

High-Intensity Ultrasound for Industrial Applications



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ISP-3000 INDUSTRIAL-SCALE PROCESSOR

SYSTEM OVERVIEW

The ISP-3000 industrial-scale ultrasonic liquid processor is designed for high-volume commercial production. It outputs up to 3,000 W of acoustic power and operates at the frequency of approximately 20 kHz. The processor is supplied with a 3,000 W ultrasonic **generator**, a water-cooled **transducer**, a **Barbell horn** and an optional **reactor chamber** (flow cell).



The 3,000 W **generator** has rugged internal circuitry and ensures a continuous resonant frequency lock during operation. The LCD display can be used to change the settings for the ultrasonic amplitude, starting frequency and ramp-up or ramp-down parameters. Constant amplitude is provided, regardless of the power draw, which is automatically adjusted to compensate for variable loading conditions. The ultrasonic vibration amplitude level can be adjusted from 20 to 100 %. The generator passes strict CE test specifications for global applications.

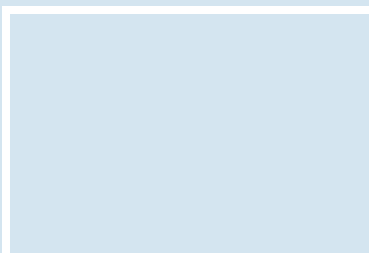
The water-cooled piezoelectric **transducer**, **SWCT-20-ISP**, is sealed to the outside environment, which makes it suitable for the use with flammable materials, such as fuels and organic solvents, as well as for high-humidity conditions. When properly cooled, the SWCT-20-ISP can operate continuously (24/7). This transducer is compatible with all ISM's **Barbell horns**, which are used to amplify its

vibration amplitude to the desired value and deliver the ultrasonic energy to the processed liquid.

Several types of **Barbell horns** may be utilized with the ISP-3000 processor. The **HBH**-type horn is commonly used in the flow-through processing mode, while the **FBH**-type is generally preferred for the batch processing mode. Our new HBHB-type horn is also becoming increasingly popular because it combines the advantages of the HBH and FBH models and can be used in both processing modes. The horns have large output tip diameters (45 - 47 mm) and can deliver extremely high vibration amplitudes (over 100 microns, calibrated by a high-precision fonic sensor). These levels of vibration amplitudes are unprecedented: irrespective of their specified power, all competing industrial-scale ultrasonic systems with horn tip diameters of at least 40 mm are restricted to amplitudes below about 25 microns, which severely limits their utility.

System Productivity

Productivity rates provided by the ISP-3000 processor are highly dependent on the nature of each process and range from about 5 L/h for challenging tasks (e.g., top-down **nanocrystallization** of active pharmaceutical compounds) to over 3,000 L/h for fast processes (e.g., waste-water purification, **biodiesel** production).



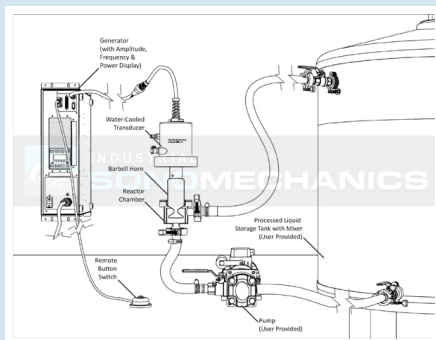
The Importance of High Ultrasonic Amplitudes

The ability of an industrial-scale ultrasonic processor to operate at high vibration amplitudes is essential. It has been shown that at the amplitudes below about 50 microns, many processes, such as nanocrystallization, nanoemulsification, deagglomeration, extraction, sterilization, dispersion as well as many others, are very inefficient. However, prior to the introduction of Industrial Sonomechanics' proprietary Barbell Horn Ultrasonic Technology (**BHUT**), high-amplitude industrial-scale ultrasonic liquid processors were unavailable.

High vibration amplitudes are relatively easy to produce in a laboratory setting - processors equipped with small-tip ultrasonic horns are readily available and widely used for lab-scale process optimization. A great deal of data has been published, showing that the required amplitude for many processes is between 60 and 100 microns at the frequency of 20 kHz. In order to implement a process in a production environment, it is necessary to switch from a lab to an industrial ultrasonic system. The industrial system must incorporate a large-diameter horn operating at the same high vibration amplitude and the same frequency as the lab system (direct scale-up). Based on **BHUT**, the ISP-3000 processor includes a large-diameter **Barbell** horn capable of providing any vibration amplitude necessary to exactly replicate even the most demanding laboratory optimization results at the industrial scale.

The ISP-3000 processor can be implemented in two processing modes: **flow-through** and **batch**. Several configurations of each mode are possible.

FLOW-THROUGH MODE CONFIGURATIONS

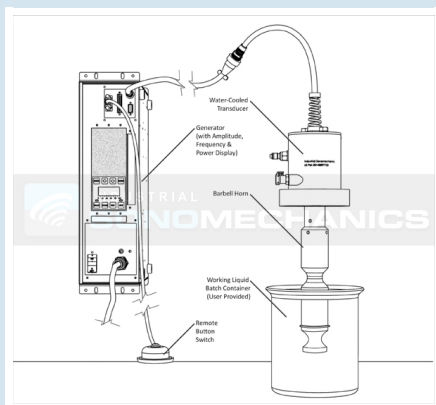


Recirculating, **single-pass** and **multi-reactor** configurations are possible in the flow-through processing mode. In the **recirculating** configuration (*schematic shown on the left*), the material passes through the reactor chamber multiple times, which increases the cumulative exposure time. This configuration is the most common and especially recommended for challenging processes, such as top-down [nanocrystallization](#) (sonofragmentation) or the production of [translucent nanoemulsions](#). A separate heat exchanger is commonly used to cool the processed liquid. The **single-pass** configuration is used for faster processes, such as oxidative waste-water purification, the production of white [nanoemulsions](#), [degassing](#) and [biodiesel](#) manufacturing. In this configuration, the processed formulation may be prepared in the premix tank or supplied by dosing pumps, followed by a static mixer. The **multi-reactor** configuration requires several ISP-3000 units to be used simultaneously and combines the advantages of both configurations described above.

During the flow-through mode processing, the 3,000 W ultrasonic generator excites vibration in the water-cooled piezoelectric transducer, [SWCT-20-ISP](#). The vibration amplitude is then amplified by the Barbell horn to about 70 - 110 microns (adjustable from 20 to 100 %), having the tip diameter of about 45 mm, and delivered to the liquid flowing through the [reactor chamber](#).


No restriction on the total treated liquid volume exists as long as sufficient processing time is allowed so a storage tank with any necessary capacity can be used. The pump is selected according to the desired flow rate and liquid properties.

BATCH MODE CONFIGURATION



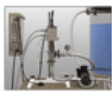
The batch mode does not require the reactor chamber. The processed liquid is contained in a batch container or a reservoir that may already be a part of the setup used in the process. This mode is commonly used for such processes as ultrasonic [degassing](#) of oils, paints, epoxies and other liquids. Several configurations are possible, corresponding to different types of Barbell horns, which are inserted directly into the processed liquid as illustrated in the schematic shown on the left.

During the batch mode processing, the 3,000 W ultrasonic generator excites vibration in the water-cooled piezoelectric transducer, SWCT-20-ISP. The vibration amplitude is then amplified by the Barbell horn to about 70 - 110 microns (adjustable from 20 to 100 %), having the tip diameter of about 45 mm, and delivered to the liquid in the batch container. The horn is immersed into the liquid to slightly above its nodal point (to the depth of about 60 - 80 mm). Batch sizes up to about 10 L can commonly be processed using this setup, directly. Larger batches may require that the processed liquid be independently mixed.




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