University of Minnesota Nano Center Standard Operating Procedure

Equipment Name: Ultrasonic Processor/Homogenizer
Model: Qsonica Q700 Sonicator
Location: PAN 185
Version Number: 4
Written by: M. Johnson, **Revised by:** J. Marti
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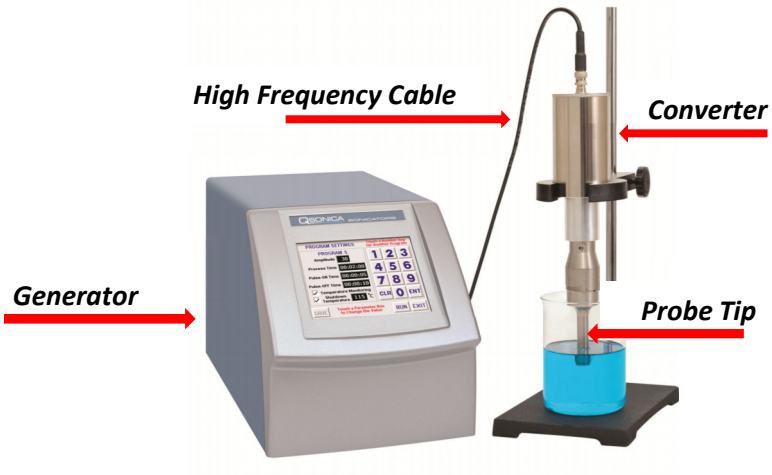
A. Introduction

1. **Tool Description.** The Qsonica Q700 is a 700 watt probe ultrasonicator, which applies intense acoustic energy to samples of liquids and dispersions. The Qsonica has a range of power settings and may be operated continuously or in pulse mode. If necessary, samples can be cooled in an ice bath during sonication, as fluids under sonication tend to heat over time. The ultrasonic generator head of the Qsonica may also be air cooled during extended operation.

2. **Components.** Figure 1 shows a front view of the Q700 Sonicator. Key components visible in this view are the generator, converter, high frequency cable, and probe tip.



3. **Safety.** Since high voltage is present in the generator, power supply, converter, and high frequency cable, observe the following precautions.
   a. Do not touch any open cable connections on the unit while the power is turned ON. High voltage is present in the cable and may pose a shock hazard.
   b. Do not attempt to disconnect the converter high voltage cable while the unit is running.
   c. The Q700 emits high sound levels and is mounted in a sound enclosure. Do not operate with the enclosure door open.
   d. Never grasp an ultrasonic probe. It can cause severe burns and tissue damage.
   e. Never allow a probe to vibrate in air. Do not allow the tip of a vibrating probe to touch the countertop or any other hard surface.
   f. If you plan to run the sonicator continuously for longer than 15-20 minutes, consult the lab manager about plumbing an air cooling line to the convertor.

g. Avoid touching the bottom or sides of a glass or plastic container with an activated probe. It could crack or shatter the glass or melt the plastic.
h. Inspect high frequency cable for cracks in the protective outer jacket, and do not operate unit with a damaged cable. Alert the lab manager.

4. **Required Facilities**
   a. Single phase 120V electrical
   b. Source of compressed air (optional, to allow cooling of generator)

5. **Theory of Operation.** The ultrasonic electronic generator transforms AC line power to a 20 KHz signal that drives a piezoelectric converter/transducer, which produces mechanical vibration. The vibration is amplified and transmitted down the length of the probe, where the tip longitudinally expands and contracts. The distance the tip travels is dependent on the amplitude selected by the user through the touch screen pad. Increased amplitude setting applies greater ultrasonic intensity.

   During sonication, rapid vibration of the probe tip causes cavitation bubbles to form in the liquid surrounding the probe. When these cavitation bubbles collapse, high shear forces and pressure differences ($\geq 1 \times 10^8$ Pa) are generated; even durable materials are thoroughly homogenized via the micro jets that are produced from the violent collapse of these microscopic bubbles. The resulting liquid flow also aids in the mixing process. Samples subject to ultrasonication typically contain droplet sizes in the micrometer to nanometer range.

B. Setting up the Q700 Sonicator

1. Begin a new entry on the tool log sheet. List your name, the date, the materials you are working with (particle material(s) and suspending fluid), and any issues you encountered during your run.
2. Select a probe tip (standard or microtip), based on the volume of your sample.
   a. For processing volumes of 0.5-15 mL or when using short, narrow sample vessels, use the Microtip ⅛" (3.2mm) diameter probe tip.
   b. Use the standard ½" (12.7mm) diameter probe tip for processing sample volumes of 20-250 mL
   c. If the standard probe is not long enough to fit into your vessel, use the extender probe to increase the length of the tip by 5" (12.7cm).
3. Select a sample container
   a. A narrow vessel is generally preferred to a wide vessel. Ultrasonic energy is produced from the probe tip and directed downward, pushing the liquid in all directions. If the vessel is too wide, the sample will not mix properly and some will remain untreated.
   b. The sample container needs to be rigid enough to prevent absorption of ultrasonic energy. A glass beaker or scintillation vial is recommended over plastic containers.
4. Mount the container and adjust probe position
   a. Containers may be mounted at the desired height using the 3-pronged clamp attached to the support rod.
   b. The probe should be immersed at least 1.5 times the tip diameter (e.g. a ½" diameter probe tip should be immersed at least ¾" below the liquid surface).
   c. Before processing actual samples, it is recommended to test the probe in a vessel filled with water to observe the ultrasonic energy and the flow pattern of the liquid. Adjust

the probe depth to achieve adequate mixing.

d. To adjust the probe position, hold the black plastic converter housing with one hand and unscrew the knob to release it from the support rod. After the probe has been adjusted to the right depth inside the sample vessel, secure the probe and converter assembly by tightening the knob.

C. Running the Sonicator

1. Determine power level and duration. Sonication effectiveness is determined by the amplitude of the probe oscillation. The QSonica provides controlled amplitude under varying load conditions in order to give reproducible results. Although the degree of cavitation/ultrasonic energy required to process samples can be determined by visual observation, the amount of power required cannot be predetermined.
2. Using a temperature probe. If desired, the temperature probe option can be selected during set up. Consult the lab manager for set up.
3. Optional sample cooling
    a. To reduce heat build-up during intense ultrasonic processing, samples should be cooled by suspending containers in an ice water bath.
    b. To further manage heating during sonication, the Qsonica can be programed with specific On/Off times and output settings.
4. Optional Converter cooling. Users planning to run the sonicator for more than 15 minutes must consult with the lab manager about plumbing an air cooling line to the converter, which is used to prevent excessive heat transfer to the converter during sample processing.

D. Tool Shutdown

When your work is complete:

1. Turn off the power switch located on the back of the Generator.
2. Clean the probe with IPA
3. Close and latch the door of the sound enclosure.