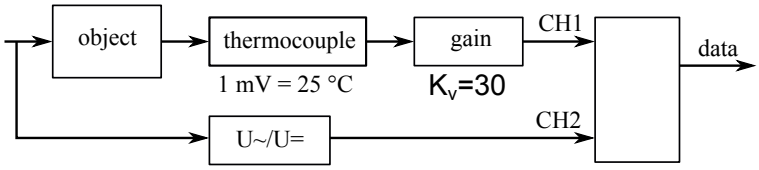
Thermal processes



Measurement results are saved in a text file TERM_objekt.txt (1-st column: samples, 2-nd column: system output, 3-rd column: system input). The test was a step change of the power in power supply $U_v = 0\ V \rightarrow 150\ V$, the transfer function of the input voltage of the converter [$U = /U \approx$] is not exactly known. Object has thermocouple type K (sensitivity 40 $\mu V/K$ or 1 $mV \approx$ 25 $°C$).

- Calculate FOPDT object model from experimental data (gain K, time constant T and the delay τ).

Comments

Import data from a file in Matlab. If data saved in the different variables. Plot figure:

```
plot(N,CH1,N,CH2);
```

else

```
plot(data(:,1),data(:,2),data(:,1),data(:,3));
```

Extract needed data. We need data only at the beginning of the step and until system reaches the next steady state. Assign $n1, n2$ parameters.

```
 ts = ...  ;% data is taken twice a second ⇒ ts = 0.5
t=(data(n1:n2,1)-n1)*ts;
y=data(n1:n2,2)-y0 %y0 - output signal at step time instance
plot(t,y);
```

If you have extracted data into different variables, then

```
 ts = ...
t=(N(n1:n2)-n1)*ts;
y=CH1(n1:n2)-y0 %y0 - output signal at step time instance
plot(t,y);
```

In that case (at zero initial conditions) we will have the step response

$$y(t) = 0, \quad t < \tau \qquad \text{and} \qquad y(t) = K \cdot (1 - e^{-(t-\tau)/T}), \quad t > \tau. \tag{1}$$

Use MATLAB (SIMPLEX) `fminsearch` program that searches the model parameters (K, T, τ) values in order to minimize the root mean square error between the experimental data and the values calculated by the model.

```
[x fval]=fminsearch(@FOPDT_model, [150 50 50])
```

Write the function to calculate the error signal and step response function of the model.

```
 function c=FOPDT_model(in)
global y ts t
K=in(1); %gain
tau=in(2); %delay
T=in(3); %Time constant
% y -data
% ts -sampling
%t -time array
if tau<0 tau=0.1; end; % keep "+" delay
vone=[zeros(ceil(tau/ts),1);
ones(length(t)-ceil(tau/ts),1)]; %1(t-τ)
e=y-K*(1-exp(-(t-tau)/T)).* vone; %error
c=e'*e;
```

- Try to minimize with different initial coefficients. Provide parameters. Try minimization if:
  1. initial parameters are different, with what parameters SIMPLEX method does not converge
  2. data is less: data $< n2$
  3. data sampling time is greater (choose larger ts)
- Calculate steady-state coefficient c in the equation $T(^\circ C) = c \cdot U^2(V) + T_0$ with final temperature T and input voltage 150 V.