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# PLC Based Control System for Brix Measurement.

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**Abstract**— This paper presents utilization of Programmable Control System (PLC) for sugar factory brix measurement. Brix is dissolved amount of sucrose crystal to clear syrup named after German mathematician and engineer Adolf Brix (symbol °Bx). Sugar industry use batch pans for boiling of clear syrup to form the sugar crystals. This pure crystal can only be developing in certain confined pan parameters. Pressure, temperature, vacuum and level are the main parameters of a pan system. One degree Brix is 1 gram of sucrose in 100 grams of solution and represents the strength of the solution as percentage by mass. PLC is a current trend in control system. In sugar industry PLC can be used for controlling parameter of the batch pan. PLC based control system can improve the results of this non-linear multi input multi output system.

**Keywords**— PLC, CONTROL SYSTEM, BRIX, CONDUCTIVITY, CRYSTALLIZER.

## INTRODUCTION

INDIA is one of the largest sugar manufacturer country in the world. Cane farming is major source of income for the farmers in India. Process of sugar manufacturing starts from cane feeding to crushing unit where cane crushed and juice is extracted. This juice is then purified by various method and it is made available for evaporators. In evaporators the syrup is evaporates 75% to 85 % of water to 34% to 45% giving more viscous syrup to crystallizer pan hence leading to vacuum in crystallizer. Operators on pan floor control various valve by observing temperature, level, vacuum, pressure on gauges. For controlling of level workers looks at glass windows available on pan. Hence by observing various parameters operator controls the working of this crystallization process and bring the brix of syrup to 60% to 65%. Automation of such multi input multi output can give benefit of accurately measuring and controlling parameter over operator's judgement and fluctuations in the inputs hence minimizing error.

Brix increases with evaporation of water from syrup. This happens when heat transfer from steam to syrup. Evaporation rate depends on heat transfer in calandria walls from steam to syrup from tubes. Ratio can be defined as

$Q = T_c \cdot A \cdot \Delta T$

$T_c$: Heat Transfer Coeficient.

A: Area of heat exchange in $m^2$.

$\Delta T$: Difference in temperatute of steam to boiling syrup.

Q: heat transfer quantity 1/(Kcal/kg/hr).

$T_c$ depends on resistance to

1. Tube wall resistance ($R_t$).
2. Surface to syrup resistance ($R_{s1}$).
3. Steam to syrup resistance ($R_{s2}$).

$$Q= (A\cdot\Delta T)/( R_t + R_{s1}^{+} R_{s2}).$$

Some other factors which adversely affect the heat transfer are

1. Hydrostatic head.
2. Boiling Point elevation.
3. Incondensable gases.
4. Viscosity.
5. Surface tension.

Measurements of various parameters are done by different gauges and controlled by respective valves. Variable that to be controlled are

1. Juice input: Juice input to syrup crystallizer can be controlled by level controller. Level controller helps to control the rate of juice input to the pan.
2. Level: Level in syrup crystallizer can be controlled by regulating feed inlet.
3. Steam flow: Steam flow rate must be controlled in comparison with Temperature and vacuum.
4. Brix: Brix meter uses the conductivity of syrup and transmits signal to control vacuum and temperature percent of body.

## RELATED WORK :-

Saravanan, V. Electron. & Instrum. Eng., M. Kumarasamy Coll. Zigbee based monitoring and control of melter process in sugar industry. The brix rate of the sugar masseicuite (semisolid state) has been measured using a micro-polar brix sensor. The objective of this paper is to monitor and control the brix in wireless manner using Zigbee network. The process has been designed using sensor networks and PIC controllers [1].

Rahim, A. Hashim, H.; Abdullah, N.E.; Hassan, S.L.M.; Shairah, I.; Halim, A.;Igol, F.A. "A numerical analysis of correlation between sucrose level measurementand near-infrared (NIR) for various grades of watermelon ripeness" This paper presents the determination of sucrose level content in various grades the relationship between the brix percentage value and the reflectance wavelength. Through the curve fitting line, the wavelength is successfully identified with respect to brix percentage value [2].

Elhaq, S.L.; Giri, F.; Unbehauen, H. "Experimental identification of five-effect evaporator in sugar industry " The dynamic behaviour of an industrial five-effect evaporator in sugar manufacturing is determined using the parameter identification approach. The purpose is to obtain an accurate mathematical model that can be used for advanced control design [3].

## CONTROL ACTION:

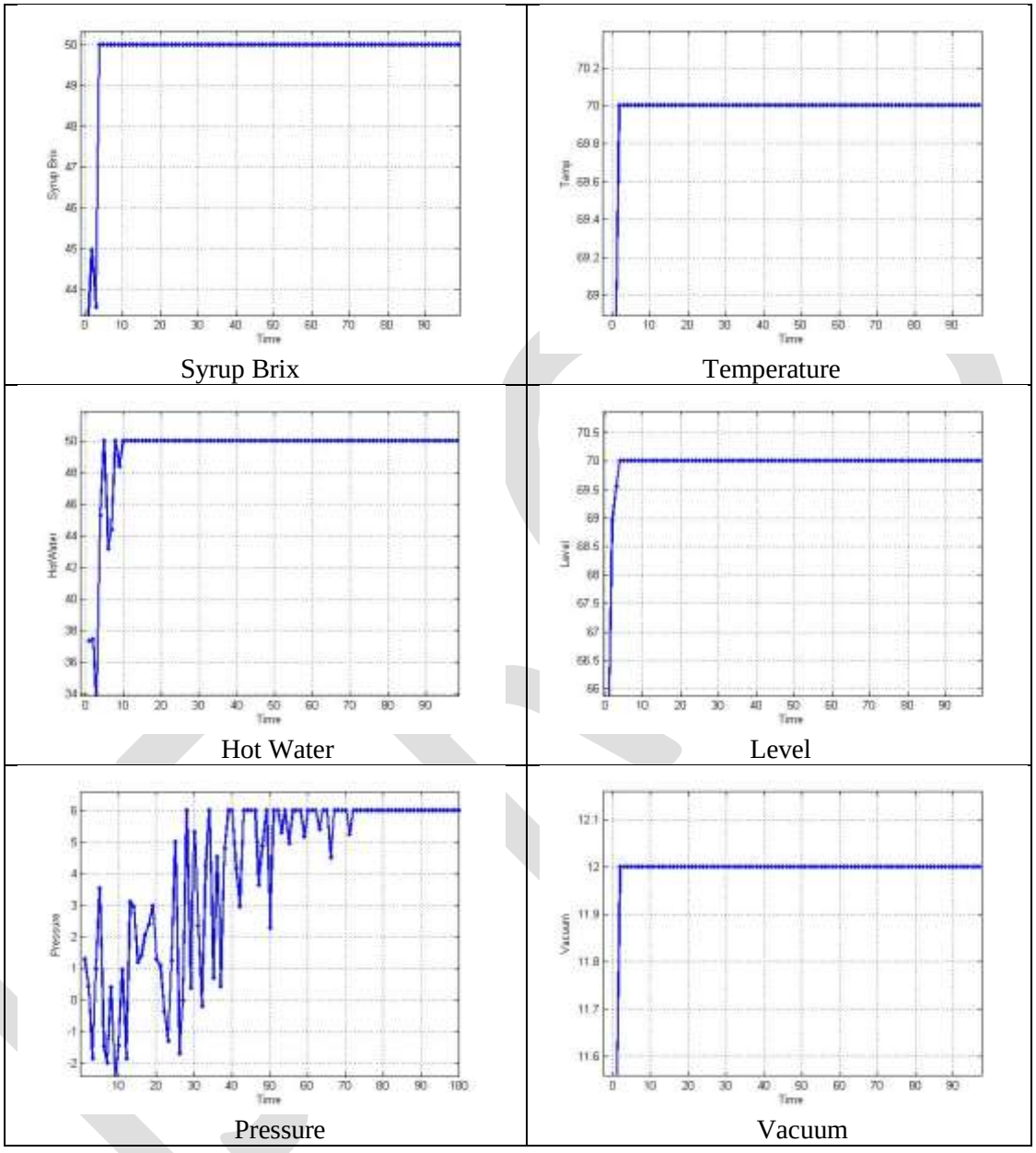
Regulation of pressure (0 psi to 15 psi): It is done with controlling the steam flow rate inside the calandria. Opening the valve the flow rate of steam increased and by controlling flow valve down flow rate decreased.

Regulation of vacuum (-15 psi to15 psi): It is achieved by controlling input of finely sprayed cold water in condenser. Vapours evolving from pan is fed to condenser. Condenser is a closed chamber. This vapours condensate in condenser hence leading to vacuum in pan.

Regulation of Hot water and Syrup (0% to 100 %): this must be set by the operator on the concentration of syrup being heated in pan. On the basis of operator experience operator sets the boiling condition of pan. In order to increase and decrease concentration over time. This is used when crystal growth is taking place.

Level is maintained with control of Hot water valve once the syrup is being started heating. Conductivity is maintained with syrup control valve. Pressure and temperature is maintained with the controlling steam flow rate to calandria.

**RESULT:-**




## CONCLUSION

By controlling various valves or by maintain the set points of various parameters of syrup crystallizer good production can be achieved. Syrup crystallizer can be set in auto mode where all parameters managed by PLC based control system.

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