The Analysis of Water.

The impurities that affect the quality of water for domestic purposes are inorganic and decomposing vegetables and animal matter and the micro-organisms of disease. Some of these exist in harmful quantities in the water of many streams and in other sources that flow through or originate in rich agricultural or swampy land and densely-populated districts. A small amount of fine, non-silicious mud or silt in drinking water is not known to produce disease, and is objectionable only from an æsthetic standpoint. But the large amount of angular particles of sand and decaying vegetation found in some streams is frequently productive of intestinal disturbances, like inflammation of the bowels, diarrhœa and dysentry, and any water that is distinctly turbid should be regarded as non-potable until it has been clarified and freed of its organic matter.

Far more important and dangerous, however, than mineral and vegetable matter is animal refuse, such as sewage and drainage from cesspools and privies. There is a vast difference, however, between the infectious nature of sewage in its fresh condition and that of sewage which has undergone complete chemical change. So long as it remains sewage — *i. e.*, retains its original nitrogeneous ingredients not converted into compounds —it is liable to be disease-producing. Among the numerous bacteria of its earliest existence there are some that are harmful, and the sewage environment may so modify others as to render them pathogenic; but through the defects of dilution, precipitation, oxidation and nitrification, these ingredients gradually disappear from contaminated water. Still, we cannot rely upon the disappearance of the most harmful agents at any given time or under any given condition, for it is now well known that the self-purification of water, so far as bacteria are concerned, is much less than was supposed.

Still, under nature's agencies, polluted water may be so improved that the factor of danger becomes inappreciably small, and it may then be drunk with the same assurance of safety as when we eat or breathe. Hence, it will be seen that pure and impure waters are distinguished only by the amount of certain constituents common to all, and it is true that nearly all natural waters have some foreign substance which would condemn them were they present in sufficient quantity From the nature and effect of this extraneous matter it is evident that a drinking water should be considered pure only when practically free from decomposing vegetation and absolutely free from fresh products of the human body. So sanitarians have learned that it is not so much the quantity as the quality of impurities in water that determines its suitability for drinking, and the foremost investigators uniformly condemn all waters that are in the least contaminated with fresh sewage.

A water is pure and wholesome when it meets all the requirements of the body in absorption and elimination even in the most delicate constitutions. But some waters have unpleasant tastes from mineral and decaying organic constituents; some have an unsightly appearance from color or suspended matter; some have a disagreeable or disgusting odor, while others are so charged with inorganic salts that the kidneys are overworked in eliminating the waste products of the body. All these objectionable waters should be regarded as impure, and they are certainly unwholesome, because the system rebels against anything which is not approved by the senses of sight, taste and smell. Such water is sometimes forced upon a community until public necessity compels it to be abandoned in favor of a pure and wholesome water supply. We are safe in going still further, for when a water is even liable to become contaminated with sewage it should be guarded against with the same care that is exercised in dealing with the most dangerous poisons.

The diseases that are known to be produced by impure water are Asiatic cholera, typhoid fever, malaria, diarrhœa, dysentry, and some other intestinal disorders. These diseases are either the result of an irritant or are produced by bacteria or other micro-organisms, and it seems at first that an investigation to determine the wholesomeness and suitability of water for domestic use should consist in searching for the immediate agents of disease. But experience shows that the bacteria in water are so numerous and so resemble one another that the harmful micro-organisms, even in the most contaminated waters, are but a small proportion of those that are present. Their determination requires the most careful study and patience and much time, and the results are generally negative and unsatisfactory. So, in ascertaining the sanitary condition of a water it is safer, as well as easier, to determine the organic impurities, like sewage, than the bacteria, for the pathogenic micro-organisms exist only in natural water that has or once had measurable quantities of organic matter. The amount of water required for a chemical and microscopical analysis is so large that any foreign matter which might exist in the general supply would, in all probability, also exist in the sample operated upon, and the determination of sewage shows the possibility of accompanying dangerous micro-organisms. In sanitary water investigations it is not customary, therefore, to search for pathogenic germs, but to determine irritating substances and other associations and conditions that favor disease. This is done principally by chemical and microscopical analysis, and in the testing of filters, and by additional bacteriological examinations of the water. But a thorough investigation of a public water supply should always involve a sanitary survey of the surrounding country to determine the contaminating agencies. A study of statistics will show a relation between death rate and quality of water supply.

Rotating Bridges.

One of the fundamental essentials in the successful operation of a large draw span is accurate rotation about the centre. Yet simple as this point is, there is a considerable percentage of cases in which it is not attained. If the centre pin is held truly in its place, the turn-table is bound to turn accurately about it. In some instances, however, the centre pin is not held truly in its place, and it is probable that the number of such cases is not so small as might at first appear. It seemed to be thought by early designers that the great weight of the draw rotating on the coned wheels would somehow keep itself on its centre without much care in the design to compel that end. This is a serious error and it has given trouble in some large spans. There may even be small defects of centering, or in the shape of the drum or in the tracks, which, while they militate against perfectly satisfactory operation, may not be very serious provided the rotation be about a fixed centre. If, on the other hand, rotation be eccentric, every existing defect will be aggravated and new ones will be produced although none may have originally existed. It goes without saying that the drum should be perfectly circular, and the wheels or rollers as well as the tracks should be turned accurately and placed in position carefully, but those measures will be of little avail if the centre casting holding the centre pin be not securely anchored to the masonry of the pier.

A draw span with the usual type of rim bearing table, had been giving trouble and at times could only be moved by the aid of a tug. Examination proved that the original anchor bolts holding the centre casting to the masonry, were but about ten inches long, and had been pulled loose so that the centre pin could wobble about as required by the wind and the turning machinery. After the centre casting was firmly secured in place by anchor bolts running four feet into the masonry, the operation of the draw was in every respect perfect.

A tendency to pull the pin out of centre is not only produced by ill shape of the drum and bad fitting of the wheels and tracks, but also by unequal efforts exerted at the pinion shafts at opposite ends of a diameter of the drum. Some form of equalizer ought always to be used so that equal turning movements would be imposed on the pinion shafts opposite to each other. In other words, whatever form of mechanism be employed, the turning effort should be so applied that there will be no tendency to lateral displacement of the centre. Experience has demonstrated that when true centreing is maintained, the operation of the heaviest draw spans will be uniformly satisfactory and free from difficulties that have attended even some of the latest structures.