Chapter 8

LOW FREQUENCY - HIGH INTENSITY ULTRASOUND

Ali AKYÜZ[1]
Mehmet ÖZKAN[2]
Onur İNAN[3]
Kazım KUMAŞ[4]

Introduction

Sound waves are longitudinal waves emitted in solid, liquid or gas medium. Waves are generated by any mechanism that is based on compressing and vibrating the medium surrounding the wave source. The simplest sound waves are sinusoidal waves, which have a certain frequency, amplitude, wavelength, and travel in the form of compression and expansion through an environment. As sound waves move through an environment, there is a change in pressure as well as the location of molecules in the environment. It is more appropriate to show sound waves in physics by pressure changes because the human ear is sensitive to pressure changes. The sound frequency spectrum that the human ear can hear ranges from 16 Hz to 20 kHz. The area below this range is called infrasound and the area above it is called ultrasound. If the pressure change generated by the sound waves is called acoustic pressure, the change in acoustic pressure (P) at a given frequency (f) with respect to time (t) can be given by equation (1).

$$P = P_{max}.sin(2\pi ft) \qquad (1)$$

In equation (1), P_{max} is the maximum acoustic pressure. The maximum acoustic pressure can be given by equation (2). In the equation, v represents the sound velocity, ρ is the medium density, Q is the power transferred to the fluid and A is the surface area of the source [1, 3].

1 Burdur Mehmet Akif Ersoy University, Turkey, aakyuz@mehmetakif.edu.tr,
2 Afyon Kocatepe University, Turkey, mozkan@aku.edu.tr.
3 Burdur Mehmet Akif Ersoy University, Turkey, oinan@mehmetakif.edu.tr.
4 Burdur Mehmet Akif Ersoy University, Turkey, kkumas@mehmetakif.edu.tr.

to acoustic cavitation, i.e., growth and implosive collapse of microscopic bubbles generated in the rarefaction part of the ultrasound field in a liquid. The implosive collapse of bubbles generates extreme conditions like high temperatures and high pressures in very short times.

Keywords: Ultrasound, cavitation, applications.

References

1. Mason, T. J. (1999). Sonochemistry. New York: Oxford University Press.
2. Mason, T. J., Dietmar, P. (1991). Practical Sonochemistry. , New York: Ellis Horwood.
3. Leighton TG. Prog Biophy Molec Bio. 2007; 9: 3.
4. Mason, T. J., Morimer, J.P. (2003). Applied Sonochemistry. New York: Wiley VCH.
5. Henglein A. Ultrasonics. 1987; 25: 6.
6. Crum LA. J Acous Soc Am. 1994; 95: 559.
7. Srivastava, P., Ashokkumar, M. (2011). Theoretical and experimental sonochemistry involving inorganic systems, Dordrecht: Springer.
8. Mittal, K. L., Kohli, R. (2010). Developments in Surface Contamination and Cleaning: Particle Deposition, Control and Removal. Norwich: William Andrew.
9. Kanegsberg, B. and Kanegsberg, E. (2011). Handbook for critical cleaning: Cleaning agents and systems. Boca Raton: CRC press.
10. Mason, T. J., Lorimer, J. P. (1988). Sonochemistry: Theory, applications and uses of ultrasound in chemistry. New York: Ellis Harwood Ltd.,
11. Considine, D.M., Considine, G.D. (2013). Van Nostrand's scientific encyclopedia. New York: Springer Science & Business Media.
12. Pecha R, Gompf B. Physical Review Let. 2000; 84: 1328.
13. Plesset MS, Prosperetti A. Annu Rev Fluid Mech. 1977; 9: 145.
14. Shima A. Shock Waves. 1997; 7, 1:33.
15. Apfel RE. J Acous Soc Am. 1997; 101: 1227.
16. Suslick, KS. Scientific Am. 1989; February:80.
17. Suslick, KS. Science. 1990; 247: 1439.
18. Wong MM. Phil Trans R Soc Lond. 1999; 357: 335.
19. Price GJ. Ultra Sonochem. 2003; 10: 277.
20. Pokhrel N et al. Ultra Sonochem. 2016; 29: 104.
21. Pollet, B.G., Ashokkumar, M. (2019). Fundamental and applied aspects of ultrasonics and sonochemistry. Pollet, Bruno G. (Ed.) Introduction to Ultrasound, Sonochemistry and Sonoelectrochemistry (pp.1-19). Switzerland AG: Springer, Cham.
22. Suslick KS et al. Industrial & Engineering Chemistry Research. 1999; 38: 1215.