The Liquid Bulk Viscosity Effect on the Dynamics of a Single Cavitation Bubble

Hypothesis:

Bubble collapse will result in light emission, known as sonoluminescence, initiating from the core of the bubble during the final moments of collapse.

Introduction:

Sonoluminescence, is an experimental phenomenon which results in light emission generated by imploding bubbles due to sound waves. In this phenomenon, a small gas bubble that is acoustically suspended is periodically driven in water, using ultrasonic frequencies, resulting in bubble collapse. Starting with millimeter-sized cavitation, sonoluminescence is dependent on high ultrasonic amplitudes and high viscosities to implode the bubble. During an implosion, extreme temperatures are generated. Furthermore, the pressure inside a bubble and the maximum pressure value is extremely affected. At the end of the implosion process, and for a short time afterward, there are conditions of extreme energy-infused cavity collapse. High densities and temperatures achieve light emission. As a result of these factors, sonoluminescence is one of the current methods used for estimating the extreme temperatures generated in the bubbles during the implosion. Not only is this experiment educationally beneficial as it shows real physics phenomena, but also has industrial and medical applications which are being studied and tested today.There have been numerous proposals through the years of sonoluminescence being used in medical ultrasounds, assisting boats using high-speed propellers, as well as being helpful in nuclear fission.

Materials:

1. Black paper , Distilled water & 100 mL round bottom flask
2. Araldite 90-Minute AB Epoxy Adhesive-
3. Coil Spool with diameter of 23mm
4. Transducer Plate
5. Digital Oscilloscope
6. Amplifier Board
7. Power Supply
8. Digital Capacitance & Inductance Tester

Procedure:

1. Tape black paper on the counter and wall where this experiment will take place.
2. On a piece of paper, mix an equal amount of each Araldite 90-Minute AB Epoxy Adhesive together.
3. Apply a fair amount of the mixed epoxy adhesive onto the ultrasonic transducer then attach it to the bottom of a round 100 mL flask. Leave it to cure for 90 minutes.
4. Connect the frequency generator into the input of the amplifier using two pieces of coax.
5. Connect the central amplifier to the central power supply using two pieces of coax.
6. With another two pieces of coax connect them to the output of the amplifier.
7. Coil wire around a 28 gauge empty spool about 200 times.
8. Saw two pieces of wire, one from the spool and another separate coax to either side or the bottom of the ultrasonic transducer.
9. Split another transducer disk in half and saw two pieces of wire to the bottom of it.
10. Attach the disk to a random place on the outside of the flask using the epoxy solution , then connect the wires to an oscilloscope.
11. Bring distilled water to a boil for 15 minutes then set it in a cool, tightly closed, container until no bubbles are visible.
12. Once the water is degassed, pour it into the flask up to the neck of it while ensuring no bubbles appear.
13. To hold the flask in place use a clamp around the neck of it.
14. Set the oscilloscope to one volt per division and the frequency to around 25 - 27 kilohertz.
15. Power on the amplifier about half way up
16. Monitor the oscilloscope and adjust the frequency until the signal and scope grow to its max limit.
17. Once you find the resonance point, slide a metal rod in and out of the inductor until the amplifier is as high as it gets.
18. Now adjust the amplifier until it reads 3 volts peak to peak.
19. Using a clean pipette extract a small amount of liquid and let it pour onto the water.
20, With a bubble trapped, slowly turn up the amp.
21. Then cover up any lights that may be in the room, including the lights coming off of the materials used in this experiment.
22. Lastly, turn the light off. Record wattage, voltage, amplifier ic, light emission, resonant frequency and record inductance.

Results

Specs:

Resonant frequency: 28kHz
Wattage: 6-7 watts
Amplifier ic: TPA3118D2 60W
voltage: 24VDC

LC Calculator

27.5kHz 8 nF
4.18 mH

Inductance Calculator:

Loop Diameter 23 mm
Turns 200
Coil Length 37 mm
0.56 mH

Discussion/Conclusion:

We were successful in conducting an experimental phenomenon consisting of sonoluminescence. The concluding result was light emission inside the flask as intended. For this experiment to be successful the resonant frequency was set at 28kHz, wattage set to 7 watts, amplifier set at 60w, and voltage set at 24VDC. The LC Calculator was set at 27kHz, 8nF, and 4.2 mH. And the inductance calculator had 200 turns of coil with a length of 37mm around a spool with a diameter of 23mm producing 0.56 mH. The results were as following: