Performance of new on-site Lead Test
By I. Jaunakais, A Zicmanis  USA
Industrial Water Systems
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Lead In History

• It’s been used by civilization from ancient times

• Georgius Agricola described Lead in the 16\textsuperscript{th} century as a “pestilential and noxious metal

• Saturnism – the Greek name for the planet Saturn and the ancient symbol for Lead

• Saturnism disease symptoms included colic, delirium, and paralysis

• Plumb is a Latin word referring to Lead
Lead Regulations

- Government and industry accepted the dangers of Lead in the 1900’s
- Regulation in gasoline (1975), paint (1978), and plumbing (1986)
- Average American blood Lead level has declined over the last 30 years
- Current research has not been able to identify minimum Lead thresholds.
Lead Levels Affects Humans

- Lowers I.Q.
- Elevates blood pressure
- Alters kidney function
- Measurable cognitive decline
- Increases violent behavior
- Death from high exposure
Lead F.Y.I.

• Lead is the element number 82 with an atomic mass of 207.19
• Lead is a heavy element with a density of 11.4 grams per cm$^2$
• Lead is soft, bendable, and easily cut with a knife
• Lead is present in most metal plumbing
• Most metal items we use each day may contain Lead
The Chemistry of Lead

• Oxidation states of Lead are 0, +2, and +4
• Organic and inorganic salt compounds of Lead are state +2
• Inorganic salt compounds are only slightly soluble in water at or below 0.1 gram per Liter
• Below pH 6, Pb$^{2+}$ is the major Lead-containing species
• At higher pH values the polymeric hydroxocomplexes predominate
Fig. 1. Species distribution of lead in an aqueous Pb(II) solution $C_{T,Pb}$ 0.04 M. by Olin A. Svensk Kim Tidskr., 73:482(1961).
Maximum Containment Level

- U.S.EPA maximum containment level allowed in drinking water is 15 PPB
- World Health Organization limit is 10µg/L
- Canada has a limit of 20µg/L
- Plumbing and fixtures must contain below 8% Lead
- California regulation limits for faucet fixtures is very low for extraction “California Prop 65 and NSF.ANSI 61 lead-free”
Testing for Lead

• Most reliable method for testing is laboratory analysis by instrumentation but cost per test very expensive (over $20) and must allow for a delay in results

• Hazardous reagents in field kits and complicated test procedure may include extraction step

• Field kits don’t meet EPA detection requirement of 15 µg/L
LEADQuick™ Lead Test

• Uses a Hach® LeadTrak Pocket Colorimeter II
• Four minute test uses four reagents
• Minimum chemical hazard (0.5m Nitric Acid)
• Easy on-site procedure
• Affordable ($2 per test)
LEADQuick™ Chemistry

Step 1
Collect a 10 mL water sample in clean sample cell.
LEADQuick™ Chemistry

Step 2
Lead solubilized to Pb$^{2+}$ by the addition of five drops of Pb-1 Acid reagent, followed by a swirl to mix sample, and a two minute wait.
LEADQuick™ Chemistry

Step 3

While waiting, wipe the cell and place into the Hach LeadTrak colorimeter II. Turn meter on and select “abs” mode.
LEADQuick™ Chemistry

Step 4

Ten (10) drops of Pb-2 Buffer is added to make the solution alkali (about pH 9).
LEADQuick™ Chemistry

Step 5

Dip an eXact® Strip Pb-3 for 20 seconds with gentle back and forth motion which adds the porphyrin indicator and mixes the solution
LEADQuick™ Chemistry

Step 6

Wait one minute to allow the porphyrin and Lead hydroxocomplex, \( \text{Pb}_6(\text{OH})_8^{4+} \) to form a colorimetric complex in the cell; At the end of the one minute the meter is zeroed in the “abs” mode
LEADQuick™ Chemistry

Step 7

eXact® Strip Pb-4 is dipped into the cell sample for twenty seconds with gentle motion. This releases EDTA which breaks up the colorimetric porphyrin-Lead complex.
LEADQuick™ Chemistry

Step 8

Press the read key and record the “abs” value. The value will be negative if Lead is present. The larger the negative reading the higher the Lead concentration. Determine the Lead concentration from the “abs” value chart.
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<th>µg/L</th>
<th>&quot;abs&quot;</th>
<th>µg/L</th>
<th>&quot;abs&quot;</th>
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</table>

Rev. 03/20/08

"abs" value chart
LEADQuick™ Graph

**High Range Lead Graph**

\[
y = 0.0014x + 0.0084 \\
R^2 = 0.9982
\]
Facts About LeadQuick™

• LEADQuick™ modified procedure uses TMPYP and is U.S. Patented
• It delivers optimum accuracy and best sensitivity using minimum manipulation
• The Lead Test Interference chart details what concentration of ions this test will tolerate
# Interference Chart

## Lead Test Interferences

<table>
<thead>
<tr>
<th>Ion</th>
<th>Interference Level</th>
<th>Ion</th>
<th>Interference Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum, $\text{Al}^{3+}$</td>
<td>2 mg/L</td>
<td>Magnesium, $\text{Mg}^{2+}$</td>
<td>200 mg/L</td>
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<tr>
<td>Barium, $\text{Ba}^{2+}$</td>
<td>3 mg/L</td>
<td>Manganese, $\text{Mn}^{2+}$</td>
<td>0.5 mg/L</td>
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<tr>
<td>Bromide, $\text{Br}^-$</td>
<td>20 mg/L</td>
<td>Mercury, $\text{Hg}^{2+}$</td>
<td>0.01 mg/L</td>
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<tr>
<td>Cadmium, $\text{Cd}^{2+}$</td>
<td>0.07 mg/L</td>
<td>Nickel, $\text{Ni}^{2+}$</td>
<td>1 mg/L</td>
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<tr>
<td>Calcium, $\text{Ca}^{2+}$</td>
<td>500 mg/L</td>
<td>Nitrogen, Ammonium, $\text{NH}_4^+$</td>
<td>40 mg/L</td>
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<tr>
<td>Chloride, $\text{Cl}^-$</td>
<td>150 mg/L</td>
<td>Nitrogen, Nitrate, $\text{NO}_3^-$</td>
<td>20 mg/L</td>
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<tr>
<td>Chromium, $\text{Cr}^{3+}$</td>
<td>0.1 mg/L</td>
<td>Nitrogen, Nitrite, $\text{NO}_2^-$</td>
<td>300 mg/L</td>
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<tr>
<td>Cobalt, $\text{Co}^{2+}$</td>
<td>1 mg/L</td>
<td>Phosphate, $\text{PO}_4^{3-}$</td>
<td>100 mg/L</td>
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<tr>
<td>Copper, $\text{Cu}^{2+}$</td>
<td>5 mg/L</td>
<td>Sulfate, $\text{SO}_4^{2-}$</td>
<td>200 mg/L</td>
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<tr>
<td>Fluoride, $\text{F}^-$</td>
<td>40 mg/L</td>
<td>Tin, $\text{Sn}^{2+}$</td>
<td>0.2 mg/L</td>
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<tr>
<td>Iron, $\text{Fe}^{2+}$</td>
<td>0.2 mg/L</td>
<td>Zinc, $\text{Zn}^{2+}$</td>
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<tr>
<td>Iron, $\text{Fe}^{3+}$</td>
<td>0.1 mg/L</td>
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</table>

*Rev. 07/03/07*
Interferences

- All interfering ions, except for Mercury and Cadmium, inhibit the TMPYP-Lead complex formation
- Mercury and Cadmium give similar color reaction with TMPYP
- Mercury is rarely found in tap water above 0.005 mg/L
- Hardness ions such as Calcium and Magnesium are tolerated
Interferences In drinking water

- Most potable, municipally treated water samples experience no interferences
- When using the LEADQuick™ with potable water samples use the “Standard Additions” or “spike” method to determine interferences
- For best results test on unpreserved, freshly drawn water samples
## Lead Recovery In Samples

<table>
<thead>
<tr>
<th>Water Origin</th>
<th>Water Sample Type</th>
<th>Water Spike abs.</th>
<th>20µg/L Spike abs.</th>
<th><strong>Equivalent ppb (µg/L)</strong></th>
<th>% Recovery</th>
<th>50µg/L Spike abs.</th>
<th>Equivalent ppb (µg/L)</th>
<th>% Recovery</th>
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<tbody>
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<td>Vienna, Austria</td>
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<td>-0.035</td>
<td>21</td>
<td>105</td>
<td>-0.093</td>
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<tr>
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<td>0.003</td>
<td>-0.032</td>
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<td>95</td>
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<td>-0.082</td>
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<td>92</td>
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*M = Municipal, W = Well

** from Conversion Chart
## Lead Recovery In Samples

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<th>Water Origin</th>
<th>Water Type*</th>
<th>Sample Type</th>
<th>Water Sample</th>
<th>20µg/L spike</th>
<th><strong>Equivalent ppb (µg/L)</strong></th>
<th>% Recovery</th>
<th>50µg/L spike</th>
<th>Equivalent ppb (µg/L)</th>
<th>% Recovery</th>
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<td>-0.031</td>
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<td>95</td>
<td>-0.093</td>
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</tr>
</tbody>
</table>

*M = Municipal, W = Well  
** from Conversion Chart
Spiked Recovery Test Method
Or Standard Additions Method

• Add a known amount or concentration of Lead standard solution to the questionable sample.
• Add a Standard Solution amount that is at least equivalent to three times the minimum detectable limit of the test (10 ppb).
• This is the “spiked sample”
Spiked Recovery Test Method
Or Standard Additions Method

- Test the spiked and un-spiked (original) sample using the same reagents, instrument and technique or test method.
- The “spiked sample” should show an increase equal to the amount of standard added.
- The value obtained is called the Recovery. Ideally the % recovery is 100%.
Spiked Recovery Test Method
Or Standard Additions Method

• Results are acceptable if the % recovery is +/- 10%.
• If the recovery is not in the acceptable range there may be interferences.
• Dilute the sample with Lead free water past the point of interference, if the sample is within the detection limit of the test kit.
Spiked Recovery Test Method
Or Standard Additions Method

The percent recovery formula is as follows:

\[
\% \text{ Recovery} = \frac{100(C_s - C_u)}{K}
\]

Where:
\( C_s \) = concentration found through testing of the spiked sample
\( C_u \) = concentration found through testing of the un-spiked sample

*(Note: result should be adjusted for the dilution of the spike volume if volume change is more than 5%)*

\( K \) = concentration of the spike added to the sample
Lead in Tap Water

• I’ve measured Lead levels throughout the world for the last 6 months.

• Latest publication by Triantafyllidou *et al* (*“Lead Particles in potable water,”* Journal AWWA, June 2007) prompted me to test aerator filters and nozzles.
# Lead in Tap Water

World-wide water samples

<table>
<thead>
<tr>
<th>Sink and Tap Location</th>
<th>Extracted Lead in Water ug/L</th>
<th>Extracted Lead in Particles ug/L</th>
<th>Extracted Lead in Nozzle ug/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Men’s Room</td>
<td>&lt; 3</td>
<td>190</td>
<td>135</td>
</tr>
<tr>
<td>Business Women’s Room</td>
<td>&lt; 3</td>
<td>19</td>
<td>90</td>
</tr>
<tr>
<td>Business Lunch Room</td>
<td>&lt; 3</td>
<td>52</td>
<td>195</td>
</tr>
<tr>
<td>My Home Guest Bathroom</td>
<td>&lt; 3</td>
<td>15</td>
<td>80</td>
</tr>
<tr>
<td>My Home Bathroom</td>
<td>&lt; 3</td>
<td>11</td>
<td>115</td>
</tr>
<tr>
<td>Daughter’s Home Bathroom</td>
<td>&lt; 3</td>
<td>&lt; 3</td>
<td>230</td>
</tr>
<tr>
<td>Associate’s Home Bathroom</td>
<td>59</td>
<td>&lt; 3</td>
<td>430</td>
</tr>
<tr>
<td>Banff, Canada Hotel Bathroom</td>
<td>&lt; 3</td>
<td>25</td>
<td>NT</td>
</tr>
<tr>
<td>Edmonton, Canada Hotel Bathroom</td>
<td>&lt; 3</td>
<td>63</td>
<td>NT</td>
</tr>
<tr>
<td>Barcelona, Spain #1Hotel Bathroom</td>
<td>&lt; 3</td>
<td>12</td>
<td>163</td>
</tr>
<tr>
<td>Barcelona, Spain #2Hotel Bathroom</td>
<td>&lt; 3</td>
<td>104</td>
<td>28</td>
</tr>
<tr>
<td>Nozzle/Aerator bought in USA</td>
<td>NA</td>
<td>&lt; 3</td>
<td>125</td>
</tr>
<tr>
<td>Nozzle/Aerator bought in Spain</td>
<td>NA</td>
<td>&lt; 3</td>
<td>420</td>
</tr>
<tr>
<td>Deionised water (Blank control)</td>
<td>&lt; 3</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Lead Free Fixture (nozzle)</td>
<td>NA</td>
<td>NA</td>
<td>&lt; 3</td>
</tr>
</tbody>
</table>

*Interference suspected since precipitate appeared during testing; but test reported below detection level of Lead (< 3)

Table 2. Samples tested by Ivars Jaunakais over the last few months and his results.
Lead In Tap Water

• 7 of 9 sediment samples contained lead.
• (POU) point-of-use filtering devices are important.
• Brand new nozzles were positive for lead.
• Stainless steel filter screens tested negative.
Lead In Tap Water - Conclusions

• Exposure to lead may be more common than we think.

• Shocking that store-bought tap nozzles still contained lead.

• The tap that – “meets California prop 65 and NSF.ANSI 61 lead-free standards” was free of lead.
Lead Quick Test Kit Promises

• Quick 5 minute results.
• On-Site testing convenience.
• Economical – 3 Euros per test.
• Easy test procedure.

Questions?