

Leaching of Nickel in Saltwater and in Ultrapure Water

E. B. Norman and R. M. Larimer
Lawrence Berkeley Laboratory
Berkeley, CA

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We have performed a simple experiment to measure the rate at which metallic nickel dissolves in saltwater and in ultrapure water. High-purity metallic nickel sheet of 0.001" thickness was cut into 3 strips, each 1-cm wide by 15-cm long. These strips were first wiped with a cleaning solution obtained from Edmund Scientific Co. and then each was placed into a clean polyethylene bottle of 150 ml volume. One bottle was then filled to the top with "Nanopure" water that had been purified to a resistivity of 17.3 M Ω -cm. The second bottle containing a nickel strip was filled with a solution of the "Nanopure" water to which sufficient NaCl had been added to make the solution 0.25% NaCl by weight. The third bottle containing a nickel strip was filled with a similar mixture that was 2.5% NaCl by weight. As a control sample, a fourth bottle (not containing any nickel) was filled with this same 2.5% NaCl solution. These bottles were tightly sealed and were allowed to sit at room temperature for a period of 75 days.

After this period of 75 days, we opened the bottles and performed a standard chemical test for nickel using dimethylglyoxime (DMG). We boiled each sample down to a final volume of 5-15 ml, added 5 drops of a saturated DMG-alcohol solution, and then added 5 drops of NH₄OH to make the solution basic. These solutions were stirred and then centrifuged and we looked for the characteristic scarlet color of Ni-DMG. We found that for both the nickel in 0.25% saltwater and nickel in 2.5% saltwater solution we did see the Ni-DMG form. For the nickel in ultrapure water we did not see any color change. For the case of the 2.5% saltwater control solution we also found no indication of any Ni-DMG, thus proving that our reagents did not introduce nickel into the system.

In order to quantify the above results, we made up nickel solutions of known concentrations and performed the same chemistry on them as was done in the above-mentioned tests. By comparing the amount of Ni-DMG precipitates or colors of solutions obtained from the nickel samples of interest with those obtained from the standards, we were able to determine the amount of nickel leaching that had occurred. From these measurements we conclude that in 75 days: (1) the amount of nickel that dissolved in the 0.25% saltwater solution was no more than 10 μ g; (2) the amount of nickel that dissolved in the 2.5% saltwater solution was approximately 200 μ g; (3) the amount of nickel that dissolved in the ultrapure water was less than 5 μ g. From these results we infer the following rates of nickel leaching:

Nickel in ultrapure H ₂ O	< 22 μ g/m ² /day
Nickel in 0.25% saltwater	44 μ g/m ² /day
Nickel in 2.5% saltwater	890 μ g/m ² /day

After these tests were performed, all of the nickel foils were examined and to the naked eye none of them showed any sign of corrosion.