Microprocessor 8085 Based Control System: A Study on Prototype Greenhouse

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Abstract: Microprocessor based systems are playing important role in today's instrumentation and control systems. These provide better control, good efficiency, higher reliability at low cost. These also reduce circuit complexity and gives better choice of controls with design flexibility. Microprocessors are available with wide variety as per requirement of control system. The microprocessor 8085 is most widely used microprocessor in small scaled and less complex control systems. It is an eight bit processor which can handle medium scaled control systems. In this paper we have presented a closed loop system, which control the temperature of greenhouse by controlling on-off action exhaust fan. The control system is tested in prototype greenhouse and shows good control in lowering the greenhouse temperature.

Keywords: Control system, temperature control, greenhouse, microprocessor based control.

I. Introduction

A Greenhouse provides a favorable and controlled environment for the crop in all seasons. A typical Greenhouse climate control system consists of several subsystems enlisted as: Lighting System, Cooling System, Heating System, Carbon Dioxide Generation System, Watering System (Drip Irrigation, Sprinkler, etc) and Fertilization System. These systems will be activated based mainly on the temperature, relative humidity, light intensity, wind speed and its direction, and water level inside the Greenhouse. Temperature in the Greenhouse can be maintained in several ways [1]. Exhaust fans employed at the top enhances the hot air movement on the top of the system and removes it from one end and lets inside the cool air from the other end which is incorporated with cooling pads. Fans inside the Greenhouse, mounted above the crop help keep temperature uniform. With a pad and fan system the air can be too cool at the cooling pad end and too warm at the fan end. Fogging system also helps reducing the air temperature, but necessarily employed with due care because it puffs up the air humidity. Thus greenhouse temperature control involves complexity of the physical and physiological process; it is hardly possible for the human operator to achieve energy efficient operation of the Greenhouse climate control [2][3]. Hence microprocessor based control system is one of best option for greenhouse temperature control.

II. Greenhouse Temperature Control System

The figure 1 shows block diagram of greenhouse temperature control system.

A. Description of Control System-

The control system consists of four major blocks as follows:

1) Supply Section- This section provides Dc regulated power supply for Temperature sensor LM 35, Voltage Divider, Op-Amp comparator, the microprocessor and PPI chip, relay and Fan driver circuit.

2) Control Section- It consists of Microprocessor 8085 and PPI 8255 chips. Basically it is a Project development board of ANSHUMAN. It provides controlling of the system through Assembly Language Programming.

3) Input Section- It consists of Sensor LM 35, a reference voltage developing circuit and a comparator using op-amp.

4) Output Section-It consists of relay and driver circuits which are controlled by output port of 8255.

The proposed control system can be implemented on a prototypical greenhouse and results will be compared for better control of temperature of greenhouse.

B. Circuit diagram and arrangement of control circuit-

The circuit consists of

1) Microprocessor 8085 as main control unit,

2) PPI 8255 chip to connect Sensor and actuator to the microprocessor,

3) A temperature sensor NS LM35,

4) Op-Amp 741 Comparator,

5) Resistive voltage divider,

6) Relay and fan with drivers.

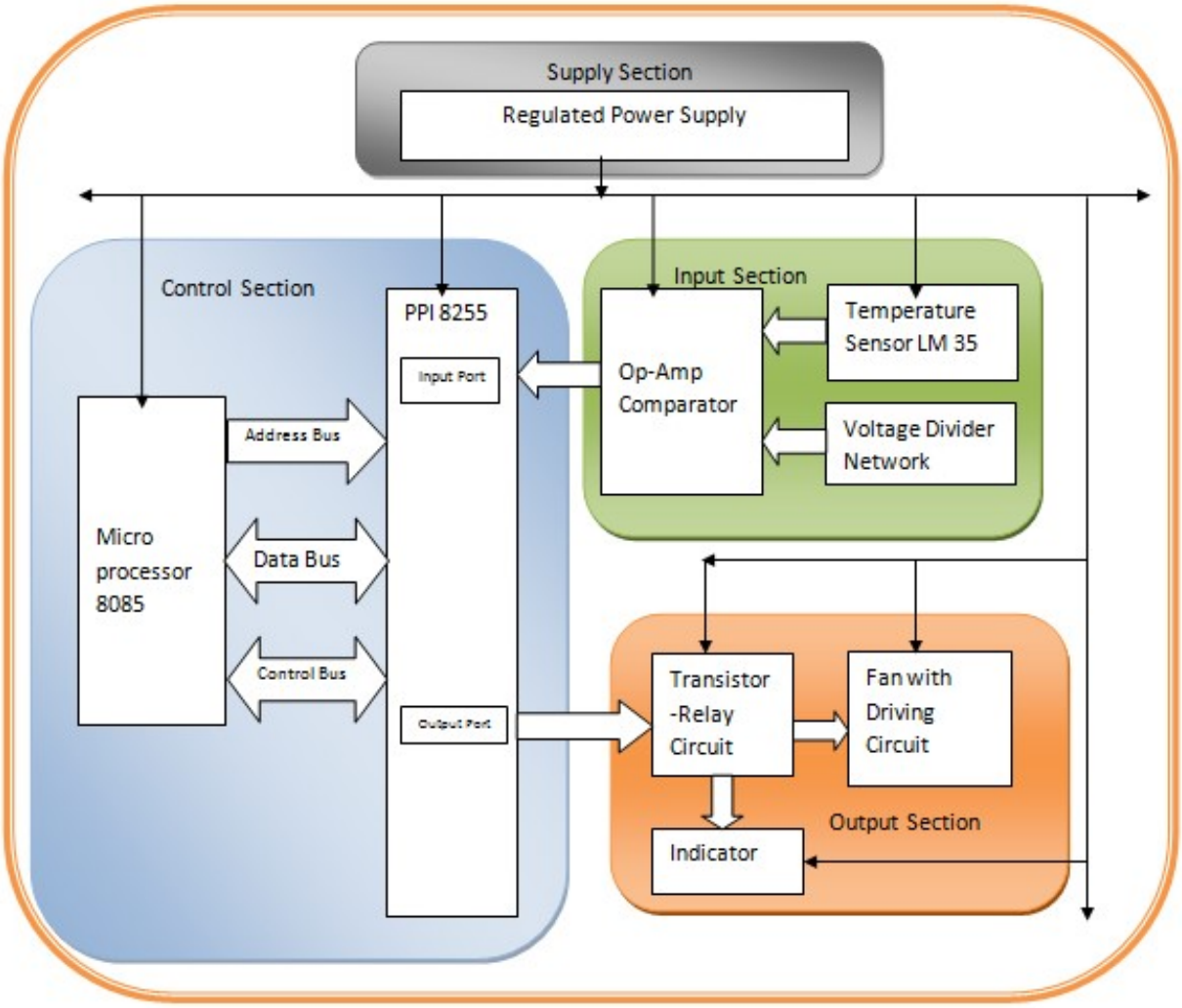

Figure 1: Temperature control system implemented in the prototypical greenhouse

As shown in figure 2, the inverting terminal of op-amp comparator is connected to a voltage divider network which provides a reference voltage proportional to temperature set point. The non inverting terminal of comparator is connected to temperature sensor which produce input voltage of comparator to decide its output. The output of comparator is connected to LSB of port A of PPI 8255. The microprocessor reads the PA0 bit of 8255 and produce the control signal. The control signal is given to LSB of Port B. According to value of PB0 the relay turns on or off to drive the fan. The turned on fan increases ventilation in greenhouse and reduce the temperature of greenhouse.

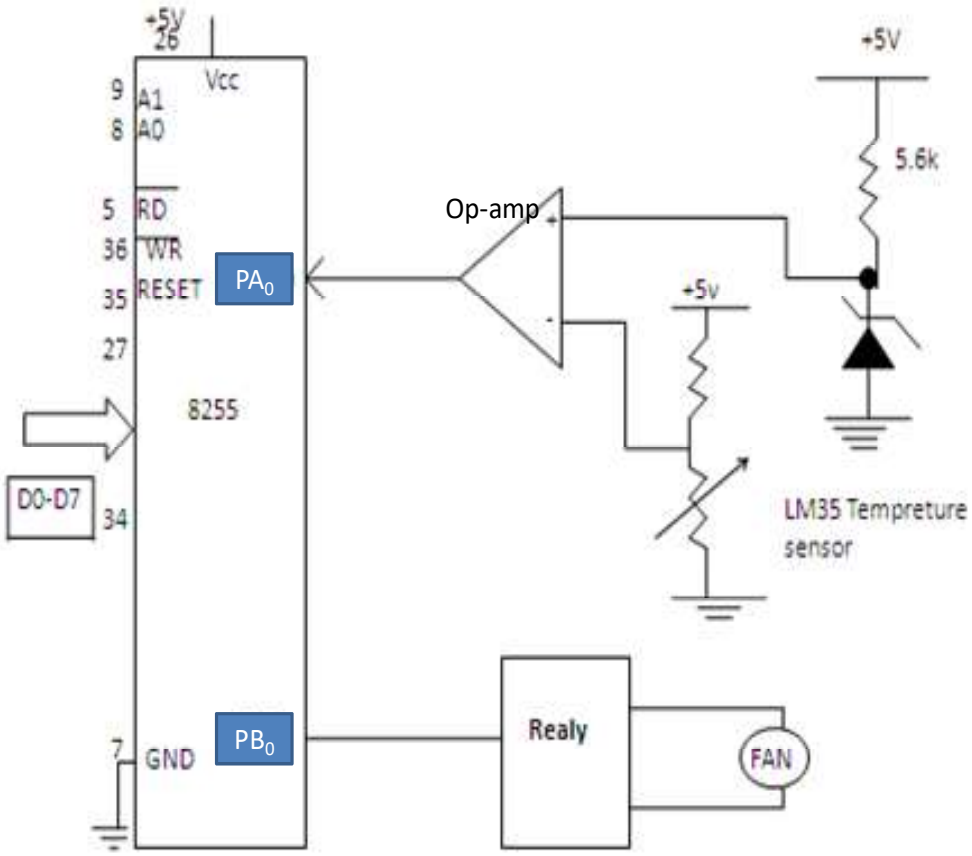

Figure 2: Circuit diagram of Microprocessor based Temperature control system

C. Working of circuit-

The Circuit consist of a voltage divider which is used to design trip point of comparator and other terminal of comparator is connected to LM 35 which provide voltage proportional to temperature of Greenhouse. The Sensor LM 35 produce output voltage 10 mV/^{0}c. Thus at 30^{o}C the output of LM 35 is 300 mV or 0.3 volt. Hence the resistance values in voltage divider are also arranged to produce same voltage across it. The set point voltage is adjusted to 0.3 volt with help of a potentiometer. When temperature of greenhouse increases beyond 30^{0}c the voltage of LM 35 increases above 0.3 volt. The comparator compares the two voltages and provides a high output voltage (+5V). This voltage is read by 8085 through 8255 to take proper decision. The processor reads this bit waits for few milliseconds and again reads PA0 bit. If it is again high then the 8085 turns on the fan through PB0 bit of 8255. When temperature of greenhouse decreases below 30^{0}C the comparator output becomes low and fan turns off.

D. Function of op-amp comparator-

The Port A of 8255 is connected to O/P of comparator. If the O/P of comparator is high (Logic 1) When (T >30^{0}C or V_t>V_r) & O\P of comparator is low (Logic 0) When (T<30^{0}C or V_t< V_r). Thus op-amp compares the two inputs and provides output to port A.

The microprocessor reads the PA0 bit of Port A; if PA0=0 it sends PB0=0 to output port B. But if PA0=1, it wait for few microseconds, again read PA0. If PA0=1 again then it sends PB0=1.

This method is useful in designing of temperature controlling of processes.

Any temperature value can be set with this circuit. Also any output devices like LED/Relay/Fan can be operated with help of this circuit.

E. Algorithm-

Step1: START

Step2: Set Port A= I/P Port, Port B= O/P Port

Step3: OUT 00000000 to Port B (PB_0=0)

Step4: Read Port A (PA0= 0 or 1)

Step5: If PA_0=0 go to step 4

Step6: If PA0=1 set counter register B=FFH

Step7: DCR B

Step8: If B=00H again read PA_0

Step9: If PA_0=0 go to step 4

Step10: If PA0=1 then OUT 00000001 TO Port B i.e PB0=1

Step11: go to step 4

F. Flow Chart-

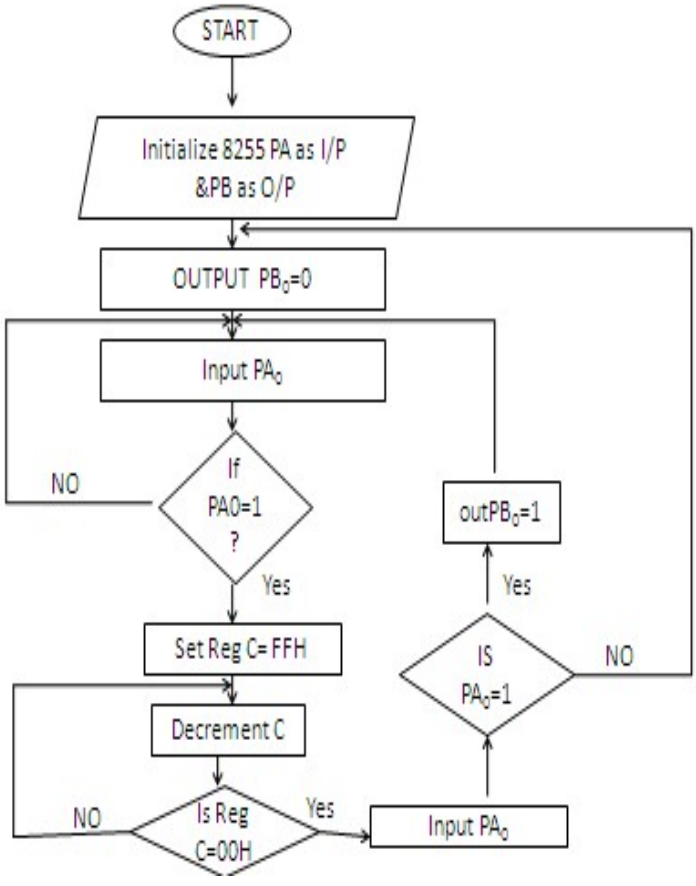

Figure 3: Flow chart

G. Program (ALP)-

Label	Address	Mnemonics	Hex code	Comments
START	7000	MVIA,CWR	3E	Load accumulator with Control word register(PA i/p & PB o/p)
	7001		90H	
	7002	OUT #CWR	D3	Send to CWR(Initialize 8255)
	7003		03	
Low	7004	MVIA ,00H	3E	Load Accumulator with 00H (PB0=0)
	7005		00	
	7006	OUT, #PB	D3	Send to output port B
	7007		02	
High	7008	IN, #PA	DB	Read content of input port A(PA=?)
	7009		01	
	700A	RAR	1F	Rotate content of Accumulator (carry=PA0)
	700B	JNC #LOW	D2	Jump to label LOW if PA0=0.
	700C		04	
	700D		70	
	700E	MVIB, FFH	06	Load register B with FFH (Set counter)
	700F		FF	
Decrement	7010	DCR B	05	Decrement counter (register B)
	7011	JNZ # Decrement	C2	Jump to label counter is not zero.
	7012		10	
	7013		70	
	7014	IN #PA	DB	Read again content of input port A (PA0=?)
	7015		01	
	7016	RAR	1F	Rotate content of Accumulator (carry=PA0)
	7017	JNC #LOW	D2	Jump to label LOW if PA0=0 (carry is ZERO)
	7018		04	
	7019		70	
	701A	MVIA, 01H	3E	Load accumulator with 01H
	701B		01	
	701C	OUT #PB	D3	Send 01H to output port B (PB0=1)
	701D		02	
	701E	JMP #High	C3	Jump unconditionally to Label HIGH
	701F		08	
	7020		70	

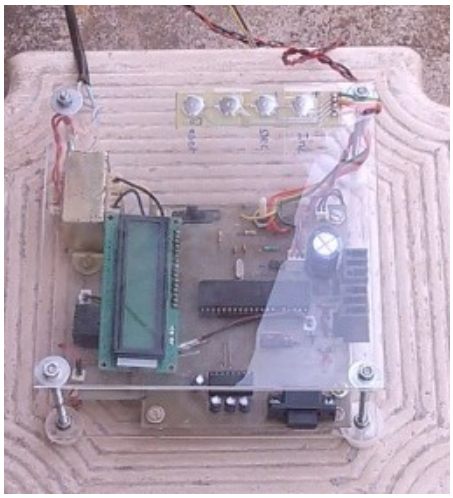

Figure 4: Sensor circuit

Figure 5: Control circuit testing

Figure 6a: Prototype Greenhouse

Figure 6b: Prototype Greenhouse

III. Results and Discussion

The system is implemented in prototype greenhouse and temperature-humidity is recorded at various instants with and without control system active. The Temperature and Humidity data logger is used for temperature measurements. The following figures show results of control action.

The Figure 7 shows variation of temperature and humidity inside greenhouse when no control system is implemented inside. The readings are taken for 23 hours a day using data logger. It shows variation in temperature from 15^{o}c to 45^{o}c. When day starts the solar radiations starts heating of greenhouse to increase its temperature. After 11 am the temperature is approximately saturated to maximum value. After 4 pm the temperature starts to decrease due to decreasing sunlight. This temperature variation is harmful for crop. The temperature variation can be controlled using a control system.

The figure 8 shows variation in temperature under uncontrolled and controlled conditions. Initially the system is turned off and temperature is allowed to reach its maximum value. When temperature saturates the control system is turned on. The control system starts cooling of the greenhouse and the temperature starts to decrease to a set point value of 27^{o}C.

Figure 9 and figure 10 shows results of the greenhouse temperature when control system is kept continuously active. This also shows that temperature can be kept at set point using this control system.

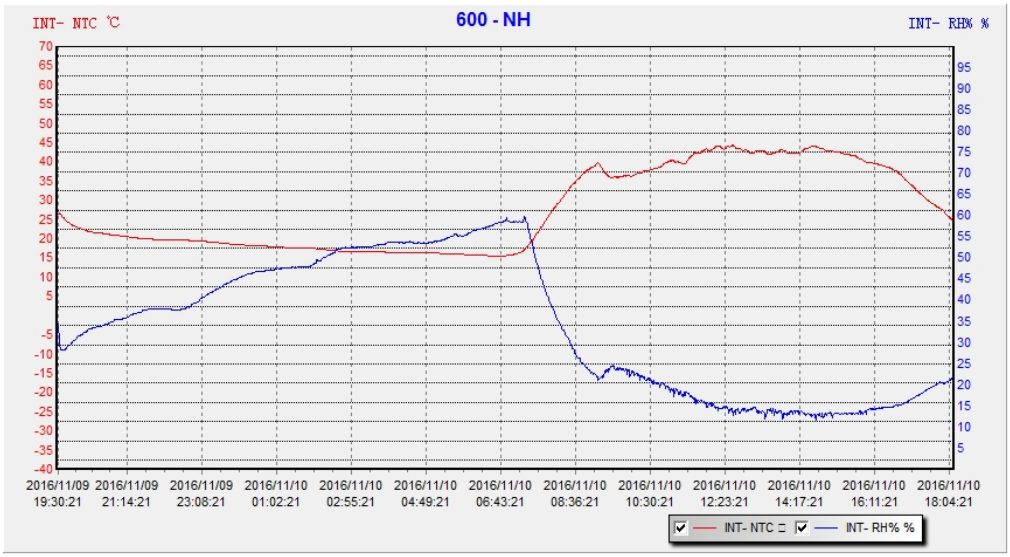

Figure 7: Air Temperature and Humidity variation in Greenhouse

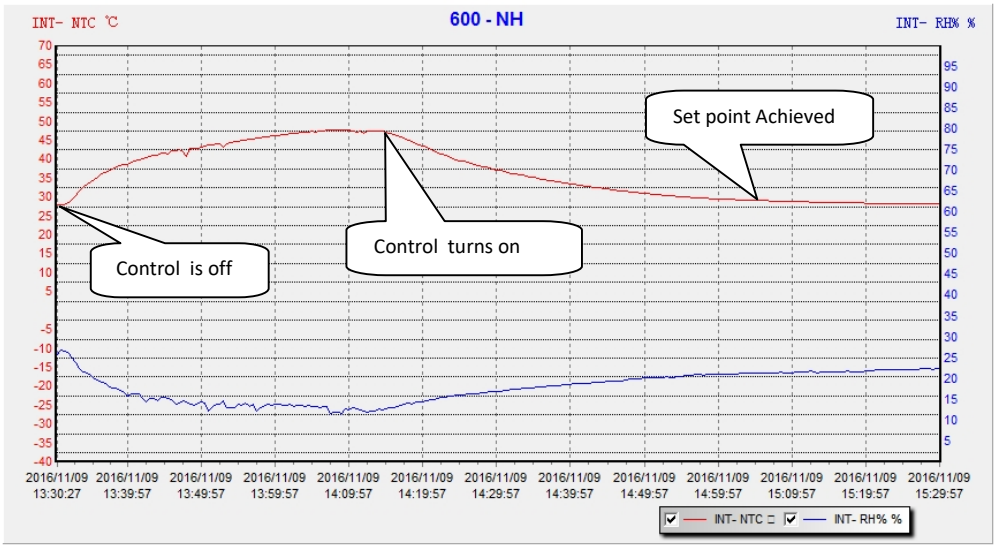

Figure 8: Air Temperature variation under Uncontrolled and controlledconditions

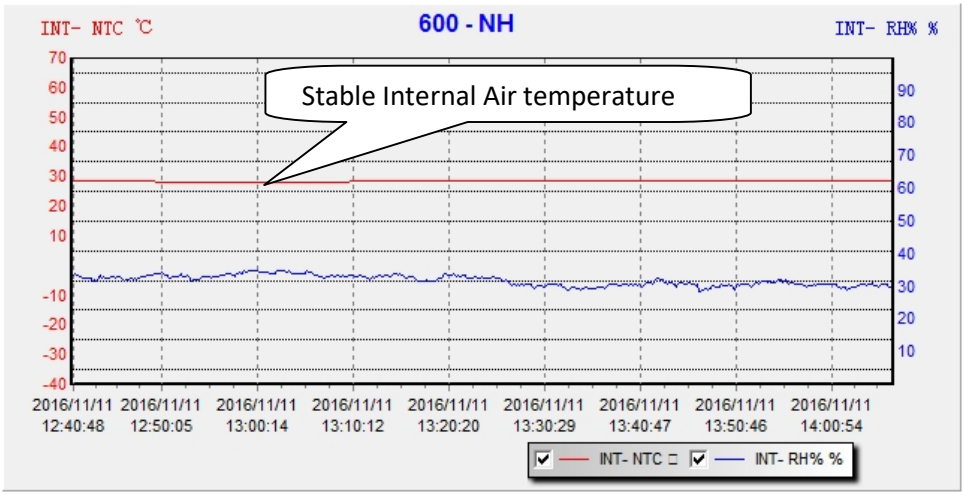

Figure 9: Air temperature variations in fully controlled conditions

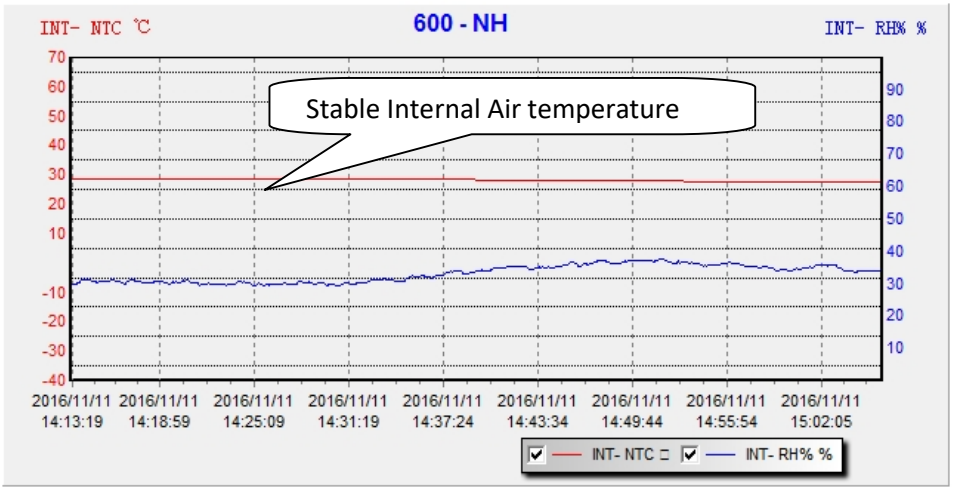

Figure 10: Air temperature variation in fully controlled conditions

IV. Conclusion

The system is based on concept of ventilation of greenhouse using Exhaust fan or Fan-Pad greenhouse cooling. When internal temperature of Greenhouse increases beyond set point the system turns on and ventilation started. The ventilation allows inside hot air to move outside to reduce temperature. The incoming air is passed through pad of greenhouse where evaporation of water takes place. The evaporated water molecules absorb excess heat from air inside greenhouse and temperature of greenhouse again decreases. The size of water molecule, the rate of ventilation and time for which water molecule remains in air decides the cooling effect of system. If ventilation rate is made proper the set point temperature is archived in greenhouse. The ventilation requirement is found by taking observation of temperature at various vent rate in a greenhouse. The fan speed is adjusted to achieve required vent rate using control system.

The control system is implemented using 8085 microprocessor, 8255 peripheral chip, temperature sensor LM35 and necessary comparator-relay circuits. The system is implemented and control action is studied in a greenhouse. The system shows good control over temperature parameter. However it cannot control the greenhouse humidity to required level.

The system requires large time to achieve set point temperature if it is activated after saturation of temperature or hottest condition. If system is active continuously, it can control the temperature effectively and set point is achieved in short time interval.

The designed circuit controls the temperature effectively and it is useful in temperature control of greenhouse, polyhouse or any other industrial application.

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