OPERATION OF FUELWOOD AIR HEATER SYSTEMS IN TEA FACTORIES AND THEIR MAINTENANCE

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After the steep rise in oil prices, many factories have converted their oil-fired air heaters of the tea driers to make use of fuelwood which is less expensive. With the increasing use of fuelwood air heaters, problems in tea drying have increased. Unduly prolonged periods to raise the inlet air to the required firing temperature, wide fluctuations in the inlet air temperature, high moisture content in the fired tea, high fuel consumption, frequent damage to air heater and furnace parts are some of the common problems factories face today. Our observations have revealed that most of these problems arise out of faulty operation of the air heater.

Tea driers used in our plantations are fitted with indirect type air heaters - either multi-tubular or finned type. The finned type is usually worked on liquid fuel while the multi-tubular type is adaptable for liquid fuel as well as firewood and the conversion from one to the other is not very expensive. All air heaters are fitted with induced draught fans and the natural chimney draught furnaces are now obsolete.

This article is intended to provide some information on the correct operational techniques of the firewood air heaters. Causes and remedial measures for some common problems are also discussed.

Starting up an air heater:

The following points should be observed in starting up an air heater:

(a) The ID fan should be started before the fire is lit;

(b) The furnace room doors and windows opposite the air heater admitting air should be opened to admit adequate air for the functioning of the furnace and the drier;

(c) The ash pit door slides should be in the open position. However, some adjustment may be found necessary for the correct draught regulation;

(d) About 30-40 minutes after lighting up the furnace and depending on the fire that has built up, the drier fan should be switched on and the fan damper opened about 1/5th or 20% of the total damper opening;

(e) When the inlet air has reached about 180°F (81°C), the fan valve should be adjusted to half open position;

(f) When the inlet air has reached about 205°F (95°C), the fan valve should be brought to normal working position;

(g) A uniform fire-bed without wide gaps should be maintained. A fire-bed about a foot thick should be sufficient to produce the required inlet temperature. Excessively thicker fire-beds are wasteful of firewood, and would cause difficulty in controlling the inlet air temperature and could even damage the stove;

(h) The induced draft fan should be adjusted to obtain the correct flue draught adequate for complete combustion of firewood. Excess air will result in lowering the furnace temperature. The flue gas temperature at the ID fan valve should be around 325-350°F (161-175°C).

Stoking:

Stoking has to be done correctly to ensure even firing temperature and fuel economy. Generally, for good, dry firewood a fire-bed around a foot thick is adequate to maintain the correct inlet air temperature. The important principles to observe here are:

(a) Before stoking reduce the ID fan draught by partially closing the damper;

(b) Gently rake and remove the ashes;
(c) Stoke little at a time and at short intervals;
(d) The wood should be pushed to the rear of the furnace and cover the entire grate evenly without gaps;
(e) The furnace doors should be closed quickly;
(f) Reset the ID fan damper to the working position; and,
(g) Lowering of inlet air temperature by opening the furnace doors should never be resorted to.

It is a common practice in many factories to open the furnace doors wide to lower the inlet air temperature when it exceeds 200°F (92°C). This will cause sudden cooling of the heated metal components of the air-heater by the rush of cool air. This can damage the air-heater.

The ash pit should be periodically cleaned. It should never be allowed to be filled up. Regular raking and removal of ash from the fire-bars will prevent clogging of the grate. If this happens the induced draught will get reduced and a sluggish flame will result affecting the inlet air temperature. The flame in the furnace can also be judged from the type of smoke emitted from the chimney. While black smoke indicates insufficient air for combustion no smoke would indicate excess air.

Shutting down air-heater after firing:

The following procedure should be adopted while closing down an air-heater after use:

(a) Reduce the ID fan damper;
(b) Remove unburnt wood, rake out the fire and clean the ash-pit;
(c) Close furnace and ash-pit doors;
(d) Stop the drier fan and close the damper;
(e) Allow the ID fan to work for about 20 minutes and then shut down.

Operation (e) will retain some heat in the air-heater and will help to shorten the period required to bring the drier to firing temperature the following day. There is no danger of ash entering the drying chamber since the drier fan

damper is partially closed during the blow out refiring operation and also if the ash-pit cleaning is done carefully.

Maintenance of air-heater:

Proper care and maintenance are prerequisites for trouble free and efficient functioning of the air-heater.

Daily attention:

1. After the day's manufacture when the air-heater has cooled down sufficiently all tubes should be thoroughly cleaned of ash. For this job the appropriate brushes and scrapers recommended should be used.

2. Oiling and greasing of all moving parts like bearings should be carried out.

Annual attention:

A careful inspection of the air-heater has to be carried out after removing the side covers. Asbestos packings between the plates and the tubes have to be inspected. Often these get burnt and tend to be loose. These joints have to be strengthened with additional packings. Otherwise, smoke leaks can occur.

Depending on the soot deposits the ID fan has to be cleaned periodically. Usually, the inside of the fan casing and the fan wheel get coated with a thick layer of soot.

Firewood:

The fuel cost for drying tea is a major item in the budget of a tea factory. As firewood is locally available it is generally not given the attention it deserves. Moreover, lack of appreciation of the proper use of firewood in driers is the primary cause of innumerable problems in drying tea.

The moisture content of green wood *ie.* freshly cut wood, depending on the species and the age, may be as high as 50 per cent. That is, the combustible substance, the wood, is only half its total weight. For combustion to take place the wood should be adequately dry. Otherwise, a con-

siderable amount of heat may have to be supplied to evaporate the excess moisture. The heat utilized for this is a waste. Therefore green or wet wood should never be used.

The firewood fed to the stove should have a moisture content of less than 20-30 per cent and split into small pieces. This would ensure maximum efficiency and maximum life of air-heater components.

All available varieties of firewood, when completely dry, have more or less similar heat values per unit weight, the heat value of a pound of wood being around 9,000 British Thermal Units (BTU). Damp wood has less useful heat value than dry wood. For instance, wood with 50 per cent moisture may have a heat value that is less than 4500 BTU. Hence it should be noted that the practice of computing drier efficiency based on weight of made tea per yard of firewood is erroneous. This does not give the correct information. The amount of tea produced as well as the amount of firewood consumed should be on a weight basis. What matters is the weight of wood and not the volume. Denser the wood lesser the volume it would occupy.

Estates purchase their requirement of firewood by cubic yard or cubic metre. The jungle wood which is normally more denser is termed hardwood and other varieties like Gum, *Grevilleas, Albizzias, etc,* are termed softwood. The actual quantity of wood by weight is never considered. Irrespective of variety, plantations should purchase reasonably dry firewood on a weight basis.

In addition, firewood with high moisture creates other problems. Either it may take a long period or sometimes it may not be possible to raise the inlet air to the correct firing temperature. This is generally due to low flue gas temperature. The excess moisture and air passing into the flue ducts cause this. When the flue temperature drops below 275°F (134°C) condensation of the products of combustion may also take place. In several estates because of the use of very wet firewood during the wet weather it is even possible to see the condensed substances flowing out of the soot box covers on to the floor. Pyroligneous acid, phenol and tar are some of the products of combustion and these substances have an offensive smell. Under these conditions teas are noted to absorb these taints. Acids could

act on metal parts and cause corrosion of flue tubes, ID fan blades, *etc.*

The logs should be split and cut into small pieces before use. This would be beneficial from the following points of view:

(a) Prevents damage to the stove;
(b) Facilitates maintenance of an even fire-bed without wide gaps resulting in better efficiency;
(c) Increase the burning efficiency by providing a greater burning surface.

A common practice in many factories is the use of big logs for the furnace in the mistaken belief that the labour saved on getting the logs split would bring in some saving on the cost of production. In the process of levering these big logs into the furnace the side tiles and the fire-bricks frequently get damaged. Further, an even fire-bed cannot be maintained. Gaps will occur in the fire-bed and more air than that necessary for combustion will pass through the fire-bed causing low flue gas temperature. This will result in the use of more firewood to compensate for the heat loss and this accounts for the high firewood consumption in several factories.

Logs should be cut into pieces of about a foot in length with a girth less than 8-10 inches. By cutting the logs into smaller pieces the burning surface is increased several fold with consequent increase in burning efficiency. Sufficient quantities of such smaller pieces should be available to maintain a contiguous fire-bed.

The fuelwood that is commonly used in tea factories, when split and stacked in suitable sheds, will take about 4-6 months to dry.

Common problems encountered in tea drying:

The common problems factories face in drying tea are mainly, uneven firing due to wide inlet air temperature fluctuations, high fuelwood consumption and frequent damage to fire-bars.

1. The wide inlet air temperature fluctuations are caused by:

   (a) The use of green or wet firewood;
   (b) Feeding the furnace with big logs;
   (c) Improper stoking - stacking too much firewood inside the furnace;
   (d) Trying to regulate the inlet air temperature by manipulating the furnace doors, ID fan damper, the cold air opening on the air-heater and the the drier fan damper;
   (e) Operating the air-heater without the ash-pit doors.

When too much of firewood is fed initially there will be a drop in temperature. With time, the temperature starts rising much above the required temperature which would be difficult to control. Maintenance of the correct type of fire-bed with the proper system of stoking will help to maintain a steady temperature. Small variations in temperature can be corrected by the proper adjustment of the ash-pit slide doors.

2. High firewood consumption is generally due to:

   (a) The use of green or wet firewood for the furnace;
   (b) Feeding the furnace with logs;
   (c) An uneven fire-bed with vacant spaces;
   (d) A thicker fire-bed;
   (e) Incorrect stoking;
   (f) Incorrect flue draught;
   (g) A larger grate area;
   (h) Regulating inlet air temperatures by keeping the furnace doors open;
   (i) Too much accumulation of ash in the ash-pit which would choke the fire-bed;
   (j) Heavy coating of ash and soot inside the flue tubes reducing the heat exchange efficiency;
   (k) Damaged fire-bars and side tiles.

3. The frequent damage to fire-bars is generally caused by:

   (a) An excessively thicker fire-bed;

(b) Sluggish fire caused by insufficient induced draught.

When the induced draught is inadequate thick black smoke would form in the furnace and the glow of the fire tends to be dull. Sometimes the smoke escapes out into the furnace room through the narrow gaps between the furnace doors. The fire-bars tend to get overheated and thereby get damaged.

The insufficient ID fan draught can be caused by several factors, such as:

(a) Faulty ID fan;
(b) Incorrect ID fan damper adjustment;
(c) Obstructions in the flue duct;
(d) Ash-pit filled with ash;
(e) Wrong power connection which reverses the direction of the fan.

Sometimes taints are caused by carelessness in the furnace room as less attention is given to this room. In some factories uncovered drains with a thick accumulation of dirt and offensive materials pass through this room. Sand buckets may be filled with dirt, spit and chewed remnants of betel and tobacco. Sometimes the refuse collecting bins are found very close to the furnace room in which all types of materials including sweepings of the lofts and factory premises will be found in various stages of decomposition. The furnace room and its immediate surroundings should be kept tidy. The torch used for lighting the oil furnace should never be left in the sand bucket to smoulder till the entire cotton waste or cloth to burn out. Depending on the proximity to the air-heater, the thick oil and cotton smoke can taint the teas. Smelling damp firewood should never be dried by stacking them closer to the furnace. Lastly, the hot ash removed from the ash-pit should not be heaped up near the air intake area of the drier fan as is often done due to carelessness. This can cause taint similar to those caused by smoke leaks in made teas. The source of some of the taints, especially when they are indistinct, is very difficult to identify and the detrimental effect on the tea sales could be enormous. Therefore, attention to detail is very important. The practice of cleaning the

soil, dust, *etc*, at the air intakes found on either side of the multi-tubular type air heater at the bottom of the tubular sections before starting should be adopted as a routine.