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COMPARISON BETWEEN PID CONTROLLER IN CONVENTIONAL CONTROL AND PID IN SIMULINK IN REFINING GOLD SCRAPS

Nehal EL Fadil HasabSeedo*, Prof. Gurashi A Gasmelseed, Prop. Ibrahim Hasan Amine
* Karray university, Faculty of Engineering
University Science and Technology, Khartoum, sudan

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ABSTRACT

In this study a comparison between PID controller in conventional control and PID control in Simulink was investigated. A control strategy was developed for purification of gold by aquaregia method. The aquaregia was composed of 1:3 HNO3 and HCL, therefor a ratio controller was designed to constantly adjust this ratio. The block diagram was drown and the transfer functions were cited from the literature. The stability of the control loops of the system ware calculated and used in the simulation of the loops. From the results of the simulation the controller that gives minimum interaction was selected. The loop paring was determined by the Relative gain array which gives the coupling with minimum interaction.

KEYWORDS: conventional, tuning, Simulink, simulation.

INTRODUCTION

There are a number of refining techniques available for recovering gold, but not all are suitable for small –scale refining in a jewellery production environment. It is worth noting that:

1-The gold purity obtained can vary, depending on the technique and the skills employed in operation. As long as assay is made to ascertain gold purity, this may not be important if the gold is being used for re-alloying in –house, although knowing what the impurities are is important if alloying to a tight colour or property requirements as satisfied.

2 –The impurities not removed by the technique may also be important in considering re-use of the gold for new alloy production. This may be an influence choice of technique.

3 –Ensuring all the gold is recovered, i.e; a yield close to 100%, is economically important. An understanding of underlying technology and good process control is vital.

4 –There are health, safety and environmental pollution aspects to be consider, too. Local legislation on disposing of effluents and release of toxic fumes may restrict choice of techniques required to use strong acids, and the safe strong and handling of these may also restrict choice. Cupellation, Inquartation and parting, Miller chlorination process, Wohlwill electrolytic process, Fizzer cell process, Solvent extraction process, Aquaregia process, Pyrometallurgical gold refining process,

Research objectives:
İnvestigtion of gold extraction methods efficiency and hazop analysis
selection of the more efficient , safe and parameter of control system
development of complete closed loop control method for gold extraction

METHODOLOGY

system stability and tuning by relative gain array ,conventional and Simulink by MATLAB were undertaken. The system is stable when all poles of transfer function have negative real parts. If any poles has positive real part the system is unstable. To checking stability by the four method: Ruoth-Hurwitz, root locus, direct substitution and bode plot were investigated.

Routh-Hurwitz:

The stability of a linear system is determined from the system characteristic equation If there is any negative, the system is unstable, no further calculations. If all the terms in the characteristic equation are positive, then proceed as follows:

- Number of rows = n + l
- Development of array.

Root locus:

- The root- locus is the plots, in complex plane, of the roots of the OLTF.
- They are very useful to determine the stability of closed-loop system as the gain k changes.

Direct substitution:

Determination of the ultimate gains and period by substituting, s= $i\omega$ in the characteristic equation.

$$G_s = \frac{\pi f}{1 \pm \pi l}$$

And ultimate period

$$P_u = \frac{2\pi}{\omega}$$

Bode plot:

The Bode diagram in honour of H.W. Bode gives a convenient method for determination of ultimate gains and period.

Relative gain Array:

Relative gain array is an analytical tool used to determine the optimal input-output variable pairings for a multi-input-multi-output (MIMO) system. A ratio of this open-loop 'gain' to this closed-loop 'gain' is determined and the results are displayed in a matrix.

$$RGA = \wedge = \begin{bmatrix} \lambda_{11} & \lambda_{12} & \lambda_{1n} \\ \vdots & \vdots & \vdots \\ \lambda_{n1} & \lambda_{n2} & \lambda_{nn} \end{bmatrix}$$

The array will be a matrix with one column for each input variable and one row for each output variable in the MIMO system. This format allows a process engineer to easily compare the relative gains associated with each input-output variable pair, and ultimately to match the input and output variables that have the biggest effect on each other while also minimizing undesired side effects.

Understanding the results of the RGA:-

- The closer the values of the RGA to 1 the more decoupled the system
- The maximum value in each row of the RGA determines which variables should be coupled or linked
- Also each row and each column should sum to 1

Simulink:

Simulink is a software package for modeling, simulating, and analyzing dynamic system. It supports linear and nonlinear system, modeled in continuous time, sampled time, or a hybrid of the two. Systems can also be multi-rate, i.e, have different parts that are sampled or updated at different rates. Simulink provides a graphical user interface (GUI) Simulink include a comprehensive block library of sinks, sources, linear and nonlinear component, and connectors.

CONTROL STRATEGY

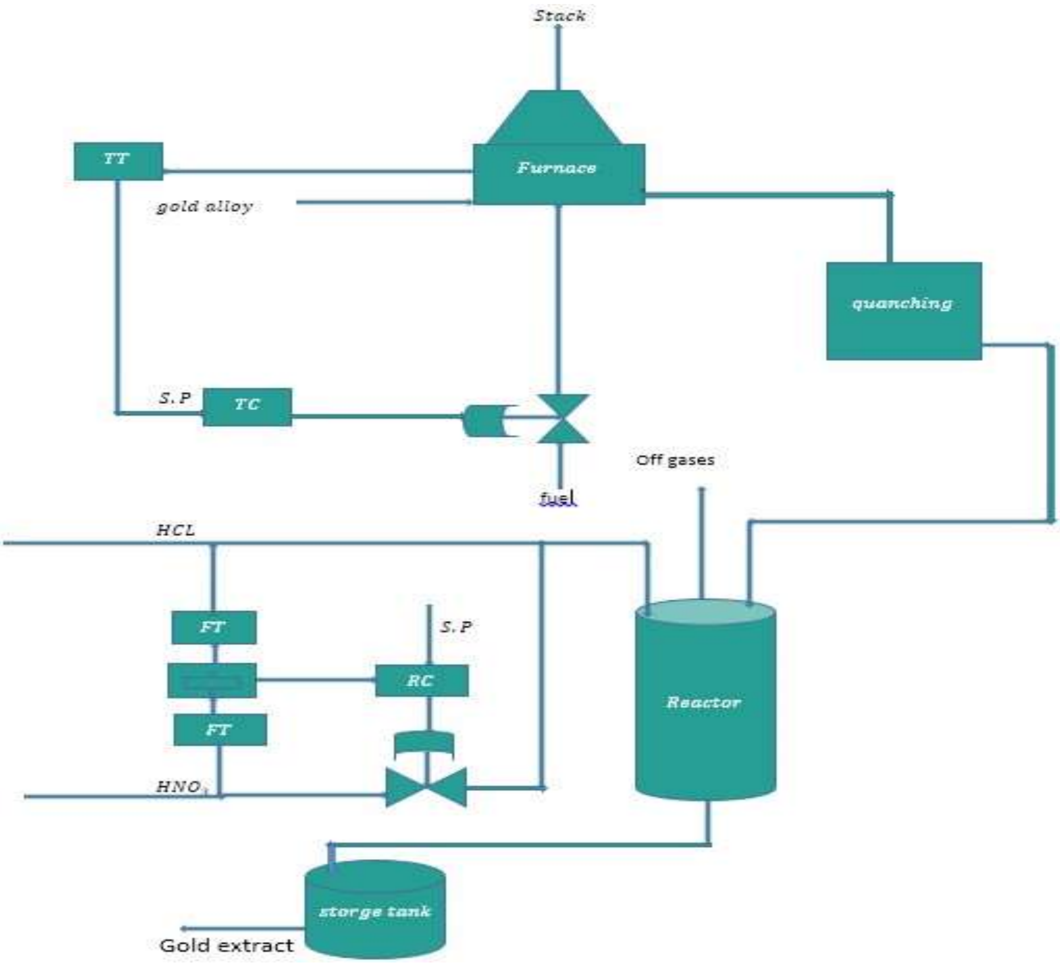
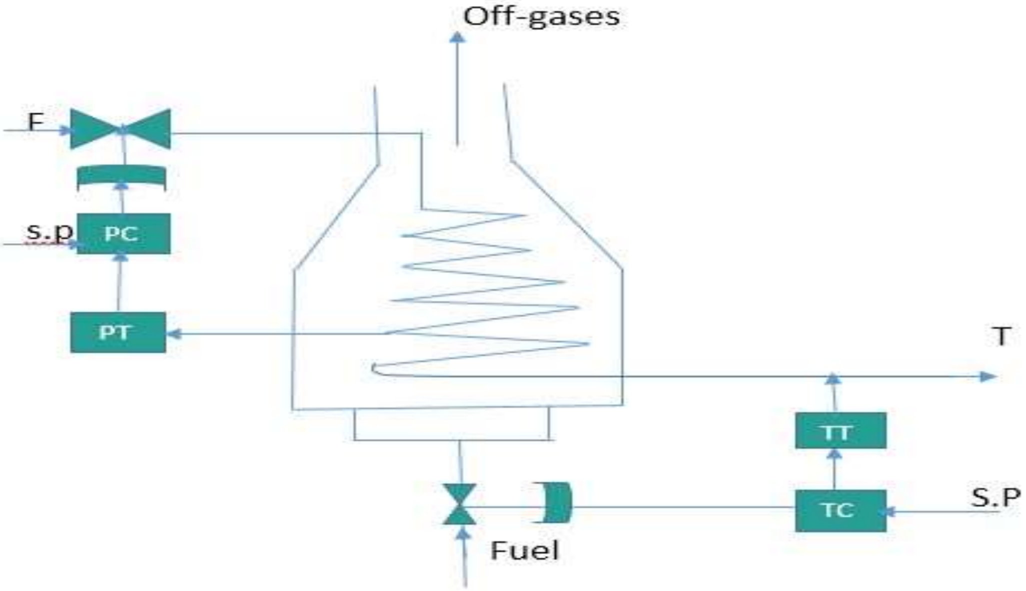


Figure (1.1) control of refined gold

CONTROL OF TEMPERATURE IN FURNACES



$$\overline{y}_1 = \frac{0.5e^{-1.5s}}{s+1}\,\overline{m}_1 + \frac{e^{-0.5s}}{2s+1}\,\overline{m}_2$$

$$\overline{y}_2 = \frac{2e^{-1.0s}}{0.5s+1}\,\overline{m}_1 + \frac{1}{s+1}\,\overline{m}_2$$

$\overline{y}_1 = tempereture$
$\overline{m}_1 = fuel\ rate$
$\overline{y}_2 = perture$
$\overline{m}_2 = feed\ rate$

$$\text{RGA} = \begin{array}{cc} \overline{m}_1 & \overline{m}_2 \\ \left[\begin{matrix} -0.3333 & 1.3333 \\ 1.3333 & -0.3333 \end{matrix}\right] & \begin{matrix} \overline{y}_1 \\ \overline{y}_2 \end{matrix} \end{array}$$

The pairing are
$\bar{y}_1$ vs $\overline{m}_1$
$\bar{y}_2$ vs $\overline{m}_2$

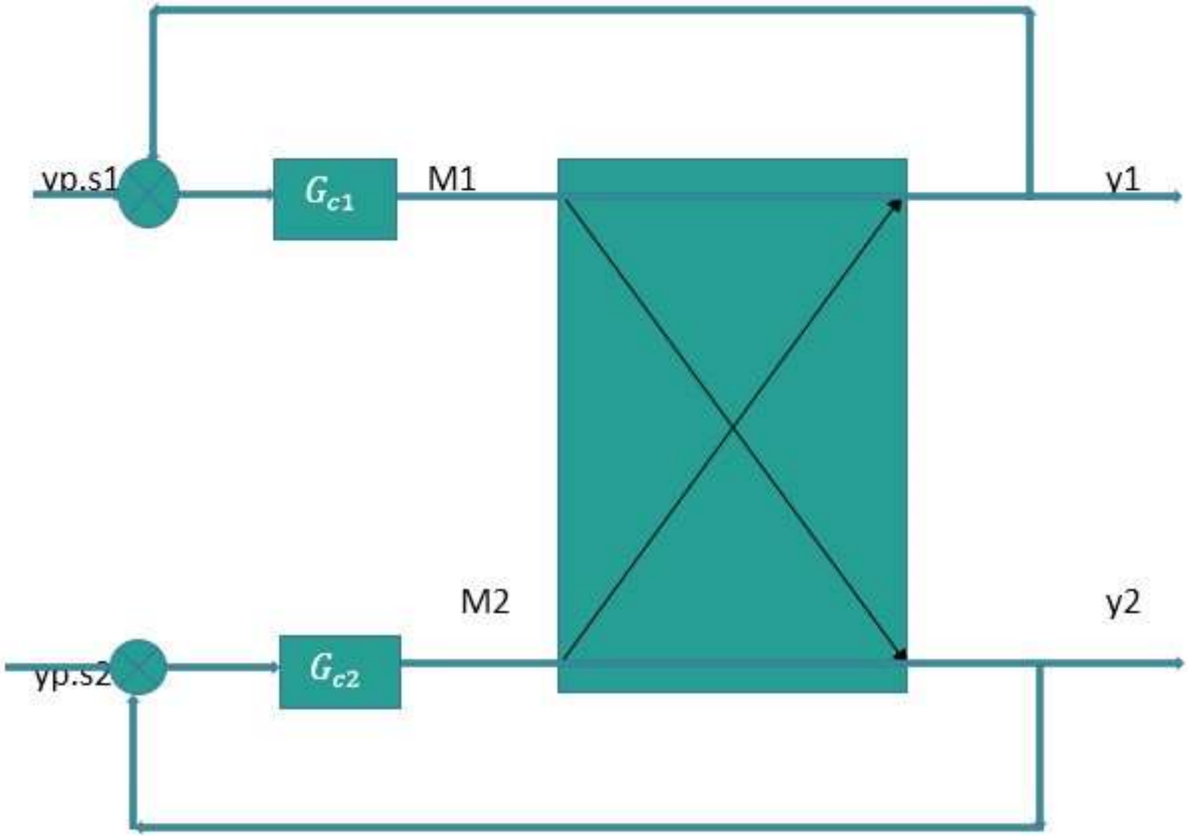


Figure (1.3) loops of minimum interaction in furnace

Identification of Transfer function:

$$G_c = K_c$$

$$G_p = \frac{3.5}{(4s+1)(5s+1)}$$

$$G_v = \frac{5}{(0.25s+1)}$$

$$G_m = 0.5$$

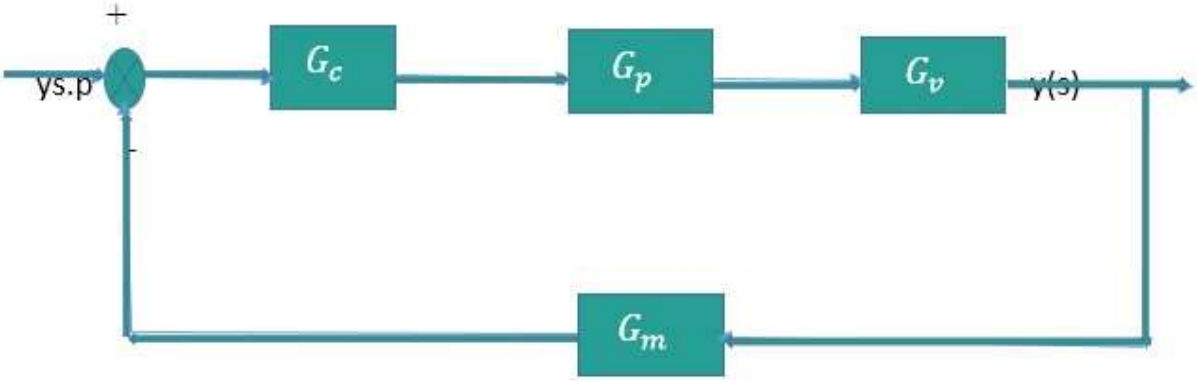


Figure (1.4) block diagram loop one

Calculations of control stability and tuning
Root locus and bode plot:

$$OLTF = \frac{8.75k_c}{(5s+1)(4s+1)(0.25s+1)}$$

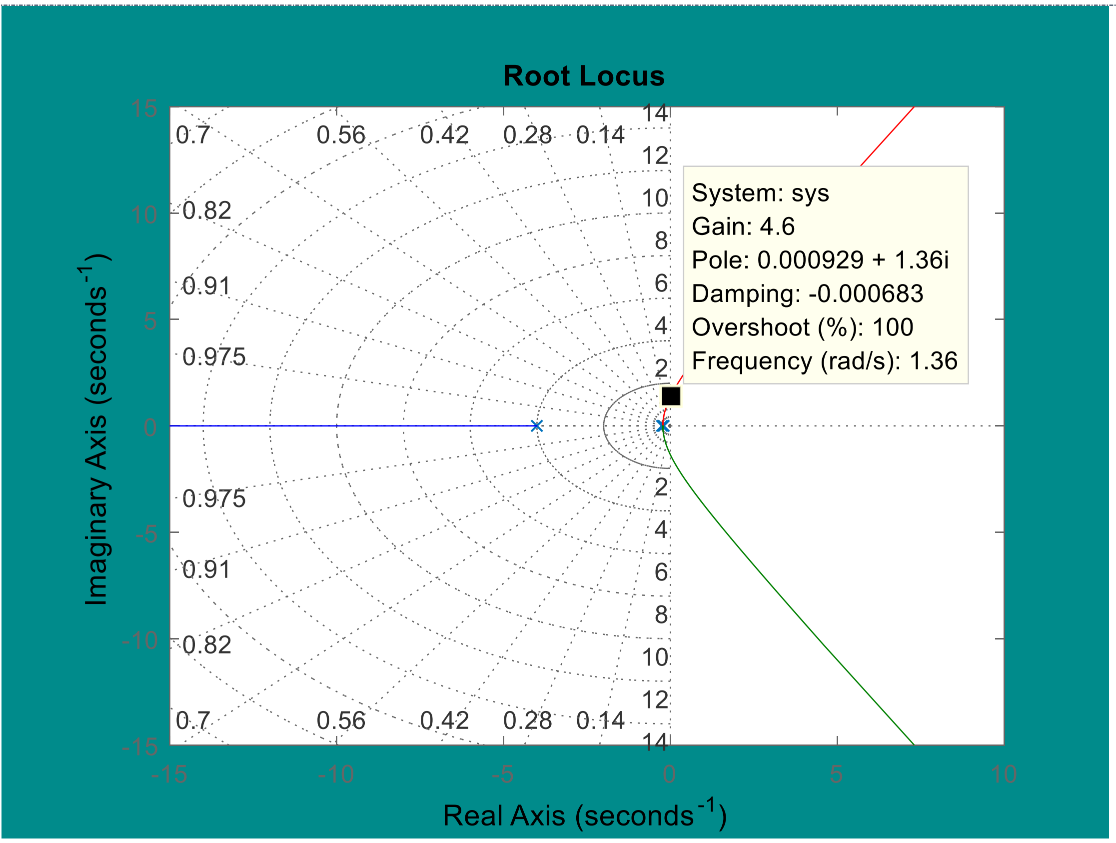


Figure (1.5) root locus of loop1

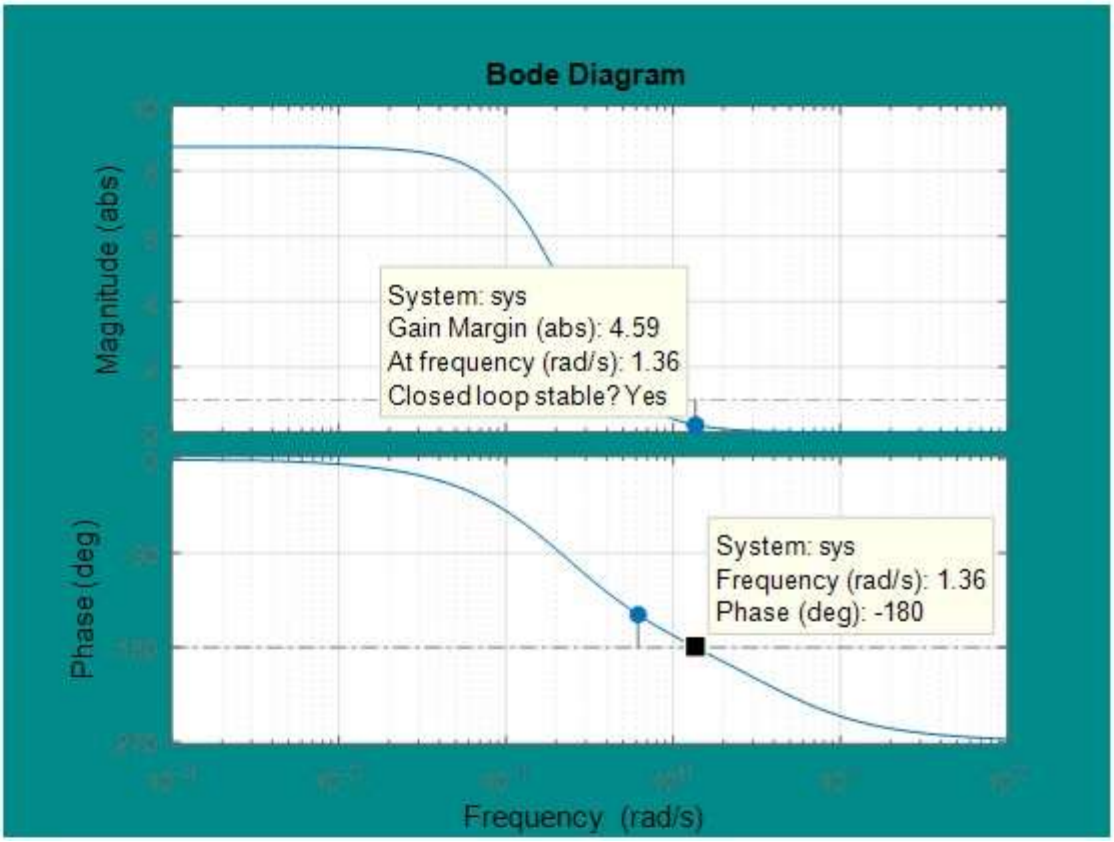


Figure (1.6) bode plot of loop1

Table (1.1) average of k_u and P_u from different methods

Method	k_u	P_u
Routh-hurwitz	4.59	**4.6199**
Direct substitution	4.589	**4.62**
Root locus	4.55	**4.65**
Bode	4.57	**4.62**
Average	4.57	**4.63**

Table (1.2) tuning by Z-N

Mode	k_c	$\tau_{i(s)}$	$\tau_{D(s)}$
P	2.285	-	**-**
PI	2.0565	3.858	**-**
PID	2.742	2.315	**0.5786**

THREE TYPE OF CONTROL RESPONSE

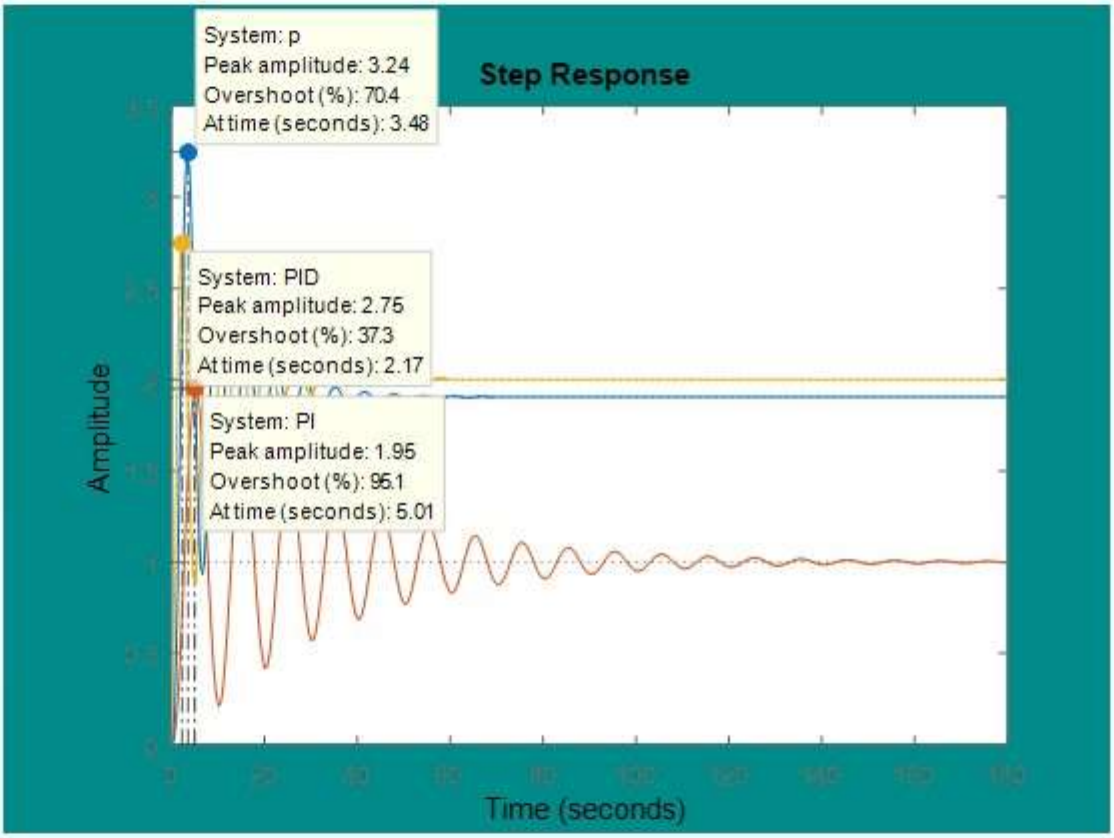


Figure (1.7) response for three type of controllers (P,PI,PID)

Table (1.3) overshoot of three type of control

Type of control	Overshoot
P-control	70.3%
PI-control	95.1%
PID-control	36.9%

Due to minimum overshoot, PID controller is preferred because it is gives minimum overshoot.

Simulink model

Temperature control:

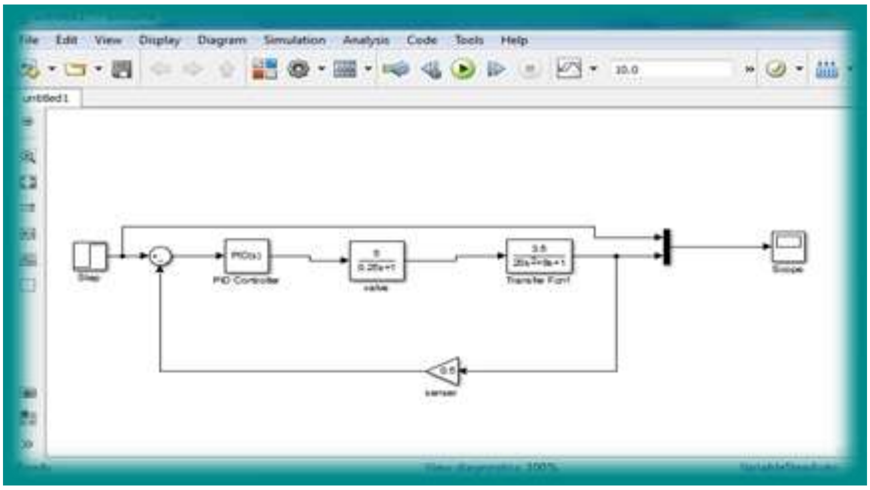
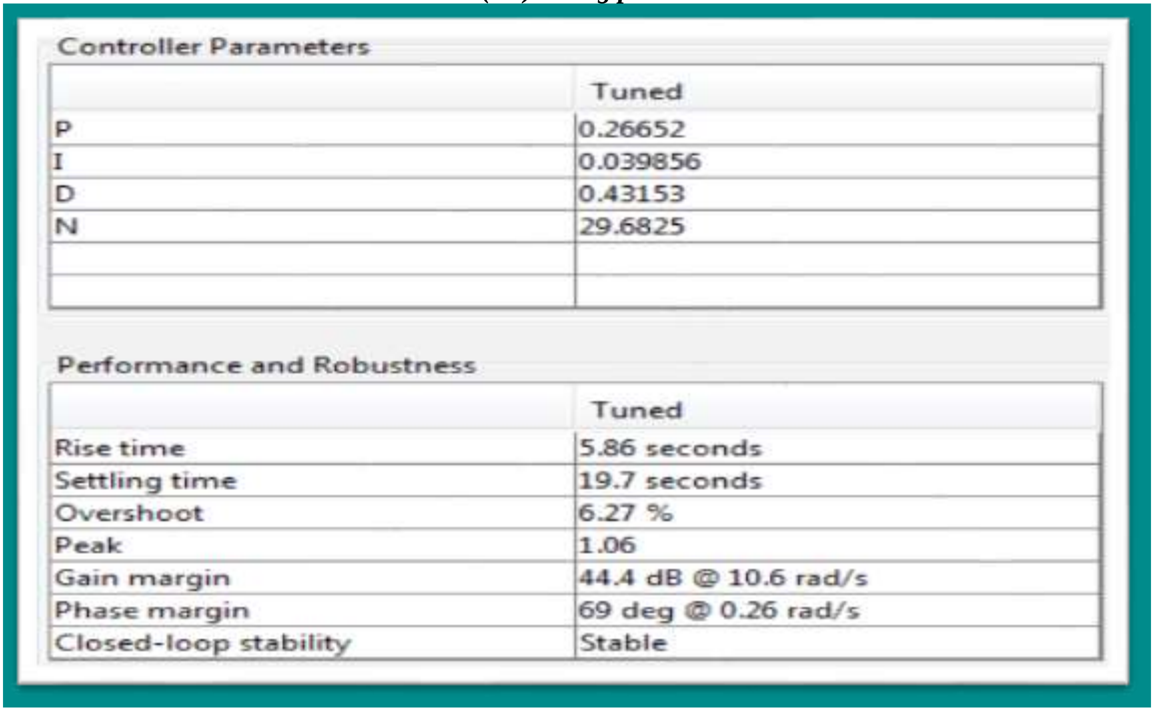


Figure (1.8) process model with PID- controller

Table (1.4) tuning parameters



Controller Parameters

	Tuned
P	0.26652
I	0.039856
D	0.43153
N	29.6825

Performance and Robustness

	Tuned
Rise time	5.86 seconds
Settling time	19.7 seconds
Overshoot	6.27 %
Peak	1.06
Gain margin	44.4 dB @ 10.6 rad/s
Phase margin	69 deg @ 0.26 rad/s
Closed-loop stability	Stable

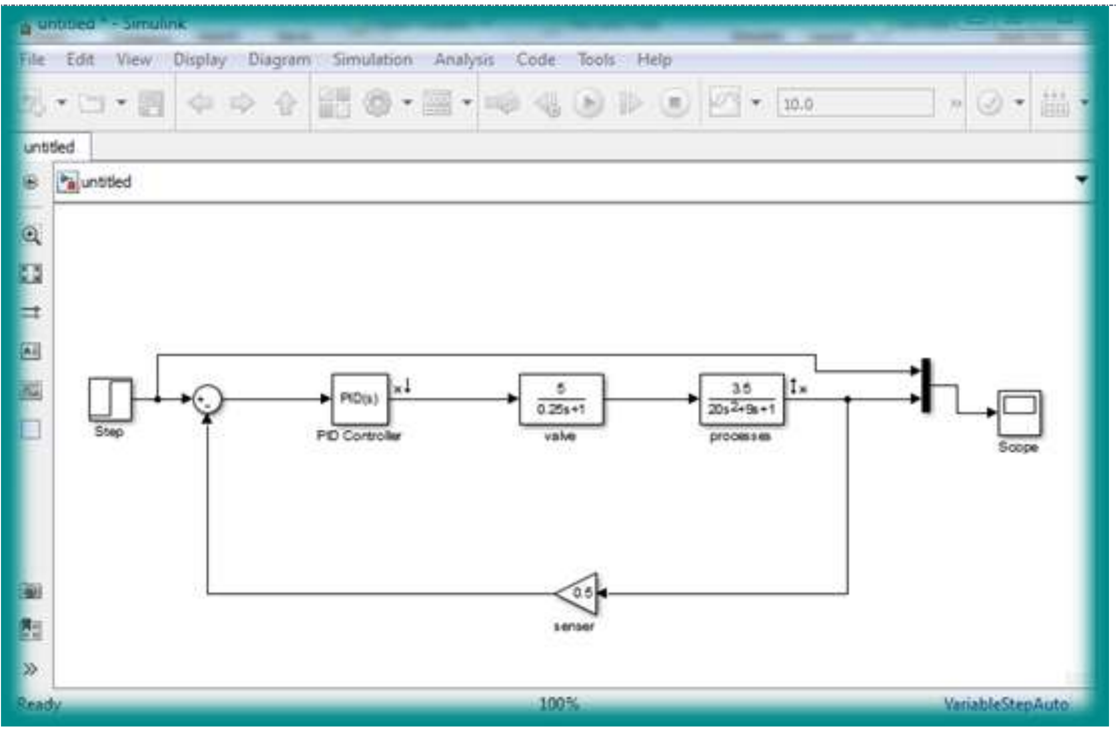


Figure (1.9) operating point and linear analysis PID- controller

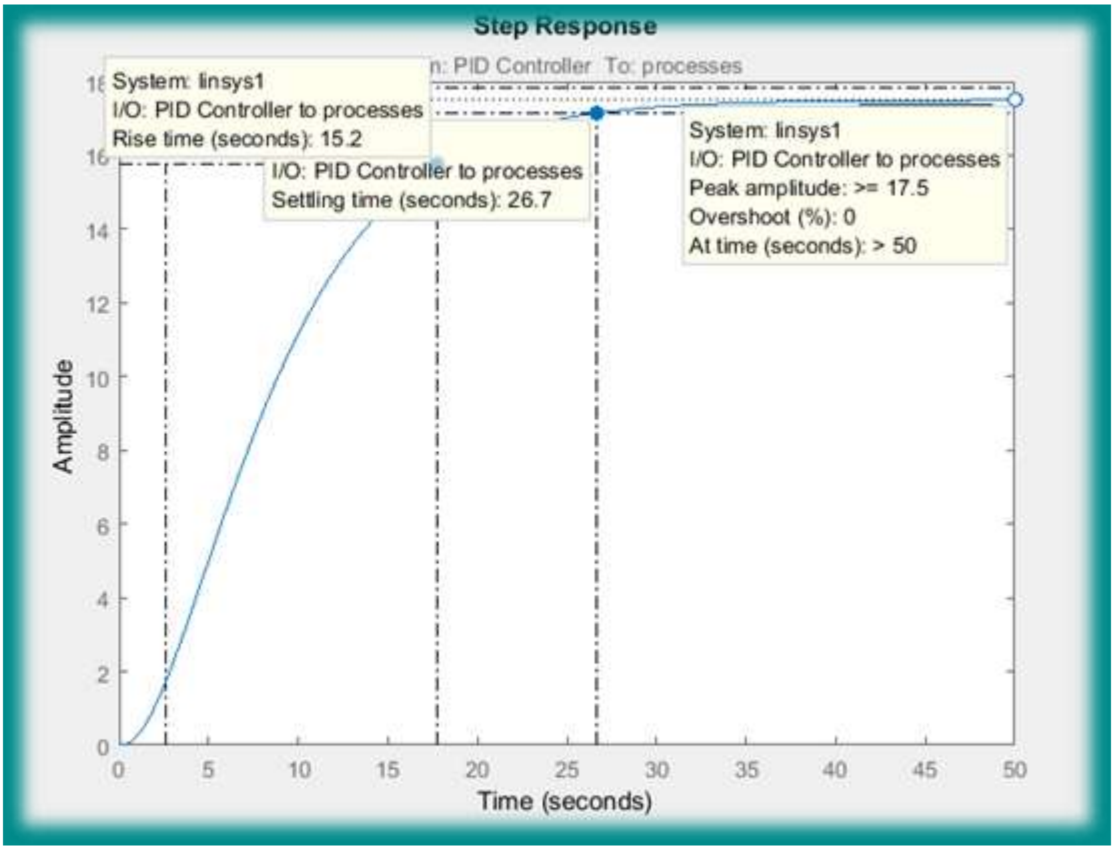


Figure (1.10) step response of loop 1 in simulink

RESULT AND DISCUSSION

Table (1.5) result of step response

Step response	*Overshoot*
Simulink	***0%***
Conventional	***36.9%***

Simulink eliminates the overshoot for the loop with it's transfer functions The Simulink is preferred to convention simulation because it eliminates any overshoot, rise time and ratio with fast response time.

RECOMMENDATIONS

Therefor it is recommended to determines the k system stability by fuzzy control and compare which is accurate fuzzy, Simulink, or conventional control. It is also recommended to replace continuous control with digital control.

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