Auctioneering Temperature Control using LabVIEW

Ameem Ahmed Khan, Derrell D'Souza

Abstract—**This paper describes an interesting approach to develop an Auctioneering Temperature control system using LabVIEW. In many processes, the reactors and its modules are enclosed. This makes it critical to control and maintain the temperature of the system so that different functions can be performed without any obstacles. The Hotspot is the highest temperature point in a system. By finding the Hotspot and by maintaining an adequate supply of coolant to the system it is possible to control the temperature of the system. The coolant used can either be a gas or in the form of a liquid. An Arduino system is used for processing the data. It collects the necessary data and passes it to LabVIEW which acts as the graphical programming interface. The Front panel of the LabVIEW displays all the necessary data on the screen. The interface for the various devices is also built on LabVIEW.**

Index Terms— **Arduino, Hotspot, LabVIEW, Thermistor**

1) INTRODUCTION

Whenever a liquid is stored in a tank, its temperature varies along its volume. The liquid has a point where the temperature is maximum called the "HOTSPOT". This point can cause damage to the body of the tank as well as to the liquid it is holding. If the Hotspot is located at the same point throughout the working of the system then it is possible to easily control the system. However in actual process, the Hotspots may take any position along the volume of liquid. If sensing and correction is applied to the temperature of a single point then the temperature of remaining points located at different positions will be left unmonitored which will lead to switching of the control element on and off continuously. Therefore, monitoring and efficient controlling of the system temperature becomes a key objective. This system uses Arduino for processing and embedded evaluation which is interfaced to the LabVIEW. In our system, the "temperature" is sensed at different points where the sensors are placed, and necessary actions are taken to control and maintain the temperature in the required range.

Auctioneering control

In a plant, sometimes it is required to have multiple measurements for a specific variable which has to be regulated through a single action of control. Many measurements are available for our specific variable at different points in the system but the control action should be based on the most critical measurement of the system variable- in our case it is the temperature. Such a technique is known as Auctioneering control.

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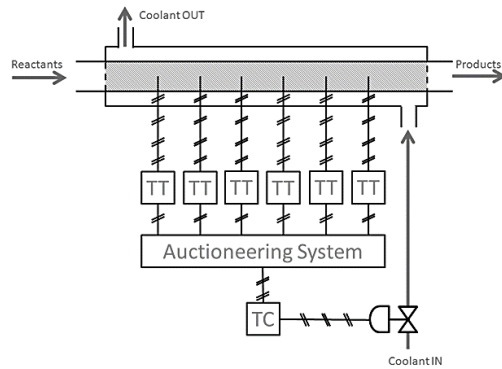
Fig.1: Illustration of Auctioneering control mechanism

Consider the tubular reactor in the fig.1. [1] has defined tubular reactor as a cylindrical reactor where reactants in liquid form react to form various products. If the reaction is exothermic, heat will be generated throughout the reactor in an uneven form. Hence it is necessary to control and regulate the temperature to prevent any damage to the system. Here, an auctioneering control mechanism can be used where the location of the highest temperature can be sensed by the array of sensors and the coolant can be flown accordingly. If the coolant flow rate (corrective action) is taken on the basis of the highest temperature measurement, it will ensure that every other temperature zone is guarded against overheating.

The temperature profile of the tubular reactor is shown in fig.2. The long reactor will consist of many sensors spatially distributed say $y_1\ y_2\ y_3\ y_4......\ y_n$ across the length of the reactor. The auctioneering system will act as a selector and will choose sensor y_k corresponding to the maximum temperature value i.e. the hotspot at any time instant. For e.g. in fig. 2, y_5 corresponds to the hotspot.
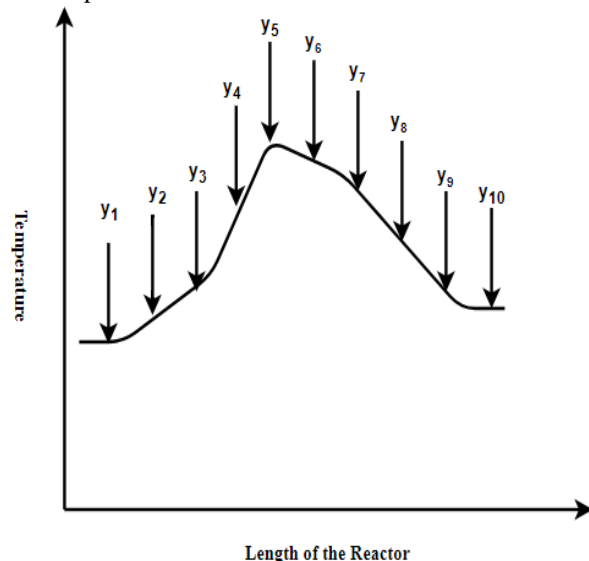

Fig.2: Temperature profile of the tubular reactor
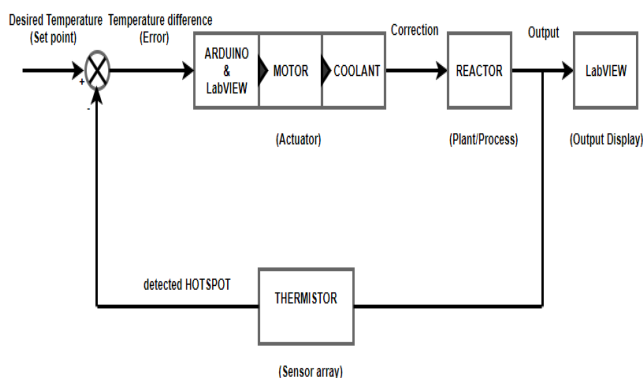
2) SYSTEM BLOCK DIAGRAM

Fig.3: Block Diagram representing the Auctioneering control

Based on the theory from [1], the block diagram has been developed for auctioneering control as shown in fig. 3. The variable temperature is sensed at various locations by the thermistors employed at the respective locations, and necessary control action is performed depending on the requirement. As the reaction inside the reactor is exothermic, reactants will give out heat during the formation of product. Hence it is very important for the temperature to be under maximum threshold beyond which unwanted changes can take place and unstability may occur. The sensors at various points will detect the temperature and the point corresponding to the maximum temperature which is the hotspot will be selected by the Auctioneering system. This temperature will be compared to the desired temperature by the Arduino. The Arduino will then command the motor to allow the coolant to circulate through the system so the temperature is absorbed by the coolant and the temperature is under control.

3) SYSTEM COMPONENTS

Arduino

The Arduino is an open source platform which accounts for both the software and the hardware part of the system. It provides a physical computing platform on a simple microcontroller board as well a development environment for writing programs. The system uses the Arduino Uno which consists of the ATmega328 microcontroller. Arduino Uno has been chosen for processing because it is inexpensive, open source and has a simple programming environment.

Thermistor

A thermistor is a sensor whose resistance will vary significantly with change in temperature. An array of thermistors is been used for measuring the temperatures over the length of the reactors. It is chosen due to its low cost and wider resistance range. The thermistor is interfaced with Arduino so that the temperature data is sent to Arduino for further processing. The interfacing of thermistor with Arduino Uno is shown in fig. 4. A baud rate of 115200 baud is used to initialize connection to the Arduino. The Arduino will read the thermistor sensor data from the Analog pin to which it is connected. The thermistor is paired with 10K resistance for protection.
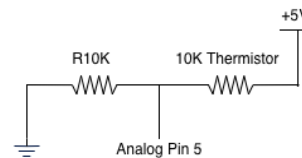

Fig.4: Thermistor interfacing with Arduino

Relay

A relay is an electromechanical device which is actuated by an electric current. They act like switches wherein the current flowing in one circuit causes the opening and closing of another circuit. The interfacing of relay with the Arduino is shown in fig.5
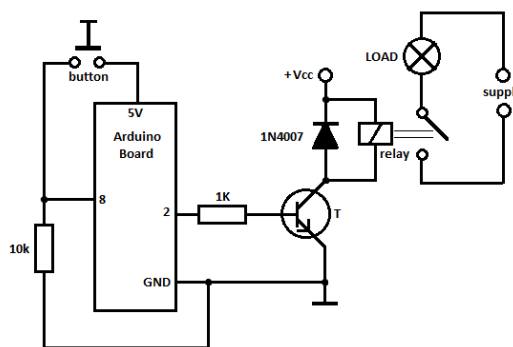

Fig.5: Relay interfacing with Arduino

Pump

Pump is the motor which is used to enable the flow of the liquid coolant throught the entire system. This is triggered if the highest temperature point in the system is beyond the threshold that is set for optimal operation.The pump is connected to the relay circuit.It is operated by a 220-240 V , 50 Hz AC source The connection of pump to the relay is shown in fig.6.
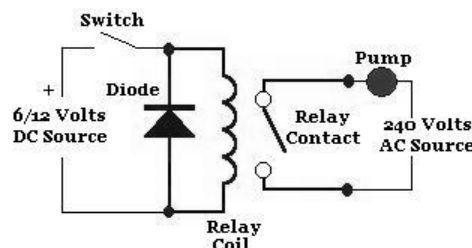

Fig.6: Coolant pump interfacing with Arduino

Heater

An Electric heater is also used to heat the reactants to the required temperature for the reaction to take place. It is interfaced in the same manner as the pump is interfaced.

LabVIEW

[2] has defined LabVIEW as a system design platform developed by Nation Instruments for visual programming and for designing automated systems. It involves three components – block diagram, connecting panel and front panel. Controls and Indicators are used to build the front panel. Indicators are essential to display the status of the system and hence acts as the output. Controls are inputs entered by the user in various format. [3] describes interfacing of LabVIEW with Arduino. The initial step involves interfacing all the sensors, actuators with the

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Arduino, installing LabVIEW 2017 (with NI-VISA drivers) and Arduino IDE for windows.Install the LabVIEW interface for Arduino (LIFA) and upload the sketch 'LIFA_Base.pde' to the Arduino and then you can start working with your LabVIEW program. The entire system with Arduino, Thermistor, Pump, Heater and LabVIEW is shown in fig.7
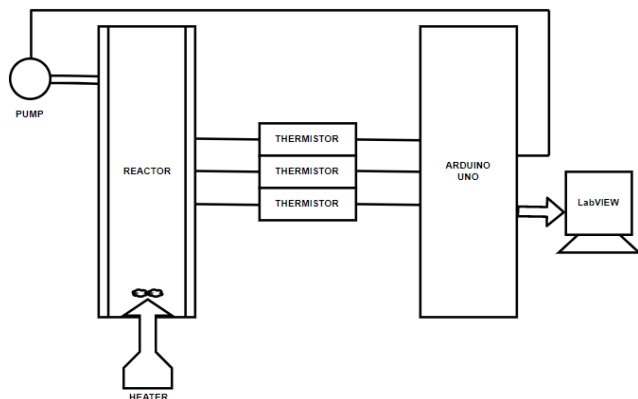

Fig.7: System Architecture

4) SYSTEM VISUALIZATION ON LABVIEW

The LabVIEW block diagram for the system is shown in fig. 8. As seen, the system consists of different components such as terminals, SubVI's, functions, constants,structures and wires that will transfer data amongst different block diagram objects.
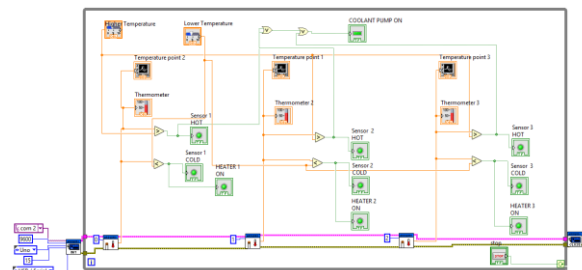

Fig. 8: LabVIEW block diagram

The LabVIEW front panel of the auctioneering control system is shown in fig. 9. It gives us a graphical user interface of the System It shows the temperature of 3 different points where the sensors are placed. It also shows whether the temperatures of the points are hot, cold or normal. The source code for the Front Panel can be obtained from the Block Diagram.
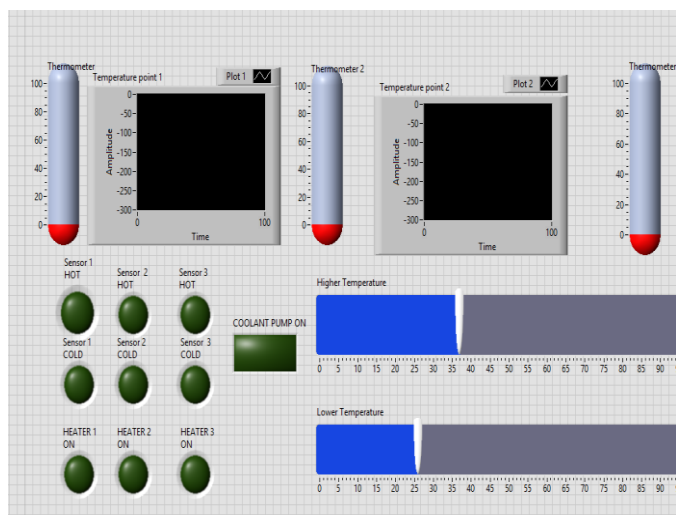

Fig. 9: LabVIEW front panel

5) CONCLUSION

This paper combines the virtual programming graphical enivornment of LabVIEW and basic principles of auctioneering control for real time control of temperature of the tubular reactor.We have shown how it is possible to control a system virtually which has major advantages of system stability and feasibility over the traditional measurement and testing technology. With further optim possible to expand the function.

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