International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 1, pp: 312-317 www.ijaem.net ISSN: 2395-5252

Maintaining Liquid Level in MultiLoop Process Trainer Using ADAM-4022T PID Controller

Prof. Prafulla Patil[1], Prof. Vishal Pande[2], Prof. Vidya Pamale[3], Prof. Megha Trivedi[4]

Assistant Professor[1,2,3], Associate Professor[4], Dept. of Instrumentation Engineering, Vidyavardhini's College of Engg. and Tech., Vasai, India.

Date of Submission: 10-06-2020 Date of Acceptance: 27-06-2020

ABSTRACT: The main purpose of the project is to control liquid level of multi-loop process trainer using DAQ card by ADAM model-4022T. USB to RS485 converter UD2535-U of milestone for interfacing computer with hardware is used. The hardware consists of plant, level sensor, signal conditioning circuit. With an excellent accuracy ±0.15%, ADAM-4022T is an ideal controller for level and other process as it has built in dual loop PID-Controller. The ADAM is provided with PID values from the level sensor installed in a tank of a plant. These values are then fed to ADAM and it takes the necessary action of controlling the plant liquid level. It also provides the trend chart which displays the actual process by taking the real time data.

KEYWORDS: DAQ CARD (Data Acquisition), PID (Proportional Integral Derivative), USB to RS485 converter UD2535-U, Capacitive (level sensor), real time trend chart.

I. INTRODUCTION

Level control is an essential parameter in many industries such as Chemical plants, beverage, oil and gas, etc. Therefore Level control is an important factor in many process measurements and control of level requires accuracy and precision, if these two aspects are not met then, anomalous results might be obtained. Considering these two parameters we have designed a liquid level control of multi-loop process trainer using ADAM 4022T. In this plant we have used capacitive level sensor which senses the level of the tank and gives output in form of current (milliampere). This current is converted into a standard signal 4-20 mA and is given as an input to ADAM 4022T. ADAM 4022T has a built in PID controller which maintains the level of the tank at given set point.

PROJECT FLOW

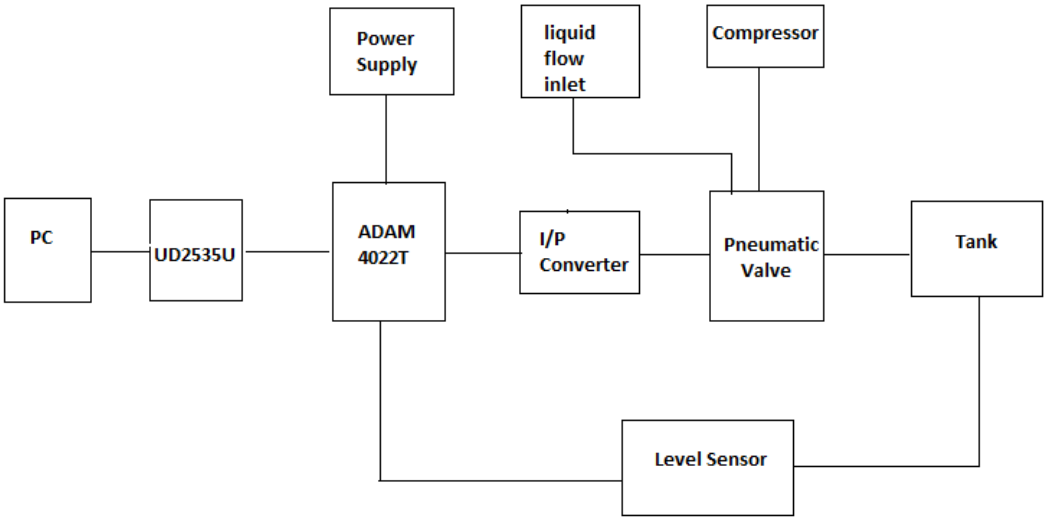


Fig.1 Project Flow Block Diagram

International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 1, pp: 312-317 www.ijaem.net ISSN: 2395-5252

The level in the tank is measured by capacitive level sensor which gives output in mA is given to signal conditioning circuit. This signal conditioning converts the output of sensor into the standard 4 -20mA current signal .This is fed to ADAM input side. As per the PID values provided by the user the ADAM takes the necessary action it also controls the process and maintains the process variable at set point. The ADAM utility software which is present in the pc is connected to ADAM by USB to RS485 converter UD2535-U.

II. SIGNAL CONDITIONING CIRCUIT

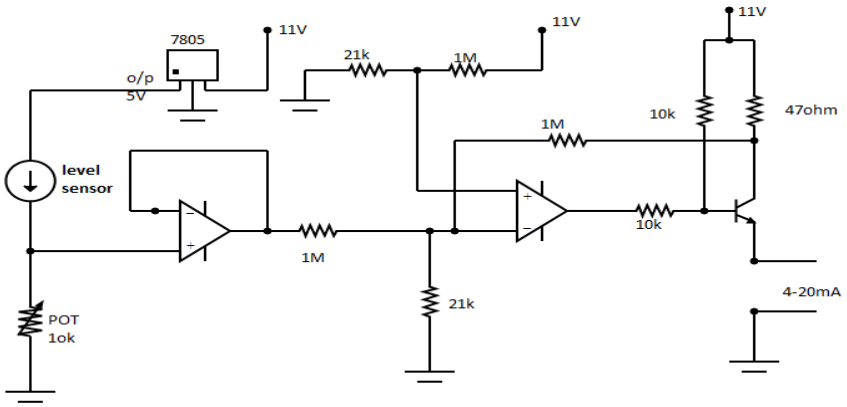


Fig.2 shows the major components of the signal conditioning circuit.

The components are described as follows:

A .Capacitive Level Sensor : capacitor is basically two parallel electrodes which are electrically insulated from each other and have an dielectric medium in between the two. The selection of these electrodes is based on their conductivity so metal are preferred. Our capacitive level sensor is based on the principle of varying dielectric between these electrodes. As liquid level varies, dielectric between the electrodes starts varying, as relative dielectric is different for different medium which results in change in capacitance. These change in capacitance is then measured and given to signal conditioning circuit for further processing of signal.

Formula :

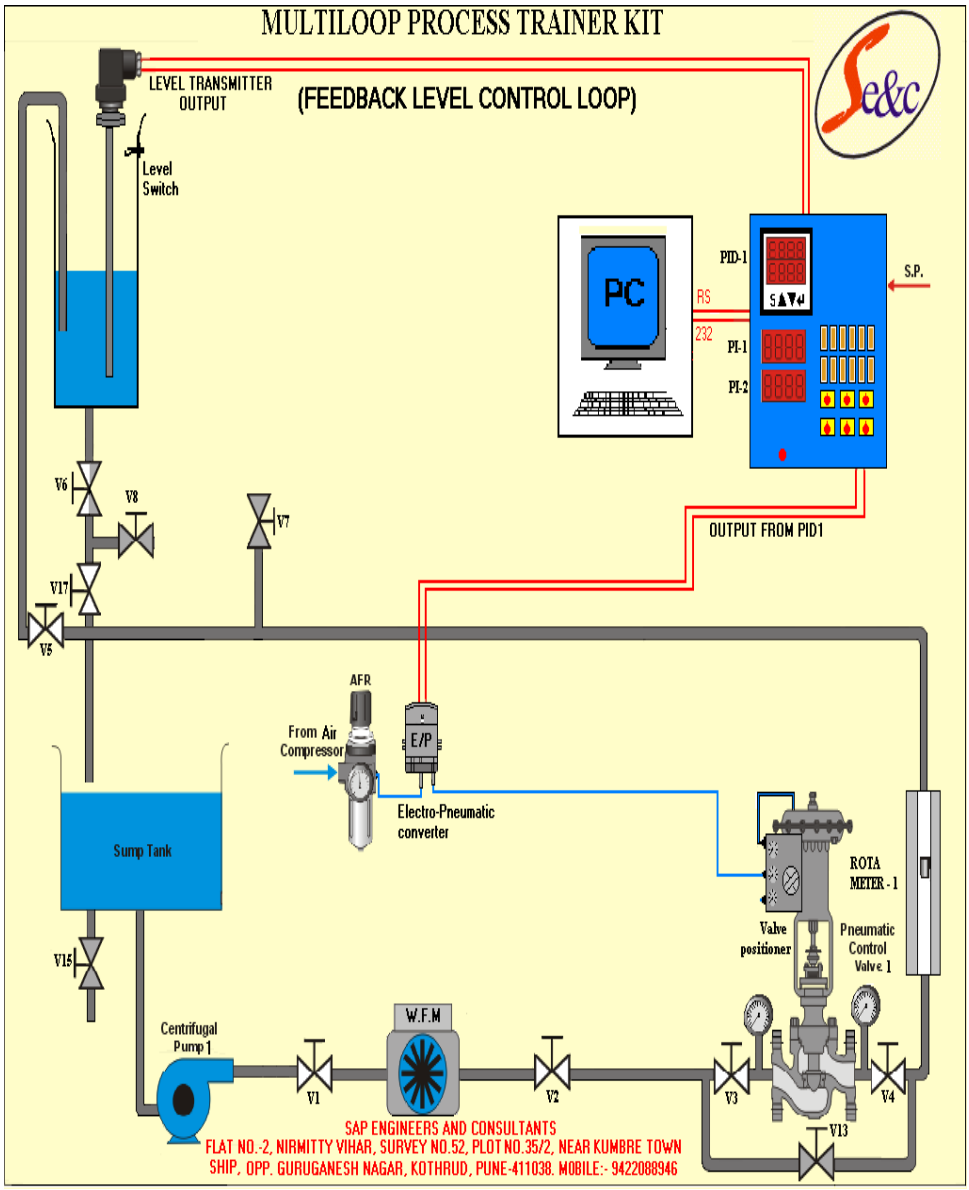
$$C = \varepsilon_0 \varepsilon_r \frac{a \times b}{d}$$

- Conductor *area*, $a \times b$
- *Distance*, d, between the two conductor plates
- Dielectric material between two conductors, characterized by the dielectric constant, ε_r.

As the area and the distance between two plates is constant, capacitance is directly proportional to the dielectric constant. In practice, for capacitance type level measurement, capacitance is formed by wall of the tank (if tank is conductive) and an insulated probe mounted in the tank.

For non-conductive tank, reference probe is used to serve the purpose of second probe. Consists of a sensing electrode with integral electronics housed in an enclosure on its upper end. The sensing electrode is provided with flanged or screwed process connections for mounting it on the tank. The sensing electrode is bare or insulated depending on dielectric of the material. The measuring principle is based on the value of capacitance formed between the electrode and tank wall, which varies with the level of material. This capacitance is sensed and converted in to voltage signal to actuate the output.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 1, pp: 312-317 www.ijaem.net ISSN: 2395-5252



B. LM324 : The LM324 series are low-cost, quad operational amplifiers with true differential inputs. They have several distinct advantages over standard operational amplifier types in single supply applications. The quad amplifier can operate at supply voltages as low as 3.0 V or as high as 32 V with quiescent currents about one−fifth of those associated with the MC1741 (on a per amplifier basis). The common mode input range includes the negative supply, thereby eliminating the necessity for external biasing components in many applications. The output voltage range also includes the negative power supply voltage. In our project we have used only two operational amplifiers.

C. BD140 : PNP power transistor in a TO-126; SOT32 plastic package. NPN complements: BD135, BD137 and BD139. Products are pre-selected in DC current gain. Features of BD140 are: High current (max. 1.5 A), Low voltage (max. 80 V)

III. UD2535-U

This device features USB (Universal Serial Bus) interface technology, it is converted to the RS-232 or industrial RS422/485, so it can be easily adopted for industrial machines with RS232 or RS422/485 interfaces. This converter is USB bus powered and does not need any power adapter. Milestone's "UD-25U" is a USB/RS232 to RS485 Converter and designed for high-speed data transmission between computer system through its

International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 1, pp: 312-317 www.ijaem.net ISSN: 2395-5252

USB Port or RS232C Port and peripherals or the other devices having RS485 interface over long distance under high noise conditions. The RS232 standard supports handshaking signals (such as RTS, CTS) and full-duplex communication.

IV. ADAM-4022T

Fig.3. ADAM-4022T

ADAM-4022T utility software can help us to select input and range configuration, set the operating parameter (SP, SV, PV….. etc.) for your process control needed. ADAM-4022T utility software also integrates the trend chart to help you to monitor and debug your control setting.

A. Instrument Driver Network for Adam 4022T:

If 3rd party software wants to connect to ADAM series, It can be communicated through OPC sever. For ADAM-4000, 5000/485 it may apply ADAM-OPC sever. For ADAM5000/TCP, ADAM-6K series it may need Advantech Modbus TCP OPC sever. However this is not free software, customer needs to buy it. The ADAM OPC Servers support three communication protocol servers, including Advantech ASCII Command (AdamOPC), MODBUS/RTU (ModbusRTU), MODBUS/TCP (ModbusTCP) protocol. The servers provide the OPC interface for monitoring the ADAM 4000, ADAM 5000 and ADAM 6000 remote I/O series products. The Modbus TCP OPC Server is used for Ethernet communication and the others are for serial port communication. Therefore the Modbus RTU and Modbus TCPOPC servers could be used for other devices which are supported MODBUS/RTU and MODBUS/TCP protocol. The servers provide several fields for specifying the properties of devices, groups and tags. Those were implemented using advanced programming concepts of the most current version of the OPC specification for use in developing next generation industrial software applications.

In the feedback level experiment the water from sump tank is pumped into the level tank through the pneumatic control valve. A capacitance level probe is inserted into the level tank where the change in capacitance takes place as the water level in the tank changes. A suitable signal conditioning circuit converts the change in capacitance into current signal (4-20 mA), which is fed to the controller via level transmitter. PID-1 controller compares the input signal measured variable (mv) with the set point value (sp) & calculates error signal (e). The output value of PID controller is proportional to the error & PID settings such as proportional band (PB), derivative time (D), integral time (I). The output of the controller-1 (4-20 mA) is given to the electro-pneumatic converter, which converts electrical signal into the pneumatic one (3-15 psi). This pneumatic signal is fed to the pneumatic actuator (diaphragm) which activates the final control element i.e. control valve by controlling its opening according to the input given & the flow is manipulated (manipulated variable). As per the manipulation of flow the level in the tank is controlled. This process goes on till the error becomes zero & output stabilizes that means actual level or measured variable matches with the set value or set point. The system becomes stable until the disturbances is inserted manually or generated by default. The manual disturbance generation means changing the set point & observing the response of the system for same settings.

B.PID Loop Configuration

ADAM-4022T, in General connection MODBUS is selected as we have used the Modbus for data transmission with the field i.e. the single board heater. Input connection channel PV0 is set with 4 to 20mA and channel ch0 is selected. Output connection AO is selected and 4 to 20mA is set. PID configuration set point i.e. SV is set at 60% of input values. Trend chart is displayed which shows PV, SV, MV values.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 1, pp: 312-317 www.ijaem.net ISSN: 2395-5252

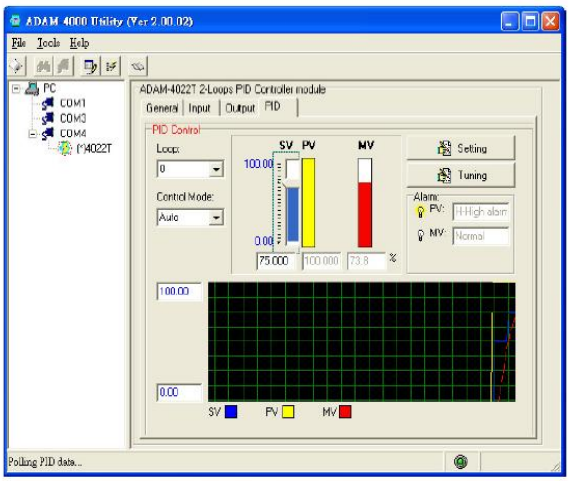


Fig.4. PID Loop configuration

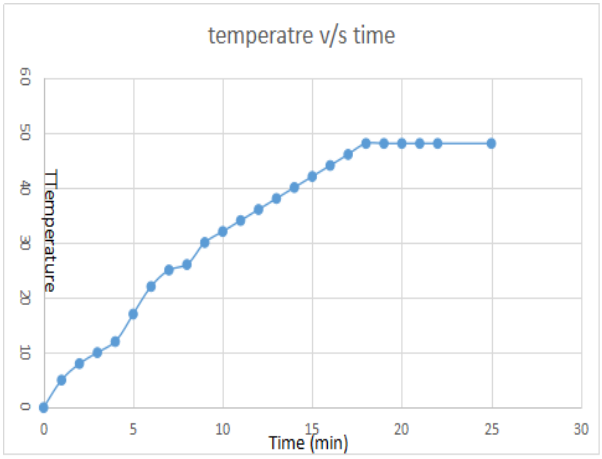


Fig.6. Response of single board heater

V. EXPRIMENT RESULT

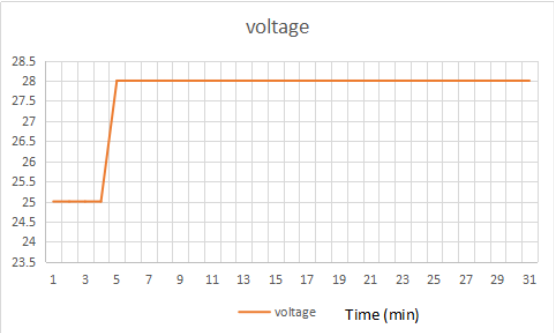


Fig. 5.Step test for Cohen- Coon testing

PID values by calculation (Cohen-Coon Technique)

	Kc	τ i	τ d
PID	$\frac{\tau}{k*td}\left(\frac{4}{3}+\frac{td}{4\tau}\right)$	$td\left(\frac{32+6td/\tau}{13+8td/\tau}\right)$	$td\left(\frac{4}{11+2td/\tau}\right)$
	7.65	4.705	0.356

VI. RESULT AND CONCLUSION

A proper level control is achieved using ADAM 4022T. As we have used the Adam in single loop mode we can only control single parameter i.e. level. Further we can also modify the system and can use the ADAM as dual loop PID controller. PID controller is easy and fast way to achieve the desired set point. The experiment performed using ADAM-4022T will help the industrial setup. In industries it becomes very difficult to make changes without any prior results this experiment will thus help them to achieve their desired modification.

REFERENCES

[1]. Paper entitled "Single Board Heater Using Adam-4022t PID Controller" In IJAREEIE Journal , Vol. 5, Issue 4, Apr. 2016
[2]. Astrom K., Hagglund T., "PID controllers: theory, design and tuning", USA: Instrument Society of America; 1995. www.prosoft.ru/cms/f/261491/ADAM-4022Tpdf.pdf
[3]. en.wikipedia.org/wiki/PID_controller
[4]. vlabs.iitb.ac.in/sbhs/static/manual/sbhs-new-manual.pdf
[5]. www.analog.com/media/en/technical-documentation/data-

[6]. www.ti.com/lit/ds/symlink/lm124-n.pdf
[7]. www.engineersgarage.com/electronic-components/7805-voltage-regulator-
[8]. www.ti.com/product/LM7805C
[9]. en.wikipedia.org/wiki/78xx
[10]. www.st.com/web/en/resource/technical/document/datasheet/CD00001225.pdf
[11]. www.milestone.co.in/usbtors485.htm
[12]. www.chem.mtu.edu/\~tbco/cm416/tuning_methods.pdf
[13]. Paper Entitled "A Systematic Method for Gain Selection of Robust PID Control for Nonlinear Plants of Second-Order Controller Canonical Form" By, Pyung Hun Chang, IEEE TRANSACTIONS ON CONTROL SYSTEMS TECHNOLOGY, VOL. 17, NO. 2, MARCH 2009
[14]. "Improving PID Controller Performance," Development zone National Instruments USA.

Prof. Prafulla Patil, et. al. "Maintaining Liquid Level in MultiLoop Process Trainer Using ADAM-4022T PID Controller." *International Journal of Advances in Engineering and Management (IJAEM)*, 2(1), 2020, pp. 312-317.

International Journal of Advances in Engineering and Management
ISSN: 2395-5252

IJAEM

Volume: 02 Issue: 01 DOI: 10.35629/5252

www.ijaem.net
Email id: ijaem.paper@gmail.com