INSTALLATION OF AUTOMATION & CONTROL SYSTEM OF WITHERING PROCESS

(*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:

Withering is principally a drying process to remove the surface moisture and partially the internal moisture of the freshly harvested green leaves. In addition, withering is done to get the correct physical condition, which will allow the leaves to be rolled without breaking. Also, the withering promotes dissipation of heat generated during continuous respiration (chemical changes). There are two major types of withering, open or natural withering and artificial or trough withering. Usually, the green leaves from the tea estates are brought to the factory in the afternoons and are spread thinly on banks of troughs (tats). The troughs are made of metal wire meshes with wooden support on which tea leaves are spread and the air is blown from the bottom so that the air passes through green leaves.

The air is the exhaust from the heater, which is located at ground level whereas troughs are located in an upper floor. Withering is done at 20-25 ^{0}C depending on the climatic conditions. For best withering, a wet and dry bulb temperature difference of 4 ^{0}C is maintained. During withering, the moisture content of the green leaves is reduced to 55% (wb) (hard withering) for Orthodox tea production and 70% (wb) (light withering) for CTC tea production. Depending on the weather and condition of the leaf, the process takes about 6 hours for light withering and about 12-18 hours for hard withering. In withering, more air is blown in the initial stage and on an average the air flow rate should be reduced to two-thirds of its initial value. Once proper withering is achieved the airflow is continued to prevent the spoiling of withered leaves.

At present the time duration to run the withering fans and gas burners is controlled manually after the physical inspection of the tea leaves. There is no automation of the process and due to the manual intervention the power and gas consumption is generally higher.

Proposed technology:

The operation of the withering fans and gas burners depends on the moisture content in the leaves which changes with the ambient climatic conditions. Typically, the withering fans are operated for around 2 ½ hours and the gas burners are operated for 1 ½ to 2 hours.

It is suggested to automate the process with the installation of a withering monitoring and control system for each trough. The system would consist of a weight sensor box, leaf,

mixing and ambient temperature sensor modules, fan controller module along with a display.

Justification of technology selection:

A typical withering section has the following specifications:

Table 1: Typical withering section specification

Particulars	Values
Number of Troughs installed	15
Number of fans per trough	2
Number of fans Installed	30
Number of Burners installed per fan	1
Number of Burners Installed	30
Type of Trough	Enclosed
Type of Fuel Used	NG
Rating of Withering Fan Motor (kW)	3.7
Average Power drawn per Withering fan (kW)	4.2

It is said that "withering makes or mars the tea". Any fault in the withering process cannot be corrected in the subsequent manufacturing processes and affects the quality of made tea. Withering depends on a multitude of widely variable parameters such as leaf moisture content, surface moisture, leaf temperature, ambient temperature, ambient relative humidity, etc.

Withering also involves the use of about 30% of the total power consumption during manufacturing process. Thus, it is very important to undertake proper monitoring of the above parameters and control of the process to get desiredpercent withering. **Simultaneously, it is also important to optimize power and fuel use during the withering process.**

The manual practice of withering depends solely on the experience of the supervisors without proper monitoring or control over the withering system, thus resulting in inconsistent withering and suboptimal use of power and fuel. The withering control and automation device helps to monitor the withering process intelligently by following the calculated weight loss profile of leaves with respect to elapsed time against a pre-set profile. A sample weight of leaf is kept in a specially designed weight sensor box as per the spreading of leaves in the whole trough bed. Weight is automatically monitored in every 30 minutes of withering operation by switching off the fan automatically for about 4 minutes. The fan operation is controlled based on the weight loss trend at each weight monitoring interval. If the rate of weight loss (moisture removal) is lower with respect to desired weight loss, then fan will automatically switch ON and run continuously till the next weighing interval. If weight loss is higher, then fan would remainswitched OFF till next weighing interval with visual LED indication of DRY condition. After achieving the desired set % wither, fan will be automatically switched OFF and it will alert the user through audio visual annunciation about the completion of withering process. Hot air application is decided and controlled (**requires Auto Ignition Gas Burner**) based on ambient % RH & weight loss trend and simultaneously audio visual annunciation will be raised for Hot Air Demand/Withdraw.

The salient features of the system are:

- ✓ System is suitable for both CTC and Orthodox Tea processing.
- ✓ Significant energy saving (On an average 20-25% energy saving throughout year) by monitoring the weight loss trend with respect to time and keeping the fan and Hot Air off as much as possible.
- ✓ Manpower saving due to automatic control of FAN and Hot Air.
- ✓ Consistency in withering of tea leaves every time.
- ✓ No/negligible chance of damage of leaves due to over fire.
- ✓ Enhance the withering quality, results in to produce quality tea for better price realization of tea made.
- ✓ User settable withering time and % withering.
- ✓ Online display of % withering and remaining time for wither complete.
- ✓ Operating temperature up to 80°C.
- ✓ Computer interface for remote monitoring of entire process parameter (optional)
- ✓ 85-264 VAC Universal power supply input.
- ✓ Audio-visual annunciation to guide the operator.

Estimated energy & monitoring saving:

Depending on the tea processed per month, units have different numbers of withering troughs. The number of withering trough typically varies for 10 to 35 nos. However, for calculating the energy and monetary benefits, only one withering trough has been considered. The energy saving through adoption of weathering automation for 1kg of weathered tea leaf has been summarized below:

Table 2: Energy savings for withering automation

Particulars	UoM	Present	Post
Fresh Leaf			
Moisture	gm	705	705
Dry Matter	gm	295	295
Withered Leaf			
Dry Matter	gm	369	320
Moisture associated with dry matter (after weathering)	gm	504	626
Moisture lost	gm	200	78
Initial Material Temp	°C	28	28
Final Material Temperature	°C	22	22
Specific Heat Capacity of tea	kJ/kg°C	4.1	4.1
Latent heat of vaporization of water at standard atmospheric pressure	KJ/kg	2485	2485
Heat Energy Required per kg of Fresh Leaf	kJ	523	219

The cost benefit analysis for installation of withering automation and control system in 1 no. of trough are as follows:

Table 3: Cost benefit analysis for withering automation

Particulars	UoM	Values
Annual tea production	kgs/y	250927
Yield conversion factor for withering		0.216
Estimated quantity of fresh leaves withered	kgs/y	1161701

Particulars	UoM	Values
Heat Energy Required per kg of Fresh Leaf at present	kJ	523
Heat Energy Required per kg of Fresh Leaf post intervention	kJ	219
Avg. GCV of fuel		9507
Saving in NG terms	scm/y	8878
NG Rate as on Oct 2018	Rs per scm	11.25
Monetary benefits	Rs in Lakhs /y	1.00
Estimated Investments per set	Rs in Lakhs per trough	2.25
Simple Payback Period	years	2.25

* extracts of calculation provided

The benefits can be summarized as:

- ✓ 10-15 % reduction in specific fuel consumption
- ✓ Improvement quality in withering
- ✓ Less maintenance

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. 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:

1. FRP based withering fan : Implemented in 4 units
2. Withering process automation: Tried by 2 units; dismantled due to lack of after sales services.
3. Energy Efficient Modulating burners with temperature based automation in NG fired dryer: Modulating burners implemented in 8 units; however not coupled with automation
4. 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 atleast40 units. The tea processing factories has large number of withering troughs ranging from 10 to almost 40 in some units. For calculation purpose, 15 withering troughs has been considered per unit. Based on 20% replication, the overall project benefits will be as follows:

Parameter	UoM	Value
Annual fuel saving (one unit)	scm/y	62417
Annual energy saving (one unit	MJ/y	2482779
Annual energy saving (considering 20% replication)	MJ/y	99311159
Annual CO_2 emission saving (one unit)	tCO_2/yr	190
Annual CO2 emission saving (considering 20% replication)	tCO_2/yr	7600
Estimated investment in technology (one unit)	Rs in Lakh	15.75
Estimated investment in technology considering 20% replication	Rs in Lakh	630
Total Investment	in million USD	0.9
Total energy savings (in 10 years)	TJ	993
Annual CO_2 emission saving (in 10 years)	tCO_2/yr	76000

Barrier for implementation:

Altough 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.
- ✓ **Non-availability of demonstration unit:** The technology of withering automation does not have any demonstration. There is a lack of confidence among units for adoption of the technology.
- ✓ **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 FRP based withering fan is well established. 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:

- ✓ Staselit Automation
- ✓ Magnum Automation
- ✓ Jaydev Automation