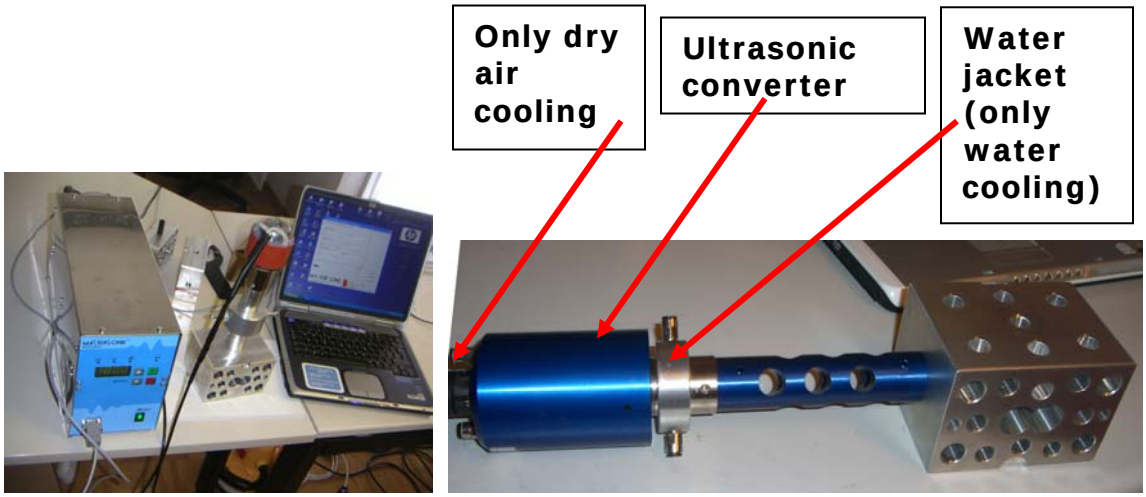
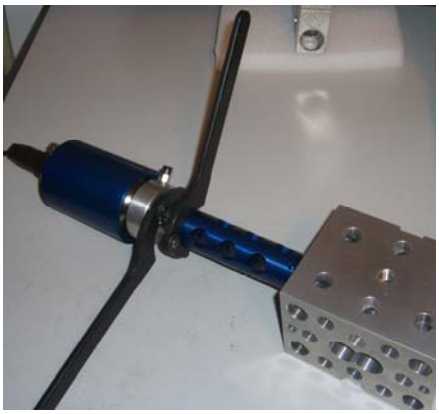
AN EXAMPLE OF ULTRASONICALLY ASSISTED PLASTIC MIXING AND EXTRUSSION



Picture of the complete ultrasonic system configuration: MMM-Generator (left), Converter-Wave-guide-Water-jacket-Aluminum block (middle) and PC (right). PC Interface RS485 to USB (or RS232) is connected between the PC and MMM generator. Client should use his own PC. Software **mpi_ix.exe** for the MSG.1200.IX should be installed (download software here: http://mastersonic.com/documents/mmm_basics/mmm_power_supplies/msg-ix-generators/latest/).

Above is presented the pictures of the aluminum blocks modified by drilling additional holes inside of the not-used aluminum mass in order to facilitate multi-frequency vibrations. Holes in aluminum blocks can be drilled on many different ways from any side of the block. The client needs to experiment making different holes distribution (with different diameters, creating new aluminum blocks). The idea behind making holes in the vibrating aluminum body is to make such aluminum block more flexible, more elastic and to reduce its rigidity in order to facilitate vibrations and increase amplitude in the internal area of plastic flow. Converter can be strongly fixed (by screwing) from any side of the aluminum block (always using the waveguide between the converter and aluminum block), taking care that vibrations in the plastic-flow central zone will be maximized. Here given solution regarding holes is probably not the best one and client should experiment with many different configurations of holes geometry and distribution in order to get optimal results. Every hole is reacting as a kind of mass-spring oscillator (with relatively high

mechanical quality factor), this way facilitating complex vibration of the aluminum block.




Picture presenting ultrasonic converter with water jacket (upper part, blue color), wave-guide (middle part) and aluminum block (bottom). In operation, the biggest care should be taken to keep constant low temperature of the ultrasonic converter (always below 50 centigrade). Water jacket should be connected to a water flow in order to keep aluminum wave-guide cold and to stop heat penetration from aluminum block towards converter. Certain forced air flow should be realized around the ultrasonic converter in order to keep converter cold (using a fan or pressurized air, or also placing certain solid envelope around the converter and making air flow inside). Usually, when generator settings are well made, when mechanical fixation is strong, and when aluminum block is well designed, converter will not generate heat, or better to say that temperature on the converter body would increase very slowly. Significant heating of the converter parts is always indicating that MMM generator settings are not well made, or that there is a problem in mechanical assembling (parts are not strongly fixed). In such situations, stop the generator, reduce the operating power and search for new settings (later we will give good settings). When new settings are found, power could be increased. Aluminum block will take so much of ultrasonic power as acoustic loading conditions would allow. Generator is able to deliver 1200 Watts (and converter can deliver 3000W), but in most of situations (like this one) aluminum block would take significantly less ultrasonic power because of acoustical loading conditions, acoustic impedances, geometry etc. Ultrasonic converter and wave-guide can be fixed from any side of the aluminum block, providing that vibrations in the plastic-flow channels are maximized. Client should experiment (with low power settings; -around 20%) in no-load open-air conditions in order to find the best generator settings and best design of aluminum blocks. All metal-to-metal joints (contact surfaces) realized by screwing should be clean, without any particles and dry (no water between contact surfaces) in order to avoid bad acoustic coupling and destruction of contact surfaces. If client intends to make new aluminum parts, the best aluminum for ultrasonic applications is AL-7075. After placing aluminum block/s in the extruder-mixer line and filling it with plastic mass (creating regular operating conditions), generator settings should be again readjusted, since initial mechanical oscillating system would change by presence of different loading conditions and different added masses. In any case, in any application, there should be applied the waveguide with water jacket between the

converter and oscillating aluminum block (because this is also a kind of mechanical interface which is separating converter from reflected vibrations. Do not apply maximal power settings on the generator, because after certain power level, increasing the power would start producing negative effects, non-linear oscillations, clipping and heat.

For fixation (screwing, unscrewing) of converter and wave-guide use here presented wrenches.

For putting the generator in operation and making proper generator settings, please download the instructions here (very important, read carefully, go step by step, do not neglect anything):

http://mastersonic.com/documents/mmm_basics/mmm_power_supplies/msg-ix-generators/latest/instructions-for-first-time-users-ix-generators.pdf

http://mastersonic.com/documents/mmm_basics/mmm_power_supplies/msg-ix-generators/latest/ix-single-converter-settings.pdf

http://mastersonic.com/documents/mmm_basics/mmm_power_supplies/msg-ix-generators/latest/ix-single-converter-settings.pdf

http://mastersonic.com/documents/mmm_basics/mmm_power_supplies/msg-ix-generators/latest/um_msg_ix_yf_2005.pdf

Read also all documents from here:

http://mastersonic.com/documents/mmm_basics/mmm_power_supplies/msg-ix-generators/latest/

If under certain settings generator starts going into overloading state (stopping operation), reduce the power and slowly and systematically change some of setting conditions. Do not force repeatedly the generator to go often in overloading conditions, because this way you would damage the generator.

Above given instructions are generally valid for all MMM and IX generators (like your generator). Details regarding settings and optimal conditions would always be

different, depending on operating conditions, geometry of oscillating objects, loading conditions etc. Here given general instructions are good to get basic knowledge and experience regarding how to operate MMM generator and how to make setting, but in client's real operating conditions, **the same instructions should be applied creatively and with intellectual flexibility (meaning client should find new set of best operating conditions that are similar, but maybe not identical to here described settings)**.

Good initial generator settings for oscillating aluminium blocks (for extruder-mixer) in no-load conditions are (see below):

DDS,
Frequency: Best operating frequencies in this case are between 17.5 and 21 kHz, when operating in no-load conditions: the best operation in air found on 20.370 kHz).

Sweeping: Keep at 0.010 kHz. Later experiment using other values.

POWER: 10% to 100%. Start with low power 25% in air, no-load conditions (or around 30% or less). Work at minimum power that is producing good results, linear, smooth and stable oscillations, and minimal heating on the converter parts. In loaded situation power should be readjusted.

Current: 4.5 A,
PWM-period 0.010s, PWM-ratio 100%

FSWM: best 0.348 kHz. (Later experiment with other values), FSWM-ratio 50%, FSWM-period 0.020 s.

DMMM,
Q-factor: 20 (also good until 100),
Frequency correction: 90 (experiment with other values),
Amplification factor: 27 (experiment with other values).

Ultrasonic power: 525 (also good from 500 to 999). Work at minimum power that is producing good results, linear, smooth and stable oscillations, and minimal heating on the converter parts.

In loading, operating conditions, above-given initial settings should be readjusted to rich maximal ultrasonic activity (start the tuning process again, slowly and step by step).