EXTRACTS FROM AN ENGINEER'S NOTE BOOK

HINTS ON TESTING A BOILER.*

How the Results Are Worked Out.

It is usually considered to be quite a simple and easy matter to conduct a test on a boiler. As with many apparently easy things there are two ways of doing the job. You may, if you wish to do it all in a slovenly fashion, just weigh the quantity of coal which you feed into the furnace, and also the quantity of water pumped into the boiler, and ergo, you have the result! But, of course, it is not so. With these two facts you have the bare statement that x pounds of coal evaporates y pounds of water—something which is rather worse than useless, for it may be misleading.

It is hardly necessary to relate the many fallacies which are to be met with among stokers. But let me give one point of advice. If a real good result is wanted, get hold of a real good stoker. There are few more difficult treasures to discover than such a man. Some inexperienced engineers think that any sandwichboard man will do to shovel coal on to a fire, which is the gravest error it is possible to make. Pick your stoker.

The Readings Needed.

At stated intervals certain readings should be taken. I will assume that the boiler only is being tested, and that the steam is running to waste, or being used in a manner which does not affect us. We will tabulate the readings to be taken.

Time.—The various readings must be taken at definite time intervals. On a long run perhaps once every fifteen minutes is sufficient, although readings once every five minutes are preferable.

Pressure.—The steam-gauge pressure must be noted. Tap the gauge before reading it as it may be that the pointer is stuck. If possible, be certain that the gauge is accurate.

Water.—Measure by means of a graduated tank, or, if necessary, by weighing, the amount of water fed into the boiler. Take the level of the water in the gauge-glasses accurately at the commencement of the trial, and finish with the same level of water in the boiler. Take the temperature of the feed-water.

Fuel.—Weigh carefully the fuel fed into the boiler and note the condition of the fire, and remember that you do not stoke a locomotive boiler in the same way that you stoke a water-tube boiler. Make the stokers keep the fire fairly uniform.

Take the air temperature and also the flue temperature. At the end of the trial take the mean of all the various readings. The following trial was run on a locomotive boiler, and is fully worked out.

The average pressure during the trial was 78.8 pounds per square inch, which gives an average evaporation temperature of 323.3 degs. F.

The total heat of steam from 32 degs. F.

$$= 1{,}082.1 \times .305 \times 323.3$$
$$= 1{,}082.1 \times 98.5$$
$$= 1{,}180.6.$$

This, allowing for the average feed-water temperature of 46.85 degs. F.

$$= 1{,}180.6 - 46.85 \times 32$$
$$= 1{,}165.75.$$

$$\text{Factor of evaporation} = \frac{1{,}165.75}{966}$$
$$= 1.206$$

The water evaporated per hour per pound of coal

$$= \frac{\text{Water per hour} \times 1.206}{\text{Coal per hour}}$$
$$= \frac{84.5 \times 1.206}{105.25}$$
$$= 9.68 \text{ pounds.}$$

The B.T.U.'s supplied per hour

$$= \text{Coal bunt} \times \text{calorific value} - \text{Ash left} \times \text{calorific value}$$
$$= 105.25 \times 14{,}500 - 9.417 \times 12{,}000$$
$$= 1{,}412{,}500.$$

The B.T.U.'s usefully employed per hour

$$= 84.4 \times 1{,}165.75$$
$$= 985{,}195.$$

The flue gas was analysed to find the proportion of carbon di-oxygen.

A special apparatus was used, in which the flue gas was passed into potassium hydrate, to absorb the carbon-di-oxyde, and into phosphorus to absorb the oxygen.

The flue gas was drawn into a central tube by means of a mercury reservoir being lowered and sucking the gas in. As soon as the tube was filled the pressure was adjusted to atmospheric pressure and the volume read on the scale. The gas was then passed three times into the vessel containing potassium hydrate, spread over gauze to present a large absorbent surface. This was sufficient to absorb all the carbon di-oxyde, and the gas having been passed back into the central tube and the pressure readjusted to atmospheric by means of the mercury column, the volume was read.

The gas was then passed into the vessel containing the sticks of phosphorus three times, and the volume again read after readjusting the pressure.

The percentages of carbon di-oxyde and oxygen could then be found by simple proportion.

The volume used in each case was 103.5cc, and the average percentage of oxygen found to be 17.3 per cent.

The average percentage of carbon di-oxyde was found to be 4.9 per cent.

Combined total is 22.2%.

Tabulated Results.

Grate area	8¼ sq. ft.
Heating surface	246½ sq. ft.
Duration of trial	4¾ hrs.
Average pressure during trial	78.8 lbs. sq. in.
Average temperature of evaporation	323.3 degs. F.
Fuel	Mardie coal.
Calorific value of fuel per pound	14,500 B.T.U.
Ash left	45 lbs.
Calorific value of ash per pound	12,000 B.T.U.
Total fuel burnt	500 lbs.
Average fuel burnt per hour	105.25 lbs.
Pounds of fuel burnt per hour per square inch of grate area	12.75 lbs.
Feed temperature average	48.85 degs. F.
Factor of evaporation	1.206
Total water evaporated in pounds	4,015 lbs.
Total water evaporated in pounds from and at 212 degs.	4,842 lbs.
Water evaporated per hour per pound of coal	9.68 lbs.
Extra evaporation due to level falling	170 lbs.
Water evaporated per hour from and at 212 degs.	1,019.3 lbs.
Chimney temperature. Average	342.8 degs. F.
Chimney temperature. Variation	91.0 degs. F.
Temperature of air supply. Average	70.0 degs. F.
Flue gas analysis. Carbon di-oxide	4.9 per cent.
Flue gas analysis. Oxygen	17.3 per cent.
B.T.U.'s supplied per hour	1,412, 500
B.T.U.'s usefully employed per hour	985, 200
Efficiency	69.7 per cent.
B.T.U.'s transmitted per square foot of heating surface per hour	4,000.

* * *

GREAT BRITAIN AFLOAT.

The British Board of Trade has just issued an interesting blue book dealing with the world's shipping. It is more valuable than the average blue book, and is in fact quite a departure in official statistical literature, being arranged so that extensive comparisons may be made. The British flag was last year carried on vessels aggregating 12,332,404 tons net, which is practically half of the total tonnage of the world. While there was a steady increase in British tonnage, that of the United States has gradually declined. Fifty years ago over two-thirds of the shipping which crossed between this country and the United States was American owned; to-day the proportion is less than one-eighth, almost the whole trade being in British hands. The United States shipping has declined till it is less than half what it was in 1854. The decline began in 1860, and was continuous until 1892, since when there has been a slight revival. The following table represents the tonnage of different nationalities which passed between ports in the United States and the United Kingdom in the years indicated:—

	British.	United States.	Other Countries.
1854	780,142	1,908,004	89,937
1860	1,025,922	2,339,101	178,134
1870	2,675,396	832,628	299,585
1890	8,219,872	259,965	849,883
1905	12,177,641	943,987	1,846,567

The total tonnage registered with the American authorities for oversea purposes is 954,503, or not much more than a third of what it was in 1860.

America shows an increase in its coasting trade, its tonnage having doubled in forty years. Although so far behind in oversea trade, the States comes second to Britain in the coasting figures:—British Empire, 12,332,404 tons; United States, 6,456,533 tons; German Empire (1904), 2,353,575 tons.

*C. A. Smith, B. Sc., in "Engineering Times."

ERRATA.—Folios from 483 to 499 should read 17 to 32.