DAMAGE DUE TO ELECTROLYSIS

According to a report on the subject recently issued by the United States Bureau of Standards, electrolysis often causes much damage to water and gas distribution systems. The damage is said to be due to electric currents which have been using a pipe as a conductor, leaving the pipe and removing a part of the metal in doing so. Electric corrosion occurs only when and where the current leaves the pipe; but this may be at insulating joints, where it passes from one pipe to the next through the earth, as well as where it leaves the pipe line permanently.

Such corrosion, by removing the metal from the exterior of pipes, causes a pitting that may develop into holes in the pipe; or the pitting may be so general over a given area as to weaken the strength of the pipe. Holes so caused may leak water or gas for years unsuspected, and probably more or less of the "unaccounted for" water can be charged to electrolysis. Pipes weakened by general corrosion may give way at any time of unusual pressure, although originally sufficiently strong for all emergencies. The losses due to electrolysis of water mains, therefore, include lost water as well as the value of the pipe that is deteriorated to the point where it must be renewed. And the many forms of danger and possible loss resulting from a lowering of the strength of the pipe are apparent to any waterworks man.

Street Railway Currents Responsible

When electric current flows through a continuous metal conductor it causes no chemical change. When it passes through an electrolyte, however, chemical decomposition occurs at the electrodes, where the current enters and where it leaves the electrolyte. Pure water is not a conductor, electrolytic or otherwise, of electricity, but becomes so by the addition of even minute amounts of salts, either acid or alkaline. The water held in most soils contains dissolved salts, such as chlorides, nitrates, etc., and furnishes an electrolytic conductor for stray currents. The electrolytic action that takes place where current enters a pipe from the ground is not detrimental to the pipe.

Practically all of the current that finds its way to underground pipes comes from street railway tracks. The current that is sent out through feeders and trolley wires passes through the motors of the cars and from them, through the wheels, to the rails. The rails are supposed to conduct the current back to the power house, but seldom if ever retain all of it, some portions leaving the rails through the ground for other conductors, such as underground pipes. The less the resistance the rails offer to the passage of the current and the greater the resistance offered by the ground and by pipes or other conductors near the rails, the less will be the amount of current that leaves the rails and traverses such other conductors.

Methods of Prevention

The methods of reducing or preventing entirely the electrolytic corrosion of pipes may, therefore, be classified as those reducing the resistance of the rails (or other return conductor), those increasing the resistance of the path from rail to pipe, other methods of reducing the flow from rails to pipe, and those calculated to minimize the effect of the current that flows in the pipes. The first remedy must be applied by the railway officials; the second and third may be applied by either railway or waterworks officials, or both; and the fourth may be applied by the waterworks officials. The last is but a palliative, and chief reliance should be placed on the first three, the first being most effective.

A comparison (which cannot be carried too far, however), may be made between the conditions that cause electrolysis and parallel systems of canals. Suppose that two canals with porous banks run side by side, each set at some depth into the ground. One of these leads to a power house, which pumps water from it, this water being pumped through a main that parallels the canal and discharges into it at intervals; the other has no outlet, nor any source of water supply except such as seeps through the ground from the former. Assume that for some reason the seeping of water from the latter canal (which we will call B) into the ground causes a deterioration of the canal which it is our aim to prevent. At any point where the water in canal A is higher than that in B, there is a tendency for the water to seep through the ground from A to B; and where the height in B is greater than that in A there is a tendency for flow in the opposite direction. In each canal there are baffles at frequent intervals, those in canal A representing the rail joints, those in canal B representing pipe joints. Both canals are lined with dry rubble, so that, although porous, the banks are not eroded by high velocities.

Comparison With Parallel Canals

If the baffles nearly fill the canal, the flow past each baffle must be largely through the ground around the baffle, and there will be a considerable fall in surface level at each. This can be prevented by supplying a by-pass around each baffle.

Given canal B empty and canal A full at its upper end, there will be a tendency for water to seep from A to B, the rate of such flow depending upon the height to which the water has risen in B and the porosity of the soil. This difference in level between A and B at any point is known as "potential difference." The fall in surface level in canal A per 1,000 feet is called "potential gradient." The potential gradient decreases as the size of canal A increases and as the obstruction offered by the baffles is decreased by by-passes or in other ways.

Since there is no outlet for canal B, if water flows into it from A there is a tendency for the water to stand at the same level throughout the length of B. But since there is a fall in level in A, such level near the power house will be lower than that in B, and water will flow back from B to A near this point. It is this flowing back that causes the damage to B. This damage is somewhat similar to a wear of joints between the rubble lining, and increases with the velocity of flow—that is, given a certain amount of seepage from B, the damage at any point increases with the concentration of seepage at that point.

Remedies for Seepage

If the baffles in B should practically fill the canal it would be possible to thus keep the water level at all points in B at a level with or lower than the water in A; but this might cause a flow around the baffles by seepage through the ground, which seepage would cause damage at every point where it left the canal. Also a connection could be made between B and A at the power house end of A, thus eliminating seepage from B at this point, but this would increase the amount of water flowing in B, and might cause considerable by-pass seepage around the baffles if these caused any obstruction. (Most joints in mains offer more or less obstruction to current flow.)

The remedies or palliatives of the damage done by seepage from canal B may be classed as follows, and will be referred to by number in comparing with actual methods employed for electrolysis:—