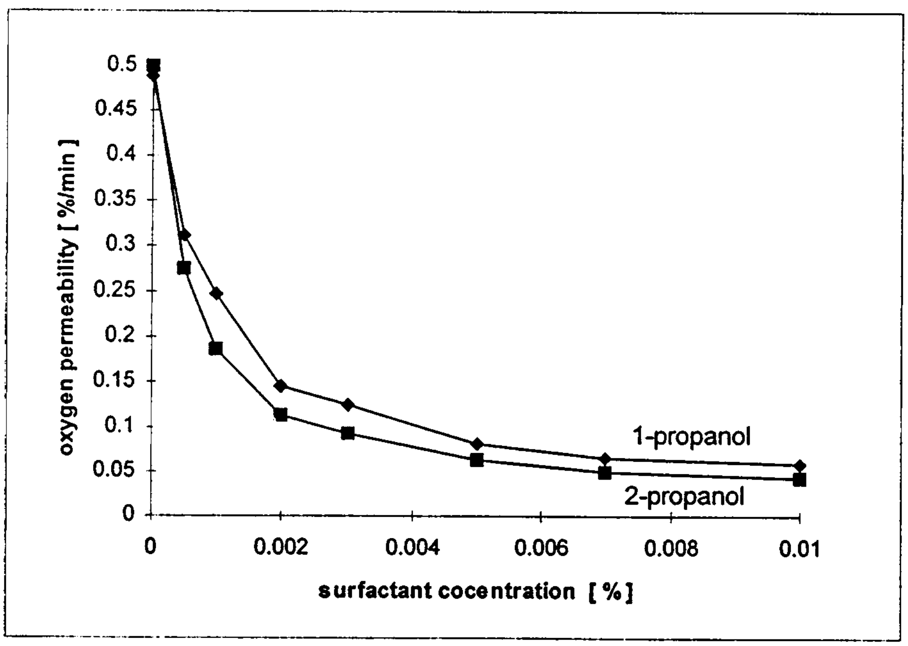

Figure 5. The comparison of the influence of 1-propanol, and2-propanol to the oxygen permeability through air water interface.

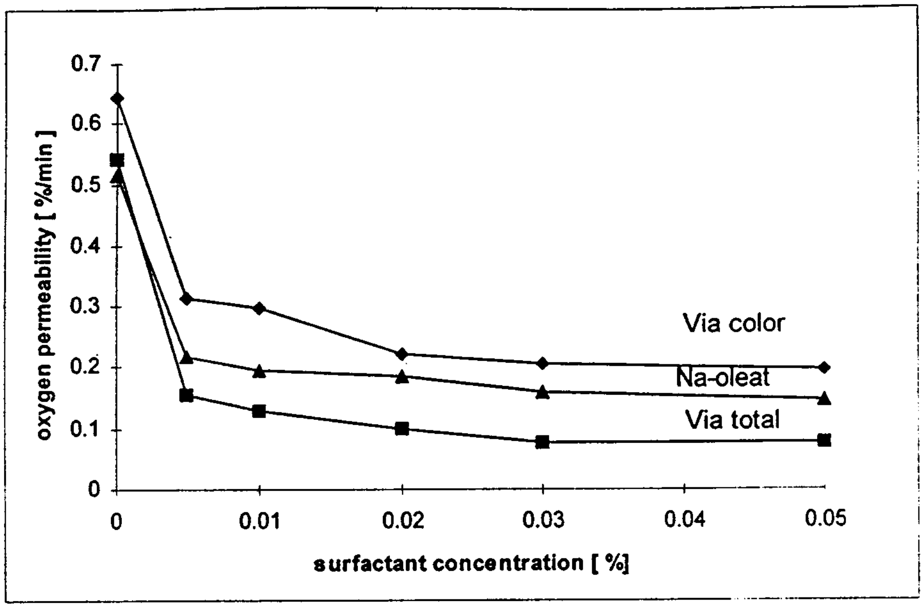

Figure 6. The comparison of influence of two washing powders and Na-oleat to the oxygen permeability through air water surface.

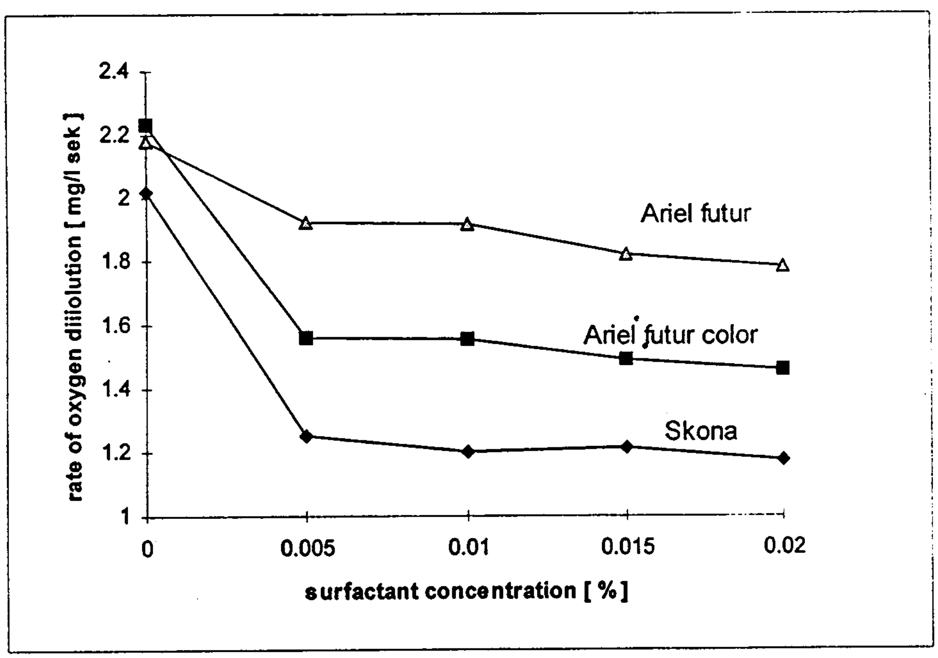

Figure 7. The rate of oxygen dissolution in washing powder solution.

As it is seen from figures 4-6, the decline of oxygen diffusion is more deep in the water solutions with longer alcohol molecules. The diffusion rate is reduced from methanol to penthanol. The increasing of the lenght of hydrocarbon chain diminishes the solubility of surfactants and therefore the surface activity will arise.

At the same time the iso-alcohols show the bigger resistance to oxygen molecules. Comparing the influence of 1-propanol and 2-propanol to the oxygen permeability through air-water surface shows that 1-propanol with straight chain has less influence on the gas transfer. But 2-propanol covers a larger area in the surface and by the same concentration the permeability of a gas molecule passing through air-water surface diminishes more (Fig.5).

b) Aeration measurements of deaerated waters.

In figure 6 the comparison of the influence to oxygen permeability through air-water surface of three washing powders as compound of unknown surfactants (modelling wastewater to contain unknown surfactants) and Na-oleat is given. It can be seen from figure 7. washing powders can give rather different impact to the resistance of oxygen permeability.

CONCLUSION

The above described experimental results will be on the basis for working out the analytical method for measuring the complex behavior of the surfactants to the rate of gas permeation through gas-liquid boundary. Oxygen exchange between the gas phase and water is especially important for wastewater cleaning systems where the increasing of surfactant concentration in water decreases the rate of oxygen dissolution in water and therefore it needs more energy to maintain the desired oxygen level.