A NOTE ON THE LIFE OF DRIER TUBES*

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In the air heater attached to the most usual type of tea drier the hot products of combustion pass through a series of tubes and up the chimney. The air to be heated is sucked over these tubes. Heat passes from the hot furnace gases through the tubes to the cold air. During normal firing a fairly steady heat transference will occur, resulting in the inside of the drier tubes being hot simultaneously with the outside being cold.** This difference in temperature of the two sides of the tubes results in a 'temperature gradient.' Those tubes nearest the furnace will be much hotter inside than those nearest the chimney. In the latter tubes wear is caused by scaling, a form of corrosion due to condensation, whereas in the former tubes the inside is too hot to permit condensation and wear is caused by burning.

In a drier too ambitiously designed, heat can be so effectively removed from the chimney gases that condensation occurs. Analysis of a sample of the liquid that drips out of the stove has shown that

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** In those stoves in which the cold air passes through the tubes instead of outside them, the same principle applies, although the direction of the flow of heat will be reversed, condensation occurring on the outer surface of the tubes.

this may be a 4.2 per cent solution of iron acetate.[1] Rapid disintegration of drier components is bound to follow. This can be prevented by slightly increasing the chimney draught. Combustion will be accelerated and, since the heat demand of the drier does not change, the surplus heat will go up the chimney, keeping the inside of the tubes warm enough to avoid condensation.

It is not generally recognised that the products of combustion from liquid fuel, coal and firewood all contain water vapour. The fuels all contain hydrogen, which burns to water, and carbon, which burns under good conditions to form carbon dioxide.[1] The proportions formed by dry fuels are given below.

TABLE I

PRODUCTS OF COMBUSTION OF DIFFERENT FUELS

Fuel	% Combustible Hydrogen	Lbs. water formed per 100 lbs. dry fuel
Coal (Ceylon quality)[2]	5·5 %	49·5 lbs.
Liquid Fuel [3] ...	12·8 %	115·2 lbs.
Wood [4] ...	6·0 %	54·0 lbs.

In order to correlate the values given in Table I, the following assumptions have been made in Table II. A drier such as a 4-foot E.C.P., turning out 185 lbs. of made tea per hour, would consume fuel at the rates given in the table. These are based on figures actually obtained during tests, being the average of one day's firing (excluding lighting up) namely:—

(a) 2.35 lbs. of made tea per 1 lb. of coal.

(b) 40 lbs. of made tea per gallon of liquid fuel.

(c) 1.55 lbs. of made tea per 1 lb. of firewood.

TABLE II

WATER PRODUCTION PER HOUR

Fuel	Fuel used	Lbs. of water formed even if fuel is completely dry
Coal ...	78·7 lbs. per hour	39·0 lbs. water per hour
Liquid fuel ...	4·6 gallons per hour (app. 41·4 lbs.)	47·7 lbs. water per hour
Wood ...	119·4 lbs. per hour	64·5 lbs. water per hour

From these figures it is quite obvious that a good deal of condensation can occur with any fuel if conditions favour it. In a normally designed furnace, condensation should not occur under working conditions. But there is one factor, not generally recognised, that frequently leads to condensation with any fuel. It is the intention of this note, having shown that water may be condensed from the products of combustion of any fuel, to call attention to this little recognised cause of stove wear.

When a drier is being started the tubes nearest the smoke-box are naturally the last to warm up. If the air fan is started too soon these tubes may be cooled off so rapidly that condensation occurs. This particularly applies to cases where the drier damper is opened suddenly to its fullest capacity. While coolies have in most factories been trained to open up this damper slowly when firing is about to begin, withering is not always commenced with the same care.

Condensation can be caused also if there is a gap between withering and firing. Possibly very little leaf still requires the assistance of hot air for withering, and the cooly may allow the fire to die back without altering the fan damper position.

Secondly, even with fuel that is quite dry, condensation may occur if air is heated for withering, using the drier with the damper full open, but with the air below a temperature which in some cases is 150°F. This indicates that so much air is coming into the drier that the tubes are cooled enough to cause condensation. Condensation would not occur during final firing, since a very much smaller quantity of air is being drawn over the tubes, the heat of which is therefore maintained.

In many cases only very little water actually appears outside the drier, but the first few drops indicate that so much water has been condensed that the ash on the tubes and in the flues can no longer soak it up. The damp ash has a corrosive effect on iron, and the condensed water will dissolve out acids from the products of combustion, especially when firewood is being burned.

PREVENTION OF CONDENSATION

The above causes may be prevented by correlating the size of fire with the quantity of air drawn over the tubes.

(1). If it is necessary to use a big drier to produce a small quantity of heat, it is far better to use half the quantity of air at 165°F. than the full quantity of air at 120°F.

(2). When fires are being reduced, the fan damper should be progressively shut down, aiming at keeping the hot air at a minimum of 155°F. if the damper is at all fully open.

These remedies depend on the fact that the temperature of the air leaving the stove is raised, so that less load is placed on the bank of tubes nearest the furnace. Consequently more heat can be sent to the tubes nearest the smoke box, where the air to be heated is coldest and more likely to cause condensation. This restores the temperature gradient.

In both cases the regular removal of ash will minimise the deleterious effects of condensation, and drying of the fuel will reduce its likelihood.

SUMMARY

(1). Water may be condensed from the products of combustion of any fuel, even if the fuel is perfectly dry. Condensation takes place if the furnace gases come into contact with a sufficiently cold surface. It rapidly corrodes iron work.

(2). Corrosion may occur by overheating the stove.

(3). By reducing the quantity of air to be heated, the temperature gradient in the tubes can be restored, even if the same amount of heat is removed. Condensation can thus be prevented.

REFERENCES

(1). Lamb — *Tea Quarterly*, 1936, Vol. IX, p. 48.

(2). Brame — Fuels, Solid, Liquid, and Gaseous, p. 32.

(3). Figures supplied by Messrs. the Shell Co. of Ceylon, Ltd.

(4). Kempe's Engineering Year Book 1937, p. 1,418.