An Overview on High Power and Medical Ultrasonics in Nature

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Opinion Article

Received: 01-Dec-2023, Manuscript No. JPAP-24-124056; **Editor assigned:** 04-Dec-2023, Pre QC No. JPAP-24-124056 (PQ); **Reviewed:** 18-Dec-2023, QC No. JPAP-24-124056; **Revised:** 26-Dec-2023, Manuscript No. JPAP-24-124056 (R) **Published:** 02-Jan-2024, DOI:10.4172/2320-2459.11.4.010.

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Citation: Dew D, An Overview on High Power and Medical Ultrasonics in Nature Res Rev J Pure Appl Phys. 2024;11:010.

ABOUT THE STUDY

Ultrasonics is defined as that band above 20 kHz. It continues up into the megahertz range and finally, at around 1 GHz, goes over into what is conventionally called the hypersonic regime. The full spectrum where typical ranges for the phenomena of interest are indicated. Most of the application described took place in the range of 1 to 100 MHz, corresponding to wavelengths in a typical solid of approximately 1 mm to 10 μm, where an average sound velocity is about 5000 m/s. in water the most widely used liquid the sound velocity is about 1500 m/s, with wavelengths of the order of 3 mm to 30 μm for the above frequency range.

Ultrasonics in nature

The sensing functions include navigation and communication for group interaction or survival such as attracting mates, evading predators. The relative importance of ultrasonics in the sensing arsenal of the animal will depend on such technical factors as attenuation, scattering, directionality and so on as compared to audible or optical communication. There has recently been heightened interest in this field mainly due to the use of highly controlled laboratory experiments. Often this involves surgical intervention to allow direct study of the animal sensing system, accompanied by Magnetic Resonance Imaging (MRI) mapping of the cervical areas involved in different functions. The laboratory also allows controlled modification of the environment, which gives complementary information to field observations. Development of improved ultrasonic instrumentation, microphones and so on has also led to more refined experiments. Very recent work has also focused on breakthroughs in the genetic area.

High power ultrasonics

This was one of the first areas of ultrasonics to be developed, but it has remained poorly developed theoretically. It involves many heavy duty industrial applications and often the approach is semi empirical. Much of the early work was carried out by wood and loomis, who developed a high frequency high power system and then used it for many applications. One of the problems in the early work was the efficient coupling of acoustic energy into the medium, which limited the available power levels. A solution was found with the exponential horn, a crude model was developed by wood and loomis, and this was perfected by mason using an exponential taper in 1950. The pre stressed ceramic sandwich transducers also were important in raising the acoustic power level. Another problem, which led in part to the same limitation, was cavitation. Once cavitation occurs at the transducer or horn surface, the transfer of acoustic energy is drastically reduced due to the acoustic impedance mismatch introduced by the air. However, work on cavitation gradually led to it becoming an important subject in its own right. Ramification of the process led to operations such as drilling, cutting and ultrasonic cleaners. Other applications of cavitation included sonochemistry and sonoluminescence. High power ultrasonics also turned out to be a useful way to supply large amounts of heat, leading to ultrasonic soldering and welding of metals and plastics.

Medical ultrasonics

From a purely technical ultrasonic standpoint, there are many similarities between NDE and medical ultrasonics. Basically one is attempting to locate defects in an opaque object, the same technological approaches are relevant, such as discriminating between closely spaced echoes and digging signals out of the noise. So it is not surprising that many developments on one side have been applied to problems on the other. Of course, there are differences on is that inspection of in vivo samples is an important part of medical ultrasonics. Respiratory effects, blood flow and possible tissue damage are issues that are totally absent in NDE. This has led to much R&D on induced cavitation and cavitation damage as well as development of very sophisticated Doppler schemes for monitoring blood flow.