Possibilities of Oil Slick Detection on the Sea Surface Using Radar

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***Abstract* – Possibilities of oil films detection on the sea surface and distinction them from natural marine slicks and look-alikes phenomena are discussed.**

***Keywords*— radar detection, oil films**

I. INTRODUCTION

It is well known that surfactant films, either biogenic or antropogenic origin, can strongly damp short gravity-capillary waves and can appear as slicks, i.e. areas of depressed wind waves on the sea surface (see, [1-3] and references therein). Slicks are clearly seen in radar imagery of the sea surface at low and moderate wind velocities [4-6], and investigation of radar slick signatures is particularly important for monitoring of pollutions in the ocean. The slick signatures can be characterized by their shape and by variations of radar backscatter in slicks. Analysis of the geometry of oil slicks is insufficient for slick characterization and for discrimination between oils slicks and look-alikes. Very important additional information about film slicks can be obtained from the analysis of transformation of the spectrum of wind waves due to films. The most important for the problem is the action of films on decimeter-centimeter-scale wind waves. It is because wind waves in this range are very sensitive to the presence of films and because satellite synthetic aperture radars (SAR) usually operate in L-, C- or X- radar bands. A very efficient approach for investigation of the action of films on wind waves is field experiments with artificial films with known physical characteristics. In this paper we summarize results of field experiments with artificial slicks conducted by the Institute of Applied Physics, analyze physical characteristics of surfactant films and peculiarities of the spectrum of short wind waves in slicks, and discuss possibilities of film identification and characterization using radar probing of the sea surface.

II. CHARACTERISTICS OF SURFACTANT FILMS

The main physical characteristics of surfactant films responsible for wave damping effect are the viscoelasticity and the surface tension. Information about these parameters in the literature is still quite limited. We developed a new method of investigation of film characteristics - a parametric wave method (see, [8,9]), which is based on measurements of the damping and wavelengths of monochromatic gravity-capillary waves and on retrieval of the film characteristics when comparing the measured values with theory.

A. Characteristics of marine surface films.

To investigate characteristics of marine films the parametric method was combined with a net method of film sampling, and "a surfactant mass transfer coefficient" for the nets was estimated. This allowed us to reconstract marine films in laboratory conditions at surfactant concentrations close to 'in situ' concentrations. The measured film pressure values (the difference between the surface tension for slick and nonslick areas) can be of order 5 mN/m to 10 mN/m. The film elasticity values are up to 30-40 mN/m in slicks, while in nonslicks the elasticity normally does not exceed 3-4 mN/m.

B. Characteristics of monomolecular films used in experiments with artificial slicks

The film elasticity and the surface tension coefficient were studied for different substances, namely for oleyl alcohol (OLA), oleic acid (OLE), dodecyl alcohol (DA), polymer polyoxyalkylene glicol (Emkarox) and vegetable oil (VO). It was obtained that at concentrations exceeding the concentrations of saturated monolayers the elasticity and the surface tension coefficients are nearly constant, and these values for the mentioned substances are varied in a wide range, as shown in Table I. It follows from Table I that VO, OLA and OLE can be used to model typical biogenic films.

C. Characteristics of crude oil/oil derivative films.

Crude oil/oil derivatives form surface films of finite thickness, and they are characterized by a larger number of parameters: surface and interfacial viscoelasticities tension coefficients, film thickness and volume oil viscosity. Wave damping coefficient and effective surface tension were measured for crude oil, diesel fuel and kerosene (see, [10]). Some results are shown in Fig. 1. Preliminary estimations of the film parameters allowed us to conclude that thin oil films can be roughly characterized by comparably low elasticity values (smaller that 10 mN/m), while the volume viscosity of oil is at least one order of magnitude larger than the water viscosity.