

A Corrugated Horn Antenna with A Dielectric Lens for High Gain Performance

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Abstract – A corrugated horn antenna with a dielectric lens for high gain performance is proposed in this paper. The proposed antenna consists of a corrugated conical horn antenna and a dielectric lens at the aperture. The material used for the dielectric lens is Teflon having the relative permittivity of 2.1. The proposed antenna provides wide bandwidth to cover the X band(8~12GHz) and high gain performance. The simulated 10-dB return loss bandwidth is 7.2GHz ranging from 6.5GHz to 13.7GHz with the antenna gain of 23.6dBi at the center frequency(10GHz). The overall dimension of the proposed antenna is 110 mm × 110 mm × 135 mm. The high gain performance of the proposed antenna is typically suited for level transmitter system of a tank containing gas having low-permittivity.

Index Terms — corrugated horn antenna, dielectric lens, high gain, X band, level transmitter

I. INTRODUCTION

Most of offshore plants and vessels a tank containing various gas materials such as LNG, LPG and chemical gas such as vinyl chloride[1]. Each tank has to be equipped a level transmitter for sensing liquid-level of liquefied gas having various relative permittivity. Among many types of gas, LNG, typically, has the lowest relative permittivity showing very low rate of electromagnetic wave reflection at the liquid surface level. Such feature of LNG requires an antenna of a level transmitter module to have a very high gain performance at the desired frequency[2]. Although many researches about high gain antennas have been conducted[3-6], most of antennas in these researches could not provide a gain high enough for the aforementioned application.

In this paper, a corrugated conical horn antenna with high gain performance operating over the X band is proposed. The proposed antenna consists of corrugated conical horn antenna with a dielectric lens made of Teflon inserted at the aperture. The proposed antenna operates at X band(8~12GHz) with high gain at the center frequency(10GHz).

II. ANTENNA DESIGN AND SIMULATION RESULTS

Figure 1(a) shows the geometry of the proposed antenna. Materials used for the antenna and the dielectric lens are aluminium alloy and Teflon($\epsilon_r=2.1$), respectively. The corrugation is applied to increase surface impedance of the internal wall of the waveguide that the impedance matching of the antenna is improved. The dielectric lens is inserted to

make the maximum radiation occurred towards the orthogonal direction of aperture for high gain performance.

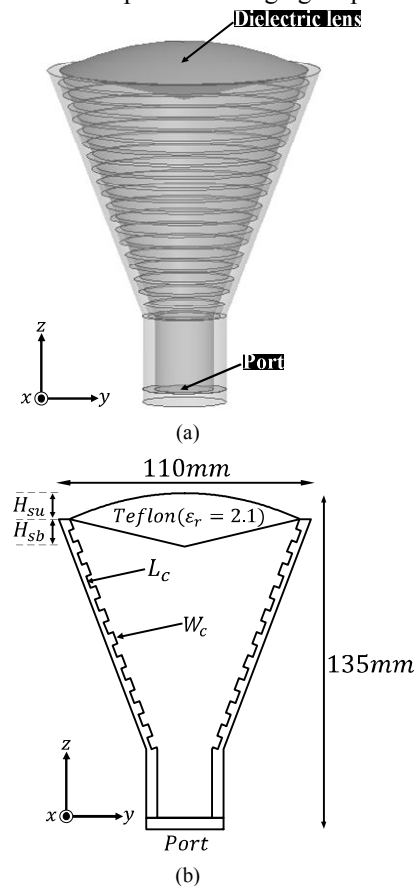
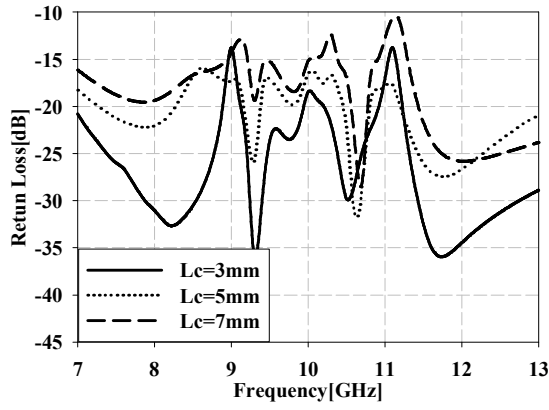


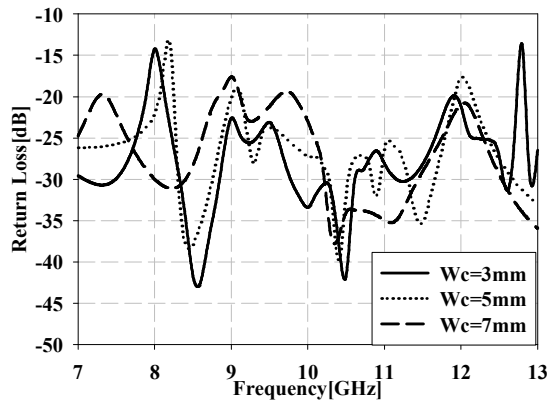
Figure 1. Configuration of the proposed antenna: (a) perspective view, (b) cross-sectional view

Figure 1(b) shows the detailed dimension of the antenna. Parameters which significantly affects the bandwidth and gain characteristics of the antenna are H_{su} , H_{sb} , L_c and W_c . Corrugation parameters, H_{su} and H_{sb} , mainly affect the impedance matching characteristic and dielectric lens parameters, L_c and W_c , significantly affect the gain performance. The overall dimension of the antenna is 110 mm × 110 mm × 135 mm.

Figure 2 (a) and (b) show the simulated return loss characteristics of the antenna for various lengths of L_c and W_c . As parameters L_c and W_c are decreased, the return loss at 10GHz is enhanced as is depicted in each plot.



(a)



(b)

Figure 2. Simulated return loss characteristics for various corrugation parameters: (a) L_c , (b) W_c .

Figure 3 shows the simulated gain characteristic for various lengths of H_{su} which is a parameter defining the curve surface of dielectric lens. As H_{su} is increased, the peak gain of the antenna towards the orthogonal direction of the antenna aperture is increased. The dielectric lens operates as a lens focusing the electromagnetic wave radiation propagating through the aperture so that the beam pattern of the antenna becomes sharper as H_{su} is increased.

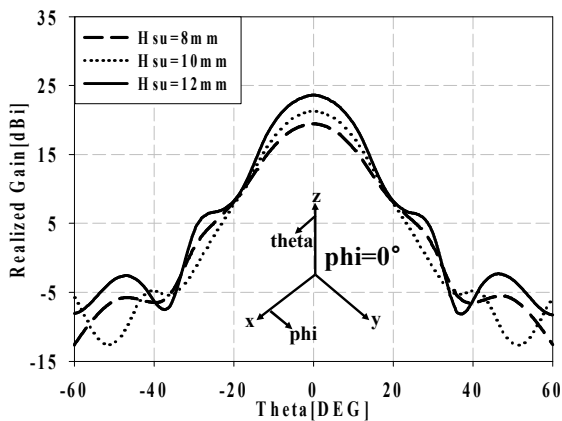


Figure 3. Simulated gain characteristics for various lengths of H_{su}

Figure 4 depicts the simulated radiation patterns of the antenna at 10GHz using optimized parameter values shown in Table 1. As can be seen in the figure, radiation patterns in

xz -plane and yz -plane are very similar and the peak gain value towards orthogonal direction of the antenna aperture is 23.8dBi.

	L_c	W_c	H_{su}	H_{sb}
Value(mm)	3.2mm	3.0mm	11.3mm	12mm

Table 1. Optimized parameter values of the proposed antenna

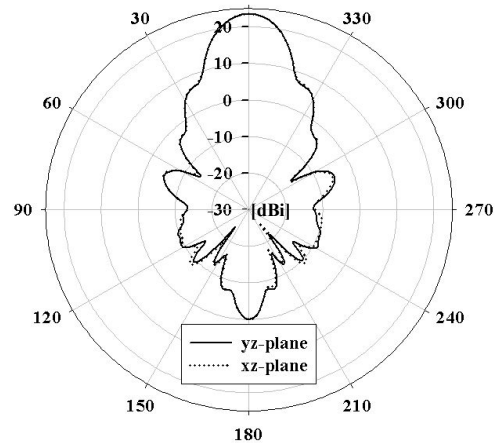


Figure 4. Simulated radiation patterns of the proposed antenna

III. CONCLUSIONS

A corrugated horn antenna with a dielectric lens having high gain performance is proposed in this paper. Simulated 10-dB return loss bandwidth is wide enough to cover the desired X band. The antenna provides a highly directive radiation pattern with the peak gain of 23.8dBi. The proposed antenna is a suitable candidate for level transmitter system applications.

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