

STUDIES ON FUELS FOR TEA DRYERS.—I.

FIREWOOD—THE RELATIVE VALUES OF DIFFERENT SPECIES OF WOOD AND THEIR STORAGE.

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INTRODUCTION.

Judicious economy is one of the surest means of increasing the profit accruing from any manufacturing process. Such economy does not impair the efficiency of the process, hence the qualification "Judicious" to distinguish it from the type of cheeseparer commonly called "Penny wise pound foolish".

The cost of fuel for firing is a considerable item in the budget of a tea factory and this very often offers an opportunity for judicious economy. In a later article it is proposed to deal with the relative costs of firing with different fuels, but before proceeding to such a discussion it is intended to refer to some of the preliminary points connected with the use of wood as a fuel for tea dryers.

In the case of coal and oil much literature, containing valuable advice, is sent round to estates, and a study of this literature enables the best results to be obtained with these fuels. In addition to the printed advice which is available for those interested in oil and coal burning, there are a number of expert advisers who are prepared to visit and give practical advice and demonstration, the value of which should be realised. Firewood being an indigenous fuel does not receive such attention; its use is not advertised by copious literature and handbooks, and there is not any service of experts willing, upon a simple request, to travel long distance to demonstrate its advantages and best use. Being the original fuel and a material with which labour is thoroughly accustomed, it usually receives little attention beyond that given by the firing cooly who, generally speaking, is an expert at saving himself trouble.

In cost, a local product has great advantage over imported fuels and, save in exceptional cases, firewood is cheaper than either coal or oil, provided that it receives the same care and attention given to its substitutes.

THE RELATIVE VALUES OF VARIOUS SPECIES OF WOOD.

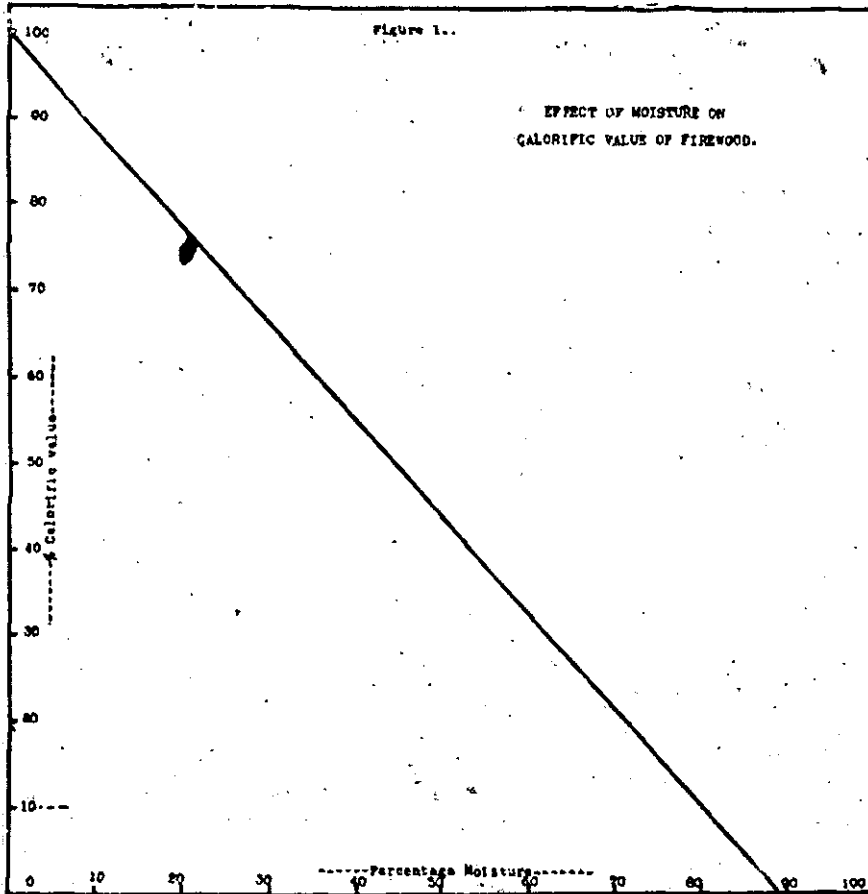
The fundamental consideration when evaluating different kinds of firewood is the calorific value per unit of weight, that is to say, the potential amount of heat contained in one pound. The commonest form of unit used by British engineers for heat values is the British Thermal Unit (B.Th.U.) which is the amount of heat required to raise the temperature of one pound of water through one degree Fahrenheit at ordinary temperature (60°F.). Thus, if we say that the calorific value of Red Gum is 9,000 B.Th.U's. per pound we mean that there is sufficient potential heat in one pound of this fuel to raise to boiling six gallons of water from ordinary temperature. This potential heat can seldom all be utilised, and the expression thermal efficiency is utilised to indicate the percentage of the available or potential heat which can be extracted with advantage. In the above case, if the boiler, or systems used for heating the water, had a thermal efficiency of 50 per cent then only three gallons of water could be raised to boiling temperature.

In comparing different fuels we must also know their moisture content; it is a matter of common experience that damp wood is not such a concentrated source of heat as dry wood. Moisture in firewood affects its value as a fuel in two different ways.

- (a) The moisture lowers the content of combustible material.
- (b) The moisture in the fuel ⁽¹⁾ has to be evaporated and carries off heat in the form of steam. In tea dryers this heat cannot be recovered by condensation of the steam. Kemp ⁽²⁾ states that moisture is also liable to cause smoking which implies further loss.

The graph in Figure 1 has been constructed after taking these two factors into consideration, and shows how the calorific value of firewood, expressed in B. Th. U's per pound is reduced by the

presence of moisture. Completely dried firewood has the maximum calorific value per pound, but in practice it would be extremely difficult to obtain large quantities of such material. On closer examination of this point it becomes apparent that there would be little gained even if completely dry firewood were feasible.



In the first case very dry wood is liable to burn too quickly in the absence of adequate control, and in the second, examination of the graph reveals the fact that there is very little loss of heat in the form of steam (*Vide* section. (b) above). Supposing a fuel contains a reasonable amount of moisture, say 15 per cent, then the graph shows

that it has 83 per cent of the heat value of the corresponding completely dry fuel. This fuel has, however, gained 15 per cent in weight by reason of its content of moisture so that the actual loss is only $(100 - 83) - 15 = 2$ per cent. When there is sufficient moisture to cause thick smoke the losses will become more serious.

This fact must be borne in mind when examining Table I which shows the observed moisture contents, the calorific value as sampled, and the calorific value after complete desiccation, of a number of different species of wood commonly used as fuels for tea dryers.

TABLE I.

Sample	Moisture per cent	Calorific value as sampled	B.Th.U's. per pound after complete drying
Young Red Gum freshly felled	48.2	4,222	9,157
12-year-old Red Gum freshly felled	48.0	4,317	9,299
Old Red Gum. Split and stored in open for a few weeks.	26.6	6,592	9,372
Red Gum, after storage under a tagaram cover	13.5	7,440	8,775
Do	10.2	8,044	9,080
Red Gum stored in the open	18.2	7,100	8,920
Grevillea — freshly felled	50.1	4,315	9,743
Acacia — freshly felled	14.8	7,719	9,253
Mixture of jungle woods	9.0	7,787	8,669
Toonah	13.5	7,471	8,806
Tea prunings	—	—	9,308

Table I shows very clearly that the calorific value of the dry matter in all the different species of wood and in different ages of the same species are very similar, which means that when the moisture contents are comparable there is little to choose between them, weight for weight. Nevertheless, it is well known in practice that different costs are obtained with different kinds of firewood.

FIREWOOD COSTING.

The reason for these differences in cost is not far to seek when the system of reckoning the amount of wood used, namely by the cubic yard, is examined. The heat value of a cubic yard of firewood is, on the above reasoning, almost entirely dependent on the weight of the dry matter which it contains. The weight of dry matter per cubic yard is not affected to any appreciable extent by moisture content since wood does not swell sufficiently when wetted to influence the amount packed into a cubic yard. There are two important factors, however, which do cause very considerable variation in the heat value of a cubic yard of firewood, and are:—

1. The stacking of the wood.
2. The density of the wood.

Stacking is not affected very much by the species of the wood and is almost entirely a matter of manipulation, but the density of the wood varies widely with its nature. Age has an appreciable effect in any one species, and between two extreme species, such as the open, light-textured Toonah and the close, dense-fibred gum, there is a large difference. Although moisture does not affect the volume of wood in a cubic yard it does of course affect the weight and in the following comparison the weights have been reduced to equal moisture contents.

Sample	Moisture content per cent	Weight per cubic yard
Young Red Gum	13	620 lbs.
Old Red Gum	"	870 lbs.
Toonah (Old)	"	500 lbs.

The stacking was carried out with the same labour and the figures are an average of measurements of two or three different yards taken from a large stack of the one species.

Kemp ⁽³⁾ gives the following figures:—

Red Gum	60 lbs. Dry weight per cu. ft.
Blue Gum	50 " " " " " "
Toonah	30 " " " " " "

If the value of the old gum is reckoned at Rs. 3.00 per yard then the real comparable value of the young gum is Rs. 2.14 and the old

Toonah only Rs. 1.80. In practice it often happens that the same price is paid for all wood! which obviously means that sums amounting to thousands of rupees may be lost in a large contract.

When assessing the value of a firewood there are two factors which must be known before an accurate estimate can be made, the first being weight per yard and the second moisture content.

The second factor is easily determined by the use of equipment now commonly used for the determination of moisture content of tea, but the following figures will show that after comparatively rough storage, wood tends to assume an approximately constant moisture content, sufficiently constant for practical calculations. On the other hand the moisture content of the freshly felled timber of any one series should be practically constant and in the case of gum and grevillea is approximately 50 per cent, which figure Kemp⁽⁴⁾ gives as a general rule.

STORAGE.

Table II shows how the moisture content of freshly cut gum fell during storage under an open verandah which gave protection from undriven rain only.

TABLE II.

Date	Per Cent Moisture
*28. 10. 34	48.0
16. 11. 34	29.0
10. 12. 34	19.5
12. 1. 35	19.0
12. 2. 35	14.2
12. 3. 35	14.6
15. 5. 35	11.6

* Date of felling and stacking.

After two months of rough storage, therefore, the wood was reasonably dry and fit for use, and after four months the wood was as dry as can be obtained by air drying. Kemp⁽⁵⁾ gives 20 per cent as the moisture content figure after air drying.

Observations made on various estates show that even under completely exposed conditions freshly-felled timber dries out quite rapidly, and, provided that the wood does not lie wet, rain does not affect the moisture content unduly since most of it runs off the surface of the wood without penetrating. Samples taken from a stack of firewood lying in the yard of St. Coombs factory gave the following results:—

1. Top of stack	8.9 per cent
2. Middle of stack	12.9 „
3. Bottom of stack	14.6 „

Samples from other estates gave similar information. The wood was in each case ready for transport to the dryer.

Estate 1.

Gum stored in open	18.2 per cent
Gum stored in rough tagaram shed	10.2 „

Estate 2.

Gum stored under cover	13.5 „
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THE VALUE OF WOOD BARK AS A FUEL FOR TEA DRYERS.

It is a common fallacy that the bark of firewood is useless as a fuel. Tests on samples from three estates have shown that bark does not, under normal conditions, contain much more moisture than the wood to which it is attached and that the calorific value is only very slightly below that of the older tissues.

TABLE III.

Samples	Moisture per cent	Calorific value of dry matter
		B.Th.U's per lb.
1. Wood	13.5	8775
Bark	15.6	8754
2. Wood	10.2	9080
Bark	11.4	8920
3. Wood	18.2	8920
Bark	19.6	8870

The practice of stripping off bark is therefore wasteful of labour and material.

SUMMARY.

It has been shown that the main difference between the values of various species of firewood as fuels for tea dryers lies in the weight of dry matter per cubic yard:

Costs based entirely on the cubic yard may mean that the potential heat purchased in one form of fuel may be nearly twice as expensive as the heat purchased in another fuel.

Figures are given to show that storage, particularly under a rough cover, is highly desirable and that under these conditions bark is almost as valuable a fuel as the wood to which it is attached.

REFERENCES.

- (1). Chemists' Year Book. 17th Edition, page 643.
- (2). Engineers' Year Book. 36th Edition, page 2,178.
- (3). *Ibid.* page 458.
- (4). *Ibid.* .. 2199.
- (5). *Ibid.* .. 2199.