



Ultrasound and Watt The Determination of Ultrasonic Power

In literature and especially in catalogues of ultrasonic equipment manufacturers often you can find informations about power and performance of ultrasonic units. Most of time this information is given in absolute readings like »350 Watt Ultrasonic Output« or »it is worked with 172 Watts of Ultrasound«.

When more involved in ultrasonic techniques you will recognize very soon, that these informations are telling the real truth in a very few points only.

Wattage information in almost every case tells only the available power of the High Frequency (=HF) Generator of the system, but tells nothing about the real power, which is delivered via the converter and sonotrodes (horns, tips etc.) into the sample.

Also you can find different power informations of the same unit in the same catalogue. It is remarkable that sometimes the power taken out of the line ("input power") is essentially lower than the ultrasonic "output power" (HF-power). Therefore it is necessary to know that the output power is measured or calculated in a different way than the standard input power coming from the power line. Usually the "HF-power" is specified as peak-to-peak-power (please notice: also the amplitudes of the ultrasonic vibration is measured usually as peak-to-peak-amplitude). Sometimes additionally to that you can also find information about "rated power" which is the power delivered to the converter by the generator (via the HF-cable). Unfortunately this is written only in very exact and detailed documentations. This rated power is always lower than the input power.

The only relevant power for the user of the ultrasonic equipment is related to the density of the cavitation activity in the sound area of the sonotrodes. This sonotrodes generate high frequented pressure differences in the liquid coming from their own high frequency movement (self oscillation - usually 20 kHz at desintegrators). At the low pressure period the static pressure decreases below the vapour pressure of this liquid and small liquid/gas bubbles appear. These bubbles implode again during the change of pressure condition generating jets with multiple sonic speed. Hereby the collapsing cavities generate extremely high pressure conditions (several thousands of atmospheres) and extrem temperature differences. Scientists are talking from conditions like on the surface of our sun!

The occurring cavitationnal phenomenas depend on several parameters:

Frequency: **Lower ultrasonic frequency generates bigger cavitation bubbles.** The bigger the cavitation bubble the more powerful the implosion influences the liquid area around. Therefore ultrasonic high power systems prefer working frequencies at 20 kHz than higher frequencies for other applications (like cleaning, some plastic treatment, monitoring etc.). Especially for applications without using the liquid based cavitation phenomena high ultrasound frequencies are used. Lower frequencies than 20 kHz are audible by human ears therefore no lower frequencies are usually used. Also technical problems (horn design etc.) are restricting this trials.

Amplitude: **Higher amplitudes bring a higher probability of cavitation generation.** The control of the ultrasonic power delivered into the sample is done by variation of the amplitude of the vibrating sonotrode.

Also factors like **temperature, air pressure, ingredience of sample** (concentration, surface tension etc.) effect strong influences to the occurring of cavitation.

The most of the modern ultrasonic desintegrators (homogenisers, cell disruptors ect.) feature an electronic amplitude control - the BRANSON SONIFIER® Ultrasonic Cell Disruptor already since 1968. Hereby the amplitude at the oscillating ceramics are kept constant regarding the change of load at the sonotrode (immersion depth, viscosity etc.). This means, that with bigger load (e.g. deeper immersion of the tip into the sample) the generator has to deliver more power to the converter to guarantee the same amplitude (power in the sample) but it also means a higher power consumption (watts) of the generator at the same power output. And therefore - again - higher reading!

Also the connected tip (sonotrode) brings a significant influence to the power intake of the generator. For example it is absolutely unimportant which generator is used (e.g. BRANSON model "450" with 400 W or model "250" with 200 W) if you work with a microtip → the amplitude at the vibrating face of the tip is exactly the same at the same power setting (output control setting) at either unit. Only the application of some special kind of horns (e.g. HIGH GAIN-horn, horns with extra booster, cup horns etc.) makes the higher power availability of the model 450 necessary. By using the "smaller tips" the only difference of the two different units is the lower reading at the model 450, due to the lower load of the generator. Even the use of a 1.000 W unit wouldn't bring better results by sonification with the same horn/tip. Therefore bigger generators (1.000 W , 2.000W and 4.000 W units are available in standard BRANSON versions) are in use only for special technical scaled applications for bigger volume treatment.

The upper limit of the load of the tips is not determined by the generator producing this high vibration-energy but by the material limits of the tips itself. For the moment the used materials in this techniques are almost every time titanium alloys. These alloys are the only materials which can stand this high internal vibration without breakage. If similar tips would be

