

A TOKEN OF APPRECIATION.

TORONTO, Jan. 19th, 1891.

Editor ELECTRICAL NEWS.

DEAR SIR,—I have pleasure in advising you that at the last regular meeting of Toronto Branch No. 1 of the Canadian Association of Stationary Engineers, the following resolution was unanimously adopted :

"That the members of this Association do hereby tender you a hearty vote of thanks for your kind liberality in advertising our Association in the late ELECTRICAL, MECHANICAL AND MILLING NEWS and also in the ELECTRICAL NEWS AND STEAM ENGINEERING JOURNAL. The Association recommends the journal to all engineers and mechanics, believing it to be a good medium through which to obtain information."

Wishing you every success, I am, dear sir,

Yours truly,

W. G. BLACKGROVE,

Secretary.

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 fuel within his reach. It is likewise difficult to determine when the greater 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 atmosphere, but as these losses, as well as the heat absorbed by the non-combustible portions, the air and fuel, are unavoidable in the present state of science, they should be taken into account in making a practical test of fuel, and strict accuracy only requires that the loss be uniform and minimum in result. Practical experience teaches that almost perfect combustion may be attained in any of the common forms of steam generator by careful and regular stoking with a proper air supply; and, that the skill necessary to produce this result is possessed by many ordinary stokers, who have no knowledge of the laws which govern the combustion of fuels, will doubtless be admitted by many persons who have observed locomotive firemen or others, who are compelled to get a high rate of steam production. It is of course impossible to transfer all the heat produced in combustion to the water in a generator, because the gases cannot be reduced below the temperature of the water or steam within the generator, and a certain temperature above the atmosphere is necessary to produce draught in the chimney, but it is quite possible to so proportion the grate surface to the heating surface of the boiler that the gases will be reduced to a certain minimum temperature, and maintained at that temperature during a test. The temperature may be indicated by a pyrometer or high registering thermometer at the base of the chimney, and the rate of flow of the gases may be ascertained by the use of a draught gauge.

Frequently an attempt is made to analyse waste gases, this gives an uncertain result on account of the difficulty of getting representative samples of the gases, but from observation and examination of many tests the writer believes it unimportant, if the stoking and air regulation receive proper attention. The surface of the grate should be so proportioned to the heating, or heat absorbing surface of the generator that the gases will, when they reach the uptake, be reduced to say 400° Fahr.; the skillful firing and air regulation will produce practically perfect combustion and uniform temperature. It is not of so much consequence either, as some people imagine, what kind of generator is used. The brick furnace is supposed to possess an advantage in maintaining the temperature necessary to perfect combustion, while contact with the cooler surface of a water lined furnace is supposed to prevent ignition of the volatile hydro-carbons coming from some fuels, producing carbonic oxide; but the writer is convinced that, by a proper regulation of the fire, so that the air will pass through and the gases will pass over a bed of hot coals, or incandescent carbon, with frequent and even distribution of the fuel, as perfect combustion may be, and is obtained in a water lined furnace as in a brick one. The water lined furnace avoids the radiation of heat and admission of air, both of which are an uncertain but certainly wasteful feature of the brick furnace.

Steam boiler tests, although attended with some difficulty, are quite within the reach of ordinary consumers, and deserve to be better understood and used more than they are. In addition to their value as a method of determining the heating properties of fuel, they furnish the best possible means of ascertaining the condition and efficiency of the generator, and of checking, and if necessary correcting waste on the part of the stoker. It is desirable that such tests should be made frequently, because steam boilers are very liable to deteriorate and become wasteful, especially when set in brick, through the cracking of the brick walls, as well as by the coating of heating surface with scale or other deposits on the inner, and soot or ashes on the outer surfaces. It is quite practicable for steam users to have tests made by their engineers and ordinary assistants, but it is preferable to have an occasional test made by a professional engineer who has had experience in making such tests, as he will have gained special knowledge which will enable him to detect and locate imperfections in the generator more readily than those unaccustomed to such work. The writer would suggest to steam users the following practice: That one or more tests be made by an expert to determine the efficiency of the generator, and that he may direct any necessary repairs or corrections in the generator. After this has been done, and a standard of efficiency established, a good water meter should be inserted in the water supply pipe, so that a record of the water used may be continuously kept, and the stoker or engineer should keep a log and make daily reports of the coal consumed and the water

* A paper read on Dec. 31st, 1890, before the Nova Scotia Institute of Science, Halifax, N. S.