CDME Commercializes Capacitor Bank

The Center for Design and Manufacturing Excellence (CDME) at the Ohio State University recently designed and fabricated a capacitor bank based on a prototype system developed in Dr. Glenn Daehn’s Impulse Manufacturing Laboratory (IML – iml.osu.edu). This lab develops techniques for forming, shearing, and welding metals using electrical energy. By rapidly discharging high power capacitors, an electromagnetic force can be generated that can repel a sheet of metal at an extremely high rate of speed. This acceleration can be used, along with a die or mold to shear or form the thrown piece of metal. If the material can be accelerated fast enough, it can be welded to another piece of metal during impact.

The high rate of speed used to fabricate the components reduces burrs, results in cleaner edges, results in lower bend radii, and will fabricate parts faster than standard methods. The prototype system developed by IML was able to discharge the energy in just under 5 micro-seconds, allowing the system to be used for shearing, forming, or welding. The Ohio Energy and Manufacturing Center (OEAMC) approached IML for a similar system and then contracted with CDME to turn the prototype into a professionally-designed and replicable system that matches industrial expectations. Staff at CDME worked with the IML to understand the requirements of the system, develop a robust design, generate 3D CAD models, and fabricate a single system. The fabricated unit met all of the system requirements and matched the performance of the prototype system.

The core of the capacitor bank is the trigger and spark gap. Multiple 50 µF, 8000 VDC off-the-shelf capacitors from SBE are charged using a DC power supply. This energy is then discharged through a spark gap that carries the energy to copper electrodes. These leads can be used to provide power to a coil or to vaporize foil that in turn creates the desired electromagnetic force.

The welding and forming system is capable of delivering 5.6 kJ of energy with a maximum output current of 300 kA. It is 55” x 30” x 45” and weighs 450 pounds. It includes a PLC that manages charging and discharging of the bank, along with synchronization of the external mechanical systems. A pedestal allows remote operation of the system. Other safety features include a light screen that encompasses the electrodes, a manual discharge switch, a NEMA 4X enclosure, and emergency stop buttons. The system includes an integral Rogowski coil and digital oscilloscope. This allows the wave form from each discharge to be recorded and reviewed. The wave form will allow calculation of the discharge current with time. This data is stored on a flash drive that can be removed at any time to review the data.

Since 2014, the Ohio Energy and Advanced Manufacturing Center (OEAMC) has been in the process of developing a High Velocity Metal Forming (HVMF) Commercialization Center within the walls of their technology center in Lima, Ohio. They had already accumulated much of the equipment necessary for the operation of the center, including a large 80 kJ capacitor bank; but, they lacked a lower-power, higher frequency system. The OEAMC invited the IML to respond to a competitive bid process to fabricate a 4.2 kJ cap bank for their Commercialization Center.

The primary goal of the OEAMC’s HVMF Commercialization Center is to stimulate investment and promote opportunities to produce commercial products using this advanced manufacturing technology. The OEAMC’s mission is to share what we have learned with manufacturing enterprises who are interested in modernizing by applying this technology to produce their existing parts with the ability to integrate value added design changes quickly with recapture of the investment within ten percent of their usual required production runs. The OEAMC provides manufacturers access to their HVMF lab where we work with companies through a gated process to test production capabilities of their specific parts utilizing HVMF technologies.