CHE482 CHEMICAL ENGINEERING LABORATORY III

1-B TEMPERATURE CONTROL

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AIM OF THE EXPERIMENT

To control the temperatures of a process at different points with a feedback control system and to examine the effects of PID (K_c, $\gamma_\imath$ ve γ_D) parameters.

THEORY

The purpose of a control system is to set the value of the process variable to the desired set point value. For this purpose, the amount of deviation is measured. Deviation (d) is the difference between the set point (SP) and the process variable values.

$d = SP - PV$

The signal that the controller sends to the final control element changes with this deviation ($c = f(d)$). The controller output is sent to the final control element (triac module + heater) and the temperature is controlled by increasing or decreasing the electric current to the heater. The temperature change depends on the controller output, the amount of water to be heated, and the transportation lag in the system.

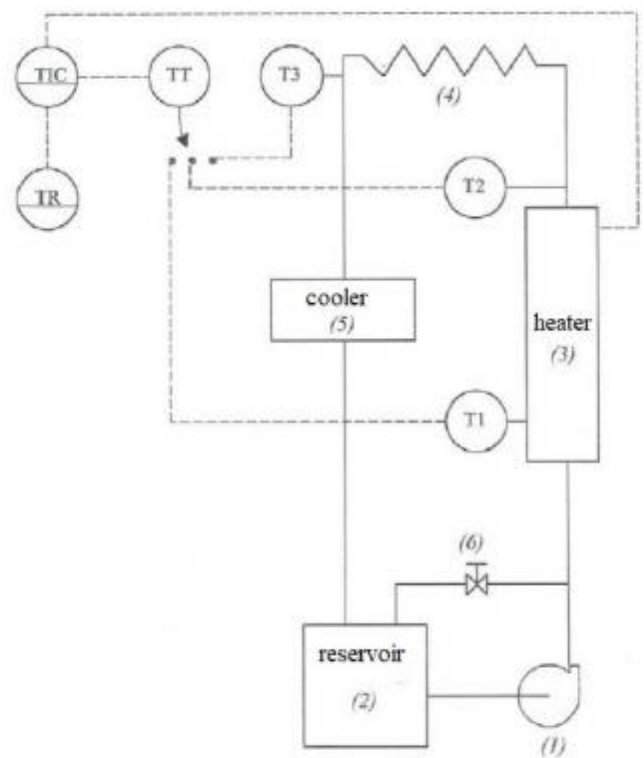
THEORY

There are three basic elements in a control system other than the process :

1. The measuring sensor and/or transmitter that will send the controlled variable to the controller.
2. A controller which will evaluate the measurement signal from the measurement sensor and send the output signal to the control element. Feedback controllers can be examined in three parts. The response of these controllers changes as the values of Kc, γ_ι , γ_D change.
3. A final control element that will reduce the amount of deviation to the minimum value with the signal from the controller. In this system, the heater is used as a final control element together with the triac module. The triac module is placed between the heater and the controller and increases or decreases the electricity power of the heater according to the signal from controller. When the input to this device is between 4-20mA, the heater power is changed according to the output of the controller. In this way, the deviation between the set point and the process value is reduced to the minimum value according to the type of the controller.

EXPERIMENTAL SETUP

The experimental setup is shown in the figüre below. The water is received from the reservoir (2) by the centrifugal pump (1) and is returned to the reservoir (2) by passing through a heater (3) located on the line and then by passing through a spiral pipe (4) with length of 4 m and the cooler (5). There is a bypass valve (6) connected to the pump to adjust the flow rate manually. Temperature at three different points; at the heater inlet (T1), at the heater outlet (T2), and at the point (T3), is measured with the thermocouples. A three-way valve connects the thermocouple output to the temperature transmitter (TT). This device converts the output to 4-20 mA and sends to the controller (TIC) and the current of the heater is changed by the triac module.



EXPERIMENTAL SETUP

EXPERIMENTAL SETUP

EXPERIMENTAL PROCEDURE

1. Wait for the temperature value to a steady state .
2. Set the rate value and the last set point value (SPLOC).
3. Switch the controller from MANUAL to AUTO. From this moment (t = 0), note down the SP, PV, OP values at regular intervals.
4. The experiment is over when the SPLOC value is reached.
5. Repeat the experiment by changing the PROP, IAt and dAt values.
6. Repeat the experiment by increasing the rate value.


POWER
HEATER
29.0
SPLOC
L Scroll R
A/M
ASN
731
FOXBORO
T1
T2
T3


OFF
1At
L Scroll R
A/M
ASN
731
FOXBORO
T1
T2
T3


POWER
HEATER
20.3
61.7
T1
T2
T3


20.1
29.0
L Scroll R
A/M
ASN
731
FOXBORO
T1
T2


OFF
dAt
L Scroll R
A/M
ASN
731
FOXBORO
T1
T2
T3


40.0
PrOP
L Scroll R
A/M
ASN
731
FOXBORO
T1
T2
T3

PRE-EXPERIMENT STUDY QUESTIONS

1. What are the controller types?
2. What is controller gain (Kc), proportional band (PROP), γ_I and γ_D?
3. What does offset, damping ratio, rise time, overshoot, decay ratio, oscillation mean?
4. Examine the effects of Kc, PB, γ_I ve γ_D values on the process variable (PV) in the controllers.

CALCULATIONS AND DISCUSSIONS

- Using the data obtained during the experiments, draw graphs showing the changes of PV and SP values over time. Find the offset on these graphs and the response parameters (such as damping ratio) in case of oscillatory response.

- Discuss the proportional effect and the integral effect by comparing your results.

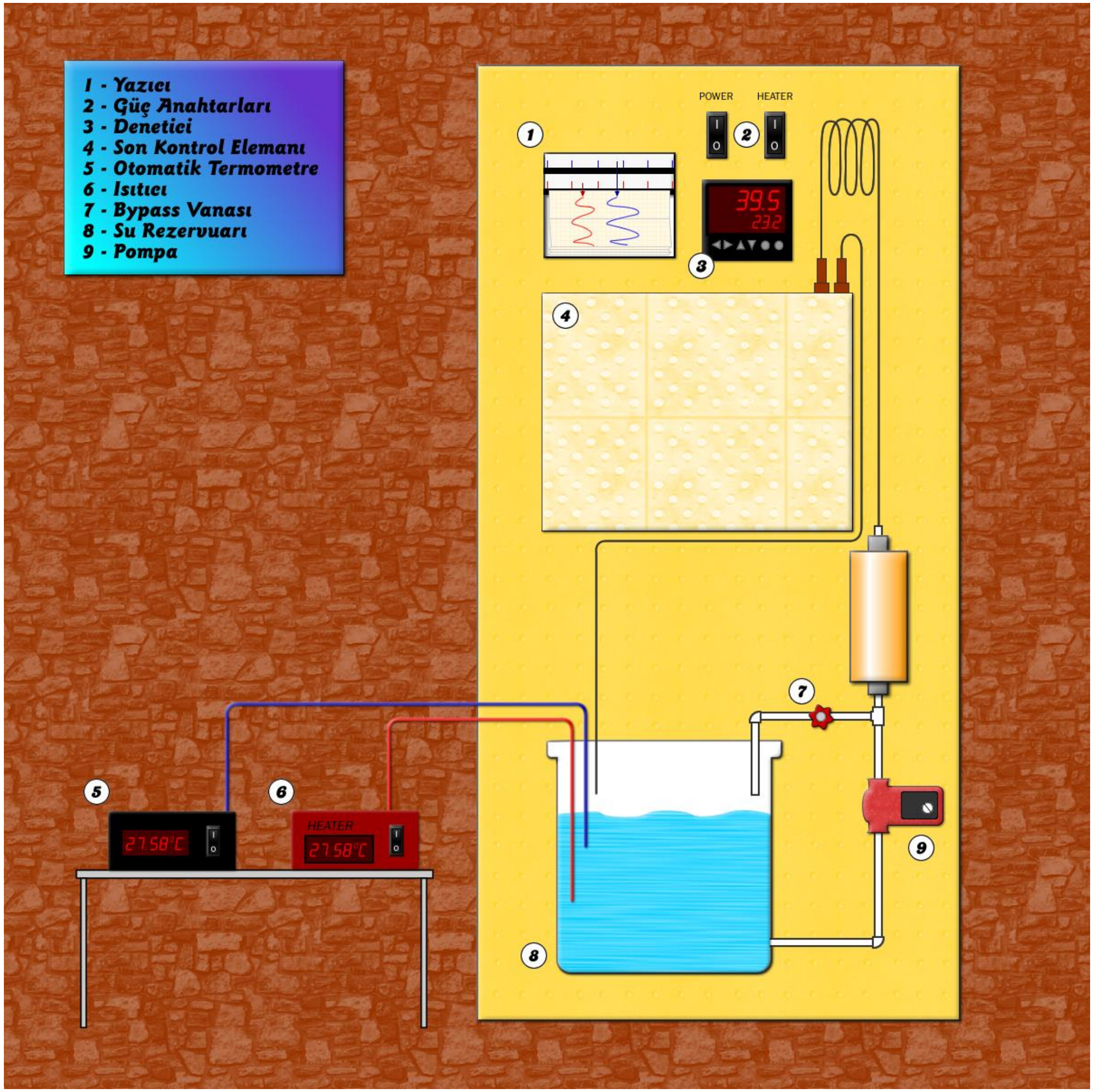
- Compare and interpret your results for different PROP and IAt values.

- How transportation lag affects the control performance? Discuss and compare the graphs.

- What changes should be made in parameters to increase stability?

- Prepare a block diagram for the feedback control system studied during the experiment.

EXPERIMENTAL SETUP



DATAS FOR 1ST SET OF EXPERIMENTS

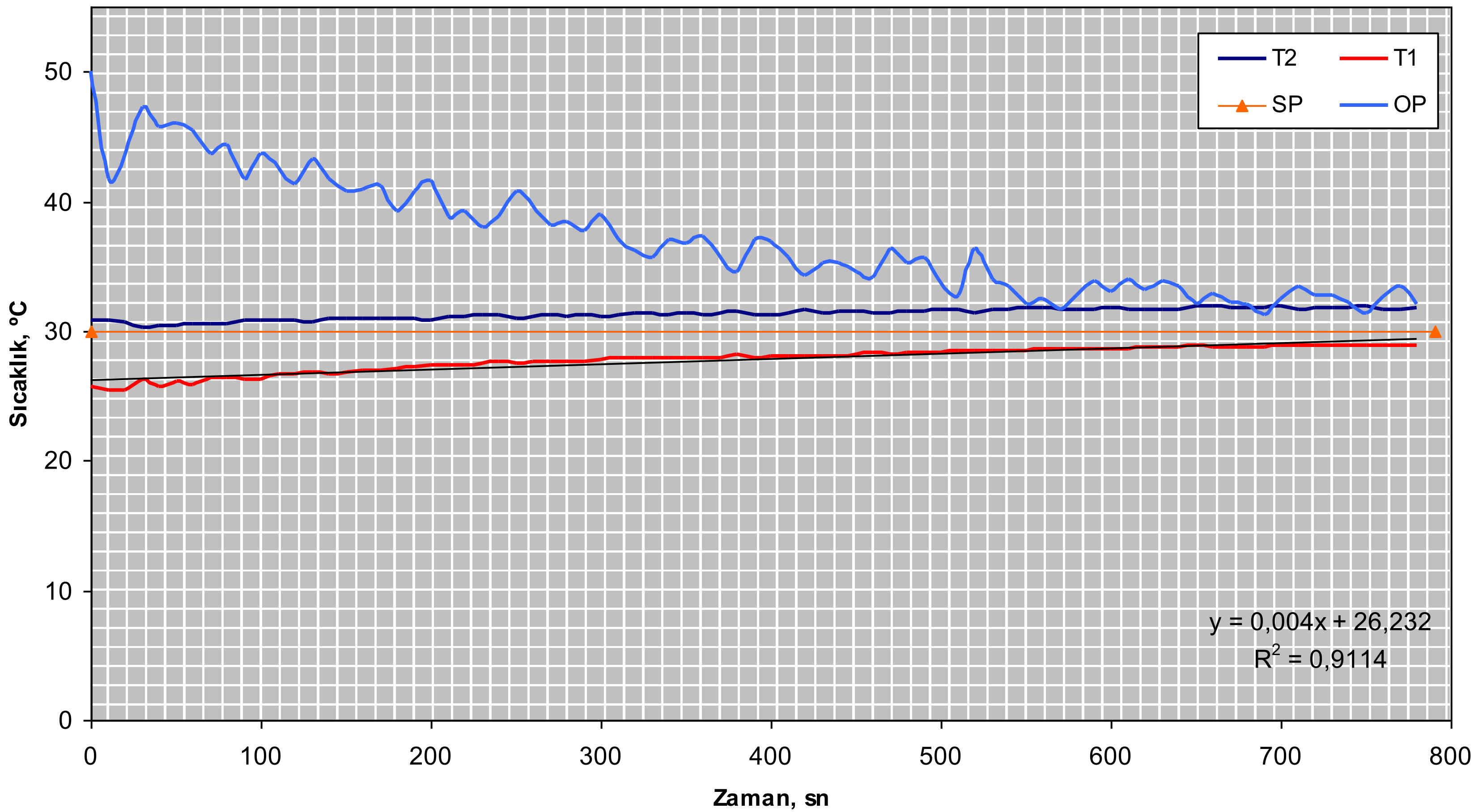


Figure 1. Graph drawn according to data for proportional control.

DATAS FOR 1ST SET OF EXPERIMENTS

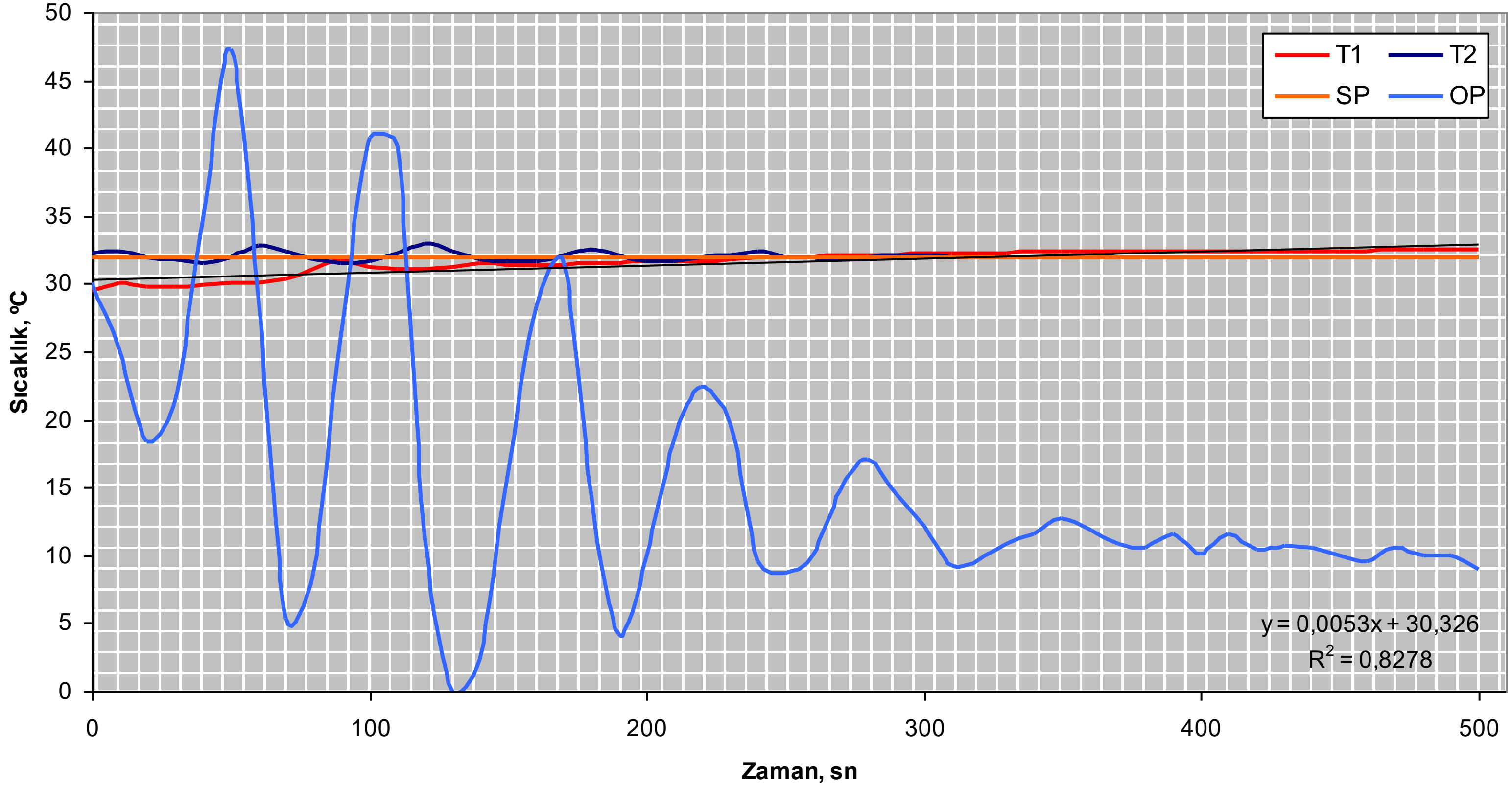


Figure 2. Graph drawn according to data for proportional integral control.

DATAS FOR 1ST SET OF EXPERIMENTS

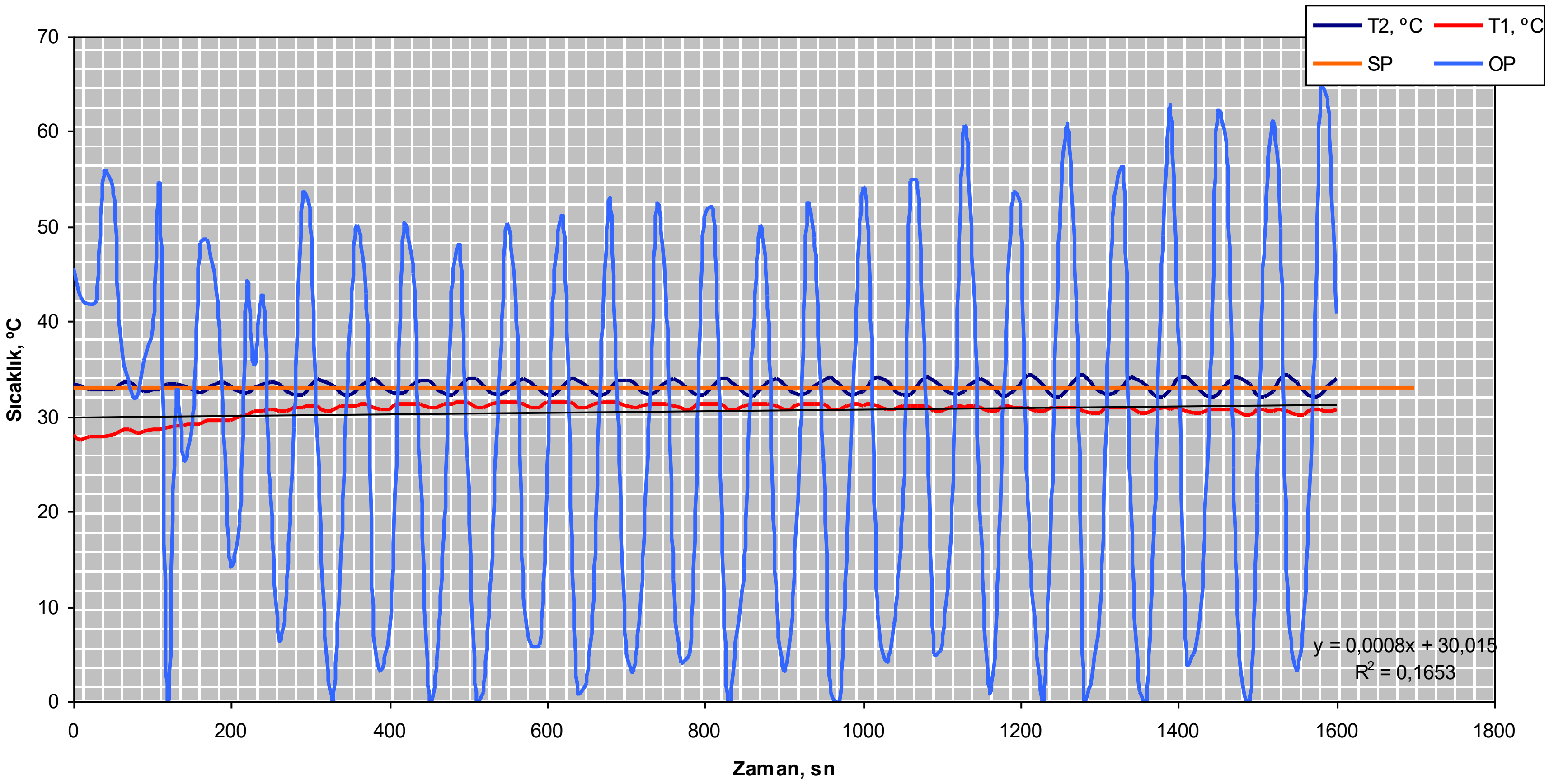


Figure 3. Graph drawn according to data for proportional integral derivative control.

DATAS FOR 2ND SET OF EXPERIMENTS

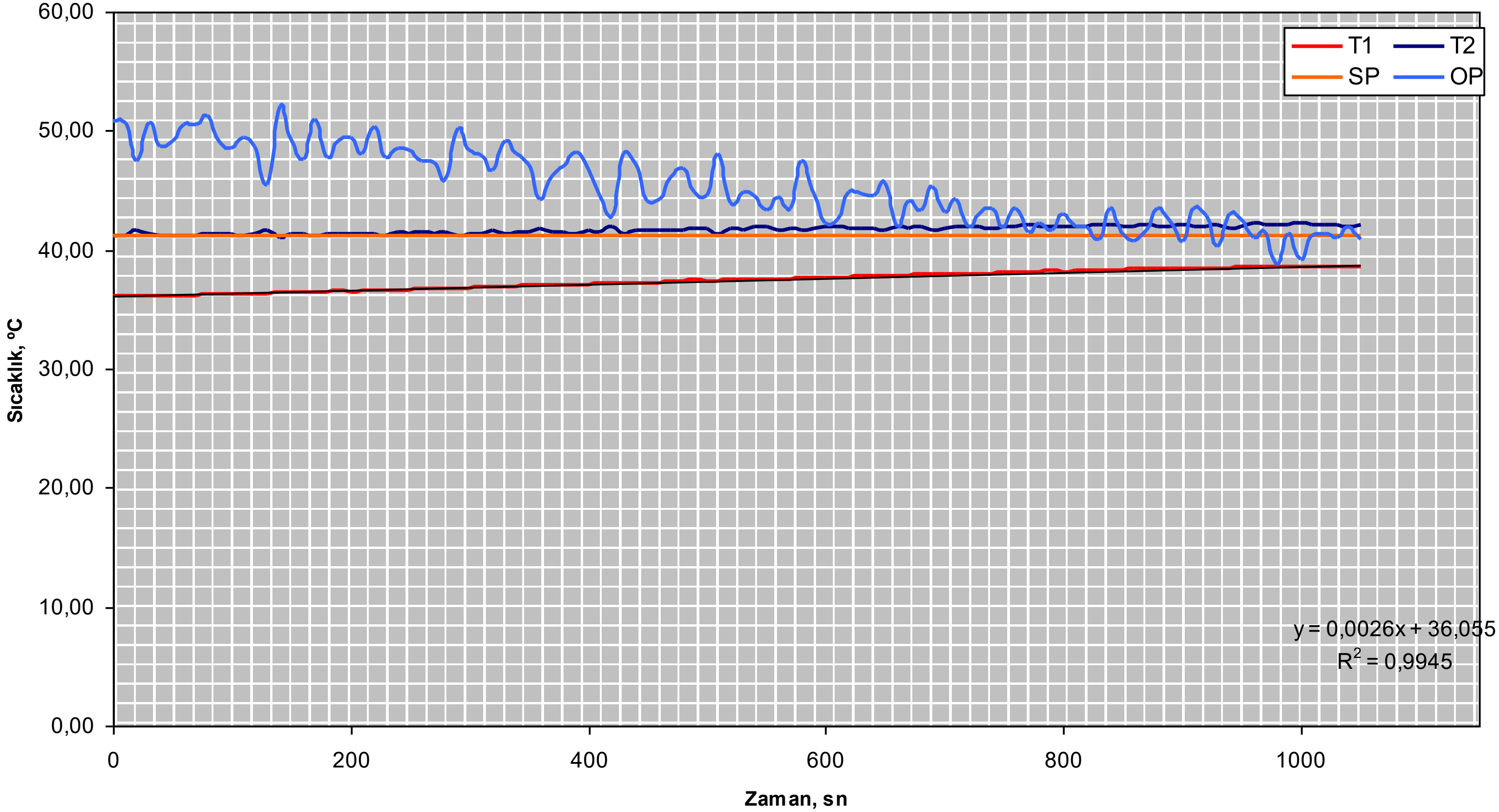


Figure 1. Graph drawn according to data for proportional control.

DATAS FOR 2ND SET OF EXPERIMENTS

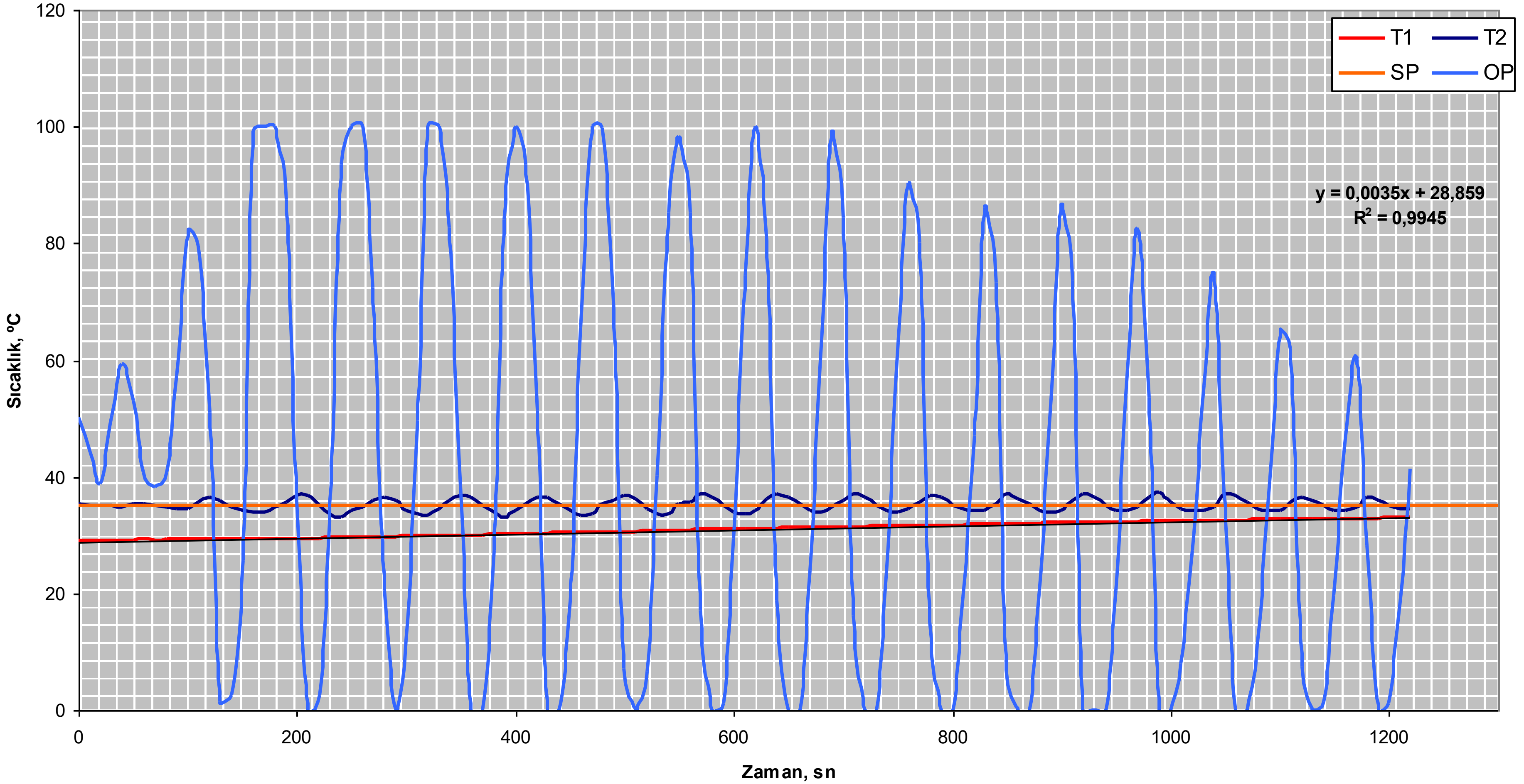


Figure 2. Graph drawn according to data for proportional integral control.

DATAS FOR 2ND SET OF EXPERIMENTS

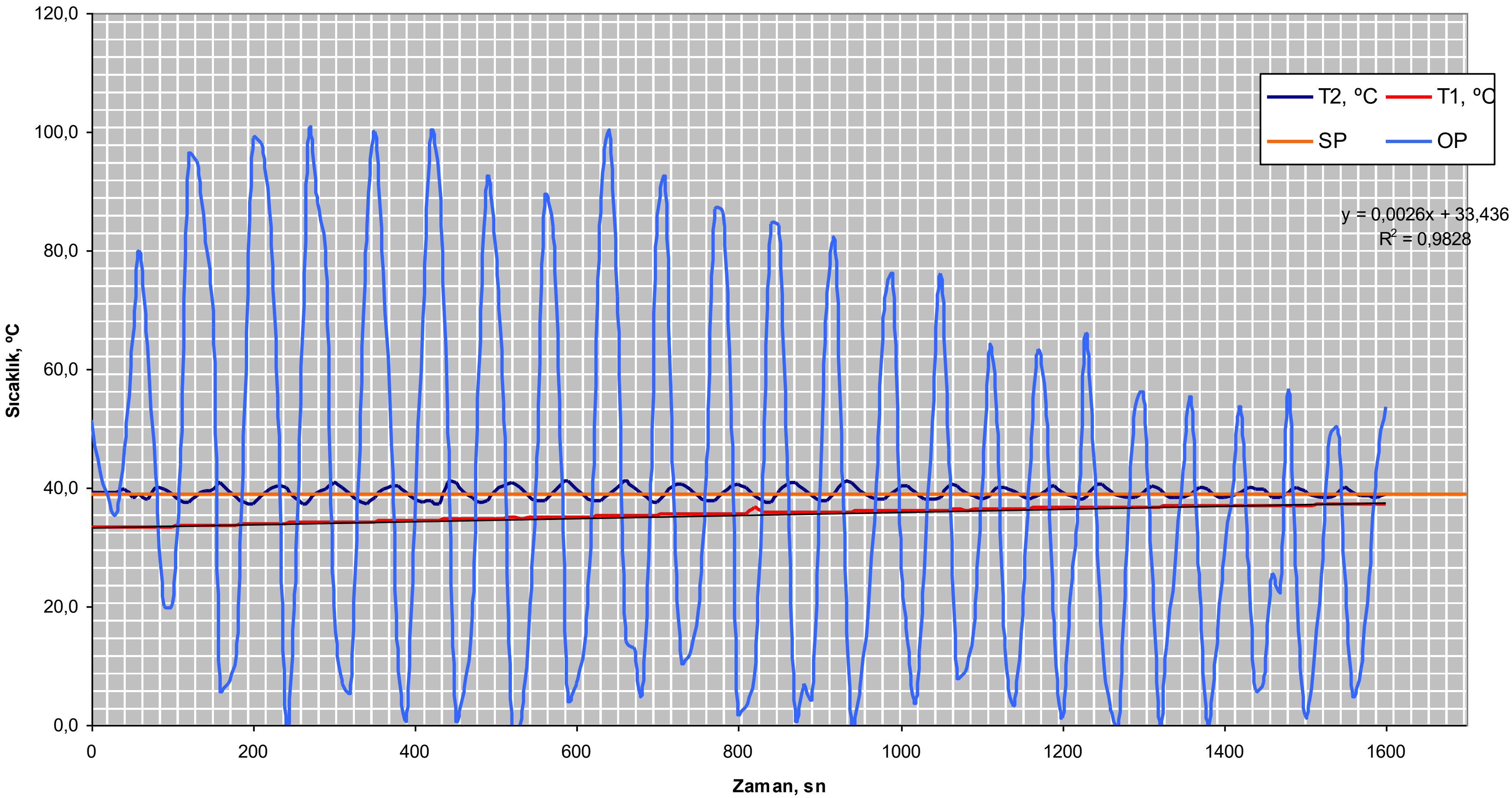


Figure 3. Graph drawn according to data for proportional integral derivative control.