MMM Stress Relief Technology

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We need to make certain classification or differentiation between what and how we can process ultrasonically for the purpose of stress relief. Generally important technical conditions and important elements for thinking about applying MMM ultrasonic stress relief are:

1. *It is preferable, and optimal that solid state (metal) body under treatment should naturally have number of resonant frequencies and harmonics, based on its geometry. Metal parts having big number of resonances can be ultrasonically processed on easier and faster way. MMM ultrasonic technology is on some way exciting different resonant modes at the same time. Only metal parts with complex or complicated geometry and shape have many natural resonances and harmonics. Of course, we can treat simple geometry (regular, symmetrical) metal parts, but we need to think about how and where to apply ultrasonic vibrations, to create external fastening tools etc. (differently saying, we need to help to metal body to resonate ultrasonically). Simple and symmetric geometry, thick metal parts tend to have limited number of natural resonant frequencies... and we need to modify such acoustic-spectrum situation appropriately (meaning we need to think about, create project, create proper fastening parts, clamps, screwing holes etc.). This is taking a time and some investments. The best is that body under ultrasonic treatment should be naturally easy to be vibrated, and naturally accepting ultrasonic agitation... but if this is not the case, we need to apply additional methods and fixing-mounting accessories in order to create such conditions. We do not need to have specific resonant frequency of the body under testing, but since we will usually apply 20 kHz high power ultrasonic transducers for stress-relief processing, it is good to analyze how the body under testing will react... This is kind of informative (preliminary) analysis to get a feeling about spectral complexity of the parts under testing.*

2. *Ultrasonic stress relief is efficient and possible only if we make very strong, screwing mechanical connection, between ultrasonic transducer and a solid body under treatment. Ordinary or very good clamping is still not good enough compared to strong screwing between parts (but in some cases we can apply clamp-on ultrasonic transducers agitation). Consequently, we need to create threaded holes where we will make necessary screwing connections. Practically, ultrasonic processing of relatively small metal parts is not at all practical, especially if creating threaded holes is not desirable or not possible, or not practical (since ultrasonic transducer should be very well fixed to the body under treatment). It is not always easy or practical to screw ultrasonic transducers in certain metal parts... Particular situations should be analyzed. MMM ultrasonic stress relief works only when we can rigidly and strongly fix ultrasonic transducer to certain metal part. Relatively thick and small metal parts are especially not easy or not-practical for proposed stress relief, because small and rigid parts have geometry-dependent resonant modes, and it is necessary to make good planning... (to analyze everything before testing).*

3. *We need to take into account elastic and mechanical properties of the body under ultrasonic processing, since acoustic impedance has important meaning when we apply ultrasonic energy... It is always easier to vibrate metal parts with high mechanical quality factor, or metal parts with holes, cavities, thin walls, and with complex geometry. Solid, thick, bulky, simple geometry, and very rigid and heavy bodies are also inconvenient to be ultrasonically processed, and we need to prepare additional accessories and conditions to make efficient treatment of such bodies.*

4. *Ultrasonic stress relief is much more economic and efficient technology to be applied on very large, big and heavy, complex geometry metal parts, where nothing else (like thermal cycling) works, or where applying heating energy would be too expensive and impractical method. Often we have metal constructions (like oil offshore, pumping platforms), where we cannot think about thermal cycling or about separating such constructions on smaller parts and make partial thermal processing.*

5. *If we have very small, light, thin-walls metal parts, we can again apply ultrasonic stress relief, but this time using MMM ultrasonic field realized in a liquid filled tank with submersed parts under treatment. It is imaginable to treat ultrasonically almost all solid state parts, like ceramics, glass and metals... (soft and plastic parts cannot be treated). The best way is to make certain preliminary (simplified) Finite Elements Analysis (and modal analysis) for every specific geometry to be sure that we create proper conditions for introducing ultrasonic energy. All of here mentioned problems are manageable and predictable, and most of such practices could be based on certain level of experience-based and intuitive thinking, but it is good to mention that nobody has a magic stick (to erase internal, residual stress), and that every solid body can be immediately and easily ultrasonically processed, without proper technical and technological preparation. We are usually using COMSOL Multiphysics software for such analyzes and simulations, since it is always better to visualize results of ultrasonic agitation, before applying other steps and producing accessories. Yes, this is taking a time, and we need to use an expensive software, and to have very good expert who will analyze... but this is not really necessary (every time) in real industrial processing. It is necessary only when we like to make test samples for scientific or concept-verification analyzes. There are possibilities to avoid all of that, but if somebody insist to test a small square-shaped, simple geometry, thick, rigid and robust sample... then we will have mentioned problems and it is necessary to make preparations. As much certain body under testing is with irregular geometry or shape, big, large, long, being spectrally multi-frequency by its nature, MMM stress relief will be more efficient, natural and more significant... Driving simple-geometry metal parts uniformly and without creating standing waves is a big problem, where MMM technology can help, but this should be first well analyzed. Hocus-pocus and fast, magic methods for residual stress erasing, without serious technical preparation, are equivalent to arbitrary trial-&-error experiments. Here we do not address (manual) ultrasonic peening. We are talking only about MMM stress Relief. Manual peening tool is applicable for cases where user is not ready to fix (screw) transducers with a stud between threaded holes. MMM stress relief is suitable for applications when we can fix (very strongly) ultrasonic transducers to a big metal construction...*

6. *Big and heavy, rectangular blocks of metal will be very difficult task for MMM stress relief, but it is possible to address such projects with applying several ultrasonic transducers, acting sufficiently long time.*