

Boiler Efficiency and Heat Balance in a Cane Sugar Factory

In considering the question of the generation and utilisation of steam in cane sugar factories, the fact should not be overlooked, that here in Natal, we are fortunate with regard to the quantity of bagasse we have available as fuel. In probably no other country do we find cane having so consistently high a fibre content, and it may be taken for granted that in Natal, no well equipped and properly designed factory should ever have to use an auxiliary supply of fuel in the form of wood, coal or oil. Some factories may be in the unfortunate position of having to deal almost exclusively with poor cane, but even these with careful management can usually run through the crop without having to go to the serious expense of procuring extra fuel. Granted then, that more than a sufficiency of fuel is available, one may be tempted to ask, why should we worry about further steam economy either in its generation or in its use? If the factory is already self supporting in the matter of fuel, why spend more money on improvements of steam plant in order, merely, to blow surplus steam off at the safety valves, or pile up a useless heap of spare bagasse, which long before the end of the crop, becomes an unsightly nuisance?

Complacency in this matter may be all very well for a little while, but we cannot afford to keep it up too long. No industrial methods can ever remain stationary. Brought face to face with the serious and increasing competition of the beet sugar industry, we must realise that the principal factor which makes our cane sugar manufacture financially possible, is the fact that we eliminate the fuel bill. Yet every new development in the industry, every improvement in the working of the factory, calls in the first place for more heat energy in one form or another. We want more power for irrigation and transport; additional milling plant and other machinery and for the constantly increasing number of mechanical appliances which have to be installed in and around the factory to make up for the ever diminishing labour supply. Extra heat—and always more of it—is required in the development of every new idea in the process of sugar manufacture. However much the selling price of sugar may fluctuate, there always will be one thing about a sugar factory which will remain a constantly increasing quantity, and that is the demand for "more steam."

We must assume, therefore, that there is no finality regarding the improvements to be made and economies to be practised in the science of steam raising and steam using and its conservation in general. We are faced with the problem, as the industry develops, of keeping up the supply of heat units, either in the form of mechanical or electrical power or of process steam, and the amount of heat demanded per ton of cane crushed, tends to increase year by year in all progressive factories. And this demand must be satisfied through the medium of a fuel

of very low calorific value, of very variable composition, both chemically and physically, and delivered into the furnace mouth, containing anything between 46 and 52% of its weight in pure water. Laboratory tests on samples of such, optimistically place its calorific value somewhere about 3,700 B.T.U. per pound, and for these and kindred figures we may refer back to the report presented by this Committee at the meeting of April, 1926. But in actual practice the process of combustion is so complicated by the presence of this heavy moisture content, that in the questions of air supply, furnace design, method of stoking and in fact the whole process of steam-raising in general, the usual practice obtaining in the case of coal—or oil-fired furnaces, does not afford us very much guidance.

So far most of the attempts at drying the bagasse before it is fed to the furnaces, have been rather a failure, as the size and weight of the plant necessary, has tended to rival that of the entire sugar factory itself. A practicable form of drying apparatus to deal with say, 20 tons of "green" bagasse per hour and using a portion of the hot flue gases as the drying medium, would naturally be of tremendous assistance in the boiler-house. The heat absorbed in evaporating this contained moisture, and heating it up to the temperature of the waste flue gases, may be taken at about one-seventh (or 14%) of the total heat generated in the furnace. In addition to this very considerable loss, there are the practical difficulties of furnace design and stoking, which further complicate the problem. Owing to the quantity of excess air required for the drying out and subsequent combustion of the fuel, the necessity for a large combustion space between the firegrate and the boiler heating surface is obvious. Two years ago, the committee engaged on this subject, collected data from most of the local factories concerning furnace proportions and design, and the figure giving the capacity of combustion chamber per unit of grate area, showed very considerable variation in the different factories. It may be taken, however, that for every square foot of grate area, not less than 6 (up to a maximum of 8) cubic feet of combustion space should be allowed between the firebars and the heating surface. With ordinary natural draught, it is a matter of considerable difficulty to keep a bagasse fire at a steady maximum temperature, and if the feed be irregular, the position becomes almost hopeless. Given a regular feed, we may next look for further help to the pre-heating of the air supplied to the underside of the firegrate, part of the heat of the waste flue gases being recovered and used for this purpose. In recent years we have seen some bold attempts to tackle this phase of the problem, and the results have been so far encouraging, that we may soon hope to see air pre-heaters as part of the standard equipment of all boiler houses.

The question of superheating the steam after its gener-

ation, is one which is receiving more attention in some of the modern factories where new boiler plant is being installed. The main advantage of this in sugar factory work is not to be looked for so much in an increased thermal efficiency of the power plant, but more as an offset against the unavoidable radiation losses. Unlike an ordinary power station where the boilers and turbines are kept as close together as possible, the sugar factory of necessity, must have long ranges of steam piping for the conveyance of steam to its various parts, and the loss through radiation looms large in the heat balance.

In dealing with heat losses, one prolific source of waste which seems generally to be overlooked, is the ordinary steam trap discharging to atmosphere. The condensed water from vacuum pans, juice heaters and so forth, when it reaches the traps, is very nearly at the same temperature as the steam from which it has been condensed. The pressure of this steam, may be that of "exhaust" steam at 5 to 10 lbs. per sq. in. or of reduced pressure "live" steam at 40 to 60 lbs. per sq. in. according to the type of heating apparatus in use and the particular practice of the factory. The condensed water at the temperature corresponding to this pressure is suddenly discharged to atmospheric pressure by the trap with the resultant total loss of the heat units corresponding to the number of degrees by which the original temperature of the steam exceeded the atmospheric boiling point. In a sugar factory of average size, one may easily count a hundred steam traps discharging condensed water amounting to a total of about 100,000 lbs. per hour. Assuming even the moderate figure of 50° F. as the average drop of temperature on discharging from the traps, we have as the hourly wastage of heat in such a factory from this source, the useful looking total of 5,000,000 B.T.U. And this is under the assumption that all the traps are doing their work efficiently. The amount of heat blown away in leakage from these pieces of apparatus is, as our Transatlantic friends would say, more easily guessed than calculated. The development of an efficient and reliable "back to boiler" system for the condensed water, will in time come of necessity.

HEAT BALANCE IN THE FACTORY.

In this country, which is now entirely growing Uba cane, the question of heat balance has not been seriously studied, owing to the abundance of fuel through the high fibre content of the cane. This amounts to roughly 16% on the cane, compared with 10 to 12% in other countries growing soft canes. But some factories are using auxiliary fuel and as it is necessary to macerate heavily, the question is now beginning to be seriously tackled.

The problem of heat balance is one of making the heat available from the bagasse balance the heat required for power purposes, also the process work in the factory and to supply surplus power for lighting, irrigation, etc. The problem can be divided into the following main sections—

1. Efficient generation of heat from the fuel.
2. Continuity and efficient operation of the plant.
3. Providing power to operate crushing plant, generators and other auxiliary plant.
4. Juice heating and multiple effect evaporation.

5. Concentration and crystallization in the vacuum pans.
6. Radiation losses.

We will now deal with each section in detail.

1.—Efficient Generation of Heat from Fuel.

In 1926, this Committee went very fully into the Efficient Generation of Steam in Boilers in the paper prepared for that year's Conference, but we could again draw your attention to the following important points, bearing in mind that the furnace is the generator and the boiler the absorber of heat. Makers of power plant will guarantee the efficiency of their plants, but with boilers, the design and general construction can be the best, but the efficiency depends on the lay-out, design and general operation, especially with regard to bagasse fired boilers. The furnace combustion chambers should be of ample capacity to allow of complete combustion before the gases reach the cooler surfaces of the boiler.

The design of the flues requires careful consideration so that the areas are not contracted and increasing the gas velocities too much. In many cases, arches and deflecting baffles have been constructed in the flues to mix the gases, increasing the gas velocity and seriously hampering proper combustion.

The boilers should have ample surface to absorb the heat efficiently.

2.—Continuity and Efficient Operation of the Plant.

Cane supply to the mill must be regular, cane carrier evenly fed and to help this, the carrier provided with revolving knives to prevent chokes in the mill. The whole machinery in the factory must be of good design and robust construction, especially the milling plant to avoid shut downs. The milling plant must have a sufficient number of units to allow of compound maceration in order to obtain the maximum extraction with the minimum maceration. Every factory should aim at low moisture content in the final bagasse as every 1% additional moisture in the bagasse reduces the fuel value of the bagasse by 2%.

3. Providing Power to Operate Crushing Plant, Generators, Etc.

The actual power requirements of a factory are about 27 h.p. per ton of cane ground per hour, of which about half is used in the crushing plant. Approximately 87% of the total steam available is required for juice heating evaporation and crystallization. 80% of this steam passes through the power units which absorb roughly 8% of the heat in this steam for power, leaving 72% from the steam available for factory requirements, but, as 87% is required for this work, the balance has to be made up from the boilers direct. The foregoing has been calculated out for a factory here with triple effect evaporation, 16% fibre in cane and a maceration of 22% on the cane. In this instance it will be seen that the power unit do not provide enough steam to meet factory requirements and more steam could have been used for power.

4.—Juice Heating and Multiple Effect Evaporation.

Heating the cold juices to 212° F. is usually done by-exhaust steam and it takes 13 to 14 % of the steam avail-

able to do this. In cases where there is a steam shortage, it is possible to bleed the evaporators for this steam and effect a considerable saving. This is now being done in cane sugar factories and has been the standard practice in beet sugar factories on account of their having to buy all their fuel. The evaporators here, are mostly of the triple or quadruple type. With a triple effect, about 35% of the available steam is required for the evaporation and about 27% with a quadruple. If the first vessel of the triple is made large enough to supply steam to the juice heaters, a saving of steam can be made of 15% of the steam required for heating and evaporation in the ordinary way, or roughly 6% of the total steam. It is also possible to instal a large pre-evaporator making the triple into a quadruple and supplying steam to the juice heaters and make a saving of 21% on the steam used for an ordinary triple and heater heated by exhaust steam. Care must be taken that the vessel is made big enough to allow of this. The juice sent to the evaporator must be at as high a temperature as possible or the work of the evaporator will be seriously reduced.

5.—Concentration and Crystallization in the Vacuum Pans.

It is difficult to calculate the amount of steam required for the pans, but this will be roughly about 35% of the available steam. A great deal depends on the efficiency of the pan boiling, and the massecuite must be struck at as high a density as possible. Often the arrangement of the pans and gutters do not allow of a high density as the massecuite will not flow and this should be corrected. Using water cooled crystallizers will also help, as they increase the recovery of sugar. The syrup should be kept as hot as possible. The dilution of molasses should be kept down to a minimum.

6.—Radiation.

The radiation loss in a modern factory is estimated at $7\frac{1}{2}\%$ of the total heat available. This loss is constant in any factory, no matter how much cane is being handled and all factories should be operated at as near full capacity as possible. It will be seen, that if the factory operates at half capacity, the loss by radiation is doubled. All steam and exhaust pipes, steam cylinders, heaters, juice and syrup tanks, evaporators and vacuum pans, should be properly lagged with the best insulation to conserve heat. A quick process of clarification would greatly reduce this loss.

General.—The overall thermal efficiency in modern power stations is about 18%, but in sugar factories, on account of all steam being used for heating and evaporation in addition to power, the overall thermal efficiency is about 60%. It is possible to greatly increase the available heat from the bagasse by extracting more heat from the flue gases by means of air preheating, economisers and superheaters. Steam pressures should also be increased which would mean the use of smaller steam pipes and steam cylinders with the consequent reduction of radiation losses.

THE EFFECT ON STEAM BALANCE WITH THE INSTALLATION OF PRE-EVAPORATOR

To illustrate the above, a concrete example will be taken. We will assume that in a factory there exists two triple effects, each having a heating surface of 6,000 sq. ft. Grinding rate of mill, 55 to 60 tons cane per hour, assume that boiler plant is at times unable to supply all demands made on it for factory requirements, the result is frequent shut downs owing to low steam pressure.

Assume that at times the evaporators and juice heaters have to resort to the use of live steam direct from the boilers (this is very bad practice and should at all times be discouraged) in order to cope with juice supply from mill. The evaporators at normal rating will be capable of evaporating 84,000 lbs. of water per hour, that is, 75% of water in the juice is done at triple effect evaporation. At this rate, evaporators should be capable of dealing with 10,500 gals. of juice per. hour, this represents a grinding rate of approximately 61 tons cane per hour. The above presupposes that all evaporators and air pumps are kept in an efficient state of repair and all heating surfaces are reasonably clean. As mentioned previously, the factory boiler plant at times fails to supply enough steam to meet requirements, and the cry is, we must have more boiler power. Now this shortage of steam can be got over in another way, and that is by the installation of a large vessel to work in conjunction with the two existing triples. The attached sketch shows in diagramatic form, the proposed arrangement. The existing evaporators, when evaporating at a rate of 84,000 lbs. of water (each 42,000 lbs.), have each to be supplied with 14,000 lbs. of steam per hour, making a total of 28,000 lbs. of steam per hour. The sketch shows the addition of another vessel having a heating surface of 6,000 sq. ft. This vessel is connected to the steam side of the two first vessels of the existing triples by means of suitable vapour pipes, we have now by this arrangement, converted the triples into quadruple evaporators, having a first vessel with a heating surface of 2,000 sq. ft. in excess of a standard quadruple, this extra heating surface will be used to supply steam for juice heating, per medium of steam connections taken from first vessel to juice heaters. With this arrangement, the evaporators will be capable of dealing with an evaporation of 90,000 lbs. of water per hour, an increase of 7% over existing conditions, which means that the grinding could be increased from 61 tons to 66 tons per hour. The steam consumption of the evaporator under new conditions will be 30,000 lbs. per hour, an increase of 2,000 lbs. per hour over existing conditions, but we have available for juice heating (due to the extra heating surface in the first vessel) an amount of 10,000 lbs. per hour.

The following figures show the economies that can be effected at juice heating and evaporating stations if an additional vessel is added to the two sets of triples.

Steam Balance of Juice Heating and Evaporating Stations.

1. Existing condition, grinding rate 61 tons per hour.
2. 6,000 sq. ft. vessel added, grinding rate 61 tons per hour.
3. 6,000 sq. ft. vessel added, grinding rate 66 tons per hour.

STEAM BALANCE.

No. 1.—Existing conditions.

<i>Juice Heating.</i>	<i>Lbs. Steam per Hour.</i>	
10,500 gallons, raised from 100° F. to 212 F.	=	10,900
<i>Evaporators.</i>		
10,500 gallons, 75% water evaporated at Triple effect	=	28,000
Total	=	38,900
		Steam required for Juice Heating and Evaporating

STEAM BALANCE.

No. 2.

<i>Juice Heating.</i>	<i>Lbs. Steam per Hour.</i>	
10,500 gallons, raised from 100° F. to 212° F.	=	10,900 (10,000 lbs. of this quantity supplied from first vessel.)
<i>Evaporators.</i>		
10,500 gallons, 80% water evaporated at Quad. effect with extra steam =		30,000
		40,900
Less 10,000 lbs.		10,000
Total	=	30,900

No. 3.

<i>Juice Heating.</i>	<i>Lbs. Steam per Hour.</i>	
11,250 gallons, raised from 100° F. to 212° F....	...	11,600 (10,000 of this lbs. quantity supplied from first vessel.)
<i>Evaporators.</i>		
11,250 gallons, 75% water evaporated at Quad. effect with extra steam =		30,000
		41,600
Less 10,000 lbs.		10,000
Total Steam required for Juice Heating and Evaporator stations ...	=	31,600

Saving, No. 2 condition.

$$38,900 - 30,900 = 8,000 \text{ lbs. steam per hour}$$

$$\text{Saving} = 20.5 \%$$

Saving, No. 3 condition.

$$38,900 - 31,600 = 7,300 \text{ lbs. steam per hour}$$

$$\text{Saving} = 18.7 \%$$

It should be noted that in example No. 2, syrups leaving evaporator will be a higher density than in examples Nos. 1 and 3.

If 75% evaporation is done in No. 2 example, 6% more maceration in water will be required in order to keep evaporator working at full capacity.

If the above conditions Nos. 2 and 3, prevailed, no increase in boiler capacity would be necessary, even when grinding an extra 5 tons of cane per hour.

It should also be noted, that with the conversion of the evaporators to quadruple effect a reduction in the amount of vapours going from the last vessel to the condensers will be obtained, the reduction will amount to 8,000 lbs. per hour, this means that a saving of 32,000 gals. of condenser water will be effected per hour.

The foregoing example, illustrates the advantages that could be derived from fuller use of the principles of multiple evaporation and the use of vapours for juice heating. When questions of extra boilers, or a deficiency of exhaust steam for evaporating and heating is raised, the multiple effect apparatus and its steam requirements should be carefully checked, and various systems of heat balance worked out, and alterations made to suit the particular case under consideration; by so-doing considerable economies with increased capacity will in most cases be the result.

Committee.

E. CAMDEN SMITH.

G. WILSON.

J. R. SIMPSON.

J. E. BIHL.

P. MURRAY (*Convenor*).

EXISTING TRIPLES.

Juice Heated 100° F. to 212° F.

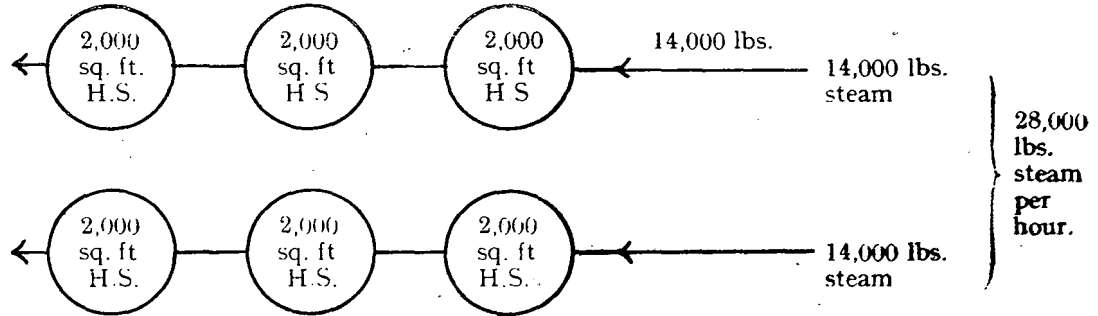
105,000 lbs. = 10,900 lbs. Lbs. of water evaporated
 steam per hour per hour = 42,000 ...

Existing conditions

Lbs. of water evaporated
 per hour = 42,000 ...

Total = 84,000 lbs

Tons Cane per hour = 61



EXISTING TRIPLES WITH EXTRA VESSEL ADDED.

Juice Heated from 100° F. to 212° F.

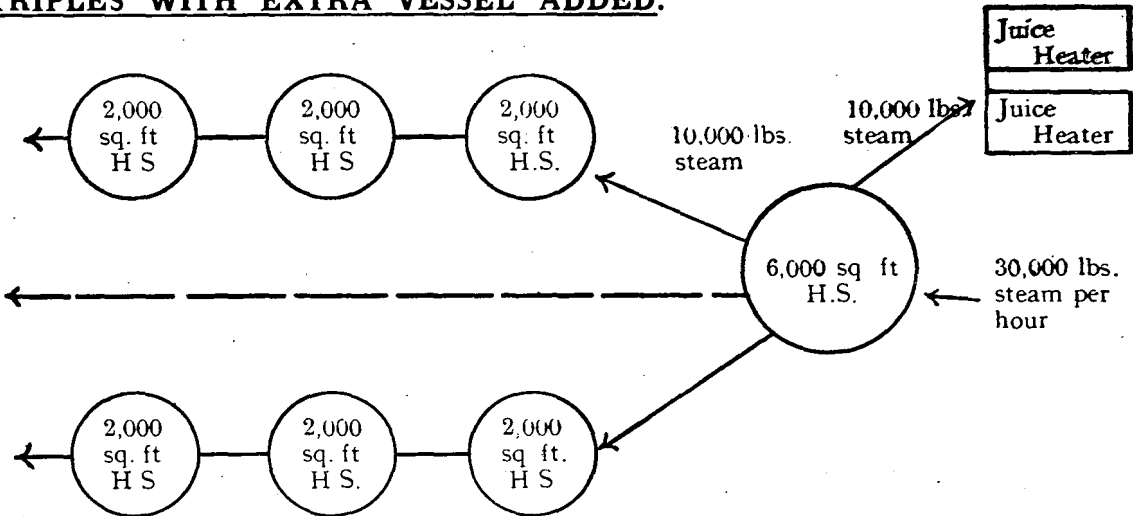
112,500 lbs. = 11,600 lbs. Lbs. of water evaporated
 steam per hour, of which per hour = 30,000 lbs.
 10,000 lbs. is available from first vessel of evaporator

Lbs. of water evaporated
 per hour = 30,000 ...

Lbs. of water evaporated
 per hour = 30,000 ...

Total ... = 90,000 lbs.

Tons Cane per hour = 66



Chairman : This is a very valuable report from the engineering side, and follows up the excellent work of this committee in the two previous years. It has always seemed to me an anomaly that the Natal sugar industry with a high fibre content in cane should have to use any extra fuel at all, when we find that other factories in different parts of the world even though they have a fibre content as low as 10 or 11 %, are liable to dispense entirely with any fuel besides the bagasse. The margin in fibre content between that figure and the 16% average in this country, seems sufficiently great, in spite of the difficulties connected with clarification boiling and so forth in this country, which dissipate extra heat.

Mr. Moberly : Have the committee studied any of the things which affect actual draught? There has been experience in some of the factories here that at certain times of the year a tremendous amount of black smuts come out of the chimney, and during those times steam seems to be poor, and at other times these disappear suddenly for no reason whatever. It looks as if there were big variations in the actual draught and evidently there are various climatic things which may affect it, but I have not been able to trace the cause of these fluctuations. Is any thing known about that?

Mr. Camden Smith : As a matter of fact, we know very little of the cause of the fluctuations, but we are painfully aware that these fluctuations do occur. With regard to the production of black smuts from the chimney, that is simply evidence of very bad combustion. Either the boilers are being forced beyond their proper capacity, or the setting of the furnaces is wrong. These smuts are composed of more or less pure carbon, which forms the greater part of the heating material in the bagasse. The fact that these are being blown out, points to bad combustion due to some cause or other. The fluctuations of natural draught can only be expected through local conditions. The average chimney is 125 to 150 feet high, and the atmospheric conditions at the furnace grate may be slightly different from the conditions prevailing at the top of the chimney. Very often these conditions help to increase the draught and just as often they help to decrease it. The ordinary assumption holds alright in theory but it is subject to these fluctuations caused by difference in air pressure. There might be a high wind blowing at the top of the chimney and comparatively calm below and vice versa. The means of counteracting that is by the installation of a forced draught or some such system as that.

Mr. Murray : I think the furnaces are too small under the conditions referred to.

Chairman : I remember when I went to live at Mount Edgcombe last year, for the first few weeks we were constantly annoyed by a shower of black smuts from the factory, but after a few weeks that suddenly ceased and we were not troubled with it again. I was wondering whether there was any fact of engineering interest connected with the change.

Mr. Simpson : I think this was partly due to the fact that we put in a dust collector chamber.

Mr. Watson : Are we going to have chimneys or controlled draught? As has been pointed out, if we are prepared to put up a proper chimney we ought to be able to overcome these difficulties. My idea is to put in a properly controlled fan; in my opinion, an induced draught fan. Not a fixed speed motor, but a variable

speed motor or preferably a steam engine. If we can control to a fine point the draught on the boilers, I think we can overcome the matter of the smuts and everything else. It does not mean we have not to go back to furnace design and so on. But I think that the days of pushing up a high chimney to overcome the atmospheric pressure so to speak, are miles and miles away behind; we have to cut out the tall chimney and put in a mechanical draught of some kind.

Mr. Murray : We had this problem last year at New Doornkop factory we are erecting. After serious consideration, we put up a chimney, as the fan was too costly. I think you will get enough draught if the chimney is large enough. You have to take the £ s. d. into account.

Mr. Watson : I don't think the £ s. d. proposition comes in very much at all. The cost of erecting a big chimney, in steel, concrete or brick is a very big matter and the flexibility of the chimney is limited by atmospheric conditions. With a fan, I think as engineers, we can hold the whole thing in the palm of our hands as regards the draught on the boilers.

One part of this report mentions the moisture of the bagasse as affecting the fuel value of the bagasse. We put average bagasse into the boilers at a moisture content of somewhere near 50%. Therefore it means that a certain amount of heat from combustion of the bagasse is required to evaporate that 50% of moisture. I think it is recognised that before we get any value out of the bagasse we have to get rid of the water in the bagasse.

Now we come to the chimney, and are putting gases up there about 500° F. Can we employ the heat of the gases in the chimney to do anything to reduce the moisture in the bagasse before it goes into the boiler? I don't see why the brains at the disposal of the engineering firms in the world should not be directed towards some means of utilising this tremendous heat which is going up the chimney, to reduce the moisture in the bagasse, before it enters the furnaces, then the combustion of the bagasse becomes a more simple matter than it was beforehand. Take into consideration a factory the size of Amatikulu or Felixton. In 18 tons of bagasse there is about 50% of moisture which is about 9 tons of water going to the furnace hourly, and that has to be converted into steam and be blown up the chimney. Our boilers are I think, rated at 2,000 sq. ft. heating surface, and you can take an efficiency of 3 lbs. per sq. ft. each boiler, evaporating 6,000 lbs. each hour. If we can take the heat from the chimney and put it to some useful work, I think it would be a very big step in the way of finding an effective means of burning bagasse as fuel.

Chairman : It seems to me that furnace gases entering the flues at 500° F. is too high. It leads one to wonder whether combustion is incomplete also, and I would like to know whether any tests of carbon dioxide in flue gases are carried out regularly in the factories and whether the records are available.

Mr. Watson : The fact of the gases being from 500° to 550° F. does not suggest incomplete combustion; that is what engineers reckon as the normal temperature of the gases, but it does not say we cannot recover the heat from these gases which go up the chimney.

Dr. Hedley : We tested carbon dioxide in the chimney at Felixton and found it was 13% average, and that is quite good combustion. We tried it all through the season,

Mr. Simpson : I should say 500° to 550° F. would not quite be modern factory practice. A great deal of this heat might be made use of to heat an economiser or pre-heater. Up-to-date practice is not to waste as much heat as that.

Chairman : I recollect that at last year's meeting we had a very interesting discussion on pre-heaters, especially with some experiments carried out at Darnall, and a further report on that matter was promised or suggested for this year.

Mr. Watson : The temperature of the flue gases has already been recovered to a certain extent for the heating of the air for combustion. The heat of the flue gases has been converted into heated air which has been applied to the furnaces for combustion. But my opinion is that we still have a whole lot in hand which might be applied to drying of the original fuel coming to the boiler. We can use as much as we can in the way of heated air for combustion in the furnace, but we still have a big supply which might be very usefully occupied in some other way. My idea is to use it to dry the bagasse.

Chairman : There are difficulties in drying the bagasse, firstly, because of the large amount of plant required, and, secondly, because of the constant anxiety and risk of fires from the spontaneous ignition of the bagasse, which no doubt the Committee have considered.

Mr. Watson : That point has been fairly closely studied. The idea is that the heat in the gases should be transferred to pure air. We get gases at between 500° and 550° F.; transfer that from flue gases into pre-heating incoming air and use that air, which has no chance at all of igniting the incoming fuel.

Mr. Camden Smith : As the Chairman has pointed out, the Committee were aware of the difficulties of drying bagasse, and so far most attempts have been rather a failure owing to the size and weight of the plant necessary. I speak from some experience in this matter. I remember seeing an attempt made at a very elaborate bagasse drying plant. I think it was built for a factory in Brazil. It was very well designed and made by one of the leading sugar machinery firms in Glasgow. It went to Brazil, and that is the last we heard of it. The whole thing was too cumbersome. The ideal way is naturally to try and get the moisture out of the bagasse before burning it, utilising part of the flue gases as suggested in the paper. The pre-heating of the air in the ordinary pre-heater is an attempt at the same thing; instead of employing an elaborate drying machine we assist the furnace itself by recovering some of the heat from waste flue gases. Of course the amount of drying is not so easily controlled and the result not so definite as it would be in a successful drying machine. But the engineering difficulties in constructing a suitable machine for drying are very great in view of the quantity of fuel required. It almost amounts to an industry in itself.

Mr. de Froberville : Some thirty years ago I saw appliances made in Mauritius for drying the bagasse, taking the hot gases from the chimney and passing them into a huge chamber or "sacherie," with chains or interior carrier on which the bagasse from the mill was drawn through, and the hot gases coming into the chamber dried this bagasse very quickly; but unfortunately at times the bagasse was so dry that there was spontaneous combustion taking place and the whole thing was speedily converted into scrap iron. But it was very efficient and

when there was no fire the bagasse was quite dry and took fire as soon as it went into the furnace. This was done some thirty to thirty-five years ago, and I don't know whether it is going on at present. I think the hot air has superseded that now.

Mr. Watson : I would like to question Mr. de Froberville's idea of spontaneous combustion. I am rather inclined to the belief that the gases from the chimney contained actual burning material along with the gases, which would set up combustion immediately. If the heat from the gases is transformed into heated air, then that objection falls away. I really think that it must have been combustion from material already ignited which took place in the experiments which Mr. de Froberville mentions.

Mr. de Froberville : I should have said there were very small sparks coming from the draught going into this hot chamber.

Mr. Watson : Then I trust that members will understand the difference between that and pre-heated air, where there is no possibility of any spark or flame of any kind coming into contact with the material at all.

Mr. Murray : In 1926 we calculated we would get 17% extra recovery of heat, but it is impossible to dry bagasse completely. If you take out the whole of the moisture you are bound to have spontaneous combustion. I understand certain experiments were carried out last year in drying bagasse, in this country.

Mr. Camden Smith : In one of the papers read this morning it stated it required four hours to dry samples of bagasse. What is it going to take to dry twenty tons per hour? (Laughter.)

Mr. Watson : In the case of the laboratory experiments it was necessary to dry the bagasse thoroughly. But in boiler work if we get a reduction of 5% we get better combustion of the bagasse. If we can utilise a little part of the heat in the flue gases we are doing useful work. I did not suggest that we could erect an apparatus to dry bagasse to the extent that Mr. Moberly requires for his experiments.

Mr. Murray : We are back to the same old trouble. The Sugar Association should put down the money for experiments in this work.

Mr. Watson : One point that has appealed to me greatly is that we always have a long way to carry the bagasse to the boilers, and in carrying the bagasse from the mill to the furthest boiler, why should we not carry it along the top of some big flue which is very hot and let the temperature in that flue evaporate so much of the moisture in that bagasse? The heat for that flue can easily be got from the chimney. In the air pre-heating apparatus now employed at one or two factories we take the heat from the gases and pass it through a tremendous big flue right along generally the high part of the boilers. Now if we can convert the top of that part of the flue into part of the bagasse conveyor and convey the bagasse along the top of that, before it reaches the boilers a certain amount of moisture will be gone. I think the two ideas could be worked together to the advantage of the burning of the bagasse; in that we can carry on with the pre-heated air and extract a certain amount of the air to dry the bagasse on top of the same flue.

Mr. Camden Smith : From every point of view Mr. Watson's argument is perfectly right. But I am afraid

the engineering troubles in connection with it have so far proved insuperable, and there have been several attempts made at it. Besides the whole thing as an experiment would be a very costly one, and as pointed out in a paper just now, this industry has not reached the stage when we have to conserve our fuel to that extent. No doubt the time will come very soon when we will have to conserve it, and then the matter of drying bagasse to increase its efficiency as a fuel will have to be taken into consideration more thoroughly and some practicable plant devised for handling it.

Chairman: I think it is only a matter of time when bagasse will become so valuable as a by-product, that every effort will have to be made to conserve it and perhaps use some other fuel in its place, reserving the bagasse for more valuable purposes.

Mr. Murray: There is another important point in drying bagasse. More hot water could be used in maceration; I believe in some mills, they use cold water only.

Chairman: I understand that the application of hot water to Uba cané tends to extract more of the gums and waxes than cold water.

Mr. Watson: More than one have tried it and without exception we have gone back to cold water.

Mr. Watson: What about a different type of furnace? Suppose we had an extended furnace, and in the first half we applied heated air to evaporate the moisture in the bagasse before it enters into the combustion space of the furnace. I would like some of the engineers to give their opinion as to whether that would be possible. It is recognised that burning bagasse is a different job from burning coal in a furnace. We make a furnace entirely apart from the boiler; that furnace is arranged so that the evaporation from the bagasse may take place in the furnace.

Chairman: At the meeting last year, when the report of the steam balance and boiler house efficiency committee was discussed there was a furnace for bagasse and molasses described by Mr. Richards, which was regarded as very promising for our conditions. Has any member any further information on that?

Mr. Murray: I think the thing is too costly, it was really designed as a refuse destructor.

Mr. Fowlie then read the following report.

