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KOLKATA

NETAJI SUBHASH ENGINEERING COLLEGE

DEPARTMENT OF APPLIED ELECTRONICS AND INSTRUMENTATION ENGINEERING

PROCESS CONTROL LABORATORY (EI-691)

EXPERIMENT NO : 1

NAME OF EXP : PRESSURE CONTROL

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Title: Study of a typical Pressure Control Loop having Pressure source, Pressure Transmitter, Motorized/Pneumatic control valve, and conventional PID controller.

Objective: To obtain the closed loop response of pressure control loop with suitable PID controller.

Theory: The major components of Pressure loop are Process tank, Pressure transmitter, controller, control valve, I/P converter

Pneumatic valve :

Pneumatic valve is a device that regulates the flow of fluids by opening, closing, or partially obstructing various passageways pneumatically.

Pressure Transmitter:

Pressure transmitter is a device that senses a process variable through the medium of a primary element & that has an output whose steady state value varies only as a predetermined function of the process variable. The primary element may or may not be integral with the transmitter.

Controller:

Two position control applied to a process results in a continuous oscillation in the variable to be controlled. This drawback was overcome by a continuous control action which could maintain a continuous balance of the i/p and o/p. The different modes of continuous controllers are proportional (P), integral (I), derivative (D), PI, PD, PID. The tuning parameters for the PID controller are

1. Proportional gain (Kp)
2. Integral gain (KI)
3. Derivative gain (KD)

Based on the nature of processes a particular mode should be selected.

I/P Converter:

I/P converter is a device which receives information in the form of an instrument signal i.e. Current signal, alters the form of information, & sends out a resultant output signal i.e. Pressure signal.

Control valve:

In most of the industrial process control systems control valve is the final control element. The control valve consists of two major components namely actuator and valve. The actuator is made up of flexible diaphragm, spring and spring tension adjustments, plate, stem and lock nut, housing. The valve is made up of body, plug, stem, pressure tight connection.

Based on the principle of operation the control valves can be classified into

1. Linear
2. Equal percentage
3. Quick opening.

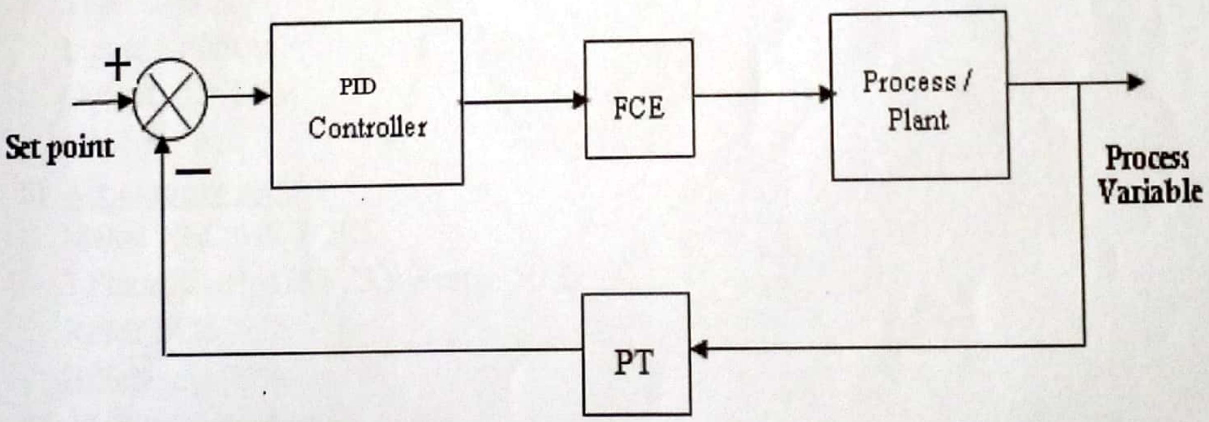
Linear control valve: Flow is directly proportional to valve lift.

Equal percentage control valve: Flow changes by a constant percentage of its instantaneous value for each unit of valve lift.

Quick opening control valve: Flow increases rapidly with initial travel reaching near its maximum at a low lift.

The output pressure of I/P converter is given to the control valve which changes the opening of the control valve and hence changes the flow rate.

Block Diagram:



Scanned by CamScanner

Specification of The Apparatus :

1) **Pneumatic valve:**
Make : Dembla Valve Pvt. Ltd.
Sr. No: 16531
Model: DVP.DA.1
Supply: 1.4 kg/cm^2
Output: 0.2-1.0 kg/cm^2

2) **Electronic valve:**
Make: Honeywell
24V, 50Hz, 12.5VA, Class2
Output: 4-20mA DC

3) **Pressure Transmitter:**
Make: Honeywell
Supply: 24V DC
Output: 4-20mA DC
Range: 0-3 Kg/cm^2

4) **I/P converter:**
Make: Watson Smith
Type: 100 X
Input: 4-20mA
Output: 0.2-1 bar
Inlet: 5.5 bar

5) **Air compressor:**
Make: NEC MOTORS
3 Phase, 2HP, 415V, 3.8 Amps, 50Hz,
RPM: 1425
Efficiency: 75%

6) **Air filter regulator :**
Make: Gautam Pneumatics Pvt. Ltd.
Supply pressure: 400 psi(max^m)
Reduced pressure: 2-150 psi

Procedure:

1. Switch on the power supply and the motor.
2. Select a suitable controller.
3. Select a suitable actuator (pneumatic /electronic).
4. Observe the response.
5. Let the process to reach the steady state.
6. View the response for different set points and plot the response.

Precaution:

1. The pressure should be maintained in constant rate for pneumatic type control.
2. The valve of pressure gauge end should be closed for maintaining pressure in the total process loop.
3. PID values of local controller should not be manipulated.
4. Always check the water level of the tank.

Observation Table :

SL. NO.	SP	AVG. PV	PV	TIME (IN MINS.)
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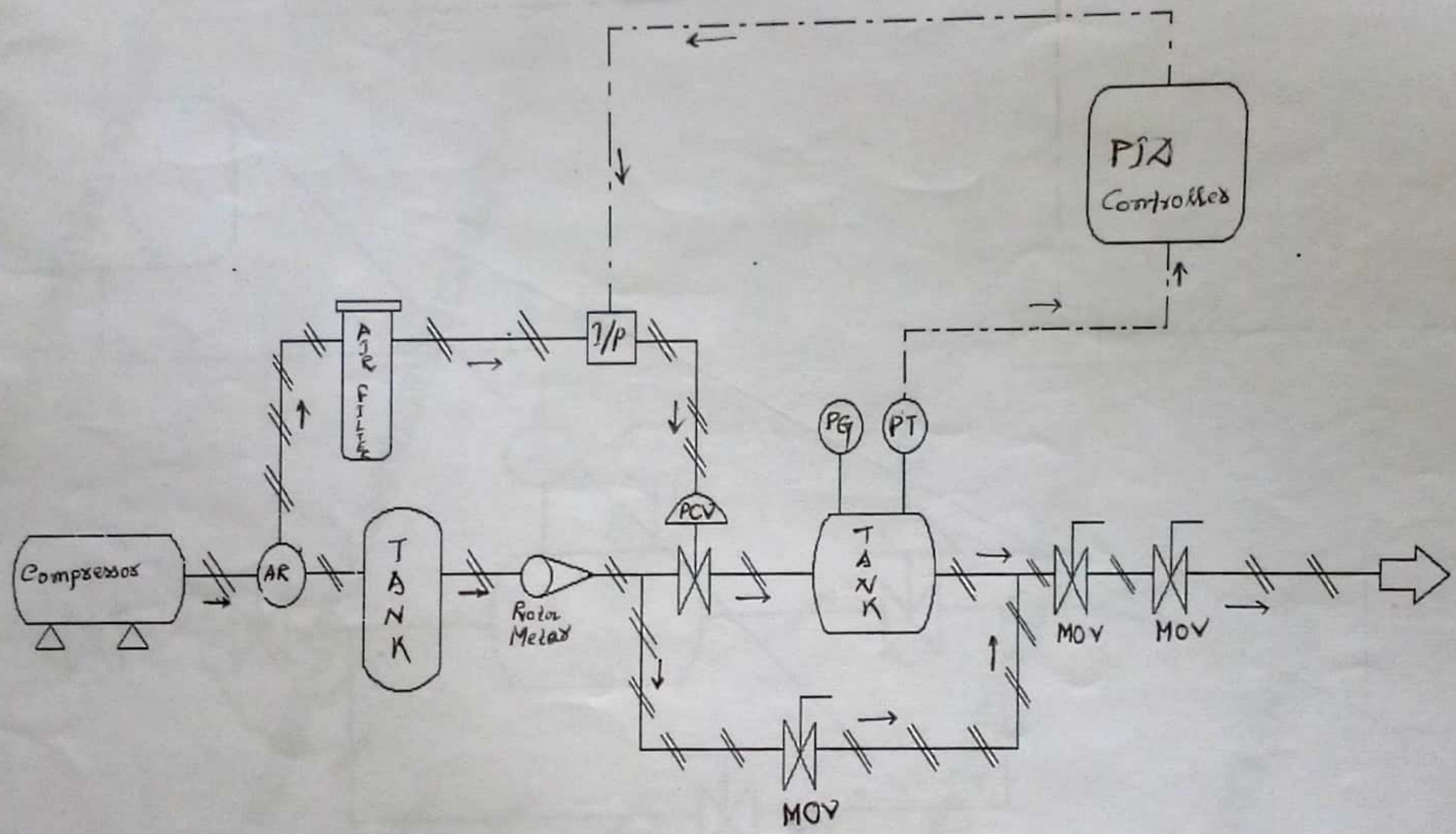
PID
Controller
I/P
Air Filter
Compressor
AR
TANK
Rotor Meter
PCV
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PT
TANK
MOV
MOV
MOV

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PROCESS CONTROL LABORATORY (EI-691)

EXPERIMENT NO : 2

NAME OF EXP : LEVEL CONTROL

Title: Study of a typical Level Control Loop having Level Transmitter, Motorized control valve, and conventional PID controller/Control System

Objective: To obtain the closed loop response of level control loop with PID controller.

Theory: The major components of level loop are Process tank, level transmitter, controller, control valve.

Process Tank :
The process tank has one inlet valve and one outlet valve. The level can be controlled either by controlling the inlet flow rate or outlet flow rate or both.. In the level loop set up the control valve is placed in the inlet path. So the level of the tank will be controlled by controlling the inlet flow rate.

Level Transmitter:
Here the Ultrasonic type transducer is used as a level transmitter.
Ultrasonic level instruments operate on the basic principle of using sound waves to determine fluid level. The frequency range is 20-200 kHz. A piezoelectric crystal inside transducer converts electrical pulses into sound energy that travels in the form of a wave at the established frequency & at a constant speed in a given medium. The medium is normally air. The sound waves are emitted in bursts onto the surface of the material whose level is to be measured & received back at the transducer as echoes. The instrument measures the time of travel down to reflecting surface & return. The time will be proportional to the distance & that will help to determine the level of the fluid.

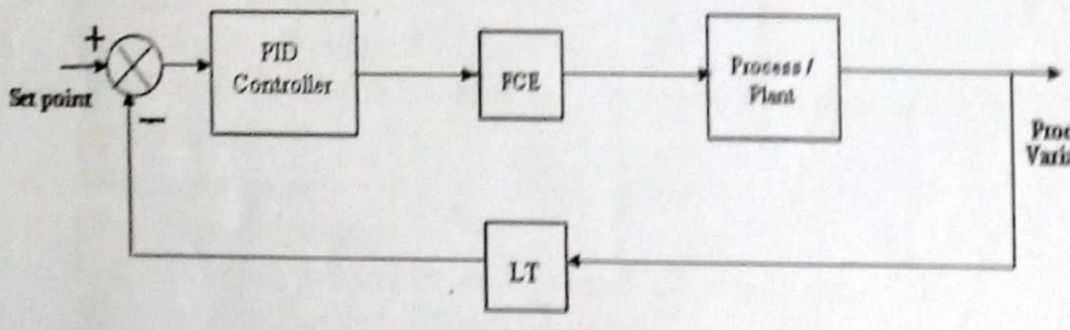
Controller:
Two position controls applied to a process results in a continuous oscillation in the variable to be controlled. This drawback was overcome by a continuous control action which could maintain a continuous balance of the i/p and o/p. The different modes of continuous controllers are proportional (P), integral (I), derivative (D), PI, PD, PID. The tuning parameters for the PID controller are
1. Proportional gain (K_C)
2. Integral gain (K_I)
3. Derivative gain (K_D)
Based on the nature of processes a particular mode should be selected.

Control valve:

In most of the industrial process control systems control valve is the final control element. The control valve consists of two major components namely actuator and valve. The actuator is made up of flexible diaphragm, spring and spring tension adjustments, plate, stem and lock nut, housing. The valve is made up of body, plug, stem and pressure tight connection.

Here the Level transmitter transmits the electrical signal of the process variable (PV) to the controller and the controller calculates the deviation from the set point and sends a control action to the actuator. The percentage of opening of the control valve depends upon the control action. In this way the inlet flow rate of the process tank is controlled, thus the level of the tank is controlled.

Block diagram:



Specification of The Apparatus :

1) **Capacitive type level transmitter:**
Make: LEVCON CONTROLS PVT. LTD.
Model: LCP133142
S/N: 10087
Power supply: 230 V AC
Output: 4-20 mA DC

2) **Electronic valve:**
Make: Honeywell
24V, 50/60Hz, 12.5VA, Class2
Output: 4-20mA DC

Procedure:

1. Check the level of water in the tank whether it is filled with water or not.
2. Switch on the power supply.
3. Switch on the motor.
4. Select a suitable controller (Remote/local).
5. Select a suitable Level transmitter (Ultrasonic level transmitter or Displacer type level transmitter)
6. Select a set point.
7. Observe the response.
8. Let the level of the process tank to reach the steady state
9. View the response for different set points.
10. Draw the characteristics graph.

Precaution:

1. Do not control the outlet valve of the drum randomly. That will not let the water level calibrated.
2. Handle the local/remote controller carefully.
3. Keep the outlet valve slightly opened.
4. Check whether there is any leakage in water path.
5. Don't switch on the motor when control valve is fully closed.
6. Fix the alarm to a proper value. That the drum never overflows.

Observation Table :

SL. NO.	SP	PV (in mm)	TIME (IN MINS.)
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Work-Sheet

Graph:

Comments:

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EXPERIMENT NO : 3

NAME OF EXPERIMENT: FLOW CONTROL

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Title: Study of a typical Flow Control Loop having suitable Flow meter, Motorized control valve, and conventional PID controller.

Objective: To obtain the closed loop response of flow control loop with PID controller.

Theory: The major components of flow loop are Orifice plate, Differential pressure transmitter (DPT), Mass flow meter, controller, control valve, process tank.

Orifice Plate:
The working principle of orifice plate is "vena contracta' effect. When a restriction is introduced in the pipe line, the velocity of the fluid through the restriction increases and the pressure decreases. The relationship between the pressure drop and the rate of flow is

Q = K p; where Q = volume flow rate
K = a constant for a pipe and liquid type
p= pressure drop across the restriction.

The different types of orifice plates are

1. Concentric
2. Eccentric
3. Segmental

DPT:
Differential pressure transmitter is a device which converts differential pressure into current. The differential pressure generated by the orifice plate is given to two sides of parallel plate capacitive transducer made up of thin diaphragms separated by a small distance. When the pressures applied, it changes the spacing between the diaphragms (d) which changes the capacitance since the equation of capacitance is $C = \varepsilon A / d$

Where C – Capacitance
ε – Dielectric constant
A – Overlapping area of plates
d – Distance between the plates

This change in capacitance is converted into current using suitable signal conditioning circuit.

Coriolis Mass Flowmeter:
A Coriolis meter works on Coriolis Effect, hence it is named so. Coriolis meters are considered to be true mass meters since they tend to measure the mass rate of flow directly while other flowmeter technologies measure volumetric flow. Since mass does not change, no adjustments are needed for varying fluid characteristics. Hence, a Coriolis meter operates in linear fashion.

These types of meters exist in variety of designs. The most common type of unit includes
1. a U-shaped flow tube
2. a sensor assembly
3. an electronics unit

In this meter unit, the liquid passes through a U-shaped tube which vibrates in an angular harmonic oscillation. Coriolis forces will then deform the tube and a further vibration component gets added to the already oscillating tube. This added vibration element results in a phase shift or twist in few parts of the tubes. This resulting phase shift which is directly proportional to the liquid mass flow rate is measured with the help of sensors. This measured information is further transferred to the electronics unit where it gets transformed to a voltage proportional to mass flow rate, which is transferred to the controller unit.

Controller:

Two position controls applied to a process results in a continuous oscillation in the variable to be controlled. This drawback was overcome by a continuous control action which could maintain a continuous balance of the I/p and o/p. The different modes of continuous controllers are proportional (P), integral (I), derivative (D), PI, PD, PID. The tuning parameters for the PID controller are
1. Proportional gain (Kp)
2. Integral gain (KI)
3. Derivative gain (KD)

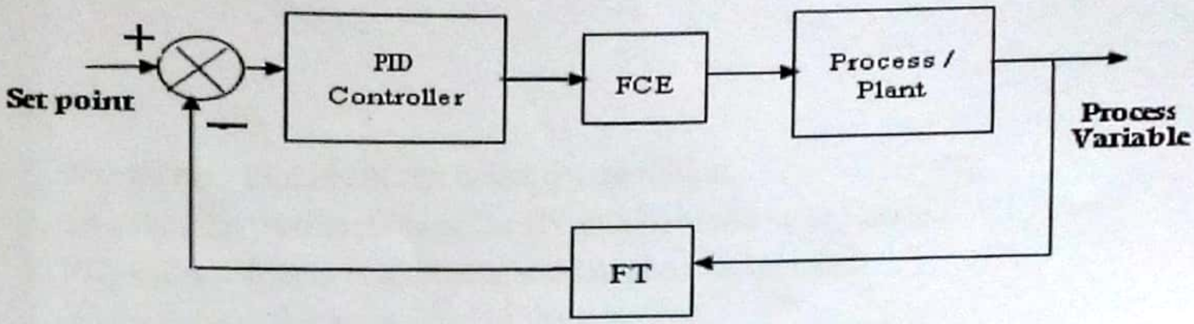
Based on the nature of processes a particular mode should be selected.

Control valve:

In most of the industrial process control systems control valve is the final control element. The control valve consists of two major components, 1. Actuator 2.Valve. The actuator is made up of flexible diaphragm, spring and spring tension adjustments, plate, stem and lock nut, housing. The valve is made up of body, plug, stem, pressure tight connection.

Here differential pressure from the orifice plate is measured by DP transmitter and the electrical signal from the transmitter is sent to the controller. On the other hand mass flow meter sends the signal to the controller when the water flows through the mass flow meter. The controller calculates the deviation from the set point and sends a control action to the actuator. The percentage of opening of the control valve depends upon the control action.

Block diagram:



Specification of The Apparatus :

1) **Flow Transmitter:**

Differential Pressure Transmitter Type
Make : Honeywell
Model : STD 720-E1AC4AS
S/N: 14W25 C4000000707426
Power Supply : 11 to 42 V DC
Output : 4-20Ma
Range: -400 to 400 InH2O

Mass Flow Transmitter
Make : Micro Motion
Power supply: 230V AC
Output : 4-20mA

Procedure:

1. Switch on the power supply and the motor.
2. Select a suitable controller.
3. Select a suitable flow transmitter (MFM/DPT).
4. Observe the response.
5. Let the process to reach the steady state.
6. View the response for different set points and plot the response.

Precaution:

1. The process should not run under dry condition.
2. To avoid the malfunctioning the PV & SP should be calibrated.
3. PID values of local controller should not be manipulated.
4. Always check the water level of the tank.
5. Only one process should run at a time.

Observation Table :

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Work-Sheet

Graph:

Comments:

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EXPERIMENT NO: 4

NAME OF EXPERIMENT: TEMPERATURE CONTROL

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Title: Study of a typical Temperature Control Loop having suitable final control element, Temperature transmitter, and conventional PID controller.

Objective: To obtain the closed loop response of temperature control loop with suitable feedback controller.

Theory: The major components of temperature loop are Water tank, heater, temperature transmitter, controller.

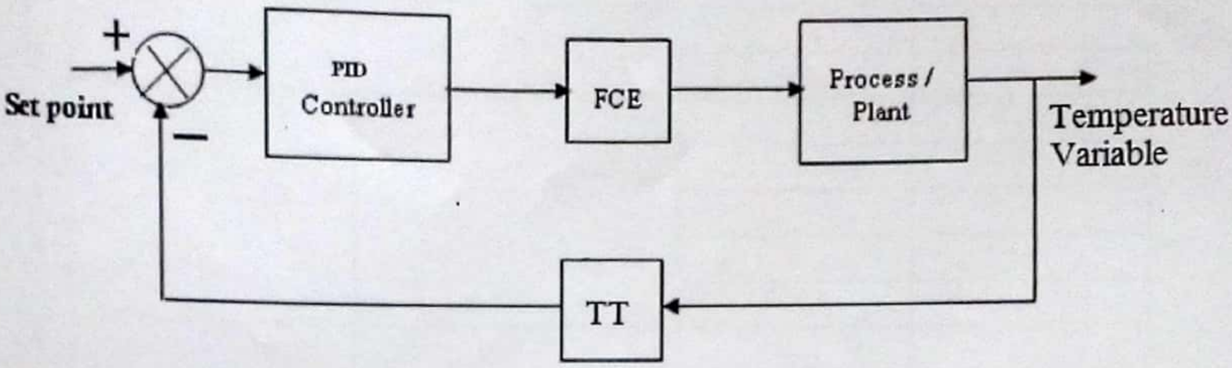
Temperature Transmitter:
Temperature transmitter consists of a thermocouple and signal conditioning circuit. Thermocouple works on "Seebeck effect", "Peltier effect" and "Thomson effect". The working principle of thermocouple is, when two junctions of two dissimilar metals are kept at two different temperatures an emf is produced which is proportional to the temperature difference. This emf is converted into current using suitable signal conditioning circuit. There are different types of thermocouple. Here in our process station K type is used.

Controller:
Two position control applied to a process results in a continuous oscillation in the variable to be controlled. This drawback was overcome by a continuous control action which could maintain a continuous balance of the i/p and o/p. The different modes of continuous controllers are proportional (P), integral (I), derivative (D), PI, PD, PID. The tuning parameters for the PID controller are

1. Proportional gain (Kp)
2. Integral gain (KI)
3. Derivative gain (KD)

Based on the nature of processes a particular mode should be selected.

Block Diagram:



Specification of The Apparatus

Water Heater:

IHCU 30/28

230V, 3000W

Procedure:

1. Give connections between the process and controller (Computer).
2. Switch on the power supply and the heater.
3. Select a suitable controller and tune the controller parameters.
4. Observe the response. After reaching the steady state give disturbance by changing the blower speed.
5. Let the process reach the steady state.
6. View the response for different set points.
7. Plot the transmitter characteristics, controller characteristics and closed loop response.

Observation Table :

SL. NO.	SP	AVG. PV	PV	TIME (IN MINS.)
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Work-Sheet

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