# Technical Bulletin

## *Water Treatment Program Recommendations for Closed Welder Water Systems*

### *Introduction*

Modern automotive manufacturers and large fabricating companies which assemble metal parts use welder systems to electrically "fuse" metal pieces together. These systems are the heart of the manufacturing operation because of their impact on the production process and ultimately, profitability.

Over the past 15-20 years, the use of robotics has emerged, elevating the sophistication of resistance welding, and cooling water treatment requirements, to a new level.

During operation, cooling water flows through the arm of the resistance welder to cool the welder tip, where tremendous heat builds up during the welding process. A properly applied water treatment program protects the substantial investment in these systems by:

- Extending service life of sensitive water cooled electrical components
- Minimizing fouling related downtime
- Reducing labor and material costs associated with replacing corroded system components

This technical bulletin discusses welder water systems in general and specifically, those with closed loop cooling water systems.

### *Water Quality Issues for Closed Loop Welder Water Systems*

The design and operation of these welder water systems present a unique combination of water quality issues. Among these are:

1. Conductivity restrictions
2. Mixed metallurgy
3. Frequent water losses
4. Low water velocities
5. System contamination

### *Conductivity Restrictions*

Conductivity in closed loop welder water systems is generally restricted to 500 µS/cm or less. The restriction arises from both operational and safety concerns.

- Excessive electrical conductivity can cause arcing and burnout in sensitive electronic circuit boards, requiring costly downtime for replacement.
- In addition, as electrical current (on the order of 15,000 amps) passes through the welding electrode, a small amount of current (leakage) will conduct through the cooling water in the hose. Power is dissipated into the cooling water in proportion to the resistance of the water. Excessive electrical conductivity will cause the cooling water to overheat. If water flow is interrupted during weld operations, the water may boil, rupturing the hose, and creating the potential for personal injury and/or operational downtime.

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***Mixed Metallurgy***

Welder water systems are notorious for having a variety of different metals in their construction. Typically, supply and return water mains are constructed of mild steel. Rubber hoses supply chilled water to aluminum distribution manifolds which are connected to the components that need cooling. These components may include a water cooled aluminum heat sink on the SCR (Silicon Controlled Rectifier), a brass transformer cooler, and a copper electrode holder assembly. These components are interconnected through a series of hoses which frequently terminate in brass fittings.

The use of mixed metallurgy should be avoided in all piping systems because of the danger of galvanic corrosion resulting from contact between metals of different electrical potential. Where systems have numerous mixed metal components, the use of dielectric unions will provide some measure of protection. The use of Teflon tape at joints, while a good plumbing practice, does little to isolate galvanic couples because the electrical isolation is usually incomplete.

The extensive use of mixed metallurgy further supports the need for conductivity control because highly conductive solutions act as electrolytes, transporting ions to further drive the corrosion process.

***Frequent Water Loss***

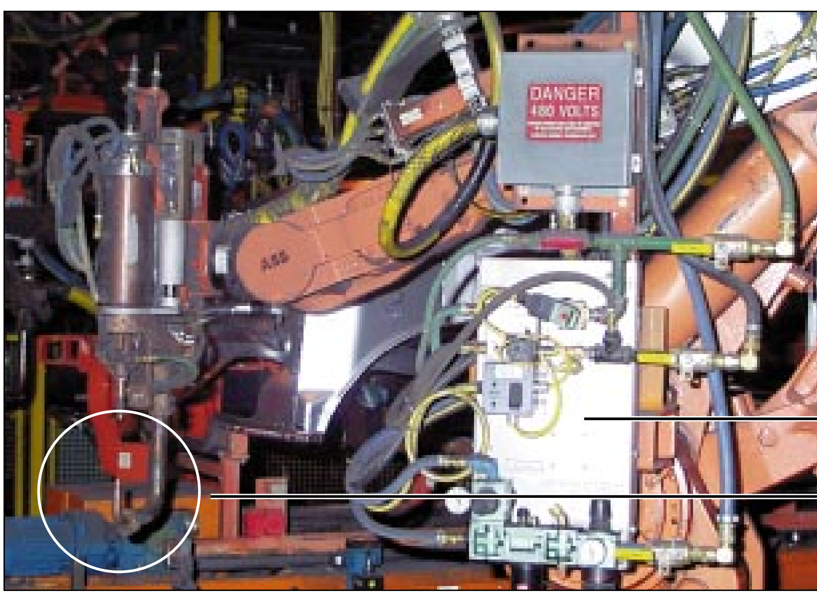
Repeated weld cycles will deform the contact area of the welder electrode. In order to maintain consistent weld quality, the electrode is frequently “dressed” or reshaped to restore the proper contact area. Eventually, due either to normal wear, insufficient cooling water flow or an improperly matched electrode for the part being welded, a welder electrode requires replacement. A typical welder water system may lose several hundred gallons a day as a result of tip replacements and nominal seal leakage. This system water loss must be replaced by fresh water make-up. The ingress of fresh water brings entrained oxygen which contributes to corrosion. Systems with irregular sources of make-up water demand frequent adjustment of the corrosion inhibitor level.

***Low Water Velocities***

Welder water systems often have extensive piping systems that deliver cooling water to the far reaches of large automotive plants. These are often large volume systems which can experience low flow or even stagnant conditions, particularly in remote portions of the loop. Low velocity conditions are a major cause of fouling and under-deposit corrosion. It is critical to look beyond the welder equipment and ensure proper flow throughout the supply and return distribution system. A “dead leg” or stagnant column of water will often build up corrosion products which are mixed into the main system when circulation is restored. In design, “dead legs” should be avoided. Where existing, they should be drained of stagnant water prior to resuming water circulation.

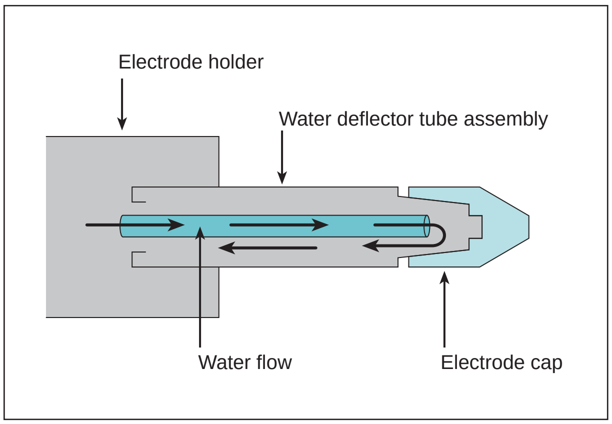
***System Contamination***

New welder system components are stored and shipped in a variety of conditions. The waterside components may be charged with water or glycol, or simply shipped dry. The residual oil from manufacturing, micro-biological growth from low glycol concentrations and construction debris can contaminate the loop and foul the heat exchangers responsible for cooling the SCR and transformer. In addition, deposition in welder tips can reduce flow in an already critical component.




*Typical water cooled robotic welder.*

*Welder electrode assembly.*




*Welder tip assembly showing cooling water flow.*

## *Welder Water System Component Review*

Welder water system designs vary widely; however, the following major components can be found in most systems:

Weld Sequence Controls - These 115 VAC controls may include a weld control, machine sequence control, operator's control station, and auxiliary devices.

- The weld control is programmed to vary the weld current automatically as the electrode wears.
- The machine sequence control contains the relays and pneumatic switches which operate the welder.
- The operator control station, often computer based, is the operator's interface with the machine sequence control.
- Auxiliary devices, such as temperature and pressure limit switches and proximity switches, interrupt the machine sequence at required points.

Welding Transformer - The transformer steps-down high voltage (low current) AC power to low voltage (high current) AC power.

Silicon Controlled Rectifier (SCR) - The SCR serves two functions - it converts AC power to DC power and also regulates (or controls) the level of DC current supplied to the electrode holder.

Water Saver Device - a general term used to describe a system of sensors and switches designed to interrupt welder operations in the event of a major uncontrolled water loss, such as that caused by a broken electrode.

Electrode Holder - applies current and mechanical force to electrode tips in order to weld parts. The holder includes the pneumatic cylinder which applies the squeezing force (usually 500 to 2,000 psi, depending on material and thickness of the part being welded).

Electrode Tip - an arrow-shaped copper fitting approximately 1-1/4" long. The tip transfers electrical current to the material being welded. These are usually replaced when they can no longer be "dressed" to the proper dimensions.

## *Water Treatment Recommendations*

*Filtration*

Every welder water system should be designed with a full flow strainer and sidestream filtration system which are inspected and cleaned frequently. Full flow filtration offers the best removal of suspended solids. Backwashable, full flow strainers allow cleaning of the filter element without operational interruption. Where full flow filtration is not practical, a sidestream filter (alone) rated to remove particles of 5 micron or less may be used to protect the system from fouling. The sidestream filter should process at least 3-5% of the recirculating flow.

In selection and maintenance of the filter, consider the tendency of media filters to harbor microbes in the media bed. The use of centrifugal particle separators (in lieu of media filters) may reduce the risk of MB contamination but will not capture solids <50 microns.

*Corrosion inhibitor selection*

Use a low conductivity, multi-metal corrosion inhibitor which, when combined with makeup water conductivity will not exceed 500 µS/cm. **CorrShield OR404** is an excellent choice. It contributes approximately 150 µS/cm to the makeup conductivity and provides excellent protection for mild steel, copper and aluminum alloys.

In high heat flux comparisons, **CorrShield OR404** outperformed molybdate/nitrite inhibitor blends without the heavy metal contribution of molybdenum. In addition, **CorrShield OR404** is formulated without microbiological nutrients such as nitrite, which can contribute to fouling.

**CorrShield OR404** contains a blend of organic inhibitors for protection of ferrous metals, a separate copper and copper alloy inhibitor, and a powerful polymer dispersant to minimize potential fouling of narrow fluid passages.

*Inhibitor Control*

"Contact head" make-up meters should be installed to maintain the correct system inhibitor residual when faced with irregular water losses. These meters automatically send a signal to begin a timed pump cycle when a preset quantity of water has been added (as make-up) to the system. In the absence of automatic chemical feed, determine whether a routine flushing of welder hoses is performed and how often. Feed chemical at the appropriate time, based on expected water losses, to maintain required inhibitor control range.

*Corrosion Monitoring*

System analysis should be based on conditions at several locations, including the most stressed part of the system. While we may expect favorable conditions in the bulk water, too often stressed areas of low flow or stagnant conditions (remote from the welders) are not closely monitored.

- Corrosion coupon monitoring is a key component in every conscientiously applied water treatment program. It allows the water treater to quantify overall corrosion rates and trend program performance. Install and analyze corrosion coupons regularly.
- An on line corrosion rate monitor, such as a Corrator® provides a continuous display of overall corrosion rates without removal of the corrosion sensor.
- A spool piece fabricated of system metallurgy and piped into a (three-valve) bypass allows analysis of actual corrosion conditions in the main piping system. The bypass permits removal and reinstallation of the spool piece without interrupting system operation. The spool piece provides a "real world" look at conditions otherwise unseen with corrosion coupons alone.

*Mixed Metallurgy*

Identify mixed metallurgy, particularly aluminum distribution manifolds. Particular attention should be paid to isolation of galvanic couples in the piping system. Systems with aluminum metallurgy should be maintained in a pH range of 8.0 to 8.2. Monitor aluminum levels in the recirculating water, supplementing program with silicate inhibitor if needed.

*New Equipment Commissioning*

Always thoroughly preclean new equipment to dissolve oil films and flush debris from the equipment. This will improve the filming ability of the inhibitor as well as rid the system of contaminants. Never flush new equipment into the system piping. New equipment should be thoroughly flushed, cleaned and discharged in accordance with applicable regulations.

*Industry Recommendations for Water Quality*

The Resistance Welders Manufacturer's Association recommends the following water quality parameters:

- pH between 7.0 and 9.0
- max chloride of 20 ppm
- max nitrate of 10 ppm
- max sulfate of 100 ppm
- max calcium carbonate of 250 ppm as $CaCO_3$
- max conductivity of 500 µmho/cm at 77°F.

BetzDearborn recommends, based on our practical field experience, a modification of the above industry guidelines. As most welder systems contain some aluminum metallurgy, pH should be maintained between 8.0 and 8.2 for optimum corrosion protection. Aluminum bearing systems should never be operated above a pH of 8.5.

## *Automation And Control Of Closed Welder Water Systems*

*Chemical Feed and Control*
*(Listed most to least accurate)*

1. *Metered feed systems* provide proportional control to replace lost inhibitor in direct proportion to make-up demand. This is the best control scheme, particularly for systems prone to large water losses. It is suitable for all inhibitor types, particularly for low conductivity inhibitors.These types of proportional control represent the most accurate method of chemical feed.

2. *Reverse conductivity feed systems* approximate proportional control by maintaining inhibitor level based on conductivity. They are not suitable for low conductivity inhibitors or systems with seasonal make-up water conductivity variations. They provide simple control, but are less accurate than metered feed systems.

3. *Percentage and interval timers* provide constant level of inhibitor feed. They are not suitable for systems with varying (unpredictable) water losses.

4. *Bypass shot feeders* provide one-shot chemical injection. Shot feeders may be unacceptable in leaking systems due to the frequency of required chemical inhibitor charges. It is the simplest feed method for common (tight) closed system.

*Corrosion Monitors*

1. *On-line corrosion monitors* provide excellent on-line monitoring in dynamic systems. They are a good means of detecting corrosive conditions before system damage occurs.

2. *Corrosion Coupon monitoring* remains the least expensive, most widely applied method. Every closed system should be equipped with multiple metallurgy coupon sites.

*Biological Monitoring Methods*

1. *BIOSCAN® ATP testing* allows instantaneous reading and corrective action. The fastest, most accurate method of MB monitoring.

2. *Dip slides* provide MB counts in two to three days. Be sure slides are used within the expiration period (one year shelf life). Dip slides will not show anaerobic bacteria.

3. *Cool Count Assayer* provides MB counts in 12 hours. Reading time is based on bacterial level and are best suited for use in relatively clean systems to provide fast results.

4. *Sessile MB Coupons* provide long-term confirmation of biological slime growth in system.

*Biological Control*

Bilogical control should be maintained by using a nonoxidizing biocide such as BetzDearborn's Spectrus NX114. This product provides broad spectrum microbial control without contributing soluble copper which can cause galvanic attack of mild steeel components.