EXAMINATION OF DRINKING WATER ON RAILWAY TRAINS

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In order to determine the character of water furnished to the passengers on railway trains, 100 samples from water containers on trains have been collected and analyzed by members of the staff of the Illinois State Water Survey. Although the number of samples examined is small, the information obtained concerning the actual condition of the waters should be valuable in formulating practical standards. The samples were secured from trains at Champaign, Urbana, Kankakee and Chicago. It was thus possible to secure samples from cars coming from all parts of the country.

Of the 101 samples: Twenty-eight of the tanks were said to have been last filled at Chicago. Nine at Peoria. Eight at Centralia. Six at Detroit. Five at Cincinnati. Four at Indianapolis. Three at Kansas City, Mo. Two each at Memphis, Tennessee; Salamanca, New York, and New York City. One each at Boston, Massachusetts; Buffalo, New York; Champaign, Illinois; Dubuque, Iowa; Effingham, Illinois; Forrest, Ill.; Ft. Madison, Ia.; Ft. Wayne, Ind.; Grand Rapids, Mich.; Havana, Ill.; Lincoln, Neb.; Mason City Ia.; Mattoon, Ill.; Minneapolis, Minn.; Montreal, P. Q.; Nashville, Tenn.; Parsons, Kans.; Pittsburgh, Pa.; St. Louis, Mo.; St. Paul, Minn.; Sioux City, Ia.; South Bend Ind.; Springfield, Ill. Four were filled with bottled water from Hammond, La., one with bottled water from Waukesha, Wis. The water in five was of unknown origin. The majority of the samples, 57, were taken from coaches, 19 from sleepers, 8 from dining cars, 7 from smoking cars, 6 from parlor cars, 2 from tourist sleepers, and of 3 there was no record.

The analyses include both bacteriological and chemical examinations and an attempt has been made to make them as complete as possible when using 120 cc. samples for bacterial examination and one liter samples for the chemical tests.

METHODS OF ANALYSIS

The analyses have been made as far as possible in accordance with Standard Methods of Water Analysis of the American Public Health Association (1912) and all analyses made after May 1 include confirmations of *B coli* made in accordance with the recommendations of the Commission on Standards for Common Carriers in Interstate Commerce.

Ninety-nine samples were examined for turbidity. Of these 70 showed a turbidity less than 5 parts per million; 82 less than 10; 69 less than 15, and only 10 showed 15 or more. A turbidity below 10 would not make the water appear unattractive and it would seem not unreasonable to require a standard of 10 or less.

Ninety-nine samples were examined for color. Seventy-nine of the samples had a color less than 5 parts per million; 88 less than 10; 93 less than 20, and only 6 had 20 or more. A color requirement of 20 or less should be easy to meet and it would not be impossible to meet a requirement of 10 or less.

Ninety-nine samples were examined for residue. Of these 28 had a residue less than 50 parts per million; 36 less than 100; 75 less than 200; 84 less than 300; 90 less than 400; 95 less than 500, and only 4 above 500. The very low residues are undoubtedly due to the presence of melting ice in the coolers. The few samples containing more than 500 parts per million would indicate that a standard of 500 or less could easily be made.

Chlorine was determined in 99 samples. Of these 46 had less than 5 parts per million; 66 had less than 10; 75 had less than 15; 82 had less than 20; 90 had less than 25, and only 9 more than 25 parts per million. It should not be difficult to obtain a water containing less than 15 parts of chlorine per million and it should certainly be easy to obtain water containing less than 25 parts per million. In special cases where it is not possible to obtain waters with low mineral content, exceptions to the rule may be made. The same may be true also of residue, magnesium, sulfates, alkalinity and hardness.

Sixty-six were examined for magnesium. Of these 39 contained less than 10 parts per million; 51 less than 15; 60 less than 20, and only 6 more than 20 parts per million. In the large majority of cases, therefore, it should be easy to obtain waters containing less than 20 parts per million of magnesium. If the magnesium were all present as sulfate, 20 parts of magnesium would be equal to 100 parts of magnesium sulfate.

The alkalinity using phenolphthalein and methyl orange as indicators was determined in 99 samples. In only one case was a water found which was alkaline to phenolphthalein. A requirement that the alkalinity of phenolphthalein shall not be greater than one-half the alkalinity to methyl orange would be easy to fulfill and would guard against the use of water over treated with lime. Forty-three samples contained less than 50 parts of alkalinity to methyl orange, 71 less than 100, 89 less than 200. Only 10 had an alkalinity of over 200, and only one of more than 300. A standard of 300 or less would be very easy to maintain and a standard of 200 or less would not be impossible.

The total hardness was determined on 64 samples. Of these 34 had a total hardness of less than 50; 45 less than 100; 57 less than 200. Only 7 had a hardness of more than 200, and but 2 a hardness of more than 300. A limit of 300 would be very easy to maintain and it should not be difficult to obtain waters containing less than 200.

Sixty-six waters were examined for sulfates. Thirty-six waters contained than 10 parts per million of SO_4; 42 less than 25; 54 less than 50; 63 less than 100, and only 3 more than 100. It should be apparently very easy to furnish waters having less than 100 parts per million of sulfates.

Ninety-nine samples were examined for iron. Eighty-six of these contained less than .5 parts per million of Fe; 94 less than 1.0; and only 5 had more than 2 parts per million. A standard of less than 1 part per million would be very easy to maintain and it would not be unreasonable to ask for .5 parts.

Sixty-six samples were examined for lead and copper. Fifty-six of these showed no trace of either metal; 7 contained .1 part per million; 2 contained .2, and 1 contained .3. It would not seem difficult to maintain a standard of less than .3 or even less than .1 part per million.

One hundred samples were plated on gelatin and the number of colonies counted at the end of 48 hours. Of these, 29 samples had less than 99; 16 samples from 100 to 499; 16 from 500 to 999; 9 from 1,000 to 1,000; 9 from 2,000 to 9,999, and 21 more than 10,000.

One hundred and two samples were plated on agar and incubated at 37½° for 24 hours. Forty samples showed less than 50 bacteria per cc; 7 from 50 to 99; 8 from 100 to 199; 14 from 200 to 499; 8 from 500 to 999; 10 from 1,000 to 1,999; 10 from 2,000 to 9,999, and 5 had more than 10,000.

While the large number of bacteria may consist for the most part of harmless forms, the results would indicate unsatisfactory conditions, either in the original water taken or in the conditions of storage and delivery.

The Commission on Standards have made no recommendation concerning the use of gelatin, but their standard of less than 100 growing on agar would mean that 53 per cent of the waters examined were unsatisfactory.

One hundred and nine positive tests for gas formation were obtained in 67 samples examined after May 1. Ninety-one, or 83 per cent of these were shown by the confirmatory tests to contain *B. coli*.

Twenty of the 67 waters were shown to be unsatisfactory by both standard for *B. coli* and agar count of the Commission on Standards of Purity for Common Carriers. Four more did not conform to the *B. coli* standard alone and 24 more did not conform to the agar count standard, making a total of 49 of 67 samples or 73 per cent which did not conform to the standards set by the Commission.

While our methods differ from Creel (Hygienic Laboratory Bulletin 100, 43-57), the results judged by the *B. coli* standard are similar, showing that a better water is found on sleeping cars and parlor cars and the poorer water is found on coaches and smoking cars.

Mr. W. W. Hanford of the Illinois State Water Survey is making a study of the character of the water supplied to railway trains from points in Illinois. As time permits we expect to make more analyses of samples of water taken from trains. An improvement is to be expected as the railway officials are endeavoring to improve conditions as rapidly as possible.

Credit must be given to the members of the laboratory staff of the Illinois State Water Survey for the work which is described in this article.

(A table showing the results of the 102 analyses is published in the Journal of the American Water Works Association for March, 1915, and in Bulletin 12 of the Illinois State Water Survey.)