

evaporated. The meter readings will need correction, if absolute accuracy is desired, but for practical purposes this may not be necessary. It may seem like unnecessary labor and expense to weigh all the coal used, but a short trial will undoubtedly prove its value, as it will not only indicate, constantly, the condition of the generator, but to a certain extent, be a check upon the working of the engine and the amount of power used by the establishment, and it will furnish a constant incentive to the engineer, stoker, and those in charge of the steam machinery, to improve its working and reduce the amount of fuel consumption to its lowest limits. A general practice of this kind throughout the country would induce a rivalry in the saving of fuel, parallel to that found in marine practice, where it is claimed a horse power is produced by from one and a half to two pounds of fuel per hour, instead of four to ten pounds—the last named quantity being not uncommon in ordinary steam plant, and would in the course of a few years cause an enormous saving to the country, as well as to individual consumers. Rules governing the standard system of boiler trade, adopted by the American Society of Mechanical Engineers may be found in the transactions of that Society, vol. vi, 1884. The following simple instructions will enable any steam user to conduct a test of his boilers for the purpose of comparing the values of fuels, etc., after the efficiency of the generator has been established by a complete test by an expert, (observations of the quality of steam, strength of chimney draught and analysis of gases are omitted, as they require special instruments and skilled manipulation).

INSTRUCTIONS FOR CONSUMERS' TEST.

A test to be of any value should be continued for not less than ten hours, and will require the constant attention of not less than four persons besides the regular attendants, appointed as follows: One or two men to weigh the coal, and one or two to attend to and weigh the water; one clerk to keep the log of the coal and water weighed, and one clerk to record the pressure of steam, temperature of feed water, temperature of chimney gases, and to keep a gross account of the coal and water as a check to the regular log. These should be careful men, well posted as to their duties. Three good platform scales will be required, and two tanks, or clean tight casks, to weigh water in. Preparation should be made so that the water can all be delivered into the two tanks, which are placed upon two platform scales, and the water pumped alternately from the tanks to the boiler. A piece of hose attached to the suction pipe of the pump or injector will be convenient to transfer from one tank to the other. It will be advisable to procure from reliable instrument makers one or two accurate thermometers for the purpose of taking the temperature of the feed water and chimney gases. The temperature of the feed water should be taken by inserting a brass or copper cup in the feed pipe near its connection with the boiler. This cup may be filled with oil and the thermometer set in the oil. The temperature of the cold water before it enters the injector or feed water heater should also be taken. Great care should be exercised that all scales, steam gauges, etc., are correct, and that there are no leaks about the pumps, pipes or boiler, by which any water may escape without being evaporated. Steam leaks are not material except as misrepresenting the consumption of the engine. The temperature of escaping gases may be taken by inserting a brass or copper pipe, with closed end in the smoke connection where it leaves the boiler. This cup, which should reach the centre of the escaping gases, may be filled with oil and a high registering thermometer placed in it. Previous to the hour for starting, say 6.30 o'clock, steam should be up to the working pressure and the tubes and all surfaces and flues should be swept clean. The ash pit should be cleaned and the first charge of kindling and coal, or the fuel to be used, should be weighed, every man should be at his post, those who are to note the various readings provided with ruled forms for recording the gross, tare and net weights of fuel and water, and others for the pressure of steam, temperatures of feed-water and escaping gases, which should be noted every quarter hour. At the hour for starting the height of the water in the boiler should be marked on the gauge glass, so that it may be brought to the same place at the close of the test, and the fire should be drawn quickly and replaced with the weighed kindlings and fuel, (wood kindlings are generally taken at 4.10 the value of coal by weight). The working of the boiler may be conducted as usual in every way, the stoking should be done

carefully, so that no waste may occur through dead spots or holes in the fire, or uneven distribution of fuel. If the fire is too thick, some of the gas will pass off unconsumed for want of sufficient air, and if the fire be too thin, too much air will be admitted. The draught or air supply should be regulated by the ash pit doors or registers, and an even fire and steady pressure of steam maintained throughout the test. If work is to be suspended at mid day, or any time during the test, the drafts may be closed, the fire banked, and an attendant left in charge who will regulate the fire if necessary, so as to keep the pressure constant. At the close of the test the water should be brought to the same level in the boiler as at the beginning and the fire withdrawn and deadened quickly with water. The remaining coal should be weighed and deducted from the quantity charged to the boiler, and the ashes may also be weighed. The net weights of coal and water may then be summed up and the result of the test ascertained and recorded in the following manner:—

Test of boiler at day of	18
Kind of boiler	
Dimensions	
No. tubes	
Size of fire-box	
Grate surface	sq. ft.
Heating surface	do
Height of chimney	
Size of chimney	
Duration of test	hours
Kind of fuel	
Boiler pressure (by gauge)	lbs.
Temperature of feed-water entering boiler	degrees Fahr.
Temperature of feed-water entering pump or injector	degrees Fahr.
Temperature of escaping gases	degrees Fahr.
Total fuel consumed	lbs.
Percentage of moisture in fuel	per cent.
Equivalent dry fuel	lbs.
Total weight of ash	lbs.
Equivalent combustible	lbs.
Total water evaporated	lbs.
Water evaporated per hour	lbs.
Water evaporated per pound of dry fuel	lbs.
Water evaporated per pound of dry fuel from and at 212°	lbs.
Water evaporated per pound of combustible from and at 212°	lbs.
Horse power developed.	

The above particulars are determined in the following manner. The pressure of steam and temperature of feed-water and gases are taken from the average readings of the same.

The total quantities of fuel, ash and water are taken from the net summing of log, great care being taken that no error is made. The percentage of moisture in fuel is determined by drying a sample of the fuel for 24 hours and getting the difference between the wet and dry weights, which difference is multiplied by 100 and divided by the weight of sample before drying.

The equivalent dry fuel is found by multiplying the total quantity of fuel by the percentage of moisture and dividing by 100, which is deducted from the total quantity of fuel.

The equivalent combustible is found by deducting the total amount of ash from the total quantity of fuel.

The water evaporated per hour is the total quantity of water divided by the number of hours duration of test.

The water evaporated per pound of dry fuel is the total quantity of water divided by the total quantity of dry fuel.

The water evaporated per pound of fuel from and at 212° is found by multiplying the water evaporated per pound by the total heat, or heat units, on one pound of steam at the average pressure, less the total heat of one pound of feed water at the average temperature of feed water before entering the pump or injector, and dividing the product by 966, which is the total heat in units, of one pound of steam at 212°.

The horse power is determined by deducting the total heat units of one pound of feed water at the average temperature before entering pump or injector, from the total heat units of one pound of steam at the average pressure, and multiplying the product by the quantity of water evaporated per hour and dividing by 110.343 (which are the heat units required to raise one pound of water from 100° and evaporate it at 70 lbs. pressure),