November 21, 1941

The Health Hazard from the Use of the Army Field Water Cans

Object

To determine whether harmful quantities of lead and zinc will be dissolved by water stored in the galvanized cans.

Conclusions

(1) The can with galvanized lining is dangerous to use.

(2) Significant amounts of both lead and zinc are present in the contained water within 5 minutes, and potentially hazardous quantities of lead go into solution in from a few minutes to 2 hours' time.

(3) Large quantities of zinc are found in the water after some days standing.

(4) There is less difference than would be anticipated in the capacities of various waters to dissolve the can linings.

Procedure

Three standard cans, painted outside, were received from the Jeffersonville Quartermaster Depot and were immediately washed with 2-1/2 liters of distilled water, shaken for 1 minute of each 15, through a period of 1 hour.

Each can was then one-half filled with 1 of the 3 kinds of water; viz.

electrolysis.

The screw caps and orifices corroded badly and the gaskets deteriorated and fragmented after a few hours' use.

The result of the pH determinations and metal analyses are given on the attached sheets.

Discussion

The changes in pH were in the main toward a greater alkalinity, resulting in all probability from the increasing amounts of zinc oxide dissolved. Variable results were encountered in the case of Can #1 (distilled water) which it was not possible to seal tightly because of a break in the top.

The amounts of lead in the waters increased steadily on standing and reached potentially hazardous levels in a short time in all cans. The amounts present after 6 hours were not of such magnitude as to be immediately dangerous when consumed under conditions of low water intake for short periods of time, but if these concentrations were ingested regularly during heavy operations in hot, dry weather when the water intake is high, lead intoxication could result. (The temperature effect was not studied and cans were stored at room temperature (74° F.). It is anticipated that all solubilities will be increased at higher temperatures.)

Large quantities of zinc were dissolved by all waters.

There was no proportionate relationship between the amounts of lead and zinc dissolved by the various waters, nor did the amounts dissolved by any one kind of water increase in all instances in the same proportion with time. Accelerating rates of solution for both lead and zinc were noted as the result of contact with distilled water, and for zinc in contact with Norwood and Cincinnati waters. The rates of solution of lead were practically constant for the entire period of contact with the Norwood and Cincinnati waters.

WATER STORED IN ARMY WATER CANS

Distilled Water (a)

Storage Duration	pH	Mg. Pb Per Liter	Mg. Zn Per Liter	Remarks
Before Use	5.88	0.002	0.030	
5 minutes	6.98	0.16	3.90	Turbid sample
10 minutes	7.30	0.14	5.40	Turbid sample
30 minutes	7.19	0.23	5.40	Turbid sample
2 hours	7.00	0.50	4.20	Turbidity of sample increased
8 hours	6.77	0.54	5.10	Definite water line on can surface
24 hours	Lost	Lost	Lost	Lost
1 week	8.61	1.80	49.5	Contents milky, faint water line
1 month	7.60	2.32	166.0	Heavy white sediment, double water line, black spots on bottom, sides coated

(a) Double distilled.

Note: Lead determinations were made by photometric dithizone method (D. M. Hubbard, Ind. Eng. Chem. Anal. Ed. 9, 493 (1937); Karl Bambach, Ind. Eng. Chem. Anal. Ed. 11, 400, (1939)).

Zinc determinations were made polarographically (unpublished method).

Samples Reported: 11-14-41

WATER STORED IN ARMY WATER CANS

Norwood City Water

Storage Duration	pH	Mg. Pb per Liter	Mg. Zn Per Liter	Remarks
Before use	7.41	0.02	0.040	
5 minutes	7.90	0.10	3.40	Cloudy sample
10 minutes	7.95	0.09	3.70	Cloudy sample
30 minutes	7.96	0.12	7.30	Turbidity of sample increased; trace of oxidation
2 hours	7.95	0.24	14.24	Turbidity of sample increased; trace of oxidation
8 hours	8.22	0.21	17.50	Increasing cloudiness; definite water line; some sludge
24 hours	8.00	0.22	17.00	Same as above plus increasing oxidation of dry surface
1 week	8.92	0.29	72.00	Pasty deposit above water line; metallic taste
39 days	9.79	0.50	168.00	Sides and bottom coated with pasty material; liquid turbid; metallic taste

Analysis of Norwood Water

	ppm	Grains/gallon
Turbidity	10.0	0.6
Free CO_2	16.0	1.0
Total Alkalinity	343.0	20.0
Incrustants	40.0	2.3
Total Hardness	383.0	22.3
Magnesium	22.0	1.3
Iron	2.2	0.13
Sulfate	41.0	2.4
Chloride	15.0	0.9
Calcium	103.0	6.0
Total Solids	425.0	34.9

Note: Lead determinations were made by photometric dithizone method (D. M. Hubbard, Ind. Eng. Chem. Anal. Ed. 9, 493 (1937); Karl Bambach, Ind. Eng. Chem. Anal. Ed. 11, 400 (1939).

Zinc determinations were made polarographically (unpublished method).

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WATER STORED IN ARMY WATER CANS

Cincinnati City Water (a)

Storage Duration	pH	Mg. Pb per Liter	Mg. Zn per Liter	Remarks
Before use	8.63(b) 8.55(c)	0.002	Trace	
5 minutes	7.80	0.15	14.50	Sample cloudy
10 minutes	8.48	0.18	18.00	Sample cloudy
30 minutes	8.57	0.28	26.70	Increasing cloudiness; acid odor; Cl taste
2 hours	8.12	0.31	29.60	Increasing turbidity
8 hours	8.31	0.34	33.00	Definite water line; very turbid; bottom and sides show oxidation
24 hours	8.16	0.44	47.00	Sample appears almost milky; metallic taste
1 week	8.50	0.53	102.00	Increasing oxidation of bottom and sides
34 days	9.9	0.69	284.0	Liquid turbid; corrosion; pasty deposit; screw cap heavily corroded

Analysis of Cincinnati Water (Avg. for 1941)

	ppm
*Phenolphthalein Alkalinity	3
Total alkalinity	28
Non-carbonate Hardness	102
Total Hardness	130
Calcium	42.5
*Magnesium	5.8
Sulfates	117.3
Chlorides	33.0
*Iron	Trace
Total Dissolved Solids	278.0
*pH Value	8.4

Free CO_2 never is present, being removed by the lime treatment.

(a) This water was treated with calcium hypochloride (HTH) to give 5 ppm. free Cl.
(b) pH before treatment with HTH
(c) pH after treatment with HTH
* Minimum and maximum values do not necessarily occur at the time of minimum and maximum hardness
HTH = Mathieson Alkali Works trade name.

Note: Lead determinations were made by photometric dithizone method (D. M. Hubbard, Ind. Eng. Chem. Anal. Ed. 9, 493 (1937); Karl Bambach, Ind. Eng. Chem. Anal. Ed. 11, 400 (1939).

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