Instrumental Technique: probe sonicator

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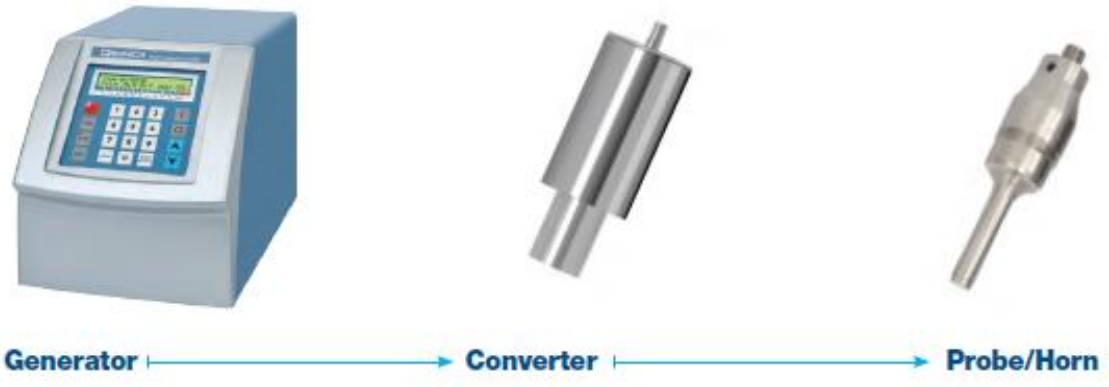
How does a sonicator work?



A Sonicator system is comprised of 3 major components: Generator, Converter and Horn (also known as a probe).

The ultrasonic electronic **Generator** transforms AC line power to high frequency electrical energy. The generator features a keypad or buttons which allow the user to control the sonication parameters.

The generator provides high voltage pulses of energy at a frequency of 20 kHz that drives a piezoelectric **Converter**. The converter is a cylindrical device which is connected to the generator by a high voltage cable. The converter transforms electrical energy to mechanical vibration due to the characteristics of the internal piezoelectric crystals.

The vibration is amplified and transmitted down the length of the **Probe/Horn**. Probes have threaded ends and attach to the converter. During operation, the probe's tip longitudinally expands and contracts. Amplitude is the distance the tip travels and is dependent on the amplitude setting selected by the user.

Ultrasonic Processor (Probe Sonicator is a tool specially designed for Pharmaceutical, Chemical Labs and various Research Institutes, Colleges, Universities.

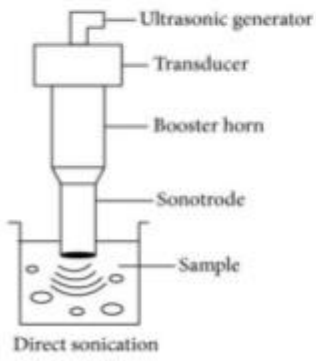
Sonication uses sound waves to agitate particles in a solution. It converts an electrical signal into a physical vibration to break substances apart. These disruptions can mix solutions, accelerate the dissolution of a solid into a liquid, such as sugar into water, and remove dissolved gas from liquids.

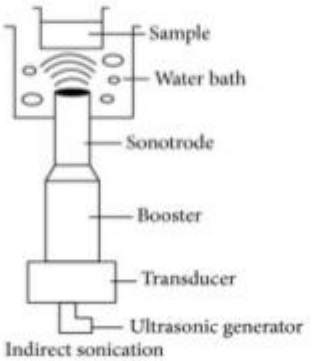
Some of its Applications are:

- Tissue Processing (Plant & Animal Tissues)
- Emulsification of Immiscible Liquids.
- De-gassing & De-aerating of Liquids.
- Formulations.
- Particle Dispersion.

Sonication Methods

- DIRECT Sonication Method
  inserting a probe directly into a sample vessel
- INDIRECT Sonication Method
  eliminates the need for a probe to come in contact with your sample.





Probe Sonicator Accessories

- Horns (also known as probes)
  - Direct Horn Options
  - High Throughput Horns
  - Indirect Horn Options
- Sound Enclosure
- Flocells
- Chillers
- General Accessories

Programmable operation
Set time and amplitude for hands free operation
Pulse mode
Prevent heat buildup in temperature sensitive samples
Digital amplitude / intensity control
Output intensity can be set from 20-100%
Elapsed time indicator
Displays duration of sonication
Display of wattage and joules
Real-time energy monitoring
Overload protection
Prevents damage to circuitry if a fault occurs
RoHS compliant
Uses lead free components

Different type of probe

Standard Probes

Replacement Tips for Standard Probes

Standard ½", ¾" and 1" horns have replaceable tips. During normal use, tips erode and become less effective over time. These worn tips can be easily removed and replaced.

Microtip Probes

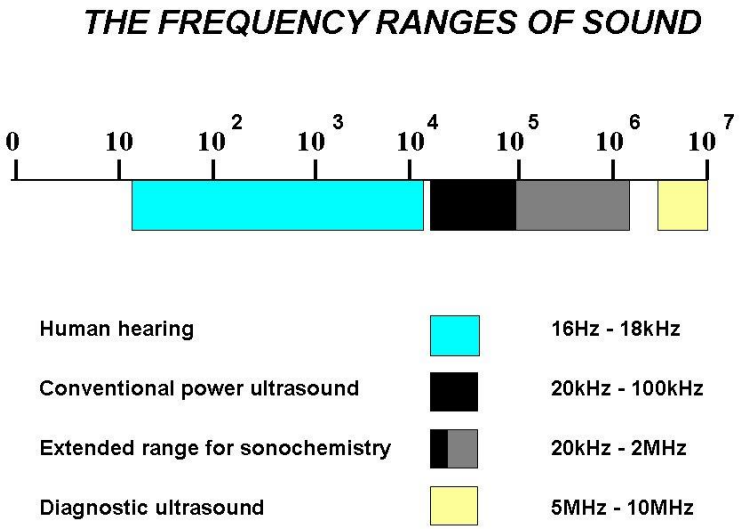
Microtips are thin, high intensity probes which are designed for processing small sample volumes. Microtips screw into the threaded end of the standard ½" probe (#4220).

Advantages:

- Homogenization, Micro fined Emulsion.
- More stable compares to other processes
- Very Flexible. It can easily be transferred from one batch to other without intermediatory operations like emptying, cleaning & refilling. Ultrasonic Processor can be transported to various locations of sample operations.

Thank you

Backup slide



Probe-Type Sonication vs. Ultrasonic Bath: An Efficiency Comparison Sonication processes can be carried out by the use of a probe-type ultrasonic homogenizer or an ultrasonic bath. Although, both techniques apply ultrasound to the sample, there are significant differences in effectiveness, efficiency and process capabilities. The desired effects from the **ultrasonication of liquids – including homogenization, dispersing, deagglomeration, milling, emulsification, extraction, lysis, disintegration and sonochemical effects – are caused by cavitation.** By introducing high power ultrasound into a liquid medium, the sound waves are transmitted in the fluid and create alternating high-pressure (compression) and low-pressure (rarefaction) cycles, with rates depending on the **frequency**. During the low-pressure cycle, high-intensity ultrasonic waves create small vacuum bubbles or voids in the liquid. When the bubbles attain a volume at which they can no longer absorb energy, they collapse violently during a high-pressure cycle. This phenomenon is termed cavitation. During the implosion very high temperatures (approx. 5,000K) and pressures (approx. 2,000atm) are reached locally. The implosion of the cavitation bubble also results in liquid jets of up to 280m/s velocity. [Suslick 1998]

Read more: https://www.hielscher.com/probe-type-sonication-vs-ultrasonic-bath-an-efficiency-comparison.htm

Whilst a ultrasonic bath provides a weak sonication with approx. **20-40 W/L and a very non-uniform distribution, ultrasonic probe-type devices can easily couple approx. 20.000 W/L into the processed medium. This means that an ultrasonic probe-type device excels an ultrasonic bath by factor of 1000 (1000x higher energy input per volume) due** to a focused and uniform ultrasonic power input. The full control over the most important sonication parameters ensures completely reproducible results and the linear scalability of the process results.

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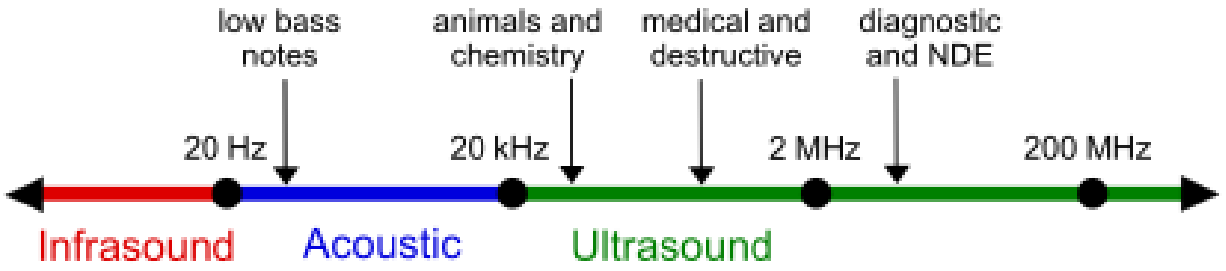

Boosters

Booster horns increase the intensity of standard ¾" and 1" horns. Boosters attach between the converter and horn to increase amplitude by the gain ratio indicated below. A 3 to 1 gain booster is available for custom applications.

Part #	For Use With	Gain Ratio
4121	3/4" and 1" Probes	2 to 1

432B with converter and jack stand

Principle of Ultrasonic Processor:

High frequency vibrations are produced by the S.S. Velocity Horn which is immersed into the liquid to be processed. The vibrations give raise to millions toIntense Microscopic Vacuum Bubbles which form & implode at a very high rate (twenty thousand times per second). This phenomenon is known as 'CAVITATION'. Cavitation gives raise to intense Local Pressure Waves & Micro Strearning of liquid round the points of collapse. This in turn produces High Shear gradients which are responsible for the above stated applications.

Ultrasonic Processor consists of:

(A) Ultrasonic Generator to produce High Electrical Energy operating at a frequency of 20Khz and an Ultrasonic Power 120watts.

(B) S.S. Velocity Horn fitted with PZT Crystals (Transducer Elements). This Velocity Horn assembly converts the electrical frequency energy fed from the Ultrasonic generator to echanical vibrations at the rate of applied electrical frequency. The amplitude of these mechanical vibrations are magnified by this velocity Horn. This Velocity Horn is used for processing application.

Type of sonication: 1. Direct and 2. Indirect sonication methods

DIRECT Sonication (inserting a probe directly into a sample vessel) is the most common way to process a sample. Energy is transmitted from the probe directly into the sample with high intensity and the sample is processed quickly.
The diameter of the probe's tip dictates the liquid volume that can be effectively processed. Smaller tip diameters (Microtip probes) deliver high intensity sonication and the energy is focused within a small, concentrated area. Larger tip diameters can process larger volumes, but offer lower intensity. Boosters and High Gain horns can be used to increase the output of large diameter probes. Probes are offered with either replaceable or solid tips and are made from titanium.

INDIRECT Sonication eliminates the need for
a probe to come in contact with your sample. This technique is often described as a high intensity ultrasonic bath. The ultrasonic energy
is transmitted from the horn, up through the water and into a vessel or multiple sample tubes. Indirect sonication is most effective for very
small samples because foaming and sample
loss are eliminated. Pathogenic or sterile samples are ideal for this method because aerosols and cross contamination are prevented. The Cup Horn and Microplate Horn deliver indirect sonication and are ideal for many
high throughput applications.