THEORY OF HEAT LOSSES FROM PIPES BURIED DEEPLY IN THE GROUND

By John R. Allen

The author, realizing the small amount of information available on the subject of heat losses from pipes buried in the ground, presented a complete mathematical analysis of heat losses from such pipes, and gives partial experimental data as a check to his deductions, proving the theories advanced substantially correct. As a result of his analysis, the author draws the following conclusions:

1. (a) That the heat loss from a pipe is not proportional to the external surface of the pipe. The heat loss per square foot of pipe in small pipes is very much larger than the heat loss per square foot in large pipes.

2. (a) That the heat loss from a pipe is not inversely proportional to the thickness of the covering and the larger the pipe the thicker the covering that can be economically used.

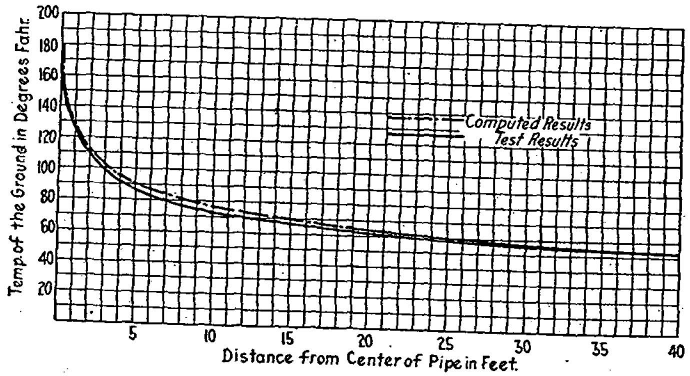

FIG. 1

3. (a) That the depth to which a covered pipe is buried in the soil makes very little difference in the heat loss, provided the center of the pipe is 2 ft. or more below the ground surface. Beyond 2 ft. in depth, unless the pipes are very large, the heat loss from the pipes remains substantially the same for all depths.

4. (a) That the heat loss from a pipe is not proportional to the conductivity of the covering, as the conductivity of the ground is as important a factor in the heat losses as the conductivity of the covering.

   (b) That poor covering in dry ground will give better results than good covering is wet ground. It is not possible, therefore, to guarantee the heat loss from a covering in the ground, as such a guarantee involves guaranteeing the conductivity of the ground.

As a result of the discussion which followed the presentation of this paper, the author presented another paper and added the following conclusions derived from his analysis:

First.—As the diameter of the pipe increases the desirable thickness of covering used should be increased. With small pipes, 1 in. thickness will ordinarily be all that would be economical; but with larger pipe it may be economical, depending on commercial conditions, to increase the thickness to 2 in. and over.

Second.—In multiple covering, the better covering should be placed next to the pipe and the poorer covering outside in order to insure the minimum heat transmission.

The author presents many interesting charts showing the relative effect of pipe sizes, depth of burying, thickness of covering, etc., on the heat loss.

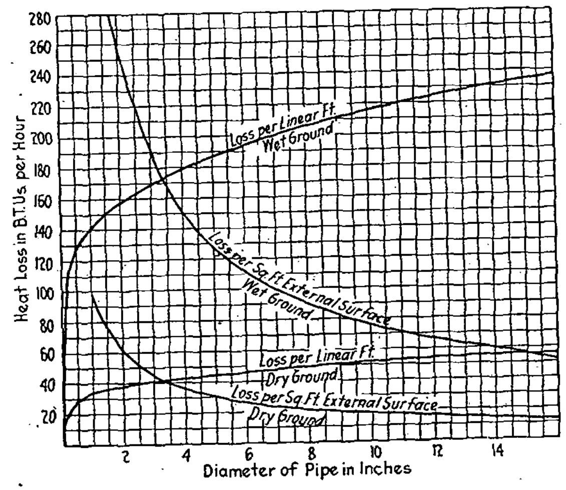

FIG. 2

Fig. 1 shows the ground temperatures at various distances from a 3 in. bare pipe buried 5 ft. 6 in. in the ground with a pipe temperature of 165 deg. fahr.

Fig. 2 illustrates the comparative effect of the pipe size on the heat loss from the bare pipes buried deeply, computed from the following equation derived by the author

$$H = \frac{2\pi k\,(t_1 - t_2)}{\log \frac{r_2}{r_1}}$$

where H equals the heat loss per linear foot of pipe; t_1, the average temperature of the ground at a point not affected by temperature of the pipe; r_2, distance from center of pipe to point where t_2 is taken; r_1, the radius of the pipe in feet, and k, the conductivity of the ground in B.t.u. per hr. per deg. fahr. difference of temperature per foot of thickness. k is approximately 0.2 for dry ground and 0.9 for wet ground. For the purposes of this chart, the following values were substituted in the equation:

$$t_1 = 225 \quad t_2 = 50 \quad r_2 = 40 \quad r_1 = \text{variable} \quad k = 0.89$$