SOME OBSERVATIONS OF THE INFLUENCE OF SODIUM CARBONATE IN WATER SUPPLIES

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The town of Normal has a water supply containing[1] 400 p.p.m. of total alkalinity and 250 p.p.m. of hardness making the sodium carbonate content, therefore, 150, all calculated as $CaCO_3$ p.p.m. The water is obtained from wells having a depth of approximately 220 feet. The water, as drawn from the ground, contains methane.

When the water is used in apparatus in which concentration due to evaporation may take place, the influence of the sodium carbonate becomes apparent. In the steam boilers of the University heating plant, a constant check on the sodium carbonate content of the boiler water must be made lest boiler plates and tubes be injured. Periodically, samples of the water are titrated for total and caustic alkalinity and the necessary quantity of sodium bisulfate is added to the make-up water to correct the causticity. Dissolved solids are determined by hydrometer, and blow-downs are practiced to keep these solids within limits. If the caustic alkalinity becomes excessive it causes frothing in the boilers, and live steam used at places some distances from the heating plant may have considerable lime and iron compounds entrained. The same frothing tendency is observed in the water still of the David Felmley Hall of Science. Increasing sodium carbonate here may cause such frothing as to carry sediment down the condenser tubes of the still, thereby seriously contaminating the distilled water. Mounting caustic alkalinity in the still boiler is prevented by daily draining and flushing.

The injurious effect of sodium carbonate in boiler waters has been pointed out by Mr. C. C. Williams, superintendent of water and light for the City of Bloomington. His attention was first called to the effect early in 1917 when some cracks near rivets in a boiler shell were observed. The boiler was one of a bank used in the municipal light and water plant. It was operating on water obtained from the Town of Normal. A repairer was employed on the boiler, and he found that the metal, under the torch, failed to flow as good steel does, and moreover had become brittle. Mr. Williams pronounced it a case of caustic embrittlement which was then just coming to be recognized. The early recognition of the failure of the boiler shell probably averted a serious explosion. Because the make-up water for this boiler had come from the Town of Normal supply, there had been a gradual increase in the sodium carbonate content.

In 1917 Stromeyer[2] pointed out that caustic liquors have a deteriorating effect on open hearth and basic Bessemer steels as well as on wrought iron. Merica[3] offered the theory that the failure of the steel was due to absorption of nascent hydrogen, forming an alloy having less ductility than the original steel. He claimed that such failure could be prevented by introducing sodium chromate into the water.

In 1926 and again in 1928 Parr and Straub[4] reported extensive studies on caustic embrittlement of steel. They found that failure was most likely to occur at seams and rivets where there is the combined effect[5] of caustic and stress, and that phosphates, tannates, nitrates and chromates inhibit such action, as well as the maintenance of a ratio of sodium sulfate to sodium hydroxide of 2 to 1. Furthermore, they found that a concentration of 6000 grains of sodium carbonate[6] per gallon (102.6 g per liter) was necessary to produce embrittlement. Straub found no steel is resistant to the embrittling effect of caustic. Since the water supply of Normal contains no sulfates it is obvious that a two-to-one sodium sulfate—sodium carbonate ratio could not operate to prevent embrittling unless some sulfate were added.

The results of the extensive studies by Parr and others offer some explanation of certain boiler failures in the vicinity.

About 1897 there was a disastrous explosion of a steam boiler in Normal used in an electric generating plant. It was operating on the same kind of water as is now supplied by the Town of Normal. A worker in the plant attributed the failure to low water. However, caustic embrittlement may have been an important factor.

In 1912 there was an explosion in the steam plant of the Illinois Power and Light corporation in Bloomington. The boiler that failed was operating on a ground water taken from what is known as the Big Four Valley, which water is of the same general character as that used in Normal. This again may be attributed to caustic embrittlement.

The sodium carbonate content of 150 p.p.m. found in Normal water makes the presence of sulfates of calcium and magnesium impossible and therefore boiler users have no adhering scale. The sodium carbonate does not become troublesome until its concentration is greatly increased. It consumes no soap. Those accustomed to drinking the water come to like it. The removal of the carbonate by use of calcium hydroxide is a simple matter, and this treatment would also remove the calcium and iron present as bicarbonates. This softening program the town expects soon to inaugurate.

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