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## **CONFIDENTIAL TECHNICAL DOCUEMNT**

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**TITLE:** GALVANIC CORROSION

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**APPROVED FOR RELEASE TO:**

All MIRACHEM Customers, Distributors and Team Members

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**Issue:** Corrosion resulting from the cleaning of dissimilar metals in the same parts washer at the same time as evidenced by a powdery residue forming on the surface of one metal. Usually not immediately visible. Galvanic corrosion.

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This type of corrosion is the result of an electric cell or galvanic cell being formed by two metals in contact in a conductive environment. The corrosion is accelerated by and the result of the difference in the electrical potential of the two metals. The resulting corrosion is to the more active or electronegative metal. The metal with the lowest electrode reduction potential (see table below) will corrode first resulting in a metal oxide formation or powder residue on that metal. For example, when the metal being corroded is magnesium, you will see a white powder of magnesium oxide on the magnesium. Iron will produce an orange residue, ferric oxide ( $\text{Fe}_2\text{O}_3$ ) or black residue, ferrous oxide ( $\text{FeO}$ ) on the iron part.

Things that can impact the corrosion rate are:

- 1) The galvanic potential between the metals; i.e. the reaction of copper to magnesium (potential =  $0.337 + 2.363 = 2.7$ ) would be faster than the reaction of iron to Magnesium (potential =  $2.363 - 0.440 = 1.923$ ).
- 2) The conducting media; i.e. water, detergent, etc.
  - a) Active detergent concentration
  - b) pH
  - c) Oxygen content
  - d) Solution conductivity
  - e) Pollutant level (both microbial and non-microbial, such as chloride)
- 3) Temperature (heat will generally speed up the reaction)
- 4) Time in the conducting media (soak duration)

To a lesser extent;


- 1) Geometry (closeness of the metals to each other, joint fabrication)
- 2) Surface area and shape
- 3) Number of competing galvanic cells
- 4) Protective films
- 5) External voltage

Recommended course of action:

- 1) Make every effort to **maintain the solution concentration** at the recommended dilution. This may require providing pre-diluted detergent solution as a makeup fluid for addition to the tank when evaporation has dropped the fluid level.
- 2) **Do not allow the parts to soak.** Reduce the time in the solution as much as feasible.

- 3) **Do not wash dissimilar metals at the same time** and if feasible do not wash dissimilar metals in the same solution.
- 4) Change out the fluid as often as feasible.
- 5) Use the Mirachem cleaner at a greater concentration, i.e., 2:1 instead of 4:1.
- 6) Use deionized or reverse osmosis water for dilution instead of tap water.

### **Standard Potentials of Some Metals\***

	Metal-metal Ion Equilibrium Unit Activity Range: Noble to Active	Electrode Reduction Potential Versus Normal Hydrogen Electrode at 25 C, V Range: Noble to Active		
Gold	Au-Au <sup>+3</sup>	+1.498		
Platinum	Pt-Pt <sup>+2</sup>	+1.200		
Palladium	Pd-Pd <sup>+2</sup>	+0.987		
Silver	Ag-Ag <sup>+3</sup>	+0.799		
Mercury	Hg-Hg <sup>+2</sup>	+0.788		
Copper	Cu-Cu <sup>+2</sup>	+0.337		
Hydrogen	H <sub>2</sub> -H <sup>+</sup>	0.00		
Lead	Pb-Pb <sup>+2</sup>	-0.126		
Tin	Sn-Sn <sup>+2</sup>	-0.136		
Nickel	Ni-Ni <sup>+2</sup>	-0.250		
Cobalt	Co-Co <sup>+2</sup>	-0.277		
Cadmium	Cd-Cd <sup>+2</sup>	-0.403		
Iron	Fe-Fe <sup>+2</sup>	-0.440		
Chromium	Cr-Cr <sup>+3</sup>	-0.744		
Zinc	Zn-Zn <sup>+2</sup>	-0.763		
Aluminum	Al-Al <sup>+2</sup>	-1.662		
Magnesium	Mg-Mg <sup>+2</sup>	-2.363		Most likely corrosion site
Sodium	Na-Na <sup>+</sup>	-2.714		
Potassium	K-K <sup>+</sup>	-2.925		

\* From "Beal On Corrosion and Testing of Engine Coolants", page 101