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(Abstract.)

“Megass- and Refuse-Furnaces.”

By WILLIAM PRICE ABELL, Wh.Sc., Assoc. M. Inst. C.E.

THE use of megass as fuel in the manufacture of cane-sugar has, during the past few years, largely owing to the increased cost of coal, become more general; and on many estates in the West Indies it has entirely replaced coal, of which 25 cwt. were formerly required for the production of one ton of sugar. During the years 1890-94, five hundred and twenty furnaces were rebuilt in British Guiana, at a cost of about £50,000, the annual saving thus effected amounting to more than £100,000.

On the assumption that sugar-cane contains 12·5 per cent. of woody fibre, and the juice 16 per cent. of sugar, Mr. Nevile Lubbock states, as the result of many trials, that double crushing extracts 72 per cent., and single crushing 66 per cent. of the juice, leaving the green megass composed in each case of woody fibre, water and sugar in the following proportions:—

	Double Crushed.	Single Crushed.
	Per cent.	Per cent.
Woody fibre	45	37
Water	46	53
Sugar	9	10
	<hr/> 100	<hr/> 100

Exhausted diffusion chips reach the furnace composed of 60 per cent. of water, 0·44 per cent. of sugar, and 39·6 per cent. of woody fibre.

In the old furnaces, which do not utilise the oxygen and hydrogen in the water of the megass for combustion, it is calculated that 4·83 lbs. of double-crushed megass and 5·98 lbs. of single-crushed megass are required to give the same amount of available heat as 1 lb. of Scotch coal. Sir Frederick Bramwell and Dr. Letheby, in their report on the sugar manufactories belonging to the Khedive of Egypt, state that 2·09 lbs. of sun-dried megass are equivalent to 1 lb. of Welsh coal.¹ From 100 tons of

¹ See also Minutes of Proceedings Inst. C.E., vol. xlviii. p. 87.

single-crushed cane are obtained 34 tons of megass, sugar and water combined as fuel, $8\frac{1}{2}$ tons of sugar and $57\frac{1}{2}$ tons of water, to be evaporated out of the juice; and from 100 tons of double-crushed cane there result 28 tons of megass, sugar and water as fuel, $9\frac{1}{2}$ tons of sugar and $62\frac{1}{2}$ tons of water to be evaporated out of the juice. With single-crushing, therefore, for every ton of sugar manufactured, 4 tons of refuse or megass, of which 53 per cent. is water, and with double-crushing 3 tons of megass, of which 46 per cent. is water, are obtained. This fuel, in modern though still imperfect furnaces, will evaporate $57\frac{1}{2}$ tons to $62\frac{1}{2}$ tons of water from the juice of 100 tons of cane, besides generating all the mechanical work

involved in crushing the canes and manufacturing the sugar. A surplus of megass should be stored whilst the mills are working, so that it may be possible to manufacture with it the offal products after the grinding ceases.

The results of long grinding at a factory producing $1\frac{1}{4}$ ton of sugar per hour show that the amount of megass available per hour is 3.75 tons, consisting of 2.03 tons of fibre and 1.72 ton of water. This is burnt in five furnaces, of which two are of the type shown in *Figs. 1* and 2, and three are of the type shown in *Fig. 3*—4.24 cubic feet of megass being thus available for each furnace per minute; but sufficient steam is maintained with 3 cubic feet per minute. Each furnace has a grate-area of 20 square feet, and each

supplies heat to a multitubular boiler containing 1,300 square feet of heating-surface. The chimney draught, as shown by a Bailey draught-gauge, is 40 feet per second, the flue temperature, as shown by a Bailey pyrometer, is 500° F., and the furnace temperature is such as to melt copper and partially melt cast-iron, about $2,000^{\circ}$ F. The steam obtained from these five boilers and furnaces concentrates and purifies 9.45 tons of juice into $1\frac{1}{4}$ ton of pure yellow sugar per hour. The boiler-pressure is 75 lbs. per square inch, and the cane is crushed at the rate of 13.2 tons hourly, 3.75 tons of megass and 9.45 tons of juice being produced—the latter consisting of 1.25 ton of sugar and 8.20 tons of water and

Fig. 2.

offal. In addition to extracting juice from the canes with a pressure of 250 tons on each of the top rolls, the water is evaporated, the sugar is cured, and the molasses is converted into rum and second sugar. The 3.75 tons of megass develop the requisite power without the assistance of any other fuel, the duty of the engines employed amounting to 463 I.H.P. and the heating-surface in the evaporators being 5,650 square feet.

The water in megass was, until a few years ago, evaporated in the furnace and driven out of the chimney as waste steam. In some cases the megass was dried in the sun or in logies, on the theory that to employ water as fuel was to use more energy than could be realised from the combustion of the oxygen and hydrogen

obtained from its decomposition. Ordinary megass, if burnt in the usual way, scarcely produces heat enough to promote its own combustion. The result of the improvements in furnaces has been that condensed steam or white smoke is seldom seen issuing from megass chimneys. Green megass may be taken to consist of 50 per cent. of fibre and 50 per cent. of free water, the small quantity of sugar and ash present being negligible. The chemical analysis of the substance is :—

	Per cent.		Per cent.
Carbon . . .	25.00	Woody fibre . . .	50
Hydrogen . . .	2.78		
Oxygen . . .	22.22		
Hydrogen . . .	5.56	Free water . . .	50
Oxygen . . .	44.44		

Fig. 3.

Megass thus contains exactly the amount of oxygen necessary for the complete combustion of its carbon.

When hydrogen and oxygen exist in a compound in the proper ratio to form water, its constituents have no effect on the total heat of combustion. This would be the case with woody fibre in megass, under ordinary circumstances, when burnt in the older type of furnace. On the other hand, in a properly designed green-megass furnace, when thoroughly heated, the water, in the form of aqueous vapour, is decomposed in passing over the highly incandescent and porous carbon of the megass; oxygen is liberated and combines with the carbon to form carbonic acid; and the hydrogen passes off partly uncombined and partly as carburetted hydrogen. The latter, in presence of sufficient oxygen and at the high temperature of the furnace, undergoes further combustion and yields additional heat by its conversion into

carbonic acid and water. This is shown in practice by the fact that little air is required for a furnace after it is properly started. If the pores of megass could be impregnated with air and saturated to the required extent, each atom of carbon being contiguous to the necessary air before the fuel was thrown upon the grate, the result would differ from the ordinary smouldering combustion, and would approach that of gunpowder, which contains the necessary oxygen for perfect combustion without air. The fuel should first be gasified and then burnt, the moisture being split up and the oxygen and hydrogen used for the combustion of the carbon in the megass.

Fig. 4.

In an efficient megass-furnace perfect combustion of the gases and carbon flecks should be produced, the gas being first liberated and then consumed, so that no white vapour escapes from the chimney. It should require no increase of chimney height, and should work without forced draught. The temperature in the combustion-chamber should be sufficiently high for the production of water-gas. Ample provision should be made for expansion through large and varying ranges of temperature. Furnaces have been constructed in which the waste heat from the chimney is utilized for drying the fuel on its way to the fire-box. Experiments made by the Author in 1887, however, showed that with a flue-temperature of 550° F., a layer of megass 3 inches thick took forty-five minutes to dry.

In *Fig. 4* is shown the Alfred Fryer furnace introduced in 1883 by Mr. Maurice Costa, and adopted with success in British Guiana. The grate *b* is inclined with the lowest part at the furnace front, and the green megass is introduced between the bars and boilers *a*, so that all the flames pass through and over the green fuel on its way down the drying-plane *c*. The megass is introduced at the opening *e*, and, falling on the inclined drying-plane, it gravitates downwards on the fire-bars, as that below it is burnt. The whole of the products of combustion pass up over this drying-plane and there evaporate, taking up much of the moisture of the megass. The flames then pass the feed-mouth into the combustion-chamber *d*, and finally into the boiler. No air was observed to be drawn in at the feed-mouth, although the stream of flame was always plainly visible passing this opening, which measured 10 inches by 5 feet.

In 1890 the furnaces shown in *Figs. 1* and *2* were introduced by the Author. They are arranged in pairs, the air for combustion being drawn between the two furnaces at *a*, over the boiler-tops *b*, and finally over the reverberatory arches, *cc'*, into the ash-pit. The air is caused to pass the hottest or lower part of the fire-bars by the deflecting-plate *d*, reaching the top end of the fire-bars and entering the megass at a temperature of 300° F. The check-wall or plate, *e*, regulates the thickness of megass on the fire-bars. In order to still further heat the air and facilitate the complete combustion of the gases and carbon flecks, a similar furnace, but possessing an additional combustion-chamber, was introduced and gave highly satisfactory results. In 1892 the automatic feeding arrangements were added, with a view to reduce labour on megass platforms, to dispense with the gearing hitherto used in mechanical firing, and to give a constant and regular feed of fuel. They have proved so sensitive in practice that without any assistance they can supply one furnace with the exact quantity of megass, passing the surplus on to the next. The megass is carried the whole length of the platform by the usual rake-carrier, connected with each furnace by enclosing hoppers. Down these the megass falls direct into the furnaces until the hopper is sufficiently full to cause the megass in the carrier to pass over that in the hopper. The surplus megass can either be discharged at the carrier end or be stored between each furnace by opening intermediate doors under the control of the attendant. No firemen are required, except when the megass-furnaces are not stopped owing to the mills ceasing work, in which case, by simply opening the door at the bottom of each enclosing hopper, the

furnace can be fed by hand in the usual way. The attendant simply regulates the flue dampers to give the necessary steam, and adjusts the intermediate doors, to prevent too much megass from accumulating at one place. He also sees, by means of the peep-holes in the hoppers, that each furnace is taking its proper amount of fuel.

The apparatus shown in *Fig. 5* utilizes the weight of the megass to regulate its own feed. The hopper is hinged at *e*, *f* being an opening in the cross carrier, *d* a damper or sluice, and *c* a balance-weight. The megass passes down the shoot *b* to the furnace until it is full, and then the weight of the megass, accumulating in the hopper, causes it to descend about the hinge into the position shown by the dotted lines, at the same time raising

the balance-weight and sliding the sluice or plate over the opening *f*, thus causing the megass to pass on to the next furnace.

In 1893 a furnace was tried by the Author in which the fuel was passed through an open-ended retort projecting vertically into the combustion-chamber. The flames of combustion heated this retort, and thereby heated, dried and distilled the gases out of the megass ready for combustion so soon as they reached the combustion-chamber, the solid partly-dried fuel falling upon a hearth surrounded by four pigeon-holed walls. It was found advantageous to block up the pigeon-holes until only 7 square feet of grate-area were allowed for burning 7 cubic feet of megass. The ratio was thus 1 square foot of grate-area per cubic foot of megass, whereas it had previously been 6 square feet of grate-area per cubic foot

of megass burnt per minute. In other words, with a boiler having 1,300 square feet of heating-surface, the furnace having one-third the usual grate-area, the amount of steam obtained from double the quantity of megass was three times that derived from similar boilers with ordinary furnaces in the same battery, and this with a natural chimney-draught of 40 feet per second. The construction of the furnaces required only about half the number of bricks of ordinary furnaces.

The loss of megass, and particularly of diffusion chips when charred and partly burnt, is considerable, on account of the unburnt carbon flecks. These are similar in appearance to the end of a charred match, and are carried through the furnace and up the chimney unburnt in such quantities that on a still morning the ground round a sugar-factory becomes strewn with them. To prevent the waste from this cause, a centrifugal combustion-chamber, *Fig. 3*, has been successfully adopted for retaining the carbon flecks until they are distilled and completely consumed. The megass enters at *e* and falls to the firebars *b*. The flames are led into the combustion-chamber *d*, tangentially at *g*, so that the heavy unburnt particles are speedily separated from the light gases by centrifugal force—the heavy sparks and carbon flecks flying off to the circumference, and the light flames of combustion finding their way through the centre *g*, up the flue into the boiler *a*. The same arrangement has been applied with success to the retort type of furnace, wherein the combustion- or whirling-chamber is arranged above the hearth, around which are fixed tangential twyers supplied with air, preferably under pressure, from the chamber. The air enters the twyers and produces a whirling motion which causes the heavier unburnt particles of megass or chips to remain in the chamber, which is of large diameter, in virtue of their weight, whilst the lighter products of combustion pass up the deflector.

The economy of megass-furnaces is still susceptible of great improvement, by the adjustment of the proportions in which the several constituents are consumed rather than by the introduction of new principles of construction or operation.

The Paper is accompanied by several tracings, lithographs and photographs, from a selection of which the *Figs.* in the text have been prepared.