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Temperature Controller of Active Power System Based Pulse Width Modulation (PWM)

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Abstract: ***Power station is regarded as the foremost dangerous place on earth, operators risk their life taking care of the facility station. The generator plays a crucial role in power plant to generate the electricity for the domestic and industrial demand for our lifestyle. It is vital to continuously monitor the temperature and therefore the voltage output of the generator all the time, so that it can be repaired immediately if it is malfunction or under critical condition. The temperature rise controller based PWM is a solution to manage all of this process automatically in a more efficient and convenient way. The purpose of this project is to build an automatic temperature rises controller based PWM system that can detect the temperature, voltage output and control the speed of the cooling fan with different PWM (0, 30, 60 and 100%) based on the range of the temperature (temp<37, 37<temp<50, temp>50) of the generator. The sensor used to implement voltage and temperature sensors are potential meter and LM35DZ respectively. The cooling fan is implemented by 6V DC motor. An emergency button is designed in this system to ensure that all operation of power station can stop immediately to ensure safety when emergency condition occurs. The project start withdrawing the flow chart and block diagram, then writing and generate hex file for program code in the MPLAB IDE. The circuit diagram is drawn in PROTEUS and run the simulation by load the hex file to detect the error in the circuit. After doing the simulation in PROTEUS correctly, the hex file is transfer to the microcontroller through Pit Kit 2 and the prototype of this automatic temperature rises controller is built. This system design can only indicate and show the condition of the generators on LCD, it cannot indicate the speed and condition of the cooling fan because no indicators that is design for it.***

Keywords: Automatic Temperature, Power station, Controller, PWM.

I. INTRODUCTION

Every power station consists of cooling tools to keep the temperature under the danger temperature [1]. Nowadays high technology can give human safety and convenient [2]. To minimize the risk and human works, this project develops a fan cooling system that can maintain optimum temperature of the generators in the power station automatically based PWM. This system also has the feature, which is voltage sensor that put on the generators for us to monitoring the output voltage of the generators all the times conveniently and safely. To ensure that all operation of the generators in the power station can be stopped immediately under critical condition, an emergency stop switch is designed in this system. The human reaction is always slower than a super computer, besides human are lazy to function the fan manually when the temperature of the generators in power station rises. The generators in the power station must function normally all the time to ensure that the electricity that generates for domestic and industrial demand are adequate. It is important to monitoring the condition of the generators all the times so that the generators can be troubleshoot immediately after it is found to be malfunction. But it is difficult to monitoring the temperature and output voltage of the generators all the time manually [3]. Other than that, approaching the generators of the power station when high temperature is risky. An automatically temperature rise fan speed controller based PWM system is recommended to be built in the power station to solve this problem.

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II. OBJECTIVE

Nowadays, the power station plays an important role in generating the electricity for our daily life in domestic and industrial demand. The main objective of this project is to develop an automatic fan cooling system with fan speed controller-based pulse width modulation (PWM). It is design to cool down and ensure that the temperature of the generator is working under optimum temperature condition. Besides that, the fan cooling system that can display current temperature and the output voltage of the generators in power station on Liquid Crystal Display (LCD) is developed in this project. The temperature and the voltage output of the generators can be monitoring all the time through LCD display. An emergency switch is developed so that we can stop all the operation of power station under emergency and dangerous condition to ensure the safety.

III. SCOPE OF WORK

In this mini project, the fan cooling system of the generators (power station temperature rises fan speed controller based PWM) have its limitation. Basically, the design fan cooling system can only show the roughly temperature of the generators.

This is because the temperature sensor used is LM35DZ, it has a tolerance of about $\pm 1°C$. Microcontroller PIC16F877A [5] is used in this project, it is the mid-range microcontroller, it is not good enough compared to advance microcontroller like PIC18F series. In this system, the user can monitor the temperature and the voltage output of the generators in a very convenient way through the display on LCD all the time. But it also has some weakness, that is, the user cannot know the speed of the cooling fan and whether the cooling fans are function normally or not.

It does not have any indicators that can show the condition of the cooling fans. This cooling fan system is only can apply in certain type of power station. For the power station that generates the electricity with the nuclear reaction, this type of cooling fan system is obviously not suitable [7].

IV. COOLING PROCESS OF POWER STATION

There are many kinds of power stations that generate power for people. Every power station can consist different kind of a cooling tools that uses to cooling the power station temperature. Most of the choices are using water and then wind. Cooling tower as shown in Figure (1) is the main buildings that use to cool down the temperature of most kind of power station. In a power station cooling tower consist of water and fan. The heat is transfer into the water, and then the fan cools the water to transfer the heart to surrounding. Cooling towers are heat exchangers that are used to dissipate large heat loads to the atmosphere.The indirect or the closed circuit cooling tower does not including air and liquid, normally water or a mixture of ethylene glycol. Not at all like open cooling towers, indirect cooling tower with two different liquid circuits. An outside circuit, wherein the water is reused in the outside of the second circuit, which is the tube pack (closed loop), which is associated with the hot procedure liquid is cooled then return in a closed loop and air by circling water falling extend on the outside of the warmth funnel to give evaporative cooling like open cooling tower. In operation, the stream of warmth from the inner liquid circuit, through the curls of the divider, and the outside circuit, then a percentage of the water, air and vaporized by the warmth to the air. In this manner, the operation is very much alike to the indirect cooling tower, open cooling tower with one special case. Process liquid is cooled contained in the "closed" circuit, and is not straightforwardly presented to the outside air or reused water [4].

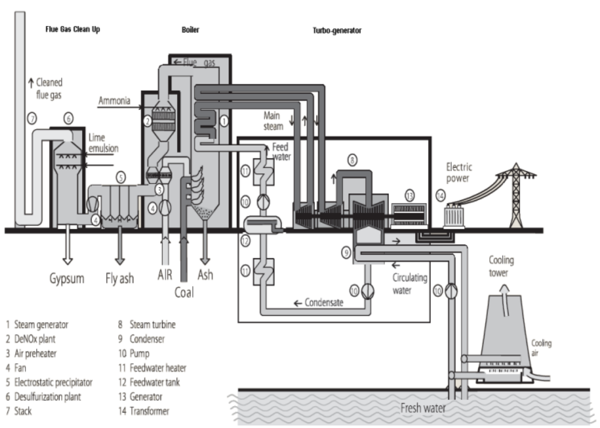

Figure (1): The cooling tower of thermoelectric power station [8]

V. SIMULATING THE CIRCUIT

The circuit is simulated by using PROTEUS. At first, the circuit could not be simulated and after many tries, it works. At last, the circuit is simulated successfully. The simulation is shown in Figure (2).

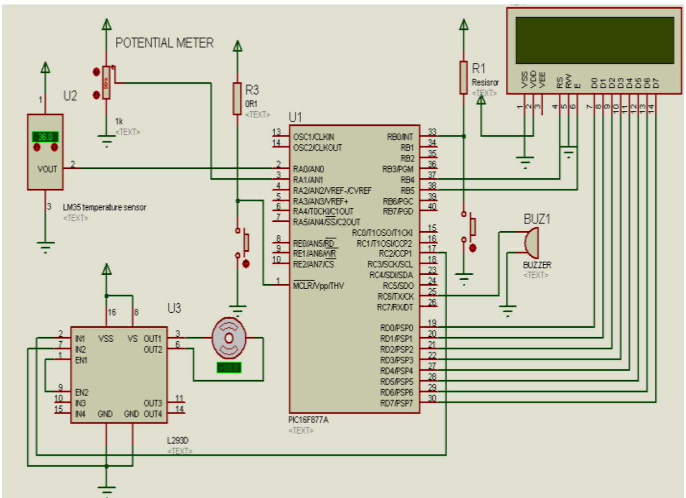

Figure (2): Circuit Simulation

VI. RESULT AND DISCUSSION

Before constructing the circuit of power station temperature rise controller based PWM, the project program is designed to achieve the desired outcomes by using MPLAB IDE compiler, and then compile and edit the program if there is any error until the program is successful running. After that, the circuit is simulated with the program that is successful obtained in previous step by uploading the program in PIC16F877A by using the PROTEUS software. This PROTEUS software is used so ensure the program is run correctly and the circuit connection is connected properly.

The figure (3) below shows the outcome of power station temperature rise controller based PWM by using the MPLAB IDE software to write the program and the PROTEUS software to simulate the circuit:

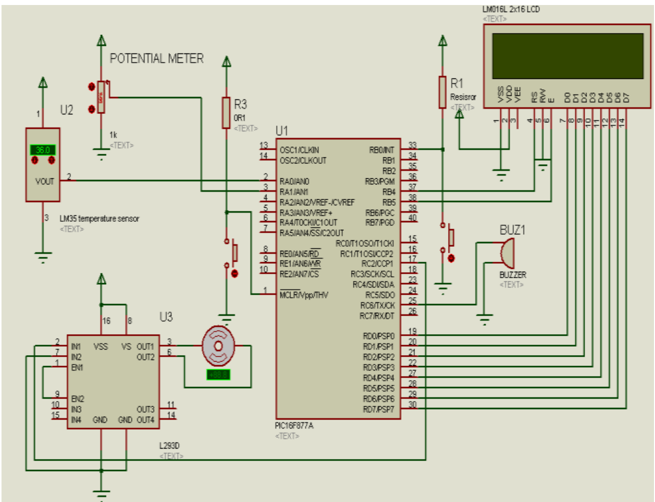

Figure (3): Power station temperature rise fan speed controller based PWM.

VII. CIRCUIT SIMULATION IN PROTEUS AND HARDWARE RESULTS

Case 1:

When power station temperature is below than 37°C, this is in safe zone. Therefore, the fan speed rotates only at 30% duty cycle. Figure (4) shows the fan speed when temperature is 35°C.The revolutions per minute (rpm) is +57.7rpm, the positive sign means the motor rotates in clock wise direction. In this case, the motor rotates in 30% duty cycle with 57.7rpm in clock wise direction. The output voltage maintains constant on 415V.

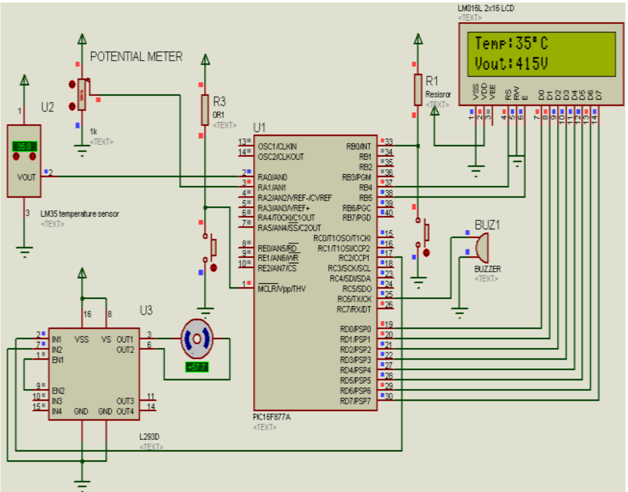

Figure (4): Power station temperature below 40°C and the fan speed controller based 30% PWM duty cycle for simulation circuit and hardware circuit.

Case 2:

When power station temperature is between 37°C and 50°C, this is in safe zone. Therefore, the fan speed rotates at 60% duty cycle. Figure (5) shows the fan speed when temperature is 42°C. The revolutions per minute (rpm) is +115rpm, again the positive sign mean the motor rotates in clock-wise direction. In this case, the motor rotates in 60% duty cycle with 115rpm in clock-wise direction. The output voltage maintains constant on 415V.

Calculation PWM-Period

Choose: PR2=249 and Prescale value=16

PWM period = [PR2+1]x[4]x[Tosc]x[TMR2 Prescale value]

$= [249+1]x[4]x[\frac{1}{20M}]x[16]$

$= \mathbf{800}\boldsymbol{\mu s}$

Calculation PWM-Duty cycle

(i)For 30% Duty Cycle

PWM Duty Cycle = [CCPR1L:CCP1CON<5:4>]x[Tosc]x[4]x[TMR2 Prescale value]

$(800\mu s)(0.3) = [CCPR1L:CCP1CON<5:4>]x[\frac{1}{20M}]x[4]x[16]$

CCPR1L = 75

(ii)For 60% Duty Cycle

PWM Duty Cycle = [CCPR1L:CCP1CON<5:4>]x[Tosc]x[4]x[TMR2 Prescale value]

$(800\mu s)(0.6) = [CCPR1L:CCP1CON<5:4>]x[\frac{1}{20M}]x[4]x[16]$

CCPR1L = 150

(iii) For 100% Duty Cycle

PWM Duty Cycle = [CCPR1L:CCP1CON<5:4>]x[Tosc]x[4]x[TMR2 Prescale value]

$(800\mu s)(1.0) = [CCPR1L:CCP1CON<5:4>]x[\frac{1}{20M}]x[4]x[16]$

CCPR1L = 250

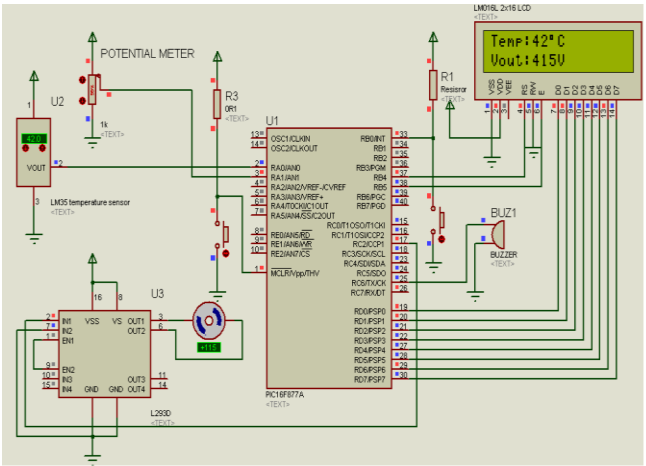

Figure (5): Power station temperature between 40°C and 60°C and the fan speed controller based 60% PWM duty cycle for simulation circuit and hardware circuit.

The data from result analysis is concluded and shows clearly in the Table (1) in case 1, when temperature less than 37°C, the speed of motor is 30% PWM duty cycle and the buzzer is off. In case 2, when the temperature is within 37 to 50°C, the speed of motor is 60% PWM duty cycle and the buzzer is off.

Table (1): Data conclusion.

Case	Temperature range	Speed of motor	Buzzer
1	Temperature<37°C	PWM 30% duty cycle	OFF
2	37°C ≤temperature<50°C	PWM 60% duty cycle	OFF

VIII.CALCULATION FOR PWM PERIOD AND DUTY CYCLE

The input part consists of an emergency switch (SW1) and a reset button. The temperature sensor (LM35) is used to sense the power station temperature and the potential meter is used to detect the output voltage. Whereas, the output part consists of 2x16 LCD, fan speed motor and buzzer. LCD is used to display the current temperature and output voltage of power station and at the same time fan speed motor is used to cool down the temperature in power station. While, the buzzer is used to inform operator the critical condition in power station so that the operator can take action quickly by pressing the emergency switch. All inputs and outputs are interfaced to microcontroller PIC16F877A for operations and displays.

In power station [6], the current temperature is display in LCD screen. When the temperature is below than 37°C, the fan speed is rotate only at 30% duty cycle. For the temperature is between 37°C and 50°C, the fan speed is rotate at 60% duty cycle. While, when the temperature is above 50°C, the buzzer is on and the fan speed is rotate at 100% duty cycle which is maximum speed. If the temperature in power station is too high, the emergency switch is pressed to stop the operation. The reset button is pressed until the power station condition is return in safe mode. Besides, the output voltage in power station is also display in LCD screen.

IX. CONCLUSION

Briefly, the purpose of power station temperature rise fan speed controller based PWM is considered as cooling system implemented in power station automatically.

On the other hand, PIC 16F877A microcontroller implements three inputs and three outputs to perform as cooling system. Temperature sensor LM35 is used to detect the temperature changes and control fan motor speed. On the other hand, potentiometer is used to detect output voltage. Both readings will be shown on LCD. Emergency switch stops the process if there is an emergency. All objectives of this project are achieved.

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