**Experiment No. (5) Feedback Control**

**Objective of the experiment:**

The object is to plot the response of the system to a step change in the setting of the out flow pinch valve.

**Introduction:**

In this system suggest that the controller should change the flow rate input by an amount proportional to the error. The controller is instructed to maintain the flow rate input at the steady state design valve qs as long as h is equal to hs as long as (error = zero) if h deviates from hs causing an error. The controller is to use the magnitude of the error to change the flow rate input proportionality. The deviation of the system from its desired value.

**Theory:**

For the first-order system consider the system is shown in Figure (l) which consists of a tank of uniform cross-sectional area A to which is attached a flow resistance R such as a valve, a pipe is a weir. Assume that qo the volumetric flow rate (volume/time) through the resistance, is related to the head h by the linear relationship.

ℎ

𝑞𝑜 = 𝑅

…… (1)

A resistance that has this linear relationship between flow and head is referred to as linear resistance. A time-varying volumetric flow q of liquid of constant density *p* enters the tank. Determine the transfer function which relates head to flow.

We can analyze this system by writing a transient mass balance around the tank. Rate of mass flow in - Rate if mass flow out = Rate of accumulation

𝑞 − 𝑞𝑜

= 𝐴 𝑑ℎ

𝑑𝑡

………. (2)

Combining Eq.(l) and (2) to eliminate qo gives the following linear differential equation.

𝑞 − ℎ

𝑅

= 𝐴 𝑑ℎ

𝑑𝑡

…….. (3)

**Procedure:**

1. With the outlet flow valve slightly opened, allow the system to operate until the water level in the lower vessel has established, write a note of the water level.

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2. Open the pinch valve fully, noting the time and measure the level of water every five seconds until the level has established again (tabulate level (cm) versus time per (sec)).

3. Repeat the experiment this time by suddenly decreasing the opening of the pinch valve so that the water out flow is substantially reduced (this method used for both cases (1) and (2)

4. Plot your measurement on the graph with time represented by the horizontal- axis and water level on the vertical axis.

**Calculation:**

The system shown in Figure below which consists of a tank of uniform cross-section area A to which is attached a flow resistance R such as valve, a pipe or weir. Assume that qout volumetric flow rate through the resistance is related to the head h by linear relationship 𝑞𝑜𝑢𝑡=ℎ𝑅

1. Derive the transfer function of the process using the following equation

𝑞−𝑞𝑜=𝑑𝑣𝑑𝑡 where 𝑞𝑜=ℎ𝑅

2. Derive the theoretical response H(t) to step change in Qᵢ (Qᵢ(s) = 𝐴𝑆 )

3. Calculate the theoretical time constant **(**𝝉**theo).**

𝝉**theo= A.R**

A = 𝜋

4

d*²* ((Radians at the vessel = 5 cm))

R=hat ssqo at ss

4. Plot the theoretical response H(t) time.

H(t)=AR (1−e−tτ)

5. Plot the experimental response H(t) versus time and calculate the experimental time constant.

H (t) = h - hs A’ = A × 0.63

A = max. Value **Process Control Laboratory Fourth Class Chemical Engineering Department University of Technology** - 13 -

6. Calculate the input flow rate:

a. Experimentally:

𝑞ᵢ − 𝑞 = 𝐴 𝑑ℎ

̥

𝑑𝑡

, 𝑞̥ = S. h

Plot level (h) versus time (t), obtain 𝑑ℎ

𝑑𝑡

equal slope for each point.

b. Theoretically:

Plot level (h) versus time (t), obtain — equal slope for each point.

. 𝑞*ᵢ* = C(G-h) at any time .

Diameter of the vessel = 10 cm.

S = 1 valve capacitance.

C = proportionality constant = 20 cm2/sec.

G = steady state level [Final level] (cm). . h = level at any time.

7. Draw the close – log Response of the liquid level control in a tank.

**Discussion:**

Compare and discuss your re

sults experimentally and theoretically.