and four drops per minute are required, then it should be one for each fifteen revolutions. The places that must be oiled by hand should receive attention at regular intervals, and all bearings inspected systematic ally, that hot boxes may be avoided.

Engineers have different opinions concerning the proper time to wipe up an engine, for while some will wipe every place possible while the machine is in motion, others will not attempt it until after it is stopped, and still others clean up early the next morning.

Little can be said of the first plan spoken of, as the only advantage to be gained is a few minutes time, and this too at the expense of thorough work. Those engineers who adopt the second one usually condemn those who think that the third plan is a good one, as they claim that if it is done at night, it will be more apt to be well done, and on the other hand, those who prefer the third plan consider that the others run a risk in getting into the engine-room only in time to oil and start the engine, for if anything has been disarranged during the night, there is no time to remedy it, and start up as usual. As many good engineers favor the one that suits their case best, and care for their plants well, is plainly a matter of choice.

In regard to firing, only general directions can be given, as each man must be governed by existing conditions to a certain extent, but in the fire room as in the engine room, all should be done systematically.

It is generally considered that to secure the highest economy possible, the fuel should be supplied in small quantities and at regular intervals (with a constant load), that the fires should be cleaned at stated times each day, the water kept at a uniform height, except just before shutting down, as at that time the boilers should be filled up to the third gauge, to leave over night, and in short, everything done in a business-like manner.

Some time ago, while on a visit to a neighbouring city, we were shown a large plant where bituminous coal was used for fuel, and it was piled into the furnaces until the bridge wall was covered up, and a part of the time it was actually in contact with the shell of boiler. The dead plate was also utilized in an endeavor to enlarge the grate surface, and it was piled on here until it dropped out of the doorways. The furnace doors were then shut up, they being in contact with the coal for about one-half their height.

While some engineers favor what is ordinarily called a thick fire, still it is not probable that any of them will endorse this plan as being a good one. The water gauge glass should be blown out whenever the water becomes discoloured, or floating particles of dirt appear on the surface of it.

The boiler fronts may be wiped off with a piece of oily waste, after cleaning fires or removing ashes, and if this is done they will seldom need repainting—By W. H. WAKEMAN, in *Manufacturers' Gazette.*

## STEAM BOILER TESTS AS A MEANS OF DETERMINING THE CALORIFIC VALUE OF FUELS.*

BY D. W. ROBB, AMHERST, N.S.

It will be recognized by those who use large quantities of fuel, especially of bituminous coals, that they differ very greatly in value, even coals which are taken from adjoining areas give very different results, so that it is sometimes very puzzling to the consumer and difficult to decide upon the merits and proportionate values of the fuels within his reach. It is likewise difficult to determine when the greatest practicable amount of work is being obtained from the fuel, and consumers are frequently subjected to great loss from the want of this knowledge. There are three recognized methods of determining the calorific value of fuels, viz.: by chemical analysis, by the use of calorimeter, and by actual measurement of the water evaporated by a definite amount of fuel in a steam generator. By the first method, it is possible to ascertain the constituents of the fuel in their various proportions, and to determine the theoretical heat value when combined with a definite proportion of pure oxygen, and approximately to compute the amount of heat which would be converted into work when combined with ordinary air, and consumed under usual conditions. But this becomes a complicated problem, as will be seen when it is considered that the heat absorbed and wasted in heating the non-combustible constituents of both the air and the fuel must be taken into account, and that these wastes vary with the amount of superfluous air admitted through the grate, and with the proportion of non-combustible matter in the fuel, therefore, any estimate of the practical value of a fuel deduced from chemical analysis can only be approximate. In testing fuels by a calorimeter, a sample of the fuel mixed with chlorate of potassium is placed in an open mouthed copper vessel, which is submerged open mouth downward, like a diving bell, in a vessel containing a measured quantity of water, combustion of the fuel takes place and the heat produced is absorbed by the water, the total quantity of heat being determined by the rise in temperature of the water. This method has some advantages over an analysis and, if care is exercised in the selection of samples to be tested—or a large number of samples tested—is perhaps the best means of establishing a theoretical standard calorific value of a fuel, but the quantity tested is necessarily small and may not fairly represent the fuel; it also leaves out the heat absorbed by the non-combustible portions of the air and fuel, which is an important factor in the combustion of fuel, under ordinary conditions. The method by which the fuel is consumed under actual conditions and in large quantities, in evaporating water in a steam boiler, is generally regarded as a test of the efficiency of the generator, rather than as a test of the value of the fuel, but somewhat extended observation of the performance of various steam generators using similar grades of coal has convinced the writer that the steam boiler test, when properly conducted, is quite as valuable as a means of determining the calorific value of fuel, and of comparing various fuels as for finding the efficiency of the generator; in fact, the latter is the more uncertain of the two, because, unless a boiler is tested with a fuel of a known calorific value, it is impossible to arrive at its actual efficiency or to compare it fairly with any other form of generator. In testing the heat value of fuel in an ordinary steam boiler two elements of uncertainty are introduced, viz., loss through imperfect combustion of the fuel, and the escape of gases at a higher temperature than the atmos-

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