Underwater electromagnetic communications

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Underwater communication using an em-wave:-

Underwater electromagnetic communications have been investigated since the very early days of radio communication and again received considerable attention during the 1970's. in those days only the extremely low frequency (ELF) submarine communications system is believed to be the only successfully devolved subsea electromagnetic application. Its implementation was only one way communication to call individual at surface of higher bandwidth using terrestrial radio. Under water networking is a rather unexplored area although underwater communications have been experimented since 2nd world war. In 1945 an underwater telephone was developed in the United States to communicate with submarines. And also underwater sensors and nodes must possess self configuration capabilities like should b able to coordinate their operation by exchanging configuration, location and movement information, and relay monitored data to an onshore station.

Water conductivity:-

Water in its pure form is an insulator, but as found in its natural state, it contains dissolved salts and other matter which makes it a partial conductor, as so in case of the sea water its becomes more conductive medium than normal water. The higher its conductivity, the greater the attenuation of radio signals which pass through it. As the attenuation of the signal increases the signal strength decreases and its leads to difficulties in propagation of the signal. Conductivity of the water varies both with the salinity and temperature. Average conductivity of the sea is normally considered to be

about 4 mhos per meter. What this means that one meter cube of sea water has a conductivity of 4 mhos or a resistance of 0. 25 ohm, (it’s reciprocal).

Attenuation:-

Attenuation of radio waves in water (any conducting medium) increases both with increase in conductivity and increase in frequency. It can be calculated from the following formula:

Attenuation (α) in db/meter = 0. 0173√ (fσ)

Where f = frequency in hertz

And σ = conductivity in mhos/metre

From the figure below states Attenuation as a function of frequency for conductive saline water verses normal water . attenuation in saline or conductive water is very high. It is necessary to use very low frequencies (10 kHz -200 MHz) where attenuation would be very low as in order of 3. 5 to 10db per metre.

Underwater attenuation (VS) frequency

Losses at the surface due to refraction or interfaces:-

As the em waves had pass through the two different medium like water and air they undergo refraction when the wave travels from the air medium to the water medium and this are also important so they can be calculated as by the formula

Refraction loss (db) = – 20 log {(7. 4586/106) x √ (f/σ)}

As this losses plays a vital role in the performance of the system to avoid such looses we can connect an antenna to the terrestrial system hanging it into the water and could reduce the loose and in sea water this looses would be high and in the vicinity 60db for lower frequency. As compared in the sea and normal water the loss decrease with increase in frequency in the figure below we would illustrate the graph between the sea and normal related with the frequency. Air to water looses are very less in the normal water it would as lees as 27db and when in sea water it would be normally between 60 to 70 db.

Wavelength in water:-

The wavelength of the wave signal transmitted wouldn't be same in the water as would be in the air it would a fraction of the original expected signal as shown below

Wavelength (λ) in meters = 1000 √ {10 / (fσ)}

And hence taking all this effects on the wave due to the underwater communication. The communication through the underwater had been developing many process and methods to develop to communication underwater. either using the sound signal or the light signal as they the sound and light are used as means of communication in various fields and hence the method that is used with the sound signal is the acoustic communication and that used after the light is the optical communication they have got their own advantages and disadvantages due to several factors influencing them directly or indirectly. As to over the defects of each the other came into existence and the acoustic and the optical methods of

communication would be referred later in our discussion and the latest and upcoming means of underwater communication is the electromagnetic wave propagation underwater.

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As electromagnetic propagation through water is very different from propagation through air because of waves high permittivity and electrical conductivity like plane wave attenuation is high compared to air and increases rapidly with frequency Through water, full bandwidth, low range, analogue voice communication was found to be impractical and so rapidly it developed an opinion as electromagnetic signals had no application in the underwater environment

Re-evolution of em capabilities:-

As both the acoustic and optical wireless subsea systems have the disadvantages and so the electromagnetic wave subsea system comes into existence. As the electromagnetic signaling transmission using different mechanism. Many of the investigation had proved that electromagnetic signaling coupled with digital technology and signal compression techniques would provide many advantages which can be suitable for underwater application. As the electromagnetic waves would be more attenuated in water than that of the air. Conductivity of the sea water would be 4s/m were in fresh water its mille-s/m range comparatively less than the sea water. Losses in the water are mainly due to the effect of conduction on the conductive field component. The below parameters shows the variation frequency parameters in fresh and sea water in conductivity.

Water relative permeability = μ = 1

Water relative permittivity = ε = 80

Sea water conductivity (typ) = σ = 4 s/m

Fresh water conductivity (typ) = σ = 0. 01 s/m