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INDUSTRIAL TEMPERATURE CONTROLLER

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Abstract- Temperature controllers are used in most of the manufacturing industries. The industries like textile mill, pharmaceutical industry, oil refinery etc. all requires temperature controller. The temperature controllers are used to maintain constant temperature of process or plant or any material. In such temperature controller system there is one reference temperature called set point or set temperature that is the desired temperature that must be maintained. This reference temperature is set by external means. In addition, it can be always adjustable according to requirements. Once this temperature is set the system tries to maintain it by sensing the current temperature and controlling it using heater, cooler or compressor etc.

It senses current temperature, compares it with reference temperature and generates error signal. Then based on this error signal it controls heating element (or cooling element). If set temperature is more than error signal is negative and vice versa.

Most popular type is the microcontroller based temperature control system. It controls the temperature of any device according to its requirement for any industrial application. This report aims at controlling the temperature of a composting process, which is being heated by a 50-watt heating element. For controlling the temperature of the heating coil, the current through the heating element is controlled. The thermal energy produced by the heater is directly proportional to the square of the current passing through the heater coil.Hence, by controlling the currentthrough the heater coil, the heat produced by the heater is controlled. The target is to control the temperature ofthe plate between room temperature and 100 °Cwith the optimal control range being from 50°C to 70°C. Following this significance of temperature control in processes to used different types of temperature controller for composting machine.

Index Terms- Temperature Controller, PIC Microcontroller, Circuit, Industrial application.

I. INTRODUCTION

Temperature: This is the degree of hotness or coldness of a body or an environment.
Control System: A control system is a device or set of devices that manage, command, direct or regulate the behavior of other devices or systems. Thus, we can literally say that a Temperature Control System is a device or set of devices that manage, command, direct or regulate the behavior of other devices or systems in order to influence the degree of hotness or coldness of a body or an environment.
A temperature control system consists of a small programmable digital logic controller device, wired to a heating and/or cooling system. About the size of a typical wall-mounted thermostat, a temperature control system contains a small circuit board and a memory chip(s). After setting the temperature control system to a desired temperature, known as a set point, the system will utilize the heater and/or air conditioning unit (as needed) as effector, to maintain that setting for the duration programmed. Temperature is one of the main parameter to control in most of the manufacturing industries like chemical, food processing, pharmaceutical etc. In these kinds of industries, some product need the required temperature to be maintained at highest priority the product will fail. So the temperature controller is most widely used in almost all the industries. The goal of this project is to design an ambient temperature measurement and control circuit. The motivation for the project is the fact that temperature measurement has become an integral part of any control system operating in a temperature sensitive environment and the various learning outcomes associated during the implementation of the project. In this project, ON-OFF type controller has been implemented. Here user can externally set the set value for temperature. The thermocouple temperature sensor senses the actual temperature. It is displayed on common cathode seven-segment LEDs with the set value. If it exceeds the set value, the heater is turned off. After then when temperature falls below the specified limit, again heater is turned on.

1.1 History of temperature control systems

The use of Automatic Temperature Control Systems began way back in the 18th Century. Warren S. Johnson conceived the idea while he was teaching at Norman School, Oklahoma. Before then, Janitors had to enter each classroom to determine if it was too hot or too cold, and then adjust the dampers in the basement accordingly. Johnson sought a way to end, or at least minimize the classroom interruptions of the janitors and increase the comfort level of the students. The Automatic Temperature Control System was to meet this very need.
In 1883, Warren Johnson gave up teaching to fully devote his time to researching and developing hisideas. He moved to Milwaukee and formed the Johnson Electric Service Company in1885. In1895, Johnson patented the pneumatic temperature control system. This allowed for temperature control on a room-by-room basis in buildings and homes. It was the first such device of its kind. By the early 20th century the Automatic Temperature Control System was being used in many notable places including the New York Stock Exchange, Palaces of Spain and Japan, West Point, the Smithsonian, the US Capitol Building, and the home of Andrew Carnegie. The use of this system has increased continuously to this day.

1.2 Why do we need a temperature control system?

The 21st Century was greeted with very unpredictable and unfavorable temperature conditions. The Green House effect has left our world exposed and this resulted in many uncertainties in our weather conditions and climate generally. There has been a growing need for the temperature of certain areas to be kept within a certain range. This has necessitated the need for Temperature Control Systems:

In the homes: In many modern day homes, the wastage margin of food stuff has increased greatly. This is due to the fact that the temperature of the storage area of the home rose above or fell below a certain allowable maximum or minimum value respectively, leading to the accelerated decay of the food materials.
In addition to this, some areas of the home have to be regulated within certain habitable temperatures (i.e. not too high and not too low). This ensures that life processes can be carried out by people conveniently in those areas.
In the industries: Many Industries(especially Manufacturing and Pharmaceutical Industries) have growing concerns for the need to store certain production materials within a specific temperature range. Some of these materials could be highly inflammable or explosive at certain extreme temperatures. This necessitates the need fora Temperature Control system.
In morgues: In morgues and mortuaries, dead bodies have to be preserved at a certain temperature to prevent them from accelerated decay. This temperature must be monitored and maintained regardless of the presence/absence of mortuary staff, and it also has to be managed in such an efficient manner that it doesn't generate enormous energy bills for the management. This problem also necessitates the need for a Temperature Control System.

In jets and aircrafts: Aircrafts are an important area where safety of passengers is mainly guaranteed by the efficient management and regulation of weather elements such as temperature, air pressure and humidity. These elements must be kept at a certain quantity / degree within the aircraft in order to sustain its weight. Practically, such weather elements as pressure and humidity are factors of adequate temperature. This also necessitates the need for a Temperature Control System.
National Energy Supply: In developed countries, the dream to conserve enough energy for future use has gradually become a nightmare owing to a decline in the use or lack of use of Temperature Control Systems. In many homes, offices and industries, many heating and cooling devices are accidentally left functioning even when there is no need of them. Occasionally, these mistakes have resulted in municipal infernos that have destroyed lots of lives and properties. In underdeveloped countries, the governments are being buried beneath extreme debts of energy bills because of wastage of energy resources.
By using a Temperature Control System, you never have to worry about wasting money or electrical energy by forgetting to turn the air conditioning or heating unit off. This greatly optimizes the cost of production in Industrial processes and the cost of living in Homes. In addition, you never have to worry about the temperature at which your living or storage area must be maintained. Just let the Temperature Control System worry about that for you. Programming the system only takes a few minutes, and weekends can have separate set points to accommodate alternate schedules (in more deluxe systems). It is also easy to override the set point with the touch of a button, in case you want the area to temporarily be warmer or cooler at any time.

II. OBJECTIVE OF THE PROJECT

The main objective of this project is to design a temperature Control System that helps to optimize Costs of production and living both in the homes and industries. It also serves to eliminate hazards that result from the accidental neglect of heating and cooling appliances in the homes and industries, even when they are not needed. To achieve this, a highly sensitive Temperature sensor detects the current temperature and feeds it as input to the Micro-controller. The Micro-controller then initiates a sequence of control procedures based on the configuration of the control program it contains. These control procedures would include turning on/off a heating or cooling system and activating a buzzer/alarm unit.

Temperature controlled system terminologies.

As shown in figure below, major building blocks of system are temperature sensor, Analog to Digital Converter (ADC), micro-controller, LCD, clock generator and LED indicators.

Temperature sensor: It is a transducer. It gives corresponding voltage (or current) output as change in temperature. It can be calibrated to degree Celsius. Otherwise, it has to be calibrated first.

Reference potentiometer: It sets reference temperature between min to max value. The system operation depends upon this set temperature value.

ADC: Its analog to digital converter with built in multiplexer. It takes two analog inputs one from temperature sensor and another from reference potentiometer. It gives 8-bit digital output corresponding selected analog input. To get the digital output of any one channel, micro controller will select the required channel and takes digital output.

Clock generator: ADC requires clock signal for its operation. This clock signal is generated by IC555 based clock generator.

Micro controller: it controls operation of ADC and LCD. It takes digital output of both channels and displays them on LCD. It takes suitable decision by comparing two temperatures. In addition, it gives different indications on LEDs

LED indicators: shows different indications like

Reading channel 1 temperature	RED LED
Reading channel 2 temperature	GREEN LED
Sensor temperature is more than set temperature (+Ve error)	BLUE LED
Sensor temperature is less than set temperature (-Ve error)	YELLOW LED

III. SYSTEM BLOCK DIAGRAM

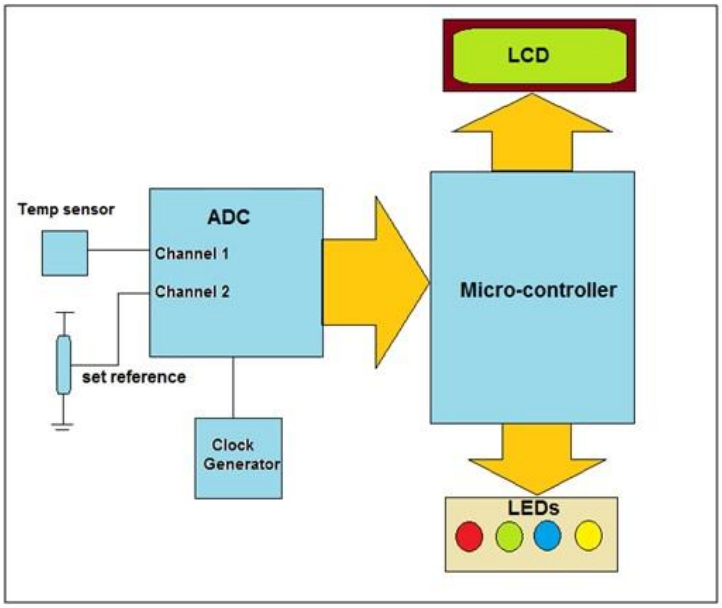

Fig.1Block diagram

3.1 CONNECTIONS

Connections: –

- LM35 temperature sensor is connected to channel 2 (IN1) of ADC0808. It will sense the current temperature and gives analog voltage output as 10 mV / °C

- A 1K pot is connected to channel 1 (IN0) of ADC0808. It will set the reference temperature between 0 to 255

- The data signals (OUT1 – OUT8) are connected to port P1 of microcontroller 89C51. So micro controller gets digital value of current/set temperature on port P1.

- The control signals START, EOC and OE of ADC0808 are connected to port P3 pins P3.4, P3.5 and P3.6 respectively. These pins are used to control ADC operation like start conversion, enable output, check end of conversion etc.

- The channel select pins ADD A, ADD B, ADD C and ALE pin are also connected to port P3 pins P3.0 to P3.4. these pins selects one of the 8 input channel for conversion

- IC555 is connected in astable mode. Its output frequency is approx 50 KHz. Its output is given to clock input of ADC. IC555 generates required clock signal for ADC0808

- Port P0 is connected to data pins (D0 – D7) of LCD. So data to be displayed on LCD or commands are given to LCD from P0. Two control pins RS and E of LCD are connected to P2.7 and P2.7 respectively. RW pin is grounded.

- A 1K pot is connected with LCD as shown. It varies the brightness.

- Port P2 pins P2.0 to P2.3 drives four different colour LEDs as shown. So these pins gives various indications through LEDs

- A 12 MHz crystal along with two 33 pf capacitors is connected to crystal input pins XTAL1 and XTAL2. This gives basic clock of 12 MHz to micro controller.

3.2 HOW DOES IT WORK?

- Microcontroller first latches address of channel 1 in to ADC. Then it asserts start signal to start conversion. It waits for end of conversion (EOC) signal from ADC. When it gets it, it takes digital input from P1 and after processing it displays it on LCD as set temperature

- Next microcontroller latches address of channel 2. Again it asserts start signal and waits for EOC. When it gets EOC, takes digital input – process it – displays it on LCD as current temperature

- Then microcontroller take difference of these two temperature values that is the error. If error is positive then it indicates this on BLUE LED. If error is negative then it gives indication on YELLOW LED

- This process is continuously repeated after every two second

IV. CONCLUSION

Microcontroller based temperature measurement and controlling system has been designed which contains few basic element having couple of lines control code using MicroC. This system measures temperature using LM35 temperature sensor device and compares the results with standard industrial thermometer value having negligible deviation. It is also able to keep maintaining laboratory temperature at constant level. The hardware validation shows that the temperature can be maintained between 50 ºC to 70 ºC, whichis displayed in LCD. In addition, a control knob has been used to set temperature according to application having a range of selection choice. Further investigation is required for getting precise temperature control in remote area application.

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