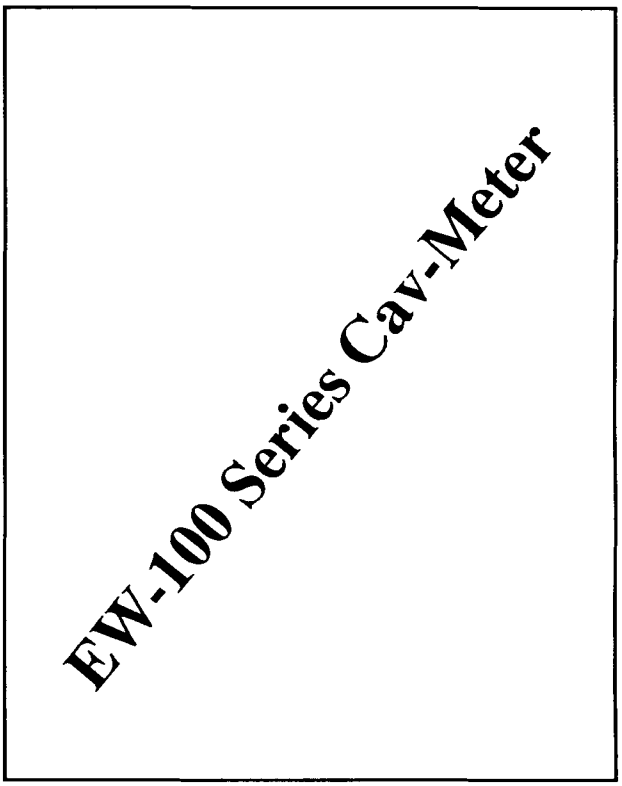
Electrowave 100 series Cavitation Meter

Cavitation Intensity Meter

FOR QUALITY CONTROL OF ULTRASONIC PROCESSING

¤ Repeatable, Instantaneous readings ¤ Accurate in any ultrasonic system ¤ Frequency range 5kHz - 500kHz ¤ Safe, simple operation ¤ All solid state ¤ Temperature range up to 100° C ¤ Flexible sealed probe ¤ Results in quantifiable units of Amperes DC or Volts AC/DC ¤



Electrowave's Cavitation Intensity Meter, Model EW-100, gives instantaneous repeatable readings on the cavitational energy present in any operating system. It provides a practical method for establishing optimum processes and making rapid, positive quality control checks of ultrasonic action. This one-piece, precision quality control instrument consists of a sensitive, flexible probe, a solid state detector with a high quality moving coil meter. It is hand held and powered by a single AA battery for safe, simple operation.

The magnitude and uniformity of cavitation at any location within any ultrasonic system can be monitored quickly and easily using the Electrowave Cavitation Intensity Meter. The readings can be compared with previously established optimum values, any deviations from 'optimum' will be immediately noted on the meter. In this way processing efficiency can be highly controlled.

A universally accepted standard of cavitation intensity has yet to be adopted and although watts per square centimeter is most often used in scientific literature, this is generally a term only referring to *input* wattage vs. radiating surface area, and does not indicate the cavitational intensity in the fluid. It is the job of a good cavitation meter to measure the output, either in watts or amperes, or some other quantifiable units.

Hermetically sealed to the tip of a 24 inch flexible probe the piezoelectric element delivers an electrical output directly proportional to the magnitude of the sonic energy in the liquid. This energy comprises of the basic center frequency, the harmonics of that frequency, as well as broad-spectrum white noise created by the implosions of countless cavitation bubbles. Taken together and summed, these components provide a meaningful measure of cavitation efficiency.

The current output from the probe is displayed on a moving coil meter. Readings are obtained instantaneously. The meter has one main control and provides sensitivity selection for monitoring the lower cavitation levels found in solvents, as well as the higher levels found in lower frequencies or focused transducers. See *'Frequency vs. Cavitation Values'* chart.

OPERATION 1.) Fill apparatus with clean liquid. 2.) Degas the liquid by operating the system for several minutes. 3.) Insert the Cavitation Intensity Meter probe approximately two inches below the liquid surface. 4.) Divide the apparatus into sections, taking a reading in each section. 5.) Repeat steps 3 & 4 at deeper levels.

Cavitation is a function not only of the liquid selected, but also the liquid temperature and state of aeration. Most low boiling point solvents are more difficult to cavitate than water based solutions, and the intensity developed may vary by a wide factor. Heavily aerated solutions will support less cavitation, while warmer solutions, up to certain limits, are generally easier to cavitate than cold solutions. (See 'Comparison Of Ultrasonic Cavitation Intensity In Various Liquids' chart)

SPECIFICATIONS EW-100 Series Cavitation Meter	
Frequency Range	5kHz to 500kHz
Temperature Range	-40°C to +100°C
Power Requirements	Single AA Battery
Circuitry	100% Solid State
Meter	Precision, moving-coil
Probe	24" Flexible PZT-type
Control	Multi-position switch
Repeatability	~5% or better
Response Time	Instantaneous
Weight	~1 lb.
Warranty	1 year

Electrowave Ultrasonics Corporation is the manufacturer and distributor of the finest built most powerful ultrasonic equipment in the world! Our clients include all branches of the U.S. military, foreign governments and their military and multinational corporations around the world. As the requirements for ultrasonics become more stringent the specific brand ELECTROWAVE, with the highest power and intensity levels in the business, is sought and specified by most industry leaders. Electrowave has become the standard against which all other ultrasonics are compared. It is our guarantee to you that you will find no competitive product that even comes close. Call or write for a free brochure.

FREQUENCY VS. CAVITATION VALUES

Values For Water Only

Frequency (KHz)	Bubble Radius [$R_o = (3\gamma p_o/\partial(2\pi f)^2)^{1/2}$] (Microns)	Bubble Volume (Intensity) (Cubic Millimeters)	Intensity Ratios (Cavitation Deferential)	Surface Area (Square Millimeters)	Surface Area Ratios	Relative Number of Bubbles At Equal Watt Density (Per Second)
10	330	0.15	(100)	1.37	(100)	10
20	165	0.019	(12.5)	0.34	(25)	20
30	110	0.006	(3.70)	0.15	(11.1)	30
40	83	0.0024	(1.56)	0.086	(6.25)	40
50	66	0.0012	(0.80)	0.055	(4.0)	50
60	55	0.0007	(0.46)	0.038	(2.76)	60
70	47	0.0004	(0.29)	0.028	(2.03)	70
80	41	0.0003	(0.19)	0.021	(1.56)	80
90	37	0.0002	(0.14)	0.017	(1.26)	90
100	33	0.00015	(0.10)	0.014	(1)	100

Intensity, strictly speaking, is a measurement of a transducers amplitude at any given frequency. The piezoelectric probe used with the cavitation meter will obtain measurements in amplitude(DC) or voltage(AC or DC) for any specific requirement the system operator may have. Cavitational intensity, however, in a liquid is a measurement of heat produced by the implosion of bubbles. The cavitation meter does not measure heat, but rather measures the transducers amplitude in relation to the efficiency of the cavitating liquid. The piezoelectric probe acts as an amplitude and voltage inductor to convert the cavitational waves into quantifiable units. This allows the operator to check the efficiency of various liquids under the influence of ultrasonics (See *Comparison of Ultrasonic Intensity in Various Liquids* Chart).

Cavitation meter readings may be obtained in units of Amperes(DC), Volts(AC), or Volts(DC) depending on user preference. Since there is no universally accepted standard for the measurement of cavitation units this meter is designed to operate in all three basic modes. The piezoelectric sensor has a conductive area of only one square centimeter yielding meter readings of units per square centimeter. If wattage per square centimeter is desired, a reading in Amperes(DC) may be taken and simply multiplied by the operating voltage. Remember, however, that you are taking a random-position reading and are not necessarily measuring the radiating surface output of the transducer. At Electrowave Ultrasonics Corporation the minimum acceptable level of cavitational intensity for an ultrasonic cleaning system is on the order of 750µAmperes/cm2 at 45KHz. It has been our experience that many ultrasonic systems do not meet this minimum level, and as a result efficiency is lost and processing time is increased.

The cavitation meter readings are highly reproducable and will indicate quickly the degradation of an ultrasonic system, or allow comparisons between any number of systems operating at the same frequency. For comparison of systems operating at different frequencies cavitation intensity ratios can be quickly calculated as follows:

COMPARISON OF TWO ULTRASONIC SYSTEMS OPERATING AT DIFFERENT FREQUENCIES

FREQUENCY VARIATIONS: Lower frequencies will show more intensity on the meter than higher frequencies due to the larger cavitation volume (bubble size) that is produced by the lower frequencies. (See Chart)When comparing two ultrasonic systems it will be necessary to obtain frequency readings with an oscilloscope [Connect scope to positive terminal of transducer]. Once frequency readings are obtained from both ultrasonic systems the intensity ratios can be calculated as follows:

$$\left(\frac{F2}{F1}\right)^3 = I_R$$

F2 = Higher Frequency
F1 = Lower Frequency
I_R = Intensity Ratio

Example: $\left(\frac{80KHz}{50KHz}\right)^3 = 4.1$

Therefore, all things being equal (output wattage, liquid volume and source-type), the lower frequency (50KHz) will show an intensity increase of over four times greater than the higher frequency (80KHz). For instance a meter reading of 500µA/cm2 at 80KHz would extrapolate to over 2000µA/cm2 at 50KHz.

Keep in mind, however that although lower frequencies show greater 'absolute' intensity they produce proportionally less cavitation points (bubbles), and the wavelengths between these points are proportionally further apart.