Design and development of underwater laser spectroscopic system for hydrocarbon deposits exploration

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The structural scheme of underwater laser spectroscopic system for hydrocarbon deposits exploration was considered. This equipment can be used to scan from the ship in aqueous environments with limited visibility, and spectral-temporal analysis of the Raman scattering of the hydrocarbons in these environments.

**Keywords**—Lidar, Raman scattering, Raman spectroscopy, selection of signals.

Offshore mineral resources of the oceans, and especially hydrocarbon, are the largest and hard-to-reach reserve for the development of the fuel and energy complex. There are currently developed laser-based methods of lidar technologies that allow making remote express analysis. [1] Raman spectroscopy method allows for geochemical analysis of gases, liquids without taking prob. Thus, it is an effective tool for use in deepwater environments.

The underwater laser spectroscopic system under development structurally consists of two recording units having one laser system: the scanning unit for monitoring the aquatic environment and the unit for researching the spectrum of hydrocarbons with one control system. The source of the radiation is Nd: YAG solid laser system LQ115 - 02, manufactured by SOLAR Laser Systems with 532 nm wavelength, 45 mJ pulse energy, 1 Hz pulse repetition frequency. The scanning unit designed based on gated electro-optical digital camera (EOC). The unit for researching the spectrum composed of second EOC associated with a spectrograph that allows making rapid analysis of the Raman spectrum. The recording system must be located in the immersion block with porthole. Control of the entire complex is carried out from a surface vessel.

After the formation of the radiation beam directed to the output optical system, the radiation is sent to an aqueous environment. At contact with an underwater object that containing of hydrocarbons, radiation is scattered including shifted frequency corresponding to the Raman transition of this hydrocarbon. This part of the back Raman scattered radiation is captured by input optical receiving system, where formed a beam of photons. These photons arrive at the spectrometer scan spectrum, which is transmitted to the input window of the gated EOC. With change the time delay between the generation of the laser pulse and the camera shutter fires we can scan aquatic environment at different depth range. (Fig.1)

![Fig.1 Example of Raman signal of methane at a wavelength of 630 nm using a gated EOC](image1)

Schematic diagram of the underwater laser spectroscopic system under development is presented on Fig.2.

![Fig. 2. Schematic diagram of the underwater laser spectroscopic system for hydrocarbon deposits exploration.](image2)