

INSTALLATION OF ENERGY EFFICIENT MODULATING BURNER WITH TEMPERATURE BASED CONTROL SYSTEM IN NATURAL GAS FIRED DRYER

(For Jorhat Tea Cluster)

Cluster Brief:

The Assam tea industry is one of the most enterprising tea-producing regions in the world. Tea estates in Assam collectively produce close to 507 million kg of tea every year, making the state of Assam the world's largest tea-growing region. The territory of Assam is characterized as having low altitude, rich loamy soil, ample rainfall, and a tropical climate which allows the region to produce some of the best loose-leaf orthodox teas. Only those teas grown and manufactured in tea estates located in the Brahmaputra Valley in the northeast India qualify to be called as Assam teas. In Assam, tea is grown both in the Brahmaputra and Barak plains. There are about 767 tea gardens in Upper Assam, out of which 471 tea gardens is having their own factory and 242 bought leaf tea factories (BLTF) run by the entrepreneurs. Tea cluster in Assam are mainly divided into three zones viz, Jorhat zone, Tezpur zone and Tinsukia zone. The sector is unorganized in nature, mostly using old and inefficient technologies. There is a significant potential to make these units energy efficient and cost competitive, through accelerated adoption of energy efficient technologies in the cluster.

Existing practice:

Drying is a simultaneous heat and mass transfer process, where heat is supplied to wet tea by heated air and the evaporated moisture is carried away by the air. The purposes of drying tea are to hold fermentation, remove moisture and produce good quality tea with good keeping quality. Fermented tea is dried from about 65-70% to 2.5-3% moisture content when the inlet hot air temperature ranges from 90°C to 130°C in a fluidized bed dryer. Tea dried at high temperatures is deficient in pungency, quality and flavour, but their keeping properties are satisfactory. In contrary tea can be satisfactorily dried at temperature as low as 71°C, provided the final moisture content is correct. This tea retains quality and flavour but deteriorate on storage. If the tea

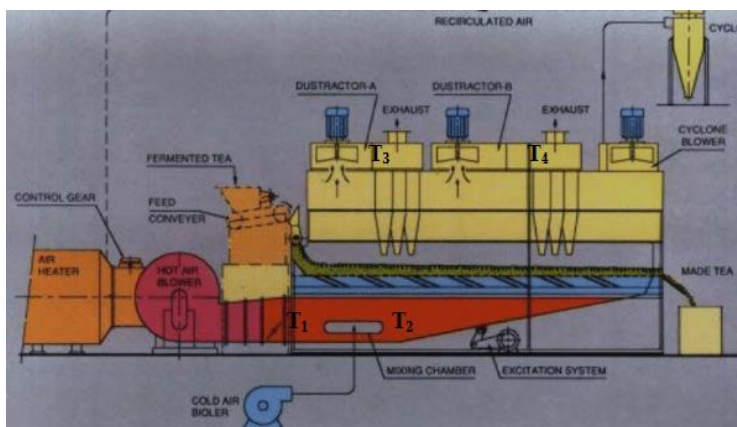


Figure 1: General arrangement for vibro fluid bed dryer

is dried below 1% moisture content, it loses some quality and on the other hand, tea dried to 3.5% moisture content and above does not keep well. So, the drying conditions play an important role in determining the quality.

There are a large number of tea manufacturing units in Assam using natural gas as the fuel. Natural gas is supplied to the units through piped gas line. Natural gas based dryers usually consists of a insulated burner block, natural gas based burners, blowers and control panel. Most of the units are equipped with Variable Frequency Drives in the blower and temperature probes in the different zones of the dryer. Firewood, Coal or Agro – is commonly used as fuel which is burnt in the central combustion chamber.

Although the temperatures of the different zones of the dryer are monitored using thermocouple, most of the units do not have provision for controlling the air flow proportionately to the fuel feed. Also, the fuel and corresponding air flow is not controlled based on the required dryer temperature.

The burners installed in most of the units are either single stage or two stage burners, which operates on On-Off basis based on the set temperature.

Proposed technology:

The following factors are responsible for drying the tea properly and produce quality tea:

1. Maintaining constant temperature at inlet and exhaust air
2. Maintaining the volume of air

3. Maintaining the feed rate / quantity of leaf fed
4. Period of time (Residence of Dryer / Throughput Time)

The industry requires wide band of temperature on the output of the stove to perform different types of production and application. Hence, it is proposed to replace the existing burners with energy efficient modulating burners along with a high intelligent automatic close loop control system to control the Air-Fuel ratio for combustion, according to preferred temperature. The salient features of the system are as follows:

- Maintain constant temperature at Dryer Inlet (T1) resulting in consistent and enhanced quality of Tea made.
- Maintain the constant temperature at T2 for ensuring the proper cooking of fed material at Dryer.
- Maintain the Fed Conveyor speed and T3 Temperature for ensuring the proper feeding in dryer .
- Maintain the Vibro mechanism speed of dryer and T5 temperature for ensuring proper blackness of tea made.
- Minimize production cost by optimum use of gas and electrical energy.
- Dual Line Digital temperature Indicator cum Controller console.
- High accurate Resistance Temperature Detectors (RTD are used for measuring the temperatures at dryer. RTD are ideal for industries where accurate temperature measurement is required.)

The technological advantages for adoption of energy efficient modulating burners along with automation and control system in the natural gas based dryer are as follows:

- ✓ Temperature at dryer inlet and outlet monitored and controlled as per requirement.
- ✓ Proper air-fuel ratio control
- ✓ Fuel flow modulated based on the air required for dryer.
- ✓ Stepless fully modulating operation over the range
- ✓ Equipped with electrical servo motor and double adjustable mechanical cam that allows air gas fine tuning
- ✓ Assures more stable flame compared to other versions.
- ✓ Reduced specific fuel consumption and power consumption.

Justification of technology selection:

Drying is one of the most energy intensive processes in the tea manufacturing process. It makes use of natural resources like coal and natural gas which makes it vulnerable to environment. Almost 40% of the plant's energy share is catered to the drying process. A significant amount of heat energy is lost due to inefficient combustion, which leads to unburned coal. Also, heat energy is lost through the flue gas due to improper control of the proper air-fuel ratio control.

- **Monitoring of system parameters:** The installation of the system allows proper monitoring of the system parameters like fuel feed, air flow, temperature at different zones of the furnace, air-fuel ratio etc.
- **Control of system parameters:** The system comprises of a closed loop system comprising of sensors and PID controller, which controls the parameters of the dryer to the desired level. Through this system, efficient combustion is ensured.
- **Modulating burner:** The gas valves of these burners open anywhere from 40% to 100%, depending on the precise need for heat in the dryer. Some of them adjust in increments as little as 0.5%. They often begin on very low capacity and ramp up during a heating cycle to meet the demand for heat. They run at less than full capacity almost all the time.

Modulating furnaces take the value of staged heat to the ultimate level. Temperatures within the dryer are very balanced in different zones. Temperature is often maintained within 1 degree, so you rarely feel fluctuations. Thus, the modulating burners help in getting the most comfortable indoor climate in the dryer.

- **Avoiding Manual Error:** The automation and control system of the dryer will help to avoid the manual intervention and related possibility of error for maintaining the correct air-fuel ratio required for the system.

Estimated energy & monitoring saving:

For calculating the energy and monetary benefits, a typical tea processing unit consisting of a natural gas based dryer is considered. The energy and monitoring saving through installation of modulating burners along with automation & control system in the dryer is summarized below:

Table 1: Cost benefit analysis for modulating burners with automation

Particulars	UoM	Hot Air Blower	Cold Air Blower
Part A : Energy Saving with VFD			
Damper Opening	%	50-60	40-50
Estimated Power Requirement with damper Control (from chart no. 1)	%	70	60
Actual power drawn per blower	kW	13.48	2.54
Standard No Load Loss	kW	0.66	0.185
Corresponding Power Requirement with VFD control (from chart no. 1)	%	25	15
Estimated power drawn with VFD control	kW	5.24	0.77
Total reduction in power drawn	kW	10.01	
Annual operating hours	hrs/y	3840	
Annual Power Savings	kWh	38429	
Power Tariff (weighted average)	Rs. / kWh	8.05	
Annual monetary savings (A)	Rs. in Lakhs	3.09	
Part B: Energy Savings by optimizing air fuel ratio			
Combustion air flow	kg/hr	1038	
Fuel Feed rate	kg/hr	50.16	
Air to Fuel ratio	kg/kg	20.7	
Theoretical Air Reqd.	kg/kg	17.2	
Excess Air	%	20	
Desired Excess Air Level	%	5	
Air to fuel ratio corresponding to 5% Excess Air Level	kg/kg	18.1	
Corresponding Combustion Air Flow rate	kg/hr	908	
Quantity of excess air supplied	kg/hr	130	
Average Hot Temperature	Deg C	140	
Ambient Air Temp	Deg C	30	
Energy Lost	kcal/hr	14300	
GCV of fuel	kcal/scm	9507	
Fuel Saving	scm/hr	1.5	
Working hrs/annum	hrs/y	3840	
Annual Fuel Saving	scm/y	5760	
Natural Gas Rate	Rs/scm	11.25	
Annual Monetary Benefits (B)	Rs in Lakhs	0.65	
Part C : Energy Savings by temperature control			

Temperature at the T1 zone of the dryer	Deg C	150
Desired temperature at the T1 zone of the dryer	Deg C	140
Heat Energy saving through maintenance of correct temperature in the dryer	kcal/hr	9080
Fuel saving due to reduction of T1 temperature	scm/hr	1.0
Annual Fuel Saving	scm/y	3668
Annual Monetary Benefits (C)	Rs in Lakhs	0.41
Total Monetary Savings (A +B+C)	Rs in Lakhs	4.16
Estimated Investment	Rs in Lakhs	7
Simple Payback	y	1.68

* extracts of calculation provided

The benefits can be summarized as:

- ✓ 10-15 % reduction in specific fuel consumption
- ✓ 5-10% reduction in specific power consumption
- ✓ Better Dryer Efficiency
- ✓ Better quality of products from dryer
- ✓ Enhanced service life of equipment

Replication Potential:

The upper Assam tea processing cluster termed as “Jorhat Tea Cluster” under the project has close to 350 tea factories consisting of both bought-out tea factories and estate tea factories. Out of these around 250 units are operating with Natural Gas firing. These tea factories are operational in clusters in and around Jorhat, Golaghat, Sibsagar, Dibrugarh and Tinsukia. A large number of associations are operational in the cluster. The tea board of India is the governing body for the tea sector and is responsible for licensing of new units, maintaining quality, setting tea prices and promoting tea across segments. To establish the replication potential of the technology in the sector, the following were considered:

- ✓ Technology feasibility and adaptability through energy audits in 8 units.
- ✓ Survey of 100 units (under process)
- ✓ Meetings held with associations / stakeholders (including technology suppliers)

However, during the survey, it was observed that there is a significance knowledge barrier towards adoption of energy efficient technologies in the cluster. The identified technologies have either been implemented in limited number of units or have no implementation records. Most of the units showed interest for implementation only after successfully demonstration in the technology. Out of 50 surveyed units till date, the technology penetration for identified energy efficient technologies has been as follows:

- FRP based withering fan : Implemented in 4 units
- Withering process automation: Tried by 2 units; dismantled due to lack of after sales services.
- Energy Efficient Modulating burners with temperature based automation in NG fired dryer: Modulating burners implemented in 8 units; however not coupled with automation
- Automation and control system in Coal fired dryer: No implementation.

The proposed energy efficient technologies for Jorhat Tea Cluster have been identified based on proven track records in other clusters such as West Bengal & Coimbatore. The technologies were discussed in detail in two nos. of brainstorming meetings held at Golaghat and Dibrugarh respectively. Based on the deliberations, the units approved the technologies and agreed on their saving projections. units of replacement of withering fans with FRP blade and IE 3 motor has a significant demand.

Considering the outcome of the energy audits and based on further discussion with associations, units and stakeholders, including technology suppliers and it is estimated that

the technology has a replication potential in atleast 40 units i.e. close to 15 % replication. Based on 10 % replication, the overall project benefits will be as follows:

Table 2: Impact on replication

Parameter	UoM	Value
Annual fuel saving (one unit)	scm/y	9428
Annual electrical energy saving (one unit)	kWh/y	38429
Annual fuel saving (one unit)	MJ/y	375002
Annual electrical energy saving (one unit)	MJ/y	33049
Annual energy saving (considering 20% replication)	MJ/y	16322040
Annual CO ₂ emission saving (one unit)	tCO ₂ /y	72
Annual CO ₂ emission saving (considering 20% replication)	tCO ₂ /y	2879
Estimated investment in technology (one unit)	Rs in Lakh	6
Estimated investment in technology considering 20% replication	Rs in Lakh	240
Estimated investment in technology considering 20% replication	in million USD	0.34
Total energy savings (in 10 years)	TJ	163
Annual CO ₂ emission saving (in 10 years)	tCO ₂ /yr	28790

Barrier for implementation:

Although the technology has been successfully proven in few units; there has been limited replication of the technology in the cluster. The barriers identified for limited penetration of the technology in the cluster are as follows:

- ✓ **Knowledge barrier:** Based on discussion with units, it has been found that knowledge dissemination related to the technology has been limited.
- ✓ **Unavailability of demo projects:** The cluster does not have any implementation of the technology. This leads to lack of confidence among units.
- ✓ **Unavailability of technology suppliers:** Although few of the technologies in the cluster are known to the units, the implementation has been hindered by the lack of technology supplier in the cluster.
- ✓ **Risk related to implementation:** The units lacks confidence related to performance of the technology. The risk of performance has been covered under the project.

Availability of technology supplier:

The technology of is well established in other tea clusters. A large number of reputed technology suppliers are available for the technology. However, local service offices for the technology supplier need to be established. Some of the established technology suppliers are:

- ✓ Stesalite Automation
- ✓ Rockwell Automation
- ✓ Magnum Automation