

# Controlling the Temperature Reactor Based on Raspberry Pi System Control

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**Abstract**—The main purpose of this paper to ensure the chemical solution inside the reactor vessel maintained based on Raspberry Pi control system to keep the temperature constant. A steam-heated jacket envelops the reactor vessel, transferring heat from the steam into the chemical solution inside. The control system maintains a constant temperature by measuring the temperature of the reactor vessel, and throttling steam from a boiler to the steam jacket to add more or less heat as needed normally this action done by PLC or DCS, in this paper we are using Raspberry pi as temperature controller to monitor and control the temperature reactor.

**Keywords**—PLC; PID controller; raspberrypi

## I. INTRODUCTION

The main objective of our paper is to reduce the cost by using raspberry pi for control the heating applications. In various heating system for several application as is required by the Industry. In the hazardous working environment, human safety is an important concern. Coal mines is a place in which human lives are more dangerous and many workers are injured due to explosions and leakage of toxic gases. Fire accidents can also happen [1]. At the same time if any person is absent in an important place for monitoring, it may also cause serious hazards. At present many systems are implemented in industrial areas but still those accidents are occurring .Here the monitoring node is raspberry pi. Programming language used for raspberry pi is Python. The temperature controller here is TCN4S-24R for measuring temperature [2]. Wireless communication is also an important issue inside the industry. Usage of wired technologies are not worthy as the cables will get damaged after a certain period of time or due to some environmental factors [3].

## II. BLOCK DIAGRAM OF PROPOSED SYSTEM

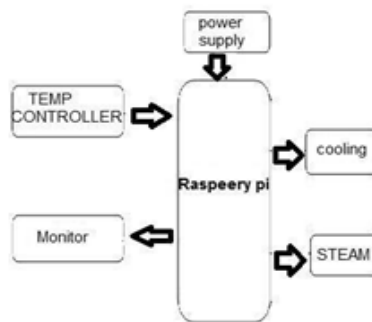


Figure 1. Block diagram of transmitter section.

Controlling the temperature reactor involves different types of sensors, actuators which can be interfaced with Raspberry Pi GPIO pins. Block Diagram of Controlling the temperature reactor using Raspberry Pi is shown in Fig. 1. LCD Display can be connected to Raspberry Pi.

## III. HARDWARE IMPLEMENTATION

The Raspberry pi as shown below in Fig. 2 is microprocessor used since this is compact in size and the power consumption is too low. Broadcom chip BCM2836 SoC is placed in it and it has a memory of 1GB RAM with 900MHz frequency. Raspberry Pi board is selected because it is fast when compared to the earlier versions Many sensors or peripherals can be interfaced with it at the same time and can work very fast as the quad core processor is used in it. This processor allows us to interface many modules at a time. It has 26 GPIO pins, two 3.3V pins, two 5v pins and 8 ground pins. It has 4 USB ports also which allows us to connect the camera, Wi-Fi module etc. [3]. The temperature controller used here is TCN4S-24R it is easy to interface with the raspberry pi board. It is used to sense the ambient temperature of the coal mine industry. This controller is connected with the GPIO pins. The working of the cooling fan depends on the above sensed data. TCN4S-24R controller has an operating range of about -55C to 1800C [4]. The cooling fan and the steam will work by means of the relay operation which acts as the switch here. A 4 channel relay board is used. The relay will also acts as a safety measure.

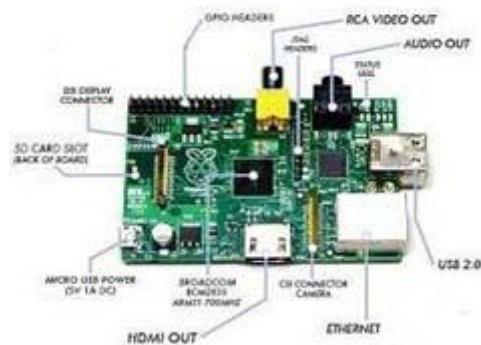


Figure 2. Raspberry pi

## IV. PROPOSED SYSTEM

In Fig. 3 explained the circuit system by using the flow chart the raspberry pi board is given a power supply of about

5V and 3V. An on-off controller is the simplest form of temperature control device. The output from the device is either on or off, with no middle state. An on-off controller will switch the output only when the temperature crosses the set point. For heating control, the output is on when the temperature is below the set point, and off above set point [4].

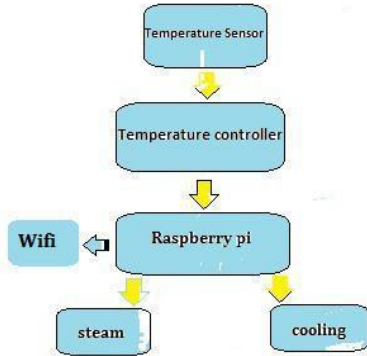


Figure 3. Flow chart of Circuit system

### V. WORKING METHODOLOGY

#### 1) Requirements of the project:

- This project is built on a breadboard, so no need to worry about soldering, or a designing PCB.
- Hardware:
  - Raspberry PI 2
  - 16 GB micro SDHC(CLASS10) CARD
  - Power Supply
  - Breadboard and Jumper Wires
  - temperature controller
  - relay
  - Wifi
  - monitor

First of all Raspberry pi has to be prepared and for that we require Debian. Debian, short for New Out of the Box Software. Its an operating system manager that makes it easy to download, install, and set up your Raspberry Pi. When you first boot up Debian, you'll get a selection of OSes to choose from. Debian makes getting started with Pi easy, and includes a bunch of different operating systems to choose from. The Raspberry Pi itself doesnt come with an operating system, we need to select it while booting of Debian. Raspbian is the official operating system of the Raspberry Pi. Raspbian has been the standard Raspberry Pi operating system. Raspbian is a version of Linux built specifically for the Raspberry Pi.

#### 2) Debian installation:

Insert an SD card that is 16GB or greater in size into your computer. Format the SD card Extract the files contained in this Debian zip file. Copy the extracted files onto the SD card that you just formatted so that this file is at the root directory of the SD card. Please note that in some cases it may extract the files into a folder, if this is the case then please copy across the files from inside the folder rather than the folder itself. Insert the SD card into raspberry Pi and connect the power supply. Raspberry Pi will now boot into

Debian and should display a list of operating systems that you can choose to install. If your display remains blank, you should select the correct output mode for your display by pressing one of the following number keys on your keyboard:

HDMI mode - this is the default display mode.

HDMI safe mode - select this mode if you are using the HDMI connector and cannot see anything on screen when the Pi has booted.

#### 3) Building the circuit:

- Connect 3V GPIO (Pin 1) from raspberry to Alarm 1 of the temperature controller as shown in Fig 4.



Figure 4. Connecting to temperature controller

- Connect Alarm 1 of the temperature controller to GPIO (Pin 29) as shown in fig 5.
- Connect GPIO (pin 30/32) to relay 1.
- Connect GPIO (pin 34/36) to relay 2.

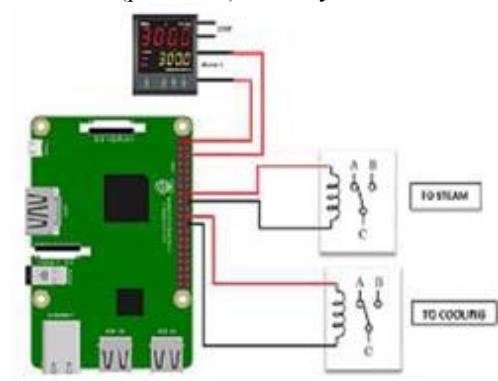


Figure 5. Circuit diagram

In Fig. 6 shown how the system is connecting to the field.

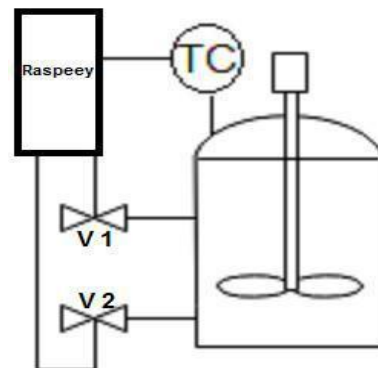


Figure 6. Connecting in field

## VI. ABOUT GPIO PINS

A General Purpose Input/output (GPIO) shown in Fig. 7 is an interface available on most modern microcontrollers (MCU) to provide an ease of access to the devices internal properties. Generally there are multiple GPIO pins on a single MCU for the use of multiple interaction so simultaneous application [5]. The pins can be programmed as input, where data from some external source is being fed into the system to be manipulated at a desired time and location [6]. Output can also be performed on GPIOs, where formatted date can be transmitted efficiently to outside devices, this provides a simple mechanism to program and retransmit data depending on user desires through a single port interface.

We are keeping the circuit simple and building it on a breadboard using our components and jumper wires. Before connecting anything to your Raspberry Pi, disconnect the power. Warning - you can destroy your Raspberry Pi with a short circuit from a wrong connection. Just be careful and double check everything before powering back on. All the connections were carefully checked and connected. Since, a little careless mistake may short-circuit the Raspberry circuit [7].

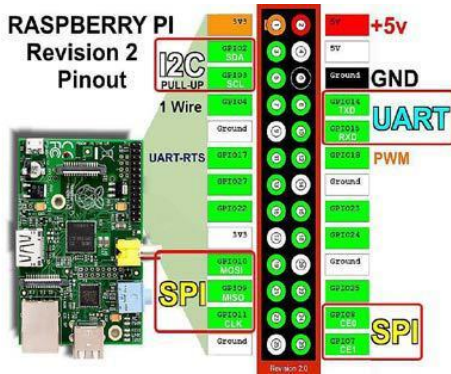


Figure 7. General Purpose Input/output (GPIO) pin schematic diagram

## VII. WHY PYTHON

Python is a general-purpose, high-level programming language whose design philosophy emphasizes code readability. Python's syntax allows programmers to express concepts in fewer lines of code than would be possible in languages such as C and the language provides constructs intended to enable clear programs on both a small and large scale. In Fig. 8 Python codes supports multiple programming paradigms, including object-oriented, imperative and functional programming styles. It features a fully dynamic type system and automatic memory management, similar to that of Scheme, Ruby, Perl and Tclm and has a large and comprehensive standard library. Like other dynamic languages, Python is often used as a scripting language, but is also used in a wide range of non-scripting contexts. Using third-party tools, Python code can be packaged into standalone executable programs. Python interpreters are available for many operating systems [8].

```
import time
import RPi.GPIO as GPIO
GPIO.setmode(GPIO.BOARD)
GPIO.setup(23, GPIO.IN)
while True:
    if (GPIO.input(23)==True):
        print "Input is True (3.3 volt)"
    else:
        print "Input is False (zero volt)"
    time.sleep(1)
```

Figure 8. Python codes

## VIII. RESULTS

Below Fig. 9 shown the assembly of hardware and test of Raspberry Pi such as Raspberry Pi, USB hub to which keyboard, USB mouse and wife is connected, LED as output, VGA to HDMI converter, temperature controller and sensor.

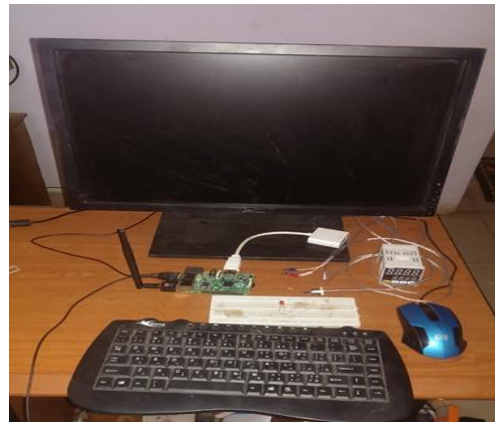


Figure 9. Assembly of hardware

Below Fig. 10 shown the test of hardware, the led it's on when our set point it's activating.

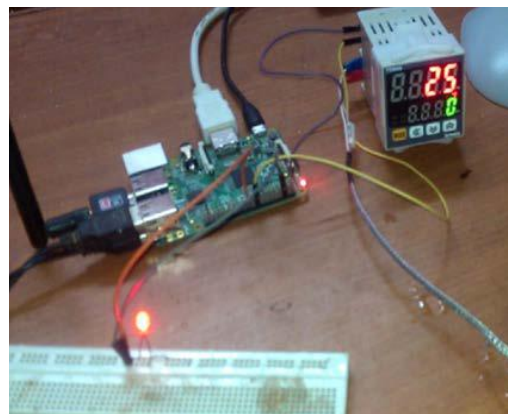


Figure 10. Test of Raspberry Pi

Below Fig. 11 shows model of reactor control plant. Green and Red lamps are connected to display status of valves.

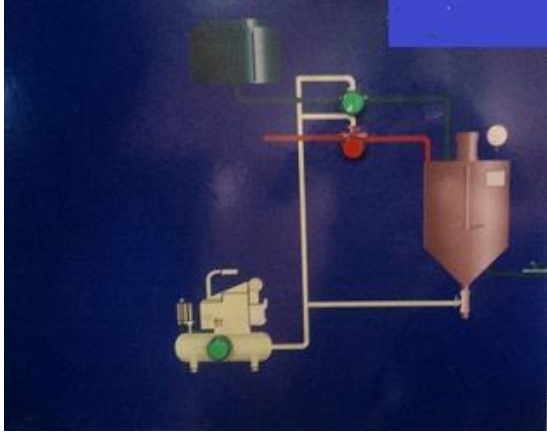


Figure 11. Model of reactor control

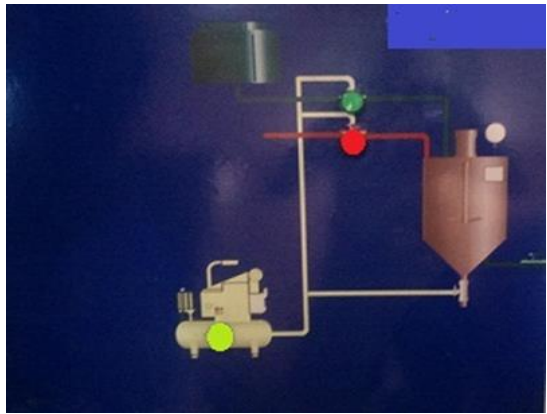


Figure 12. System starting with steam

Above Fig. 12 the system it's starting by adding the steam to the reactor (red lamp). Below Fig. 13 shown the yellow lamp its on means the cooling its adding to the reactor because the set point its active.

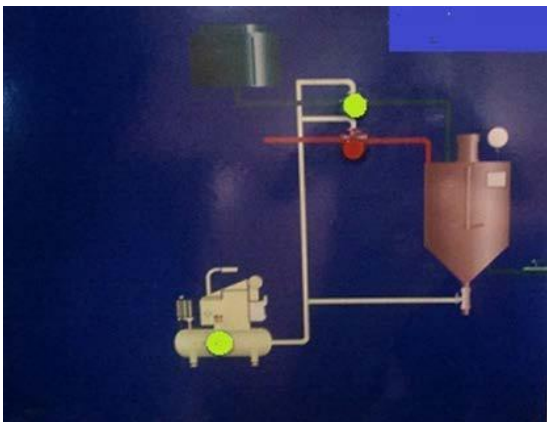


Figure 13. Steam off cooling on

Below Fig. 14 shows Current status of temperature can be monitored with the help of VNC-View based on Linux operating system installed on Raspberry Pi and also can monitored on computer using same program.

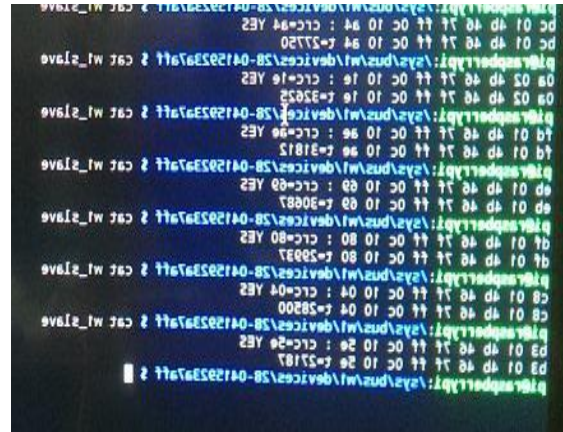


Figure 14. Display of temperature

## IX. CONCLUSION

Raspberry Pi simplifies the process of control and increases the efficiency of Plant. Use of raspberry pi dramatically reduces the price of the system. This application is used for industrial purposes such as process control and monitoring

## ACKNOWLEDGMENT

The authors gratefully acknowledge to AI-Neelain University and Alyarmook Factory.

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