NOTES ON DRYER TEMPERATURES.

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The following is an extract from a letter recently received which explains itself:—

> "While travelling around the country I noted most estates worked their tea driers, under all possible climatic conditions, at 180°Fah. and sometimes lower, whereas on other estates particularly where the Superintendents were keen teamakers, temperatures at their tea driers during recent wet weather varied between 195° and 200° Fah.
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> "I was informed, perhaps erroneously, the T. R. I. had stated 180°Fah. was the best firing temperature under any conditions, but it is my opinion that a figure in the vicinity of 195° is more correct and teas so fired keep better for the London market."

The considerations governing firing temperatures were explained in very full detail in *The Tea Quarterly*, Vol. VIII (1935), page 43, under the heading "The Theory and Practice of Tea Drying."

For reasons which will be obvious after reading this article, we have avoided hard-and-fast statements about inlet temperatures because any figure we give can never be of universal application. We have, however, made very definite statements about exhaust temperatures and we have not found any reason to alter these; on the contrary, practical experience gained from advisory work and the result of our investigations on enzymic fermentation have strengthened our views. In case there is any misconception on this point let me repeat that continual working with very low exhaust temperatures (below 120°F.) or very high exhaust temperatures (above 135-140°F.) will sooner or later give trouble with keeping quality. When low inlet temperatures (below 190°F.) are employed, the upper limit may be raised slightly.

A warning is necessary in this connection where tilting tray dryers are concerned and should be noted especially by those using Colombo dryers. The exhaust temperature measured in the fan casing of a suction dryer or in the exhaust vent of a pressure dryer may fall as low as 110 or even 105°F. for a few seconds immediately after the bell has rung and the top tray tilted; in this case the temperature passes through a regular cycle approximately every three

minutes if the drying time is 20 minutes. Immediately after the top tray has tilted the temperature falls to 105-110°F. rising quickly to 120-125°F. and then slowly to 135°F. before the bell rings again.

This cycle can only be observed with a sensitive thermometer. A thermometer with a heavy brass case will lag behind the true reading and may remain fairly steady between 120 and 130°F. depending on the thickness of the brass case.

The question as to the best inlet temperature cannot be so definitely answered, since this must vary to some extent according to the particular needs of individual estates. As an example I will quote the case of the estates where a touch of high fire amounting to a distinct maltiness in the fired tea is desired; in this case a temperature of at least 200°F. will probably be found by actual trial to give the best results.

In other cases, nowadays fortunately rare, estates are forced to use temperatures of 210 and 220°F. in order sufficiently to raise the drying capacity of their machine to cope with a large crop.

Quite recently very low firing temperatures of the order of 165-170°F. have found favour in certain quarters. In this case the exhaust temperature must still be maintained above 120°F. and to do this the time of firing has to be increased and special pulleys may be found necessary. If a very low temperature is adopted a period of greater than 25 minutes, which is the longest time possible with pulleys normally fitted to firing machines, is required for satisfactory drying. Firing at low temperatures is thermally less efficient than firing at normal temperatures and this raises the cost of firing.

Having qualified statements on the question of firing temperatures as explained above, we can however say that in the majority of cases an inlet temperature of 190 to 195°F. gives very satisfactory results with a firing period of approximately 20 minutes. When other methods are employed for some definite reasons, suitable modifications have to be made in the drying period and thickness of spreading. The limits of exhaust temperature should, however, remain unaltered.

Inlet temperatures should be measured immediately below the bottom row of trays. It is a common complaint when a machine is fitted with two thermometers at the hot air inlet, that the readings do not agree; this is usually because one is fitted towards the stove end of a longish duct and the other below the trays. When speaking of inlet temperatures the point at which they are measured should be stated.

To maintain the correct exhaust temperature the rate of spreading should be adjusted from time to time, particularly when changing over from dhools to big bulk. In the fully automatic dryer, especially the modern pressure type, this adjustment is merely a matter of a few turns of a handle and may be carried out by the firing cooly.

Adjustments to the rate of spreading are more difficult to carry out in a tilting tray dryer and may be left to the discretion of the Teamaker, who should ensure that the exhaust temperature is of the correct order. In this case the Teamaker should give instructions for increasing or decreasing the loading by a half to one pound at a time according to whether the temperature is too high or too low. Such instructions are simple and easy to carry out and will save a good deal of trouble when the withers are too hard or too soft, which variations are bound to occur from time to time in even the best regulated factories.

Big bulk is better fired at a slower rate than the dhools, and a thicker rate of spreading will compensate for the rise of exhaust temperature which takes place under these conditions. At St. Coombs we thicken the rate of spread fairly considerably and change to the slowest pulley when the big bulk reaches the third row of trays. There is invariably a slight rise of 5-10°F. in the exhaust temperature, as it is impracticable to thicken the spread to such an extent as to maintain the same temperature as when firing dhools. The big bulk however comes out fully fired and the dhools fired immediately before or following the big bulk are not over-fired. If dhools follow the big bulk, the pulley should be changed again when the dhools have reached the third row of trays. The slowest pulley on almost all automatic machines causes the leaf to pass through in about 24-25 minutes while the next pulley on which dhools are fired corresponds to 20-21 minutes.

To ensure evenness of firing it is desirable that temperature and loading should be even, and it is a sound practice to check these points occasionally. Sensitive long stemmed thermometers are best for this purpose and three of these instruments each reading up to 220°F. (they are not expensive, they cost 3/6 each in England) will be required. In an endless chain dryer they should be suspended at the two sides and the centre, across the top row of trays, at about the mid point of the length of the row of trays. Most tilting tray dryers are provided with two thermometers, one on either side of the drying chamber but, for purposes of checking, the test thermometer may be inserted through one of the bolt holes in the flange of the dryer thermometers if desired. If test thermometers are used in this manner, great care should be taken to ensure that the thermometers on either side project for equal distances into the air stream.

When the machine is empty, all thermometers in the *same part* of the machine should read alike to within a few degrees, so in the case of the Endless Chain Dryer the three thermometers suspended above the top trays should give equal readings. The expression *same part* really refers to position in the air flow because even when the machine is empty the air will cool to some extent on the way through, owing to losses by radiation and conduction of heat.

If the temperature distribution does not appear to be even, further investigation is necessary and further advice may be required, but before this is sought the temperature under working conditions should be checked.

Provided temperatures are fairly even when the machine is empty they should be even under working conditions; if they are not, a fault in spreading is indicated and the drying will probably be uneven. The three thermometers suspended above the top tray in the case of the automatic machine should all give similar readings and in a tilting tray machine, of the pressure type, even temperatures should be found across the exhaust vent. Conditions in the suction type of tilting tray dryer may be checked by boring small holes in the two fan ducts at corresponding positions and inserting the thermometers (equal distances) through these, taking great care to ensure that cold air is not sucked in round the thermometers while readings are taken. For the latter purpose the thin long stemmed sensitive thermometers mentioned above are essential.

To ensure even distribution of leaf, and therefore even drying in a tilting tray dryer, it is sound practice and quite easy, to spread the top tray in two halves. Instead of having one box to hold say 10 lbs., two boxes each holding 5 lbs are used and the leaf from these spread separately on the two halves of the tray. The centre of the top tray may be actually indicated by marks on the iron work. Such a procedure is essential when carrying out tests and should be made a regular practice for the best results. If these tests reveal uneven conditions, advice should be sought without delay.

Whilst discussing firing temperatures it is pertinent to draw attention to the fact that the inlet temperature should be maintained as steady as possible. This is an obvious necessity which is often overlooked and, save in very few cases, there is no real difficulty in maintaining a temperature to within, at the very utmost limit, 5°F. on either side of the temperature aimed at. Fluctuations are almost entirely due to faulty manipulation of the heater which subject was dealt with very fully in a series of articles in *The Tea Quarterly* in 1936 under the heading of "Fuels for Tea Dryers." Inlet

temperature is easily regulated by means of the *flue* damper unless there is some component in the heater badly out of order.

Cold air ports should only be used as an emergency means of controlling temperature. Even in a pressure dryer where the air is bulked by the fan before being forced into the drying chamber, the introduction of large quantities of cold air may prove too much for the bulking capacity of the fan, especially when the fan is fed by two separate ducts on the suction side. In a suction dryer cold air can never be expected to bulk with the hot air it is desired to temper. The hot and cold air simply flow through the machine in separate streams, leading to very uneven drying conditions. Cold air allowed to enter by the side ports on the drying chamber of some suction dryers merely cools the thermometer!!

Any discussion of dryer temperatures is incomplete without some reference to the question of the moisture content of fired tea. Here again the question is often asked "What do the Tea Research Institute recommend." Although we can be more definite on this point our recommendation should be used with reason. Apparatus for the determination of moisture content is now easily available and perfectly simple to manipulate, making it possible for each estate to work out the finer adjustments made necessary by their own particular circumstances.

In general we say it is *safe* to pack tea for despatch at 4 to 5 per cent moisture content. If more suitable packing materials are discovered in the future, it may be possible to allow another one or two per cent of moisture with *safety*. If Kraft paper had not been rejected on the grounds of absence of scrap value (see Bulletin No. 18, pages 17 and 79), this class of material would probably have afforded sure protection for tea at 6 per cent moisture content which would be an important consideration in times of unrestricted output.

Most estates accept the figure 4 to 5 per cent for packing, but question the best figure for tea discharged from the dryer. In the first case most estates fire to a much lower moisture content than generally thought, so I will outline the procedure for the determination of moisture in teas freshly discharged from a dryer.

1. Select a number of ordinary sample tins with well-fitting lids.
2. Take a sample by placing one of the tins under the discharge of the dryer and allowing the tea to fall into it. Replace the lid immediately sufficient has been collected, making sure that small pieces of leaf are not jammed between the lid and the tin.

3. Allow the sample to cool. 15 minutes should suffice.

4. Weigh out 10 grms. of the sample on the balance and transfer to another of the selected sample tins with a camel hair brush. This operation should be performed on a white glazed tile so that any scattered pieces may be observed and collected. Great care is necessary as any fragments lost will cause an erroneous result on the high side.

5. Place the sample in the oven (the lid must of course be off the tin) and allow to remain 3½ to 4 hours. The temperature of the oven, if electrical and of the hot air type, should be adjusted to within a few degrees of the boiling point of water at the particular elevation.

6. When the sample is removed from the oven the lid should be placed on the tin and the sample thus allowed to cool before weighing. 15 minutes should suffice.

7. The sample should then be carefully transferred to the pan of the balance observing the same precautions as in 4.

My attention has frequently been drawn to the use of the Silica Gel Dryer usually provided with the balance and which should be kept in the balance case. The method of using this is as follows:—

1. At least once a week, or when the paper indicator changes colour, place the Silica Gel in the oven and allow to remain at the same temperature as that employed for drying samples for 3-4 hours.

2. At the end of this period remove the Silica Gel from the oven and place the lid on the tin.

3. Allow to cool with the lid on. 15 minutes should suffice.

4. Remove the lid from the tin containing the Gel, place it on the underside of the tin so that it does not get lost and place the whole apparatus in the balance case. The paper indicator if available may be placed upright by sticking the pin in one of the holes in the perforated aluminium component.

When determining the moisture content of any other sample the procedure from 4 onwards should be followed. If these methods are adopted, an exact idea may be formed of the actual "dryness" of the tea discharged from the dryer. Samples should periodically be removed from the two sides and the centre of the discharge (or the discharge tray in a D.D. Sirocco) to check the evenness of the moisture content.

In most cases firing to approximately 3 per cent of moisture gives satisfactory results and if the bins are in good condition and facilities available for drawing hot air around the bin space, the tea may be graded, bulked and packed without recourse to final firing. Some estates prefer to final fire whatever the moisture content or season, in which case a higher moisture content in the fired tea may be practicable.

In some factories, particularly those with a small crop which necessitates long storage periods in the factory bins, and those with bins in a damp situation, or of poor construction, it may be found necessary to fire to a low moisture content initially and then to final fire before packing. Generally speaking, those factories in districts affected by the South-West Monsoon need to adopt special measures during very wet weather when damp air pervades the whole factory and dryers are taxed in raising hot air for withering.

Obviously therefore each estate must study its own special requirements; a relatively simple matter when apparatus is available for moisture content determination.

Many people have a prejudice against firing to a very low moisture content, although as stated above most estates fire to a lower moisture content than realised as I frequently find less than 2 per cent moisture in freshly discharged teas.

We are carrying out accurate experiments on this matter and will publish the results as soon as they become available. Although at first sight this appears a simple problem it does in fact involve many considerations which all have to be worked out separately. Low moisture content in the tea discharged from a dryer may be a result of:—

1. A hard wither.
2. A high firing temperature.
3. Very light loading.
4. A long firing period.
5. Various combinations of the above factors, of which there are $4 \times 3 \times 2$ combinations $= 24$ in all.

Low moisture contents may not necessarily be the cause of poor results; it may be merely symptomatic, the real cause of the poor results being, in fact, something like a combination of high temperature and long firing period, which would give equally poor results whatever the moisture content. I quote these circumstances as an example only, and it is intended as a warning against highly erro-

neous conclusions which may be arrived at by experiments of a cursory nature. Season may, in addition, affect results of firing experiments.

In actual practice I have come across teas containing only 0.5 per cent moisture discharged from dryers on up-country estates getting very good results, so I hesitate to quote a figure for the lowest moisture content to which tea should be fired. However, 3 per cent is safe and satisfactory in most cases, so this must serve as a rough guide until further accurate information is available. It is obviously uneconomical however to dry tea to a lower figure than is necessary.

In conclusion, we offer to check up results of moisture content determinations carried out on the estate if the samples are packed as described in *The Tea Quarterly*, Vol. VIII (1935), page 59. In the few cases where the estate cannot afford the cost of apparatus for determining moisture content, we are prepared to do a limited number of determinations when definite problems arise.