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A LOW COST VOLTAGE STABILIZER FOR INFRA-RED TEA MOISTURE METERS USED IN TEA FACTORIES

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The use of an economically feasible voltage stabilizer for Infra-red tea moisture meters is described. This stabilizer is capable of reducing inaccuracies in moisture determination of dry tea samples to within 2 % of the actual value.

INTRODUCTION

The Infra-Red (IR) tea moisture meter (Fig. I) was introduced to the tea industry in Sri Lanka in 1954 (Keegal, 1954). To this day this is the most popular method available in tea factories to measure moisture content of fairly dry tea samples.

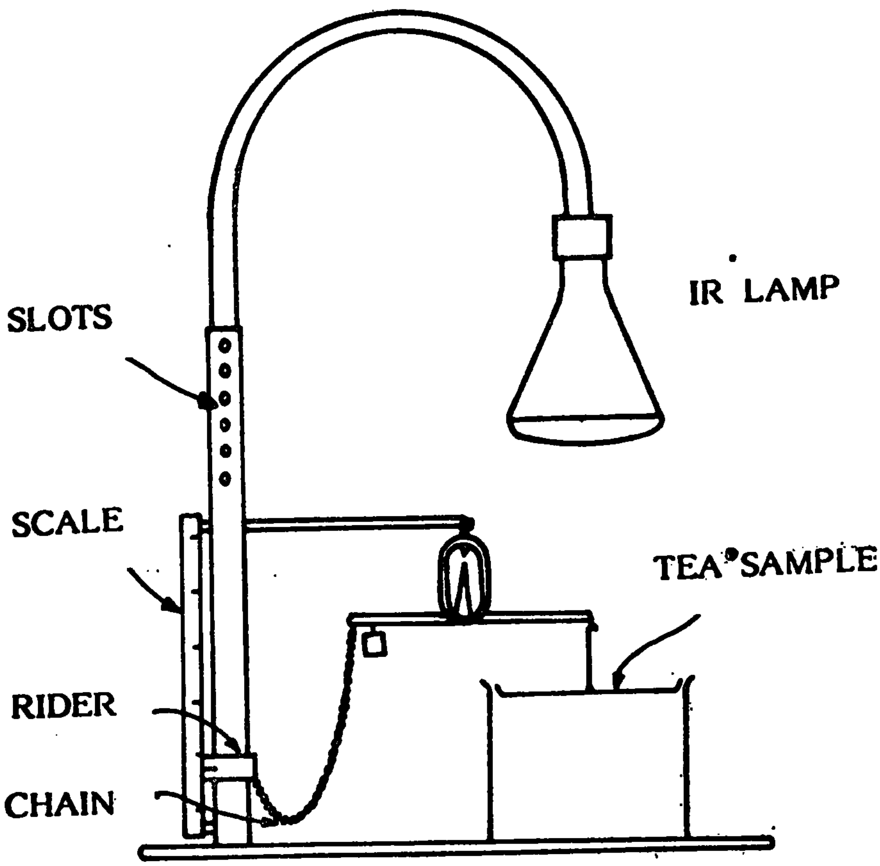

FIGURE I

Fig. I—Infra-Red Tea Moisture Meter

In this method of moisture determination of tea, a 5 or 10 g tea sample is placed on a balanced pan and dried using the IR lamp above it. The IR lamp is kept in the ON position for a pre-determined length of time which in turn is determined by a calibration test against the "oven method". At the end of the IR drying period a rider which is connected to the pan by a chain is moved along the scale to balance the pan. The position of the rider indicates the percentage moisture content of the sample.

The voltage fluctuations in a factory can cause considerable error as moisture evaporated in a given time is related to the power of the IR lamp or to the square of the voltage supply. Once the instrument is calibrated as above at a particular voltage the subsequent moisture determinations also should be done at that same voltage as otherwise there will be an error in moisture reading which will be approximately twice the percentage voltage error. For example, if an instrument calibrated at 230 volts, is used with 190 volts then the expected error on moisture reading is 34% which is approximately twice (230V - 190V)/230V %. The current investigation was undertaken to construct a low cost voltage stabilizer suitable for use with IR moisture meters without a need for recourse to correction factors.

EXPERIMENTAL

IR DRYING CURVES

A well bulked tea sample (with 6.7% moisture content) was divided into 6 parts, and one part of it was used for the calibration of the IR moisture meter at a known voltage of 230V against the oven method. Using the other parts of the tea sample, the variation of IR reading with respect to time was recorded for other possible voltages up to 180 V in steps of 10V which are plotted in Fig. 2. Based on the calibrated time the estimates of moisture level of the sample at each voltage level was found. These correspond to points A,B,C,D and E of the graph and corresponding readings while the associated errors are given in Table I.

TABLE I — *Estimated moisture levels at different voltages*

Voltage supply (Volts)	*Estimated moisture content (%) and corresponding points on Fig. 2*		*% Error*
230	6.7		0
220	6.5	A	3.0
210	5.7	B	14.9
200	5.1	C	23.9
190	4.4	D	34.3
180	4.1	E	38.8

Figute 3 shows a similar set of curves for a sample having a moisture content of 4.0%

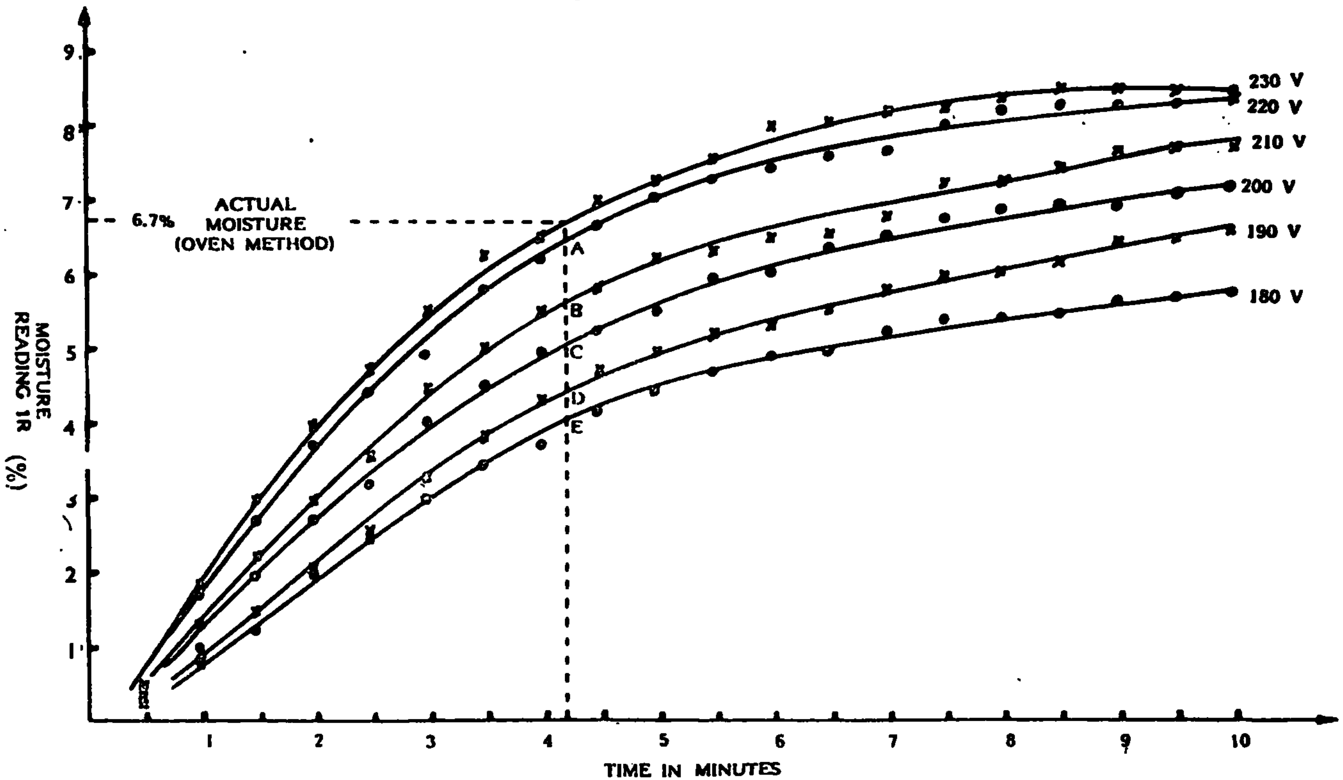

Fig. 2 — Moisture variation with time at 6.7% moisture content

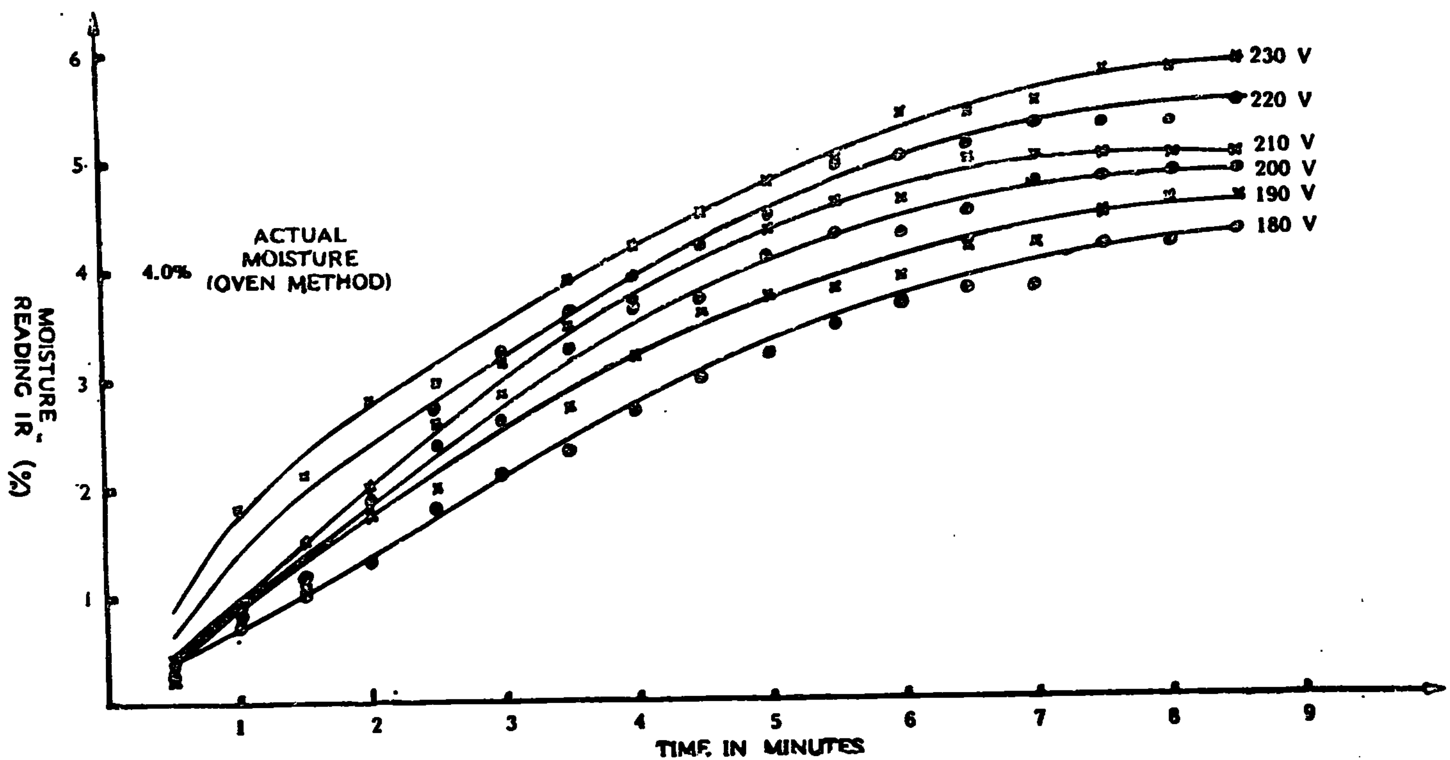

Fig. 3 — Moisture variation with time at 4.0% moisture content

From Figures 2 and 3 it is clear that there is a substantial error in moisture reading with possible voltage variations. In addition there are two other drawbacks:

1. Once the instrument is calibrated at 230V, complete dryness will never be achieved as the curve for 180V approaches a plateau after 10 minutes. Time required to achieve complete dryness then becomes meaningless.

2. If the instrument is calibrated at low voltage but having lowest position of IR lamp, then at 230V the tea will get burnt.

Development of Low Cost Stabilizer

A suitable stabilizer for IR moisture meter should be a self adjusting, continuous varying type. This rules out the use of a low cost step type stabilizer.

It is not necessary to get the full power of the IR lamp over the possible voltage fluctuation range 180V to 230V, but it suffices to have a constant power throughout this range. Therefore, if the moisture meter can be used even with a low voltage of 180V but with the IR bulb adjusted at a suitable position it is really not necessary to boost the supply to 230V. Instead the supply can be reduced to 180V and maintained so for any supply of voltage higher than 180V.

Transformer type stabilizers are important only if it is necessary to stabilize power for inductive components such as motors, as the sinosidal shape of supply voltage should not be distorted for these appliances. Since the IR bulb has only a non-inductive filament, a low cost electronic power control method such as bi-directional Silicon Controlled Rectifier (TRIAC) can be employed without any disadvantages. In this method the supply voltage wave is blocked from zero degree to a certain angle, say A degrees, and from A° to 180° it is allowed to pass in each cycle. A is called the firing angle of the TRIAC circuit which can be varied to get the required power output.

Design

A small transformer is used to pick-up the voltage applied to the IR bulb and it is rectified to run a small DC motor which in turn activates a potentiometer connected to the firing circuit of the TRIAC. A 12V bulb is connected to the low voltage terminals of this transformer and the intensity of this bulb which is proportional to the intensity of the IR bulb, is measured using a Light Dependent Resister (LDR). This signal is fed to a simple control circuit consisting of an IC and few transistors which drives the DC motor. The sensitivity of this stabilizer was found to be about 2 volts per second which is quite sufficient as voltage fluctuations are fairly slow and moisture determination test takes only a few minutes. The total component cost for this stabilizer is around Rs. 700/- and hence the cost is quite compatible with the IR moisture meter.

Performance Test

An ordinary AC Voltmeter cannot be used to check the output voltage variation of this stabilizer as most meters are not calibrated to read root mean square value of non-sinosoidal waves. A light intensity meter was used to measure the intensity variation of IR lamp and it was found to be within ±1% for 20% variation in voltage supply connected through this stabilizer.

Employing this stabilizer, moisture loss curves were observed for the IR moisture meter at 230V and at 180V. The following results, show that the 34% error in moisture measurement which would have been expected without this stabilizer is suppressed to ± 2% with this stabilizer (Table 2).

TABLE 2 — *Readings observed with the stabilizer*

Time	*Reading*		*Time*	*Reading*	
(mins)	*at 230V*	*at 180V*	*(mins)*	*at 230V*	*at 180V*
½	0.3	0.2	4	3.9	3.8
1	0.9	0.7	4½	4.1	4.0
1½	1.4	1.3	5	4.6	4.3
2	2.0	1.9	5½	4.7	4.7
2½	2.6	2.3	6	5.0	4.9
3	3.2	3.0	6½	5.1	5.1
3½	3.6	3.5	7	5.2	5.2

CONCLUSIONS

1. The Infra Red bulb method of moisture measurement is inaccurate when the voltage supply differs from the voltage at the time of calibration of the moisture meter.

2. TRIAC type stabiliser can reduce the inaccuracy to within 2% of the actual value. This means that for teas having say, 5% moisture, the error is less than ±0.1% in moisture. This is quite satisfactory for all practical purposes.

3. The cost of the stabiliser is quite small compared to the cost of the IR meter. Therefore it is an economically feasible proposition as well.

REFERENCES

KEEGEL, E. L. (1954). The 'Kaybee' Infra-red moisture tester type X-14. *Tea Q*, 25, 93-95.