A METHOD OF DIRECT AERATION OF STORED WATERS.

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The purpose of this paper is to describe a simple apparatus for the economic aeration of stored waters. The apparatus has been installed at the impounding reservoir and pumping station of the Indiana University water system.

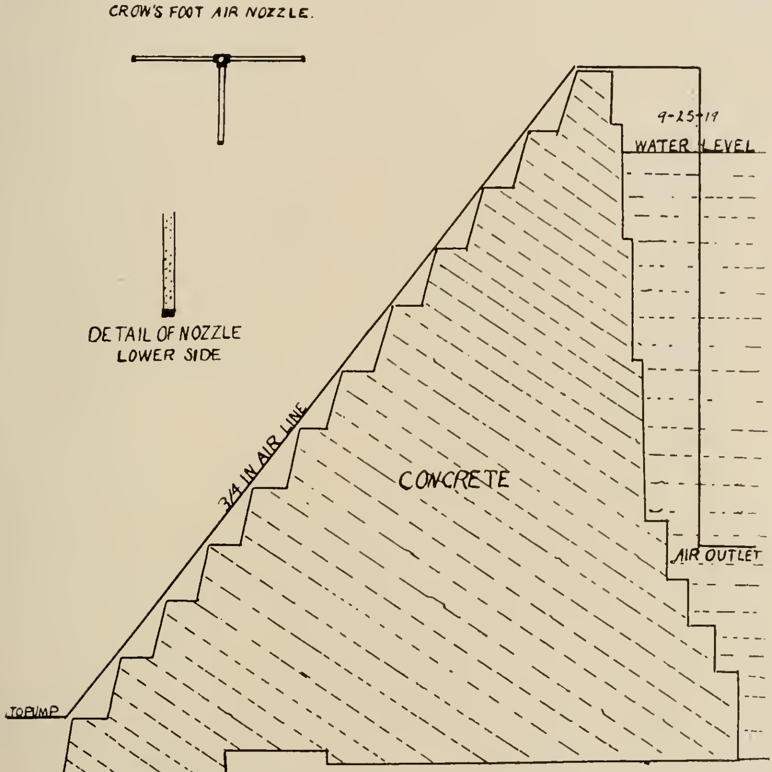

Figure 1. Shows the arangement of the air duct and nozzle in relation to the dam and the water level.

The impounding basin of this system is a dammed V-shaped valley, having the characteristic steep slopes of this valley type. These slopes are underlaid with the shales of the knobstone except at the upper levels where the shale is replaced with limestone. The knobstone is covered with a thin layer of soil on which it is difficult if not impossible to grow grass, partly because of the chemical composition of the soil, and partly because it is so thin. The only method for the prevention of erosion of the sides of the valley is forestration.

The form of the valley gives a deep narrow impounding basin, which is well protected from wind. This results in the complete thermal stratification of the water early in the summer. The leaves from the wooded slopes of the valley are blown into the water producing a very considerable amount of oxydizable material. The result is that during the latter part of the summer the oxygen is exhausted from the lower levels of the water. This oxygenless region increases in thickness until the autumn "turnover" and reaches the level of the intake early in August. As a result of this the water is very unpalatable during most of August and a part of September. Of course a better flavor could be obtained by placing the intake above the thermocline, but the water is carried directly to the taps without icing and hence it is a marked advantage to take it from the cooler water below the thermocline.

The apparatus consists of an ordinary compression pump such as is sold by the trade for use in garages. To this is coupled a ¾ inch air line which is carried over the dam and down to a point near the bottom of the reservoir, and just below the intake. This point is 9.75 M. below the top of the dam. At this end was attached a crow-foot formed of three ¾ inch pipes 7 feet long, and jointed at right angles to the line and to each other. The ends of these pipes are capped and small holes (⅛ inch) are drilled on the under side. These holes are 1 inch apart, placed alternately in two rows (Fig. 1). The pump is operated by a belt connecting it to the flywheel of one of the oil engines which operates the water pump. The pump usually runs eight hours in each twenty-four.

The pressure at the air outlet is slightly more than one additional atmosphere. The temperature was about 17 C., while at the surface it varied from 22 C. to 26 C. It was 22 C. on September 25, 1919. The increased pressure and the lower temperature would of course make the rate of gas absorbtion more rapid per unit of surface than it would be at the surface of the reservoir. By discharging the air through the small openings, small bubbles were produced which increased the surface per unit of air volume.

It was hoped that this operation would introduce enough oxygen to maintain a potable quality of water below the thermocline. The quality of the water was improved markedly, but the improvement was due, in part at least, to another set of factors which had not been considered when the apparatus was put into operation. These were the convection currents caused by the rising bubbles. The friction of these bubbles set up a vertical current that was approximately 100 sq. ft. in cross section. The rate of flow of this upward current was not measured but it was sufficient to raise the level of the surface some 2 or 3 cm.

The amount of dissolved oxygen was determined at various levels at the intake and at the deepest point in a cross section 150 feet above the dam. In the upper 8 M. at the upper station (the water was 1.75 M. below the top of the dam) there was more oxygen at every level than at the intake.

This indicates that the ascending currents carried some of the oxygenless water from the bottom toward the surface, while beyond the influence of this vertical current the water descended carrying with it oxygen which it had received at the surface from the air. Both of these currents were more or less mixed with the water that normally lay at the different levels.

The accompanying curves indicate the conditions in 1919 and also the conditions on the same date in 1912.

The usual method of aerating stored waters is to spray the water into the air or allow it to flow over rubble or an interrupted spillway. The advantage in the method just described is that it takes very much less energy to carry the air into the water than it does to force the water into the air.

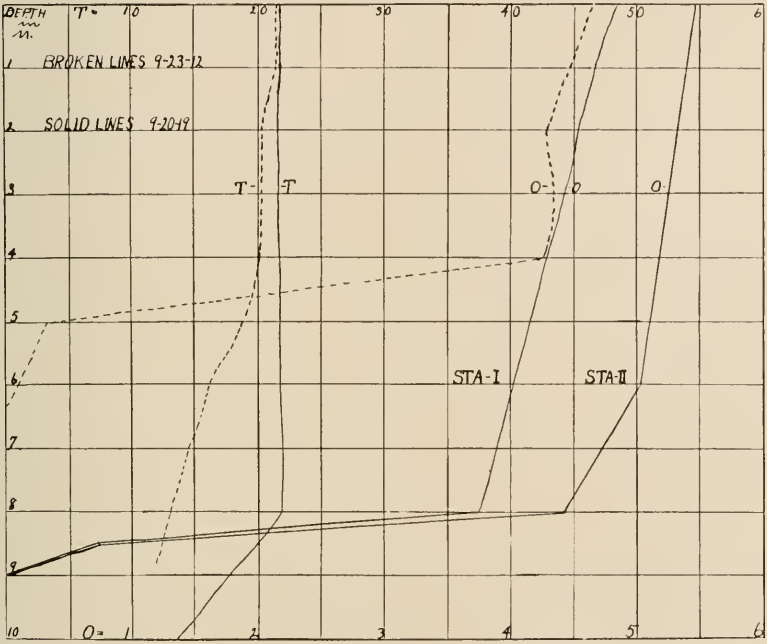

Figure 2. Broken lines are the curves for oxygen and temperature for September 23, 1912; the solid lines for September 20, 1919. T=temperature Centigrade. O=cc. of oxygen per liter. Station I is at the air outlet. Station II is 150 ft. up the pond from Station I.