Keeping the Railroads Afloat

The Water That Our Steam Lines Use in a Year and What They Do With It

By Charles Frederick Carter

WE are quite accustomed to statistics setting before us the vast tonnage of coal used up by our railroads in the course of a year, and to being told how much of this is burned up in hauling more coal for the carriers to operate their regular freight and passenger service with. That coal alone will not make a locomotive go is quite as obvious as the fact that an automobile will not run on gasoline alone, without the proper amount of air and oil and water. But when we hear the truth about the water consumption of America's railroads, the figures are sufficiently startling to justify the length to which Mr. Carter goes in writing about them.—THE EDITOR.

IF the deductive method of reasoning which made Sherlock Holmes famous were applied to their annual consumption of water as the sole clue in order to form an idea of what railroads were like, the conclusion would seem to be justified that they must be navigable streams. The quantity of water required to keep the railroads of the United States afloat is beyond the conception of the average man.

According to C. R. Knowles, Superintendent of Water Service of the Illinois Central Railroad, recognized as the foremost authority on the subject, the estimated annual consumption of water by the railroads is 900,000,000,000 gallons. As a considerable proportion of the water used by railroads, amounting to 23 per cent in some instances, is purchased from municipal or private water corporations, and hence is metered, and as a number of the larger companies have water service departments which keep careful records, this estimate is more than a mere guess.

Perhaps it may help in attempting to form an idea of the immensity of this volume of water if it be reduced to cubic feet and the quotient divided by 1,030,000 the flow in cubic feet per second of the Amazon. The result shows that the railroads consume a quantity of water equivalent to the total flow of the greatest river in the world for a period of 32 hours and 48 minutes. Or, to apply a standard of comparison nearer home, the volume of water used by the railroads is equivalent to the total flow of the Mississippi River at its mouth for 58 hours, or 2 days, 10 hours, 47 minutes.

Twenty million cubic feet of water tumbles over the crest of Niagara Falls each minute. If the annual water consumption of the railroads were diverted into the Niagara River it would run the cataract for 101 hours, the equivalent of 4 days, 5 hours, 8 minutes.

Collected into one body the railroad water supply would make a lake ten miles square and 44 feet deep. Bottled and sold at current prices for so-called "Spring" water affected in large cities, the proceeds of this railroad deluge would bring in $90,000,000,000, or enough to pay off the entire interest-bearing National debt with the proceeds of less than seven weeks' average sales.

Locomotives consume for steaming purposes, or waste, 74 per cent of the total quantity or 2,807,999,985 tons of water. The total quantity of freight hauled by the railroads in 1916 was 2,316,088,894 tons; that is, the quantity of water passing through locomotive tanks and boilers was 491,911,091 tons more than the entire amount of freight moved in 1916.

Of the remainder of water required for railroad purposes 12 per cent is required to wash boilers and fill them at terminals, 5.5 per cent is consumed by stationary power plants at shops and terminals and 8.5 per cent is required for sanitary and "domestic" purposes at stations, offices and terminals and on board trains. At 7 cents per thousand gallons the cost of the railroads' annual water supply amounts to $63,000,000.

The matter of water supply is by no means the least of the perplexing problems confronting the railroads. For twenty years the increase in consumption has averaged 1.5 per cent a year. At that rate the consumption in 1930 will be 1,035,000,000,000 gallons. Already the limit of available supply at reasonable cost at some points has been reached.

Many of the Western roads have extreme difficulty in procuring sufficient water to keep the traffic moving. Between Bitter Creek and Green River, Wyoming, on the Union Pacific, local water supplies are so bad that they cannot be used for any purpose. Every drop used has to be hauled in tank cars from Green River. Rock Springs, 15 miles east of Green River, supplies the entire Union Pacific system with coal. The water there is so bad that the company is obliged to pump a supply through an 8-inch main for the fifteen miles, including a lift of 179 feet. At Rawlins, east of the Continental Divide, the company pumps its water supply for 15 miles, the lift in this instance being 236 feet.

Near the western shore of Great Salt Lake a Southern Pacific water tank is supplied by a pipe line 52 miles long. Altogether there are 150 miles of pipe line between Ogden and the Sierras to supply water for Southern Pacific locomotives.

Locomotives are supplied at approximately 13,000 water stations in the United States. Until very recently the standard type of water station, a familiar sight to every passenger who took the trouble to look out of the windows, resembled an exaggerated butter firkin on stilts. Usually they were 16 feet high and 24 feet in diameter, their bottoms being 16 feet above the rail. Such a tank held 50,000 gallons. As locomotive tanks increased in capacity to 10,000 to 12,000 gallons and traffic grew in volume such a station became altogether inadequate.

Modern practice is exemplified on the Rock Island, which has a number of steel standpipes of a capacity of 165,000 gallons, from which 12-inch supply lines lead to 10-inch water columns, and on the Santa Fe which also has steel standpipes 24 to 60 feet high with capacities of 96,000 to 202,000 gallons. The Chicago and Alton has some tanks 18 feet high, 30 feet in diameter, 20 feet above the rail with a capacity of 90,000 gallons from which 14-inch mains lead to 12-inch water columns through which 4000 gallons a minute can be delivered. The Pittsburgh and Lake Erie has steel tanks of 150,000 to 500,000 gallons' capacity, their bottoms 21 feet above the rail, with 12-inch mains leading to 10-inch water columns, capable of delivering 2000 gallons a minute.

Even such facilities as these are wholly inadequate to keep the traffic moving on the great trunk lines. On these lines all fast trains are watered from track tanks without stopping. On the New York Central between New York and Buffalo are 14 track tanks, and 10 more between the latter place and Chicago. From each of these tanks from 500,000 to 1,000,000 gallons of water are delivered into locomotive tanks daily.

The usual track tank is pressed out of a single piece of sheet steel from 3/16 to ¼ inch thick, stiffened with a half-round or bar of steel riveted to each upper edge, and supported directly on the ties. The width varies from 19 to 20 inches, the former being the prevailing size. On the New York Central the standard length is 1400 feet; on the Pennsylvania 1500 feet. The depth is strictly limited by the necessity of keeping their tops below the tops of the rails because of the scant clearance of brake rigging, and the impracticability of dapping ties to a depth of more than 2¼ inches. This restricts the depth to 6 to 7½ inches.

To take water from so shallow a trough requires accurate adjustments. The scoop should not scrape the bottom of the trough and it must dip at least 2 inches in the water. The height of tender and scoop may vary an inch between light and loaded weight; the wear of scoop pins and bearings and of tender springs and wheels may cause another variation of ¾ inch, while tests have demonstrated that the pressure of the water against the scoop when running 40 to 60 miles an hour will pull the tender down an inch. Therefore it is necessary to allow for a variation of not less than 2 inches. These tanks are kept filled through several inlets by automatic valves actuated by the change in water level in the trough. Three minutes is the average time allowed for filling a track pan. In winter the pans are heated to prevent freezing by a steam pipe discharging directly into the pan at intervals of 33 feet. The surging due to scooping and filling distributes the heat sufficiently. A boiler of 100 horsepower is required to heat two track pans and furnish power to pump water into them.

While, as already noted, the railroads in numerous instances have incurred great expense to secure a water supply from a distance this would be altogether impossible in all cases. Usually it is absolutely necessary to use whatever local supply is available. Much of the boiler feed water contains salts of lime and magnesium which form a scale on the tubes and boiler surface. Often various other foreign matter is contained. Water in the coal regions contains liberal quantities of sulfide of iron which, when oxidized, forms free sulfuric acid. There are instances on record of such water corroding tubes, fireboxes and boilers so rapidly as to threaten to put busy railroads out of business. This trouble is now obviated by treating the water with soda ash.

Generally speaking, water in eastern territory contains very little foreign matter and boiler tubes will last 15 or 20 years with little attention. In the Middle West the water is hard, while west of the Missouri River and in the Southwest it is hard and also contains alkali which causes a great deal of trouble by foaming. Foaming can usually be controlled by blowing off, but at excessive cost for fuel. Iron Mountain, Neb., is said to be the worst place in the United States, for the boiler water there contains an average of 253 grains of encrusting solids to the gallon. In addition to the encrusting solids raw water from the rivers of the Middle West, often used for locomotives, carry from 5 to 6 pounds of suspended matter, *i.e.*, plain mud, per thousand gallons, which means that a locomotive takes into its boiler from 100 to 120 pounds of mud on a trip.

Five years ago the American Railway Engineering Association estimated that every pound of encrusting matter kept from entering the locomotive boiler meant a saving of 7 cents, taking into account only the cost of fuel, repairs and renewals of flues and boilers and loss of engine time, but not including cost of engine failures which were estimated at $17 each.

The enormous increase in the cost of fuel and labor for boiler repairs since then has given a great impetus to the work of installing water treating plants. It is estimated that there are now 600 railroad water treating plants at which 21,600,000,000 gallons of water are treated annually. This is only 6 per cent of the treatment needed.

As a practical example of what can be accomplished, the Missouri Pacific treated 1,368,305,000 gallons of boiler feed water in 1918, removing 3,589,473 pounds of scale forming material, thereby effecting a saving of $279,843.

Engineering Bulletin No. 3 issued by the U. S. Fuel Administration estimates that the use of hard water in locomotive boilers involves the consumption of 15,000,000 tons of coal more than would be required if the water were softened by proper treatment.

In many ways there has been a marked improvement in the handling of the railroad water supply. Formerly the Superintendent of Bridges and Buildings exercised a sort of casual oversight of water supply. Wherever possible a windmill pumped the water, provided the windmill wasn't broken down. Elsewhere an uneconomic steam plant, often in incompetent hands, did the pumping at extravagant cost.

In recent years a good many electric pumping plants have been installed entirely controlled by floats connected with a switch. One such plant on a Western road has been installed in duplicate so that there may be no failure of supply in case of breakdown. The plant has a capacity of 1,000,000 gallons a day. The old steam plant required a force of 3 men; the electric needs but one man. The current costs no more than fuel for the former plant, so the net saving amounts to $1500 a year. Oil engines of the semi-Diesel type are being extensively installed, a single manufacturer having sold 495 such engines of 9827 aggregate horsepower to railroads in 5 years.

Another saving is being effected by stopping the waste of water which is very great, for the daily consumption average 2,500,000,000 gallons, delivered through innumerable connections under the control of thousands of employees who have no conception of the value of water. There is no such thing as an insignificant waste of water. For example, a 1/16-inch stream, such as may escape through a worn faucet washer will, at 40 pounds' pressure, waste 18,844 gallons a month which at 20 cents a thousand gallons amount to $3.68, enough to buy a new faucet. The Illinois Central, by a continuous campaign against waste of water, has effected a net saving estimated at $326,900 in five years.

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