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INTERACTION OF TWO-FREQUENCY ELECTROMAGNETIC WAVES WITH ANISOTROPIC MEDIA OVER HYDROCARBON ACCUMULATION

Viktar F Yanushkevich, Dzmitry A Dauhiala, Aliaksandr L Adamovich, Siarhei N Abramenka and Siarhei V Kalintsau

Polotsk State University

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Abstract

The article analyzes the interaction of two-frequency electromagnetic waves with anisotropic media over hydrocarbon accumulation. The behavior of the real component $\dot{\varepsilon}_3$ of the dielectric permittivity tensor is investigated. The choice of signal characteristics is based on the use of different electromagnetic wave emission sources with amplitude and frequency ratio coefficients in the modes of powerful low-frequency and high-frequency signals. The dielectric permittivity tensor component $\dot{\varepsilon}_3$ as a function of dielectric permittivity and frequency of sounding signals was analyzed. Sounding modes of anisotropic media over hydrocarbons are recommended to identify the medium over the deposits and increase the accuracy of determining the boundaries of hydrocarbon accumulation. The obtained results of the research can be used in prospecting geophysics.

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$$\vec{S}(t) = \vec{S}_1(t) + \vec{S}_2(t) = A_1 \cos \omega_1 t + A_2 \cos \omega_2 t, \qquad (1)$$

where $A_1, A_2, \omega_1 = 2 \cdot \pi \cdot f_1$, $\omega_2 = 2 \cdot \pi \cdot f_2$ - amplitudes and frequencies of two EM waves respectively.

The choice of signal characteristics for such electrical exploration tasks is based on the use of different emission sources of EMW with coefficients of amplitude and frequency ratio

$$k_E = \frac{A_2}{A_1}, \quad k_\omega = \frac{\omega_1}{\omega_2} \qquad (2)$$

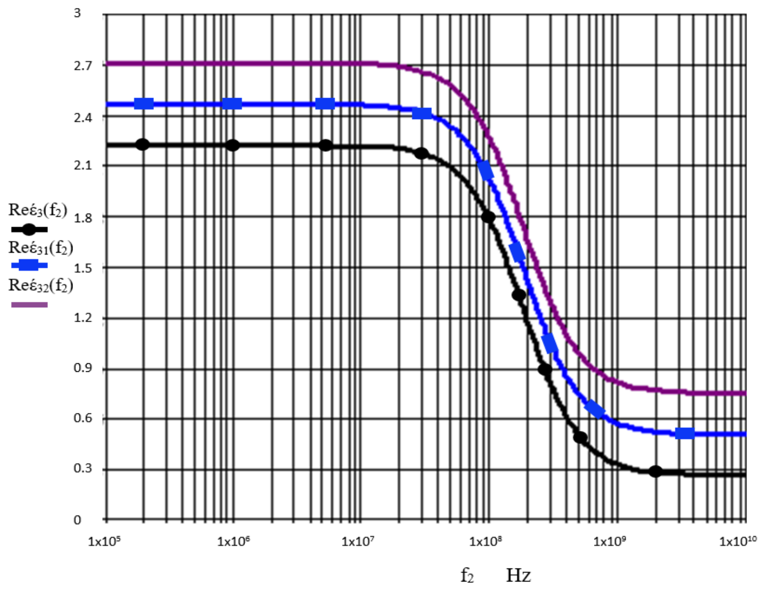

Figure 1. Dependencies of the Re $\dot{\varepsilon}_3$component on the high-frequency component of the signal for $k_\omega = 10^{-1}, k_E = 10^{-1}$, $N_e = 10^{16}$ m^{-3}, $N_i = 10^{18}$ m^{-3}.

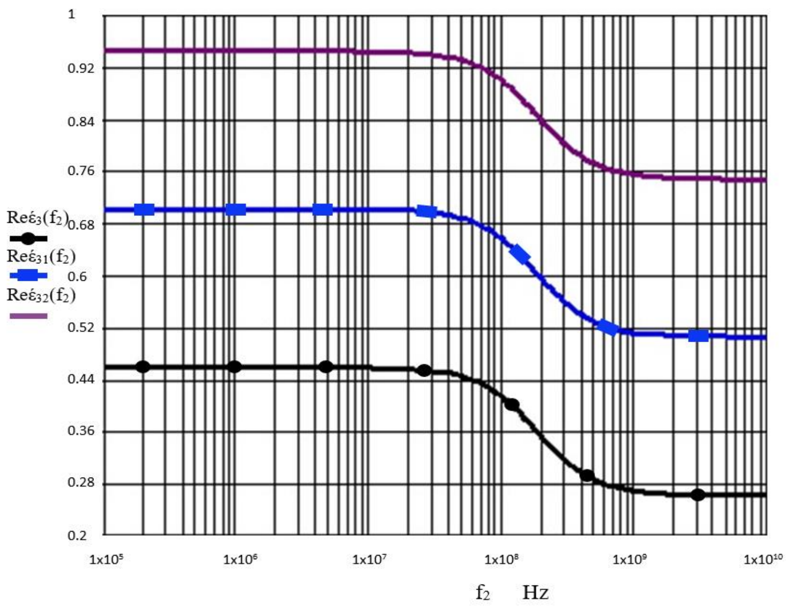

Figure 2. Dependencies of the Re $\dot{\varepsilon}_3$ component on the high-frequency component of the signal for $k_\omega = 10^{-1}, k_E = 10^{-1}$, $N_e = 10^{16}$ m^{-3}, $N_i = 10^{17}$ m^{-3}.

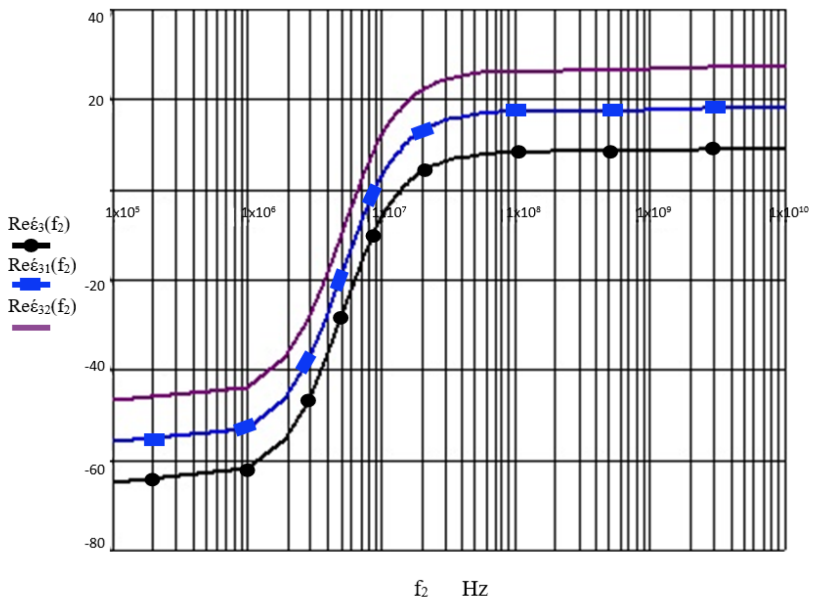

Figure 3. Dependencies of the Re $\dot{\varepsilon}_3$ component on the high-frequency component of the signal for $k_\omega = 10^{-6}, k_E = 10$, $N_e = 10^{16}$ m^{-3}, $N_i = 10^{18}$ m^{-3}.

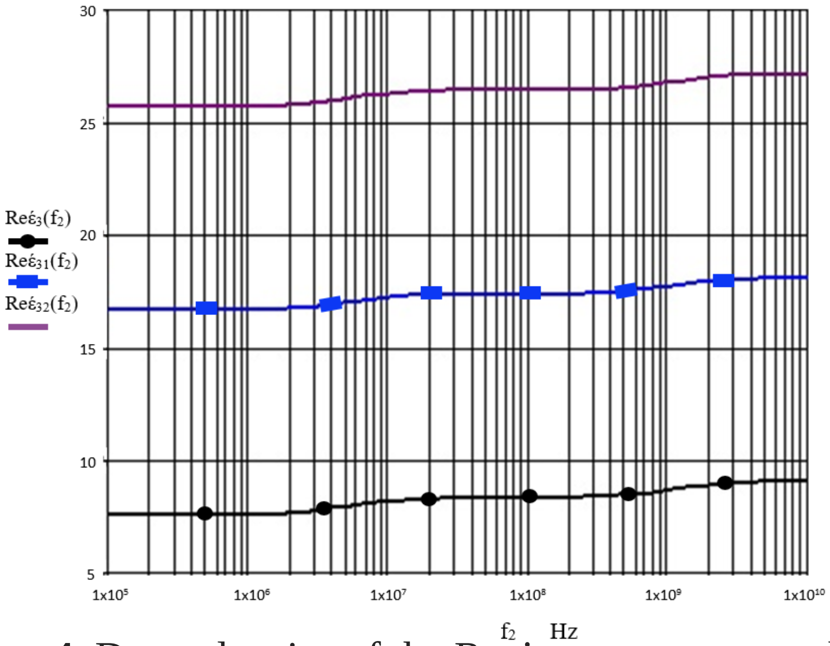

Figure 4. Dependencies of the Re $\dot{\varepsilon}_3$ component on the high-frequency component of the signal for $k_\omega = 10^{-6}, k_E = 10$, Ne = 10^{16} m^{-3}, Ni=10^{16}m^{-3}.

Conclusion

The analysis of two-frequency EMW interaction with anisotropic media over HC deposits in LF and HF signal modes showed:

- In the mode of low-frequency exposure the range of the HF component of the two-frequency signal f_2 = (2·10^7 Hz – 2·10^9 Hz) at particle concentrations of $N_e = 10^{16}$ m^{-3}, $N_i = 10^{18}$ m^{-3}, characterized by a sharp change in the real component of the dielectric permittivity tensor of the medium over the HC deposits, is of interest;
- In the mode of high-frequency exposure a sharp increase in the material component of the tensor component $\dot{\varepsilon}_3$ with transition through zero at the interval f_2 = (5 – 15) MHz at particle concentrations of $N_e = 10^{16}$ m^{-3}, $N_i = 10^{18}$ m^{-3} is observed.