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THE THEORY OF BURNING GREEN MEGASS.

BY JAMES H. MAN.

We are indebted to the Demerara *Argosy* for the following paper on this subject, by Mr. J. H. Man. In the April and May *Sugar Cane* we gave a paper on "Cane Mills: and Megass as Fuel," by Mr. Russell, to which the present paper may be considered a sequel.

TO THE EDITOR OF "THE ARGOSY."

SIR,

I have just received from my friend Mr. James Man, whose departure from the colony last year on account of ill-health was so widely regretted, the accompanying paper on "The Burning of Green Megass," written by himself. I hope you will publish it, as I am sure a paper treating so important a subject with the thoroughness and scientific accuracy by which Mr. Man distinguished himself when amongst us, will be read with interest by the planters and engineers of the colony.

In his letter to me he says, "It is a pity I have no analysis of megass, but am sure the results of comparison between megass carrying different percentages of moisture, would not be materially altered by the substitution of more perfect data; it is only a comparison I aim at and am satisfied I can't be far wrong."

He writes from Denver, Colorado, where he has been ordered for his health; his many friends will be glad to learn that he has already experienced great benefit from the change.

I am, Sir, your obedient servant,

C. A. MATTHEY.

Georgetown, Jan. 24th, 1884.

The burning of green megass having made so great a stride within the last few months, and being likely to become generally adopted, I venture to think the few remarks that follow will prove an assistance to some and of interest to all in the study of the subject.

Combustion seems on first thoughts most complex, but in fact is one of the simplest of chemical phenomena. Each element of a fuel combines in known proportions with oxygen during the process of burning or oxidation, so that the amount of oxygen (or air containing that oxygen) necessary for the complete combustion of a given weight of fuel is ascertainable, and from this is found the weight and volume of the products of combustion. The energy or "heat" evolved by such chemical combinations is also known, and is convertible into an equivalent of work, if, however, there be any circumstance, such as water in the fuel, that will detract from the usefulness of this heat, we have merely to calculate the amount of chemical energy expended in overcoming the adverse circumstances so as to enable to compare the effectiveness of good and bad fuels.

I will confine myself entirely to the effect moisture, in the fuel under consideration, has upon combustion.

There are many ways in which the detrimental effect is made apparent, viz.: upon the *draught*, the *temperature* of combustion, and the *number* of units of heat available for work.

The moisture has to be evaporated at the expense of a portion of the fuel, and heated still further to the temperature of the other products of combustion. In this form it occupies considerable space, and increases the volume of the gases to be carried off, consequently a greater draught is necessary to maintain an adequate influx of air through the fire bars, yet by increasing the draught the gases will part with less heat in transit. The obvious remedy for this is to have a larger chimney and an increased sectional area of all the flues, the draught being increased in *volume*, not *speed*.

A given weight of canes yields a certain weight of combustible matter, *plus* a variable weight of water, according to the quality of the crushing, so that when comparing the combustion of green with that of dry megass, we must consider the equivalent weight of the green megass to be that of the dry *plus* the percentage of water contained, that is, 2 lbs. of green megass containing 50 per cent. moisture, must be comparable with 1 lb. of dry megass; the 2 lbs. of green megass, however, carry only 1 lb. of combustible matter, and a portion of it has to be appropriated to evaporate the pound of water, the actual temperature is, therefore, considerably below that attainable from dry fuel, and that the number of units of heat available are also less, as will be shown further on.

It is evident then, the effects of the draught on the heat, and of the heat on the draught, must be mutually detrimental; and considering also an estate has to consume at least 2 tons of green megass in the place of 1 ton of dried megass, modifications must be introduced in the shape and size of the furnace, the distribution of air, the area of the flues and the power of the chimney, that involve principles very different to those now in practice, and about which we probably know very little.

The presence of water, or its constituents, in fuel, promotes the formation of smoke, probably by mechanically sweeping along fine particles of carbon; the escape of smoke, so noticeable with the use of moist fuel, is therefore due to and indicative of imperfect combustion.

I will now endeavour, by means of certain figures, to place the matter in a more practical form; I am however, unfortunate in not having with me an analysis of megass, and am presuming the combustible elements of megass (inclusive of the sugar contained in solution before drying) are equivalent to those of wood, pound per pound; this I think will be quite near enough for the comparison to be made between more or less dried megass, and will actually be putting the megass on too favourable a footing as a fuel. I shall, therefore, substitute in the following quotations, &c., the word *megass* for *wood*.

In Rankine's "*Steam Engine*," page 280, I find 1 lb. of dried megass requires 6 lbs. of air to effect its complete combustion, and if the usual allowance be made for the delution of the gaseous products, we have double or 12 lbs. of air admitted for every pound of dry megass consumed. Now, let us suppose the products of combustion pass off at a temperature of 572°, the volume (page 286) will be 314 cubic feet; if, however, the megass had contained its equal weight of water, there would 1 lb. or about 50 cubic feet of gaseous steam to be got rid of besides, or 364 cubic feet. Thus, we see the presence of this 1 lb. of moisture would reduce the admission of air 16 per cent., or necessitate an enlargement of the flues to the same extent with a proportionate increase in the power of the chimney. This, I take it, would not adequately represent the extent of the evil, for with moisture in the fuel, combustion would not be so brisk, the temperature would be less, and the draught still further reduced.

In Clark's "*Manual of Rules, Tables and Data,*" page 405, the evaporative power of 1 lb. of dry megass is given as 7 lbs. of water; and if we suppose it capable of evaporating ⅔ of 7, or 4⅔ lbs. in practice, what will be the effect of moisture if present to the extent of 50 per cent.? To evaporate 1 lb. of self-contained water the useful evaporation will be reduced from 4⅔ to 3⅔ lbs., or 22 per cent., and this when the combustion is presumed to be equally perfect in both cases, a very unlikely occurrence.

From the same authority, page 444, I find the total heat of combustion of dry megass is 7,792 units, and in the manner shown, page 407, can calculate that 3·219 units of heat raise the total products of combustion 1°, from which their specific heat, ·247 is found by dividing 3·219 by 13, the weight of the products; also by dividing 7,792 by 3·219=2,424°, we get the temperature of combustion. When 1 pound of water is associated with 1 pound of megass, 1,116 units (total heat of steam) are appropriated to evaporate the water, leaving 7,792—1,116=6,676 units of heat available for raising the temperature of the gases.

To raise the direct products 1° there are required......	3·219 units.
And to raise the water (as gaseous steam) 1°..........	·475 units.
Total to raise mixed products 1°	3·694 units.

Then the units of heat available divided by this, that is, 6,676÷3·694=1,807°, gives the temperature of combustion of megass holding 50 per cent. moisture, which is only 74 per cent. of 2,424°, that of dry megass.

Now let us study the *total* units of heat with those *effective* after deducting the loss due to the escape of the gases, at some 500° above the normal temperature. As before, 1 lb. of dry megass yields 7,792 units, but, as it requires 3·219 units to raise the products of combustion 1°, there are lost 500×3·219=1,609 units, leaving 7,792—1,609=6,183 units as effective. Now, with the 2 lb. sample of megass containing 50 per cent. moisture, we have already seen there are but 6,676 of heat available, and 3·694 units are required to raise its mixed products 1°, consequently there are lost 500×3·694=1,847 units, leaving

6,676—1,847 = 4,829 units as effective. So here again we see the effectiveness is reduced to 78 per cent. of that of dry megass.

From this it would appear that megass holding 50 per cent. moisture (about the best result obtained from the heaviest mills) should theoretically burn, in its green state, with but a loss of 22 per cent. of its evaporative power; but in practice such a favourable result cannot possibly be attainable, owing to the combustion being imperfect and less rapid, neither can we hope to approach this degree of perfection until the necessary modifications in the means employed have been arrived at and introduced.

In the United States and some of the West India Islands, the Jarvis patent furnace for burning green megass is reported to be in successful operation; hot air is introduced upon the fuel, and although theoretically it can only impart as many units of heat as it receives from some other source, the idea presents two indirect methods for promoting combustion. The drying process is probably effected by the heat in the air, and, the moisture being disposed of more rapidly, the units of heat, due to combustion, are available for useful work; then a forced draught is known to increase the rapidity of combustion, besides enabling perfect combustion to take place with less air, that is, a lesser percentage of additional air being required for the dilution of the products of combustion, the products are less, the loss due to the escaping gases less, and the temperature of combustion more.

I give below, in a tabular form, a recapitulation of the above results, with the addition of two other examples, calculations for which are suppressed. One is for megass holding 66·6 per cent. its weight of moisture (as represented by 55 per cent. expression from canes carrying 15 per cent. woody fibre), it presents a sorry comparison, but is, I fear, too often the case with inferior crushing. The other is for megass containing 25 per cent. moisture, a result that could only be obtained by very heavy crushing and perfect feeding; and as this touches upon another subject of great interest to me, I will dismiss it with the hope and belief that it will be an accomplished fact before very long. It is my opinion, improvements in single crushing should be aimed at by every one of us, as in this direction alone can we expect the burning of green megass to become more and more economical, and in time a great success.

Equivalent Weights of Megass.	Combustion Matter—Approx.	Water.				Air admitted.	Products of Combustion.					Temperature of Waste Products above Normal.	Units of Heat.				Temperature of Combustion.	In Percentages.
		Useful. Evap.		In lbs.	In Percentages.		Weight.	Volume at 572°.	In Percentages.	Mean Specific Heat.	Units of heat to raise temp. 1°.		Total.	Wasted.	Effective.	In Percentages.		
		Weight.	Percentages.															
1 lb. dry ..	1 lb.	..	..	4⅔	100	12 lb.	13 lb.	314 cub. ft.	100	·247	3·219	500°	7792	1609	6183	100	2424°	100
1⅓ lb. green.	1 lb.	⅓ lb.	25	4⅓	92	12 lb.	13½ lb.	331 cub. ft.	105	·253	3·377	500°	7420	1688	5732	92	2197°	90
2 lb. green..	1 lb.	1 lb.	50	3⅔	78	12 lb.	14 lb.	364 cub. ft.	116	·264	3·694	500°	6676	1847	4829	78	1807°	74
3 lb. green..	1 lb.	2 lb.	66·6	2⅔	57	12 lb.	15 lb.	414 cub. ft.	132	·278	4·169	500°	5560	2084	3476	56	1333°	55