FDTD Analysis of Dipole Antenna with Conductive Sheath-Cover for Seawater Use

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1. Foreword To design antennas for seawater communication systems, the transmission factor of dipole antennas with sheath-cover are investigated by FDTD analysis. Effect of conductivity of sheath to the antenna characteristics is investigated.

2. Analysis model Fig. 1 shows the model for numerical analysis. Relative permittivity of ε_r=80 and conductivity of σ=4 S/m was used as surrounding seawater. Two dipole antennas with length of L=2 m covered by the liquid sheath-cover (ε_r=80, σ_s [S/m], w_s=100 mm) and with the PVC-cover (ε_r=3, σ_{PVC} [S/m], t_{PVC}=25 mm) as shown in Fig. 1 are located in seawater separated 2 m.

3. Results In order to evaluate the maximum received power between Tx/Rx antennas in the seawater, the transmission factor was calculated [1]. Fig. 2 shows the transmission factor τ of dipole antennas with changing the conductivity of liquid sheath-cover σ_s. It is observed that τ increase significantly in frequency range f < 2 MHz for all cases. The wavelength λ_g in the seawater at 2 MHz is about 1 m, and it is considered the near-field coupling appears between Tx/Rx antennas with distance $d < 2\lambda_g$. Also it is note that τ increases significantly as the conductivity of sheath-cover σ_s increases. Fig. 3 shows the transmission factor τ of dipole antennas when the liquid sheath-cover with σ_s=10 are surrounded by the PVC-cover. τ has been decreased by the presence of PVC of σ_{PVC}=0.01 S/m, however, τ can be increased significantly by increasing the conductivity of PVC σ_{PVC}.

4. Conclusion The transmission factor between two dipole antennas in seawater has been evaluated by using FDTD analysis. It has been found that higher transmission factor is obtained by using high conductive sheath-cover.

[1] H. Sato, N. Fujii, Q. Chen, N. Ishii, M. Takahashi, R. Suga, K. Uesaka and H. Yoshida, "Dipole Antenna With Sheath-Cover for Seawater Use," International Symposium on Antennas and Propagation (ISAP2017), 1376, pp.1-2, Phuket, Thailand, Oct. 2017.

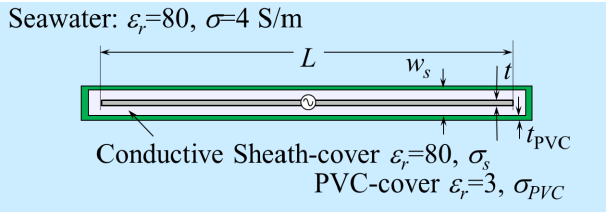

Fig. 1. Analysis of dipole antenna with sheath-cover.

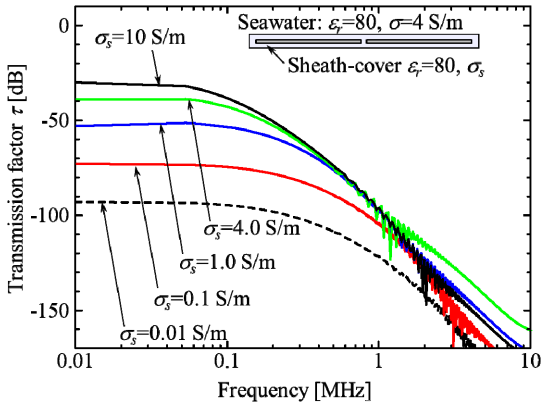

Fig. 2. Transmission factors τ with changing σ_s.

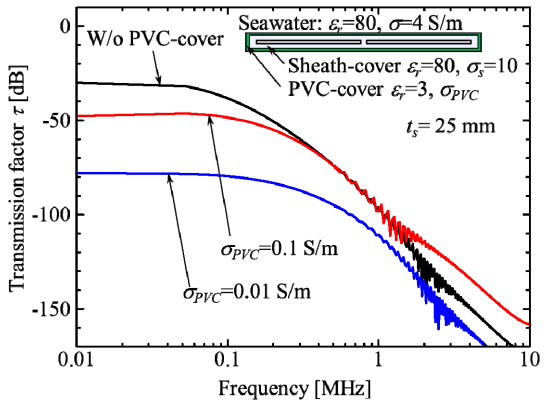

Fig. 3. Transmission factors τ with changing σ_{PVC}.