

Wireless Power Transmission to Equipment in Closed Space Box by Acrylic

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Abstract -It became clear that wireless power transmission can be performed to equipment in the closed space box by acrylic. When sea water was existed between acrylic plates, it was clarified that transmitting efficiency was deteriorated rapidly.

Index Terms — Wireless power transmission, Closed space, spiral coil and helical coil, fresh water and sea water.

I. INTRODUCTION

Recently, wireless power transfer (WPT) with magnetically coupled resonance proposed by MIT has considerable advantages because of its mid range transfer distance and high transmission efficiency.[1],[2] The research and development on wireless power transfer attracts our attention because WPT system enables us to change mobile phones, notebook computers and electrical vehicles.

The effects of metal or water circumstance on wireless power transmission efficiency were investigated. [3],[4]

However, the effect of wireless power transmission to equipments in closed space box by acrylic box or glass for deep sea investigation as shown Fig.1 is unknown.

In this paper, wireless power transmission efficiency of many cases such as distance from coil to acrylic plate, and thickness of acrylic plate in closed space box by acrylic was simulated. And comparison of coil such as spiral and helical was carried out about efficiency. Furthermore, power transmitting efficiency was also examined when water or sea water was existed between acrylic plates.

II. SIMULATED RESULTS

Fig.2 shows the arrangement of spiral coils and the size parameters of spiral coils. The power transmission efficiency was simulated by using ansys-HFSS. In this simulation, acrylic plate was used instead of acrylic box.

Fig.3 shows the simulated power transmission efficiency as a parameter of air gap distance between the transmitting spiral coil and the receiving spiral coil without acrylic. At distance between coils was 200 mm, 87 % power transmission efficiency in single peak was obtained.

Fig.4 shows the simulated result of the distance from the transmitter coil to the acrylic plate when the thickness of acrylic plates was 10 mm. The simulated results suggested that transmit and receive spiral coils were near the acrylic plate, power transmission efficiency was deteriorated and the resonance frequency was shifted. On the other hand, when

the distance between the spiral coil and the acrylic plate were detached 20 mm, degradation of efficiency was not occurred.

Fig.5 shows the simulated power transmission efficiency as a parameter of thickness of acrylic plate between the transmitter spiral coil and the receiving spiral coil when the distance from the transmitter coil to the acrylic plate was 20 mm. The efficiency was about 86 %. So, it was clarified that transmitting efficiency is not dependent on the thickness of acrylic plate.

Fig.6 shows the arrangement of helical coils and the parameters of helical coil size.

Fig.7 shows the comparison of the simulated power transmission efficiencies using spiral coil and helical coil. When the coil was near the acrylic plate, the transmission efficiency was lower. But the efficiency by using the helical coil was high compared than that by using spiral coil. On the other hand, when the distance between the acrylic plate and the coil was exceeded 20 mm, it was clarified that the efficiency using the spiral coil was higher.

Fig.8 shows the simulated results of transmission efficiency when fresh water or sea water was existed between acrylic plates. In this simulation, the spiral coil was used. When fresh water was existed between acrylic plates, almost same transmitting efficiency comparison of air was obtained. But when sea water was existed between acrylic plates, it was clarified that the transmitting efficiency was deteriorated rapidly.

III. CONCLUSION

The simulated results suggested that transmit and receive coils were near the acrylic plate, power transmission efficiency was deteriorated and the resonance frequency was shifted. On the other hand, when the distance from coil to acrylic was detached 20 mm, degradation of efficiency was not occurred. High transmitting efficiency was obtained by using the spiral coil compared than that of helical coil.

When sea water was existed between acrylic plates, the transmitting efficiency was deteriorated rapidly.

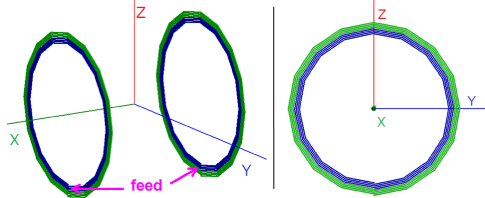
It became clear that wireless power transmission can be performed to the equipment in the closed space box by acrylic.

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Fig. 1. Example of closed space acrylic box for wireless power transmission.



Radius=110[mm], line thickness=line width=1[mm], pitch=1[mm], feed=1 × 1[mm], Number of turns=8[volume], material of coils=copper, air gap=parameter[mm]

Fig. 2. Arrangement of spiral coil and its size dimensions.

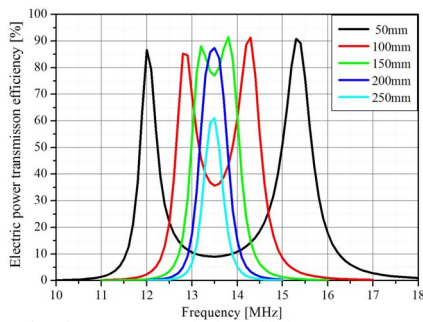


Fig. 3. Simulated power transmission efficiency as a parameter of air gap.

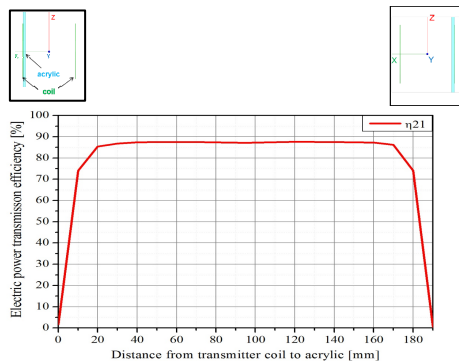


Fig. 4. Simulated power transmission efficiency as a parameter of distance from transmitter spiral coil to acrylic plates.

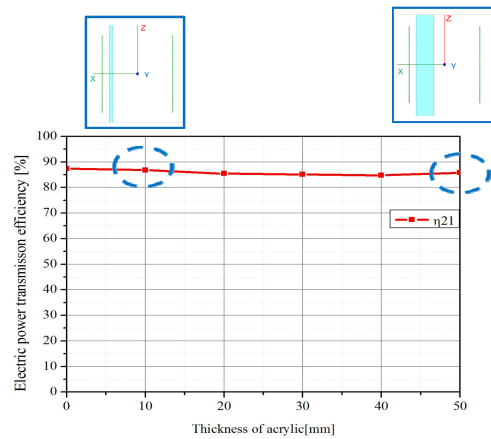
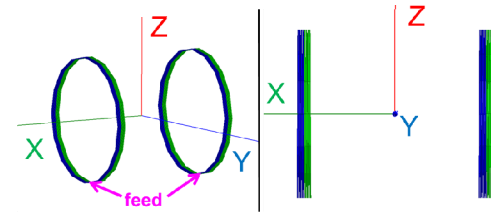


Fig. 5. Simulated power transmission efficiency as a parameter of thickness of acrylic plate.



Radius=100[mm], line thickness=line width=1[mm], pitch=1[mm], feed=1 × 1[mm], Number of turns=8[volume], material of coils=copper, air gap=200[mm]

Fig. 6. Arrangement of helical coil and it's size dimensions.

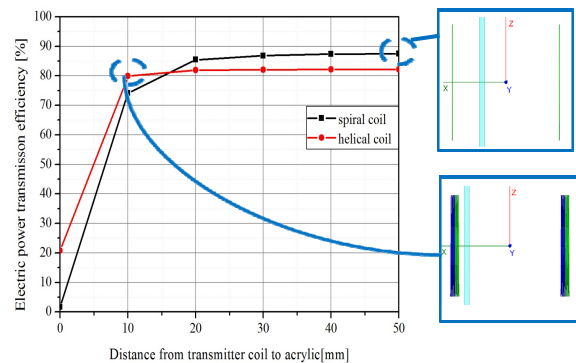


Fig.7 Comparison of power transmission efficiency by using spiral coil and helical coil.

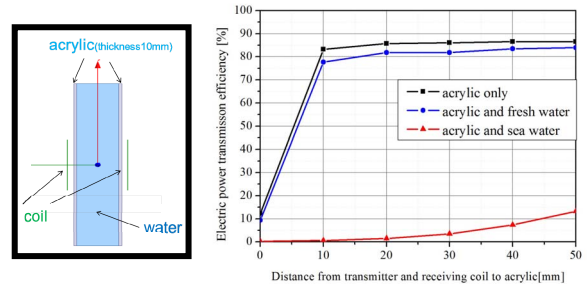


Fig. 8. Comparison of power transmission efficiency when fresh water or sea water was existed between acrylic plates.