EXAMINATION OF POTABLE WATER, PP. 1-47 (NOT COMPLETE)

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649266159

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Edited by Trieste Publishing Pty Ltd.
Cover @ 2017

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PREFACE.

Although the following notes are issued in an entirely private manner, being arranged for use in the author's classes, yet, inasmuch as they may chance to fall into other hands, it may not be out of place to state why they were prepared. Many and excellent treatises already exist on water analysis, but even a casual observer must notice the great diversity of methods they formulate, upon a subject where uniformity is of prime importance. It was with a view to advance the cause of "uniformity" that the "water committee," of which the author is a member, was appointed by the chemical section of the American Association for Advancement of Science, at its Cleveland meeting in 1888. The preliminary report of the committee may be found in the *Journal of Analytical Chemistry, vol. 3, page 398*, and it is with a view of placing before the students of this institution, analytical methods based upon such report that these notes have been prepared.

RENSSELAER POLYTECHNIC INSTITUTE,
March 12th, 1890.

EXAMINATION OF POTABLE WATER.

However faithfully the various chemical tests may be applied to the question of the fitness or unfitness of a certain water for dietetic purposes, there is nothing upon which greater stress should be laid than a thorough, personal knowledge of the surroundings of the source of supply.

It has been held as a golden maxim by one of our authorities on water analysis, "never to pass judgment upon a water the history of which is not thoroughly known."

Each sample should be taken personally and its proper shipment superintended.

About three gallons will be found a convenient quantity to insure sufficiency in case of breakage of apparatus during work, and, where possible, glass stoppered green glass bottles are the proper vessels for storage. No attempt should be made to seal the stopper, it should fit tightly enough without that, but it is always well to tie it firmly in place with stout cloth, and, where sent by express, it would be safer to place a seal upon the fastening cord. The vessel, whatever it be, should be *new*, and should be rinsed two or three times with the water to be examined before it is finally filled. Never fill quite full, but leave a small space to

allow for possible expansion. If the sample be taken from a well, pump a few gallons before filling the bottle; if from a city faucet, let enough run to waste to empty the local lateral; if from a lake or stream, submerge the vessel about a foot, so as to avoid taking surface water.

Having secured the sample, begin the analysis at once, for reasons that will appear further on.

Hitherto no small confusion existed, on account of the many ways in which the results of water analyses were stated, but this difficulty, it is to be hoped, will be greatly done away with by the report of the committee of the American Association for the Advancement of Science, appointed to examine into this question.

The committee recommended that all results be given in *parts per million in weight*. This method has the advantage, that, a litre, or fraction thereof, of water, having been operated upon, and the substances found having been determined in milligrams, no long arithmetical calculations will be required.

Of course the assumption is made that a litre of water weighs a kilogram; a true enough statement for potable waters, but one capable of introducing error where mineral waters are dealt with, whose specific gravities are appreciably above unity. In such a case, the water is actually weighed, or else the weight is estimated from the known specific gravity and volume.

The water should not be filtered before analysis. If sediment be present it should be equally diffused by thorough shaking before measuring.

Total Solids.

Source:—Material dissolved or suspended in water is naturally derived from the strata through which it passes, or the surface over which it flows. Thus are obtained waters of all degrees of hardness (see "Hardness") and of great variety of color and turbidity.

Determination:—Thoroughly shake the vessel containing the sample and then measure out 100 *c. c.* of the unfiltered water, by means of a pipette, into a weighed platinum dish.

Evaporate to dryness on the water-bath, being careful to place a filter paper between the dish and the water in the bath, in order to prevent any deposit of impurities on the under side of the dish. (A better plan is to make use of a porcelain water-bath filled with distilled water). When dry, place the dish and contents in an air bath and maintain the temperature at 105° *C* for half an hour. Cool in a desiccator and weigh. Replace in the air-bath and repeat the weighing at intervals of half an hour until a constant weight be obtained. The final weight, less the known weight of the dish, will give the amount of total solids. This weight multiplied by ten will give the weight of solids per litre of water, which expressed in milligrams will represent parts per million.

It was formerly the custom to ignite this residue, moisten with carbonic acid water and again ignite and weigh. The loss in weight was reported as organic matter.

Concerning such treatment Tidy remarks: "It presupposes three things

(*a*) That no organic matter is lost and none is gained during the evaporation of the water,
(*b*) That all the organic matter is burned off by the ignition of a residue,
(*c*) That nothing *but* organic matter is lost by ignition,

but in all these points the process fails."

It is unnecessary to further detail the fallacies of this exploded method, but it is important to note that while no quantitative results are to be expected from the ignition in question, yet considerable insight may often be obtained as to the character of the water, by observing the intensity of the charring and the presence or absence of fumes.

Dr. Angus Smith goes so far as to say: "It is remarkable what a clear insight is given into the quality of water by simply burning the residue. We can, by the eye and smell, detect humous or peaty acids, nitrogenous organic substances (smell of burnt feathers), and nitrates, and estimate their amount to a very useful point of accuracy."

Dr. Smart says: "The blackening during the process is of more interest than the mere loss of weight. No matter how few parts are lost, if the lining of the capsule blackens all over and the carbon is afterward dissipated with difficulty, the water is to be viewed as suspicious. What are called '*peaty*' waters, here constitute the exception." (*Report Nat. Board Health, 1880.*)

Dr. Smart conducted the ignition "at a gentle

heat, gradually attained," a rule to be followed in all cases. Angus Smith pointed out that "in waters containing nitrates and nitrites, no organic matter would be apparent on burning unless more should be present than these salts could oxidize," a fact always to be borne in mind.

(NOTE—So much difficulty is often experienced in weighing the "total residue," when the water contains hygroscopic salts, owing to the rapid absorption of moisture, that the author has of late substituted a large glass "weighing bottle" for the platinum dish in this determination. The bottle is constructed with a small stopcock in place of a handle on its cover, in order to permit introduction of air, and consequent easy removal of the cover after the weighing is completed. The vessel is used in the same manner as the platinum dish, but, being covered upon withdrawal from the air-bath, the weighing may be done at leisure. Another 100 *c. c.* of the water is quickly evaporated in platinum, and ignited, in order to observe the blackening of the residue, if there be any.)

Standards:—As to the quantity of total solids that unpolluted water should contain, it would be well to note the following:

"Rivers Pollution Commission of Great Britain," gives as averages out of 589 samples analyzed for total solids:

Rain	29.5
Upland surface	96.7
Deep well	432.8
Spring	282.0

Dr. Smart (*Nat. Board of Health, 1880*):

Safe limit.	300.0
To be condemned.....	1000.0

A. R. Leeds (*Water Depart. Wilmington, 1883*):

Standard for *American Rivers*..150. to 200.

Wanklyn regards as permissible ..... 575.

NOTE.—It is indeed rare for water to be considered *too* pure, but in a recent paper on the Loch Katrine water, which supplies the city of Glasgow, it was proposed to effect the silicising of the water by bringing it in contact with red sandstone; thereby neutralizing its action on lead pipe, and checking any action it may have in producing infantile deformity, which many people, rightly or wrongly, ascribe to the use of this water.—[*J. Soc. Chem. Ind.* **5**, *649.*]

Hardness.

Before entering into the question of quantitative estimation, let it be premised here that "hardness" may be classified under two heads, viz.: "Permanent" and "Temporary." The former is occasioned by the presence of calcium sulphate, and other soluble salts of calcium and magnesium, not carbonates, held in solution by the solvent action of the water itself; such a water cannot be materially softened by boiling under ordinary pressure.