Automatic Control System for Existing Humidifiers in Tea Factories

- Thammita A.S. Anuruddha
- K Raveendran
- W N K M S Dhamawardhana

Process Technology Division

Tea Research Institute of Sri Lanka

Introduction To Present Manual System Of Humidification

Manufacturing Process

Green leaf
⇩
Withering
⇩
Rolling
⇩
Roll-breaking
⇩
Fermentation
⇩
Drying
⇩
Grading

St Coomb's 1966

Fermenting Trough TRI 1966

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Essentiality of stabilizing RH and Temperature in Rolling Room

1. Chemical reactions of dhool takes place in rolling room
2. Control of humidity & temperature in the environment is important to avoid moisture loss from rolled leaf and dhool and to control the rate of chemical reactions.
1. In every rolling room, one or more manually controlled humidifiers are installed to do above task
2. Hygrometers are placed to monitor RH in the room

Problem Identification

1. Hygrometers are not in order
2. Hygrometers are not available for monitoring humidity & temperature
3. Water flow to the humidifier is not monitored & controlled
4. Humidifiers are not operated when required
5. Humidifiers are operated when not needed

This results …….

I. Surface drying of rolled leaf & dhool in less RH conditions
II. Water droplets falling on the leaf & dhool affecting chemical reactions due to the uncontrolled continuous operation of humidifier
III. Varying level of products TF&TR from chemical reactions due to uncontrolled rate

Unfortunately……

RH and Temperature are not maintained in most tea factories due to various reasons

Primary Objective

- To develop automatic monitoring and controlling system for existing humidifiers

Secondary Objective

- To digitally display Dry/Wet Difference, Temperature and RH Level in the rolling room

Existing Industrial Humidifiers

Ultrasonic Humidifier

Thin Film Humidifier

Fan Type Humidifier

Air Nozzle Humidifier

The Device

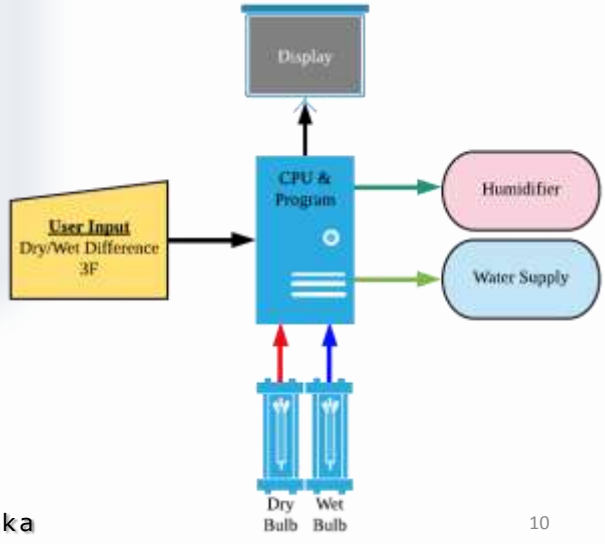
Traditional vs Electronified Hygrometer

The system is used an electronified Dry and Wet bulbs to calculate the hygrometric Difference

Conventional Dry/Wet Bulb

Electronified Hygrometer with controller

System Architecture



Commissioned in St Coomb's Factory

Methodology

1. The device is developed using an Atmel Microcontroller on Arduino interface.
2. Electronified Dry and Wet bulbs are placed around fermenting area for the experiment. (Typical Sensors are non operable)
3. Water and power supplies of existing humidifier(s) are controlled through the system using real-time sensing data through Dry and Wet Bulb.
4. A continuous regulation of humidity in the environment around sensors could be observed.

Working Principle

- By maintaining Dry & Wet Bulb (Hygrometric) Difference

"Under average conditions, that is to say with a humidifying appliance operating and a hygrometric difference of 2 to 3, and leaf spread at a thickness of 1 ½ to 2 inches, there is a very little change in the temperature on the leaf during fermentation."

(Tea manufacture in Ceylon, E.L Keegel, Page 83)

Road to the Working Principle

Formula 1 e_d for Dry Bulb Calculation

$$e_d = 6.112 * e^{\left(\frac{17.502 * T_d}{240.97 + T_d}\right)}$$

Formula 2 e_w for Wet Bulb Calculation

$$e_w = 6.112 * e^{\left(\frac{17.502 * T_w}{240.97 + T_w}\right)}$$

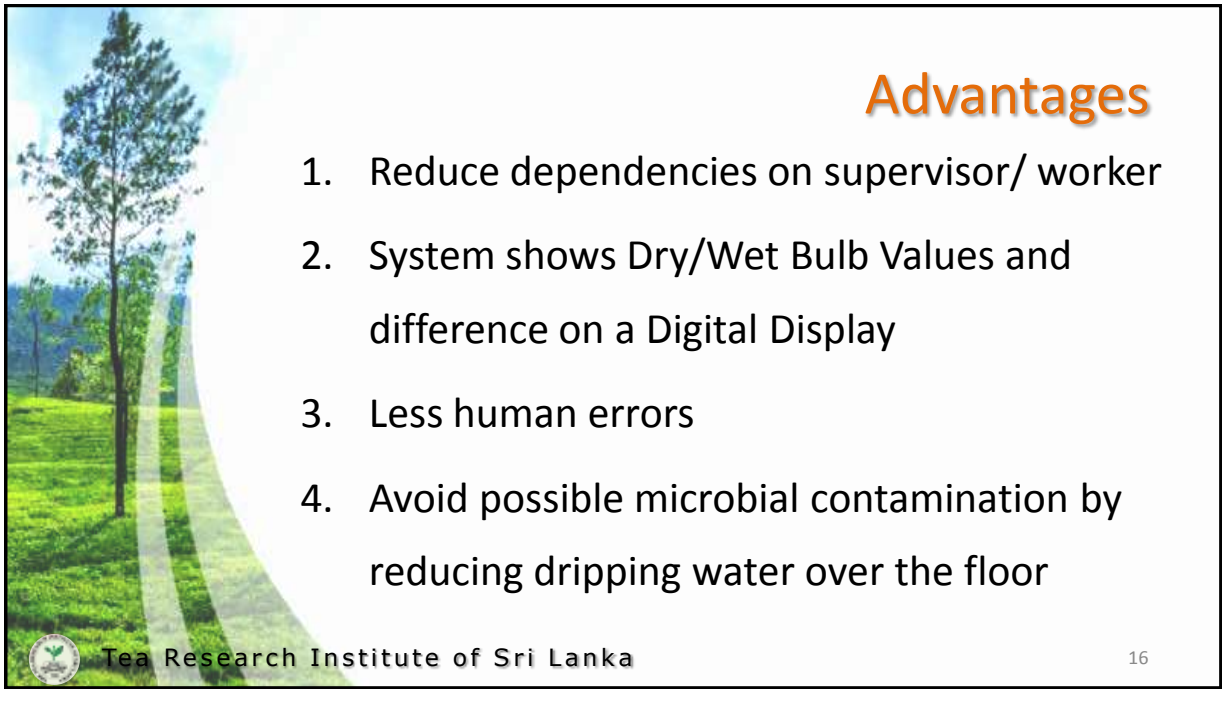
Formula 3 for RH Calculation

$$\text{Relative Humidity} = \frac{e_w - N*(1+.00115*T_w)*(T_d - T_w)}{e_d} * 100$$

Where,

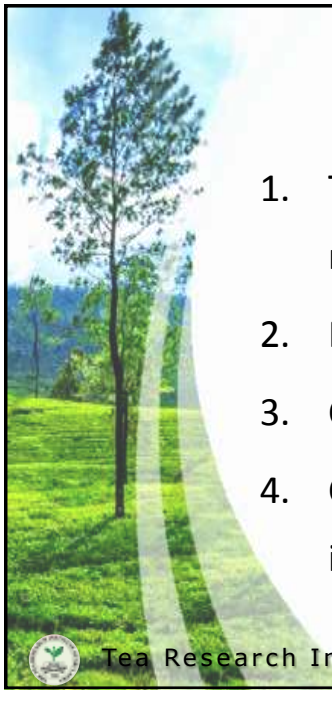
e = 2.71828182845904
T_d = Dry Bulb Temperature (Celsius)
T_w = Wet Bulb Temperature (Celsius)
N=.6687451584

Courtesy - www.1728.org



Advantages

1. Reduce dependencies on supervisor/ worker
2. System shows Dry/Wet Bulb Values and difference on a Digital Display
3. Less human errors
4. Avoid possible microbial contamination by reducing dripping water over the floor



Your Rewards

1. The system maintains hygrometric as per user requirement in it's surroundings
2. Robustive and Low cost technique
3. Can be attached to any existing humidifiers
4. Could positively impact with made tea quality and its price

Disadvantages

- Wet Bulb water tank has to be filled manually as a conventional hygrometer

Conclusions

- The Control System facilitates to maintain required hygrometric difference of less than three degrees F, in the fermenting and rolling room area.
- Can be installed to any existing humidifier at low cost.

Future Prospects

Need to quantify the made tea quality improvements and price changes

Additional Requirements for the system

If your factory has …..

- Humidifier(s)
- Water Supply
- Technician
- Adequate Wires and other necessary materials to power the system up

You Can get it for just around 25,000 rupees

References

1) Tea Manufacture in Ceylon, E.L. Keegel – 1956
2) https://www.1728.org/relhum.htm
3) https://www.engineeringtoolbox.com/dry-wet-bulb-dew-point-air-d_682.html


Thank you
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