

EXPERIMENTS ON THE EVAPORATION OF STEAM-BOILERS USED FOR HEATING PURPOSES.

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BOILERS IN THE MILLS OF THE NASHUA MANUFACTURING COMPANY, AT
NASHUA, N. H.

THIS experiment was made at the request of Gen. J. C. Palfrey, agent of the Merrimack Manufacturing Company, at Lowell, Mr. Daniel Hussey, the agent of the Nashua Manufacturing Company, furnishing all the facilities required for the purpose.

The boilers were built by the Lowell Machine Shop, and have been in operation since September last. They are plain tubular boilers. Each boiler is twenty feet long and five feet in diameter, with fifty-five wrought iron tubes, 3.25 inches in diameter inside, and about one-eighth of an inch thick. The usual level of the water is about twenty-two inches below the top of the boiler. The grates are placed under the boilers, and are each 4.86 feet long and 5.545 feet wide, having a total area, under both boilers, of 53.9 square feet. The grate-bars are in three lengths, and the spaces between them are about a quarter of an inch in width, and have a total area under both boilers of about 15.19 square feet.

The products of combustion pass, first, under the whole length of the boilers, about one-half of the area of the shells being heating surface; thence returning through the tubes; thence back again through the flues of a heater, placed above and between the two boilers. The heater is about eighteen feet long and forty-three inches in diameter, and has two flues 1.19 feet in diameter.

Fire surface in the shells of the boilers, including that portion of the ends below the water-line.....	369 square feet.
Fire surface in the tubes.....	1873 " "
Fire surface in the heater.....	160 " "
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Total area of fire surface.	2402 square feet.

The boilers and heater having 44.56 square feet of fire surface to each square foot of grate surface. The boilers and heater are protected from radiation by brick-work and ashes.

The products of combustion from three pairs of boilers pass into a

chimney, about one hundred and ten feet high, having a flue of a uniform section of about nine square feet. In the lower part of this chimney there is a damper, regulated by the pressure of the steam. Each set of boilers has also a separate damper, regulated by hand. During this experiment all the boilers were in operation in the daytime, while the mills were running, and the draught was regulated by the self-acting damper, the hand-damper being generally wide open. In the night, when the boilers being experimented on were alone in operation, the draught was regulated by the hand-damper, the self-acting damper being generally wide open. The dampers all turn on axes, on the principle of the throttle-valve; their positions were noted by means of arcs, graduated in degrees, the indices of both reading 0 when shut, and that in the main chimney reading 65° when wide open, and that in the flue reading 90° when wide open.

The fire surfaces of the boilers and heater were cleaned, and the boilers blown off, within the two days next preceding the commencement of the experiment. This is usually done once a week.

The boilers were supplied with water from a cast iron tank, 4.83 feet in diameter and 5.91 feet high, which was partially filled with water, at intervals, from the town water-pipes, and the water pumped from the tank into the heater, which is kept constantly full and under the same pressure as the steam in the boilers, the water flowing from the heater into the boilers as fast as it is pumped into the former.

The experiment consisted, mainly, in noting the quantity of water pumped from the tank into the heater, during a certain interval of time, and the quantity of coal consumed under the boilers during the same time. In order to ascertain the quantity of water, a glass tube, about six feet long, was attached to a wall near the tank, which was connected at its lower end with the tank by a pipe, so that the water stood at the same level in the tank and pipe; a graduated scale was attached to the glass tube.

In order to gauge the tank, a cask was filled with water to a certain height, and the weight of the water ascertained by platform scales. The tank was then filled by means of this cask, the height of the water in the glass tube being noted after each cask of water was put in, which gave the means of determining, at any time, the weight of water in the tank by an inspection of the height of water in the glass tube.

The pumps being stopped, the tank was filled to a convenient height, which was noted. The pumps were then put in operation, and

the boilers supplied in the usual manner. When the water in the tank was nearly exhausted, the pumps were stopped and the height of the water in the glass tube again noted, which gave the means of ascertaining the quantity of water remaining in the tank, which being deducted from the original contents of the tank, gave the quantity supplied to the boilers for that filling of the tank. This operation was repeated as often as necessary, to keep the boilers supplied with water.

The coal was weighed out at intervals, on the same scales as were used to determine the weight of water in the tank.

The experiment commenced at 3h. 30m. P. M. on Monday, February 11th, 1867, and terminated on the following Saturday, at 3h. 0m. P. M., an interval of 119·5 hours, during which time the fires were maintained with as much uniformity as practicable, two sets of firemen and observers being employed. The temperatures of the air and water were noted; also of the smoke in the flue between the boilers and heater, and in the flue just beyond the heater. Also, the pressure of steam in the boilers, the position of the dampers and the amount of ashes and clinkers.

Care was taken to terminate the experiment when the fire was in the same state as when it commenced—at least, as nearly so as could be ascertained by inspection. The height of the water in each boiler was also noted at the commencement and termination of the experiment, and a correction made for the difference.

Steam-boilers frequently carry over water with the steam, and it is often quite difficult to ascertain how this is, particularly when the quantity carried over is not large. In this case, there was little probability of it, the steam space being larger than usual in boilers used for heating purposes, and the boilers of simple form, very clean and moderately fired. But to get some positive information on this point, I put in a diaphragm at a joint in the horizontal pipe, four inches in diameter, conducting the steam from one of the boilers; the upper part of this diaphragm was cut away, so as to leave an aperture, for the passage of steam, of an area equal to about three-fourths of the area of the pipe, the part not cut away operating as a dam to prevent the free flow of water along the bottom of the pipe. A small cock was put in the bottom of the pipe, on the side of the diaphragm farthest from the boiler, where, from the position of the pipes, water would be likely to lay, if any was carried over from the boilers. This cock was frequently opened during the experiment, but on no occasion was any water found, except the small quantity condensed in the cock.

From all the circumstances, I infer that very little, if any, water passed over except in the form of steam.

The coal used was anthracite, but I was not able to learn, definitely, the kind. It was taken from a shed in which five cargoes, amounting to 1718 tons, were promiscuously deposited last spring. Two of the cargoes were "Locust Mountain" and another "Broad Mountain;" another was called, in the invoice, "White Ash," and another "Bear Valley." From the manner in which the coal was originally deposited in the shed, I infer that the coal used in this experiment was a mixture of these several kinds. The coal was of the size called "broken," containing the usual amount of dust and dirt, which was weighed in and used, and may account, in part at least, for the large proportion of clinkers.

The following are the results of this experiment:

Water evaporated	296,620 pounds.
Mean initial temperature of water in tank	36° Fahr.
Coal consumed under boilers, including ashes and clinkers	34,197 pounds.
Ashes, being everything that fell through the grates..	1,963 "
Clinkers	2,138 "
Mean pressure of steam in boilers, above atmosphere..	31.4 lbs. pr sq. in.
Mean thickness of the fires.....	7.2 inches.
Mean opening of hand-damper during the night	54°
Mean opening of the self-acting damper during the day	35°
Mean temperature in flue between the westerly boiler and the heater	296° Fahr.
Mean temperature in the flue just after leaving the heater	237° "
Mean temperature by thermometer in boiler room....	67° "
Mean temperature out-doors, in shade.....	35.9° "
Water evaporated from the initial temperature in the tank, by one pound of coal	8.674 pounds.
Equivalent amount of water evaporated from 212° by one pound of coal.....	10.201 "
Coal burned per square foot of grate per hour.....	5.309 "
Proportion of ashes and clinkers to the coal	12 per cent.

The ashes contained a considerable proportion of fine coal, partially burned, which was not returned to the fire. The clinkers were not picked over with much care, and a greater quantity of partially burned coal might have been separated and returned to the grate, which would probably have increased the evaporation slightly.

SYNOPSIS OF EXPERIMENTS ON THE EVAPORATION OF SEVERAL BOILERS USED
FOR HEATING PURPOSES, MADE UNDER THE SAME DIRECTION
AS THE PRECEDING.

February, 1840.—Upright cylindrical boiler in Massachusetts Cotton Mill, No. 1, $31\frac{1}{2}$ inches diameter, 11 feet high. Fire inside, surrounded by a 3-inch water space, which extended nearly to the level of the surface of the water. Over the fire there was a pot, leaving an annular space about three inches wide, for the passage of the products of combustion, which left the boiler by an opening through the water space.

Area of grate surface	3.21 sq. feet.
Area of fire surface	114.25 “ “
Fire surface to one square foot of grate surface	35.59 “ “
Anthracite coal burned per square foot of grate per hour..	12.75 pounds.
Water evaporated from 212° by one pound of coal.....	7.87 “

February, 1841.—Two upright cylindrical boilers in Massachusetts Cotton Mill, No. 2, similar to the preceding, except that they are one foot higher, and the annular flue extended through the steam space to the top of the boiler.

Area of grate surface in each boiler	3.20 sq. feet.
Area of fire surface in each boiler	126.50 “ “
Fire surface to one square foot of grate surface.....	39.53 “ “
Anthracite coal burned per square foot of grate per hour..	7.15 pounds.
Water evaporated from 212° by one pound of coal.....	12.06 “

April, 1851.—Upright cylindrical boiler in Massachusetts Cotton Mill, No. 1, similar to the next preceding, except that the pot contained a flue $9\frac{3}{4}$ feet in height, and $11\frac{1}{2}$ inches in diameter.

Area of grate surface.....	3.14 sq. feet.
Area of fire surface.....	154.34 “ “
Fire surface to one square foot of grate surface.....	49.15 “ “
Anthracite coal burned per square foot of grate per hour..	13.42 pounds.
Water evaporated from 212° by one pound of coal.....	9.62 “

January, 1851.—Locomotive boiler at the Boott Cotton Mills. The products of combustion passed from the fire-box, which was surrounded by water, through 64 tubes $2\frac{3}{8}$ inches diameter, $13\frac{1}{4}$ feet long, to a smoke-box, also surrounded by water; thence back under the boiler through a heater.

Area of grate surface	16.66 sq. feet.
Area of fire surface, including heater.....	748.00 “ “
Fire surface to one square foot of grate surface.....	44.90 “ “

1st Trial. The surface of the boiler not being protected from radiation.

Anthracite coal burned per square foot of grate per hour.... 5.84 pounds.
Water evaporated from 212° by one pound of coal..... 8.88 “

2d Trial. The surface of the boiler being protected from radiation, by felting and brick-work.

Anthracite coal burned per square foot of grate per hour.. 7.52 pounds.
Water evaporated from 212° by one pound of coal..... 9.43 “

3d Trial. Same circumstances as the preceding, except that bituminous coal, from the Vossburgh mines, in Maryland, was used.

Bituminous coal burned per square foot of grate per hour, 7.61 pounds.
Water evaporated from 212° by one pound of coal..... 10.57 “

February, 1851.—Three horizontal cylindrical boilers at the Boott Cotton Mills, each boiler 20 feet long and 30 inches in diameter, with the two flues 11 inches in diameter.

Area of grate surface..... 38.70 sq. feet.
Area of fire surface..... 590.00 “ “
Fire surface to one foot of grate surface..... 15.25 “ “
Anthracite coal burned per square foot of grate per hour.. 4.44 pounds.
Water evaporated from 212° by one pound of coal..... 7.53 “

Lowell, Mass., Feb. 22, 1867.

DESCRIPTION OF PARHELIUM OBSERVED AT GERMAN-MANTOWN.

By C. J. W., Jr., February, 1865.

MR. EDITOR: The exhibition of the phenomenon of parhelium, which occurred on Monday, the 4th inst., was of so remarkable a character that the writer has thought it deserving of more than a passing notice, and has therefore prepared the following sketch of its principal features for insertion in your *Journal*.

In the early part of the day mentioned, the sky was unusually clear, the sun brilliant, and the atmosphere, for the season, mild and calm. At 7 o'clock A. M., the thermometer was 30°, with a light south-west breeze. Towards noon, however, the sky became overcast with