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Damaged forging machinery or dies don't always require an investment in new equipment. Weld Mold offers the option of flood welding to repair and refurbish dies, rams and other parts necessary to the forging industry.

Weld Mold's current location in Brighton, Mich.

The business climate for forgers in the U.S. is currently a challenging one. As good managers, we have had to restructure our companies and evaluate how we do business to stay competitive. We work with our customers and our suppliers to provide the best products at the best value. Our sales departments have been restructured to maintain existing business while preparing for the recovery we know will come, though not when. We labor in our own plants and continue to strengthen the lean practices that yield us the maximum efficiencies from our operations. We continue to do these things while waiting to find out how we will be affected by new rules, regulations and government restrictions.

The forging industry has experienced difficult times of late, but there is good news to be had by the forging industry as well. Some forging operations no longer need to buy die blocks, nor do they need to buy hammer bases, sow blocks, rams, die holders, columns, cylinders or press frames.

Flood Welding

In this troubled economy, Weld Mold is happy to offer the industry an option to the high investment required to buy new tooling and machinery. Our solution is to repair and refurbish existing components using very specific materials and defined processes. Accordingly, we are into our seventh decade serving the forging industry as the inventor of flood welding, also known as Progressive Manual Cast Welding. This process provides metal deposition rates of up to 100 pounds per hour using ¾-inch-diameter x 4-feet-long (the world's largest) welding electrodes and up to 40 pounds per hour using a multiple-wire welding "manipulator."

Our company began as a welding and fabricating shop, and, as such, we have had the experience of completing difficult welding jobs that were considered nearly impossible. However, even after discontinuing our fabricating operations, we have continued with R&D programs that have allowed us to select the proper materials and perform the documented welding procedures used in many forging applications.

Using these materials and processes, existing blocks can be welded and re-sunk for new impressions. Our techniques can be used in many applications. Blocks can be cut, welded and machined; cracked or fractured blocks can be welded together; missing corners, locks and shanks can be repaired and put back into use; flash lines can be repaired and lower-alloy dies welded with high alloys in the impression; and columns, bases, cylinders and heads can all be repaired in a timely and cost-effective manner. Welding has progressed to the point of being a critical aspect of any successful open or closed hammer, press or upsetter forging operation.

Whether in the die shop or in the maintenance area, the goal of flood welding is to eliminate scrap. This can be accomplished successfully with a commitment from management and fully trained die-shop and maintenance personnel. Using the proper materials and following the proper procedures, flood-welding techniques can be nearly 100% successful. Of course, the cause of part or equipment failure must be eliminated, or at the very least addressed in some manner, to prevent or reduce continuing problems. Machine maintenance is critical in maintaining and reducing forging costs. Forging equipment has a way of self-destructing. It is the nature of the beast, and it is a beast.

Welded dies and components should always provide a *minimum*,

Fractured upper counter-blow rams (left and center) and drop hammer ram (right)

never less, of the life of the original die block or component and typically will provide increased life, sometimes by many times the original. Decreased life after welding warrants a closer look into your operation – the materials, the welding procedures in use in the weld shop and forging practices.

The forging market has changed with increased off-shore competition. The forgers experience shorter piece runs; quicker turn-around times; higher quality requirements; decreased inventory of raw materials and finished product; reduced manpower and loss of expertise due to layoffs and retirements; changes in engineering, production and machining practices; and reduced sales dollars, both from the per-piece price and from the overall sales figure. All of these factors result in shortened die-room time for maintenance and repairs of dies and components, sacrificing die life by reducing maintenance for the requirement of expediting production.

Proper Welding Procedures

We cannot stress enough the importance of sound welding procedures. All forge shops doing welding on dies and components need the necessary equipment and training to complete their work successfully – this includes proper welding materials, appropriate power sources, support equipment and supplies, cranes/lift trucks and furnaces.

The general procedures to follow are listed below:

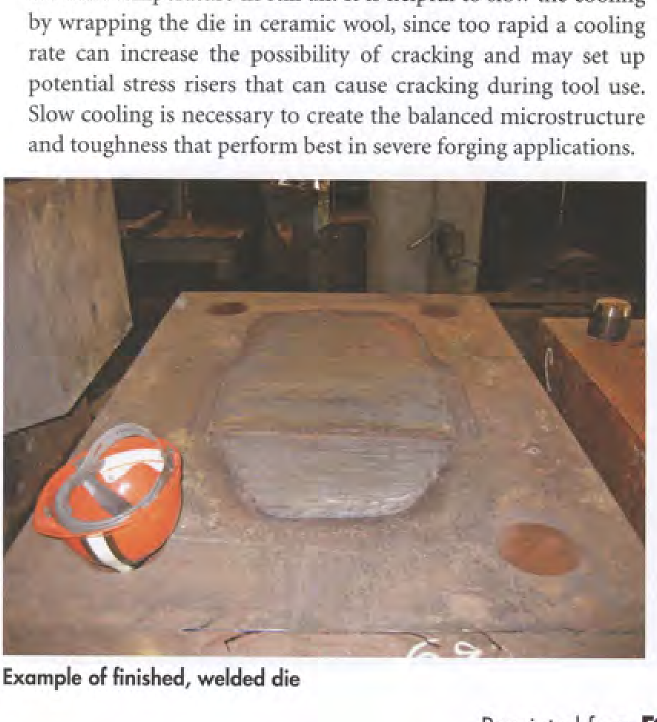
- **Cleaning and Inspection** – Proper technique begins with the cleaning and inspection of the die or component to be welded. It helps to develop a complete plan on the total welding job prior to scarfing or welding. Many welders will document the tasks required on each particular job and estimate the type and amount of materials required. *Optimum die life will be found, in all applications, by the choice of the welding alloy that will prevent premature wear while preventing crack formation due to excessive hardness.*
- **Scarfing** – This step, completed prior to welding, uncovers and removes all the cracks, scale and fatigued metal and opens the impression for welding. The scarfed opening must be large enough to be able to see both walls while welding (typically, a 40-60° included angle is satisfactory). Remove overhangs or undercuts that prevent the electrode or wire from being deposited in the proper manner. Unless the workpiece is severely cracked, it is not necessary to preheat it prior to scarfing or gouging. If it is, then it must be preheated to prevent the crack from migrating through the piece. This is often true for high-alloy H-series die alloys. If this is the case, a mild preheat of 500-600°F will reduce the thermal shock associated with scarfing.
- **Preheating** – Preheat the piece to 800-900°F for one hour per inch of thickness. This preheat is a critical aspect for successful welding. The die must be held at temperature for one hour per inch of thickness. The total time in the furnace or on the burner is dependent on the heating unit's insulation quality and burner output.
- **Positioning** – The workpiece must be positioned to expose the scarfed areas to the best advantage for the welder. It is not unusual for a job to be repositioned many times during the welding process. The centerline of the scarfed opening being welded must be perpendicular to the floor. Weld using a short arc to ensure that the walls are bonded to the weld metal. Both walls must be visible to the welder. Keep the workpiece insulated to maintain the preheat temperature during the welding cycle, and never let the die temperature drop below 700°F. Preheating reduces the cooling rate of the weld deposit.
- **Peening** – This process reduces stresses in the weld metal and forms the weld deposit, much like forging forms a billet. Peening is accomplished by using an air or mechanical hammer at the end of each welding pass and works in the same manner as thermal stress relieving. The benefits of peening include refinement of

Examples of scarfed dies

Weld Mold manipulator and arm in operation

the weld metal and the elimination of centerline shrink (or crater cracks), as the weld metal cools to the temperature of the workpiece.

- **Post-Heating and Equalizing** – This cycle has the same effect as preheating in reducing the rapid cooling of the workpiece versus the weld metal. Post-heat/equalize the piece to 800-900°F for one hour per inch of thickness. This is a critical aspect for successful welding.
- **Slow Cool** – The next step is to slow cool the workpiece to ambient temperature in still air. It is helpful to slow the cooling by wrapping the die in ceramic wool, since too rapid a cooling rate can increase the possibility of cracking and may set up potential stress risers that can cause cracking during tool use. Slow cooling is necessary to create the balanced microstructure and toughness that perform best in severe forging applications.



Example of finished, welded die

- **Stress-Relief Tempering** – This thermal process relieves the remaining stresses that have developed in the block during welding. This completes the creation of the tough structure required for forging applications and allows control of the final hardness of the weld deposit. Temper the piece at the appropriate temperature for one hour per inch of thickness.
- **Final Cool – The final step in the complete welding cycle is to allow the piece to cool to ambient temperature in still air. Again, it is helpful to slow the cooling by wrapping the die in ceramic wool. The hardness of the piece will be documented prior to machining, along with all other aspects of the weld process. These records are important for the successful welding program, for costing the job to determine the value of welding and for scheduling future jobs.**

Conclusion

Forge operators and managers will enjoy the benefits of a successful die and equipment welding program by following good business practices. The first of these is to establish and document a welding plan that includes a list of materials, supplies and time estimates before beginning. This should be followed by a documented welding procedure for preparation, welding and tempering. At the end of the process, record the final results. Compare them to estimate and make changes as necessary for the next time a similar job comes through. Finally, compare the cost of welding and machining against the cost of scrapping and replacing equipment or simply re-sinking a worn die.

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