INSTALLATION OF AUTOMATION AND CONTROL SYSTEM IN COAL BASED DRYER

(*ForJorhat 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 90^0C to 130^0C 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 71^0C, provided the final moisture content is correct. This tea retains quality and flavour but deteriorate on storage. If the tea 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.

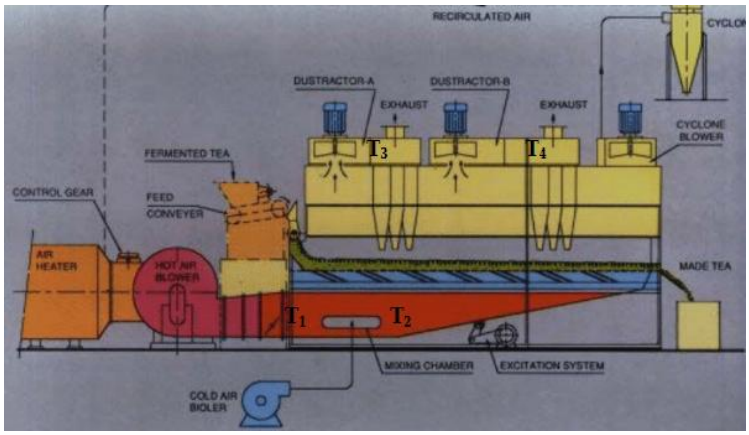

Figure 1: General arrangement for vibro fluid bed dryer

There are a large number of tea manufacturing units in Assam using coal as the fuel. Coal can be locally sourced and are used in industries where there is no natural gas pipeline. Coal based dryers usually consists of a combustion chamber, fire bars and tube banks. Firewood, Coal or Agro – is commonly used as fuel which is burnt in the central combustion chamber. The primary air required for combustion of fuel passes through the flue bed, which is supplied by the FD Fan installed in the flue inlet line. The flue gas generated in the combustion chamber is drawn by an ID fan through the tube banks installed at either side of the 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.

Proposed technology:

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

1. Maintains constant temperature at inlet and exhaust air
2. Maintain the volume of air
3. Maintain 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, a high intelligent automatic close loop control system is essential 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 coal and electrical energy.
- Dual Line Digital temperature Indicator cum Controllerconsole.
- High accurateResistance Temperature Detectors(RTDare used for measuring the temperatures at dryer. RTDsare ideal for industries where accurate temperature measurement is required.)

The technological advantages for adoption of automation and control system in coal based dryer are as follows:

- ✓ Temperature at dryer inlet and outlet monitored and controlled as per requirement.
- ✓ Proper air-fuel ratio control
- ✓ 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.

- **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 coal-based dryer is considered. The energy and monitoring saving through installation of automation & control system in the dryer is summarized below:

Table 1: Cost benefit analysis for dryer automation

Particulars	UoM	Values
Combustion air flow	kg/hr	1152
Fuel Feed rate	kg/hr	130
Air to Fuel ratio	kg/kg	8.9
Theoretical Air Required	kg/kg	6.4
Excess Air	%	39%
Desired Excess Air Level	%	7%
Air to fuel ratio corresponding to 7% Excess Air Level	kg/kg	6.8
Corresponding Combustion Air Flow rate	kg/hr	884
Quantity of excess air supplied	kg/hr	268
Average Hot Temperature	Deg C	150
Ambient Air Temp	Deg C	30
Energy Lost	kcal/hr	32160
GCV of fuel	kcal/kg	5600
Fuel Saving	kg/hr	5.74
Power saving due to reduction in combustion air	kWh/hr	1.79
Working hrs/annum	hrs/y	3840
Total Fuel Saving	kg/y	22042
Total Power Saving	kWh/y	6866
Coal Rate	Rs/kg	8
Power Rate (weighted average)	Rs/kWh	7.82
Monetary benefits/annum (due to power saving)	Rs in Lakhs/ y	0.54
Monetary benefits/annum (due to fuel saving)	Rs in Lakhs /y	1.76
Total monetary savings / annum	Rs in Lakhs /y	2.30
Investment	Rs in Lakhs	4
Simple pay back	years	1.74

* 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 100 units are coal fired. 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. Unitsof 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 20 units i.e. 20% replication in coal based units. Based on 20% replication, the overall project benefits will be as follows:

Table 2: Impact on replication

Parameter	UoM	Value
Annual fuel saving (one unit)	kg/y	22042
Annual electrical energy saving (one unit)	kWh/y	6686
Annual fuel saving (one unit)	MJ/y	516453
Annual electrical energy saving (one unit)	MJ/y	24058
Annual energy saving (considering 20% replication)	MJ/y	10810214
Annual CO_2 emission saving (one unit)	tCO_2/y	57
Annual CO2 emission saving (considering 20% replication)	tCO_2/y	1140
Estimated investment in technology (one unit)	Rs in Lakh	4
Estimated investment in technology considering 20% replication	Rs in Lakh	80
Estimated investment in technology considering 20% replication	in million USD	0.11
Total energy savings (in 10 years)	TJ	108
Annual CO_2 emission saving (in 10 years)	tCO_2/yr	11400

Barrier for implementation:

Altough the technology has been successfully proven in other tea clusters; 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