EXPERIMENT 5: TEMPERATURE AUTOMATIC CONTROL

Dear students attended to Experiment 5 for Chemical Engineering Laboratory III;

Hope you feel good in those days all of us facing with pandemic situations. In the present experiment, as you know, the main objective is to get sufficient information about the various types of automatic controllers. I would like to remind you that if you have any trouble to understand the experimental details or preparing the report, please do not hesitate to contact me.

In the temperature automatic control system realized with different controller types;

The questions in the results section, which are prepared for each type of controller and stated in the lab. manual, must be answered in detail.

AIM OF THE EXPERIMENT

- Please indicate it in the report

CALCULATIONS

- The requirements were given in your laboratory manual please see them and prepare the report according to these requirements.

RESULTS AND DISCUSSION

- The all results should be summarized in the report with interpretation of the experimental data; for instance; what do you expect about the controller in theoretical and what did you see in the experimental data.

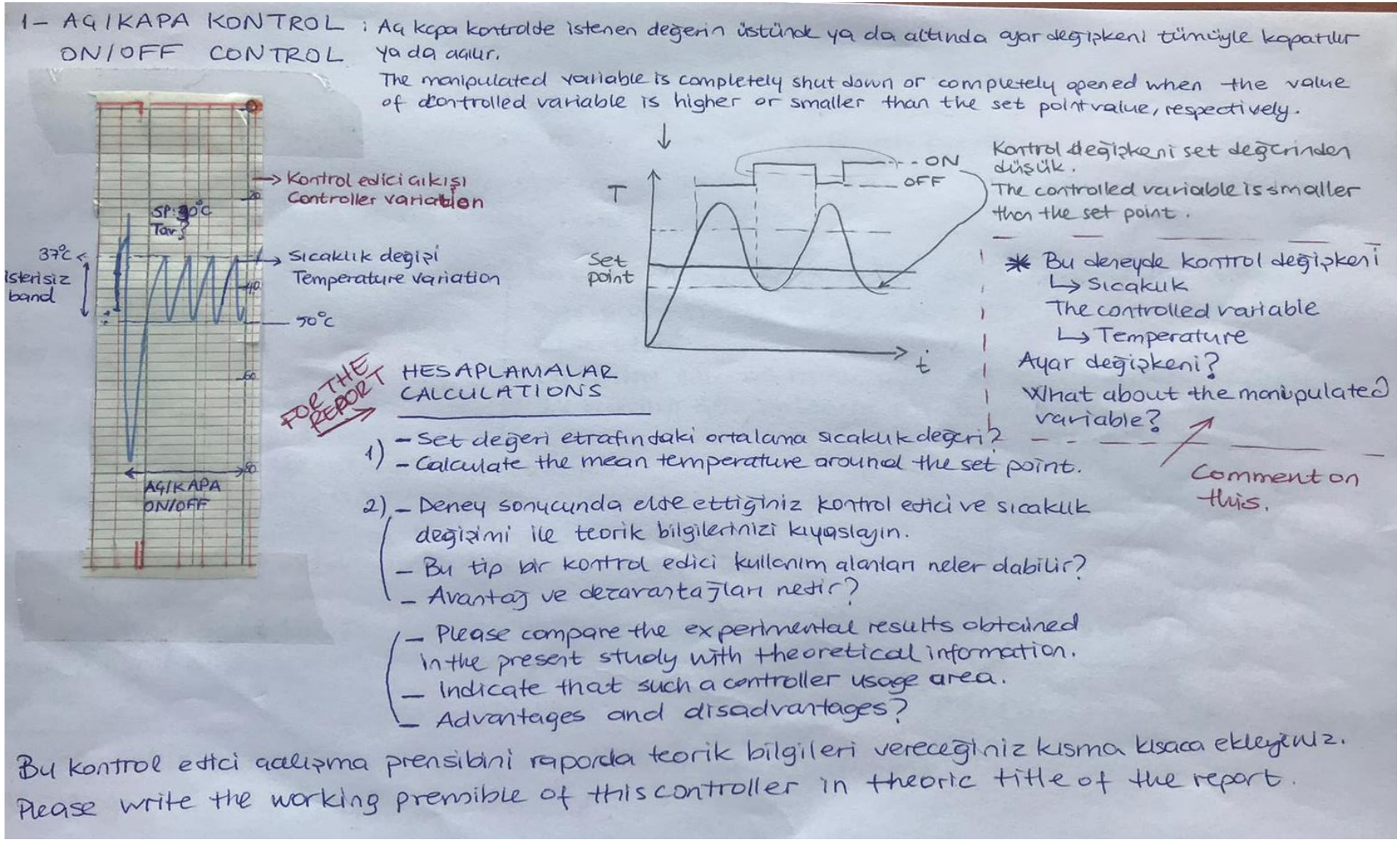
HOMEWORK QUESTION

- Here you have a homework question to give you a detailed insight about the control system, please try to understand that and solve the question.

REFERENCES

- Give the references in appropriate form.

Here I attach the experimental results which I have already go through them in the experiment video. Please follow the instructions and prepare the appropriate reports.



2- ORANSAL BANDIN ANLAMI
THE MEANING OF THE PROPORTIONAL BAND

- Deneyin bu kısmında amaç kontrol edici çıktısı (OP) ve uygulanan oransal band arasındaki ilişkiyi ortaya koymak ve oransal bandın anlamını gözlemlemektir.
- For this part ; the aim of the experiment is to reveal that the relationship between the controller output and proportional band applied.

Experimental Setup

ti : 0
td: 0
Integral and derivative time are OFF.

Prop : %100 ⊙ first time başlangıçta

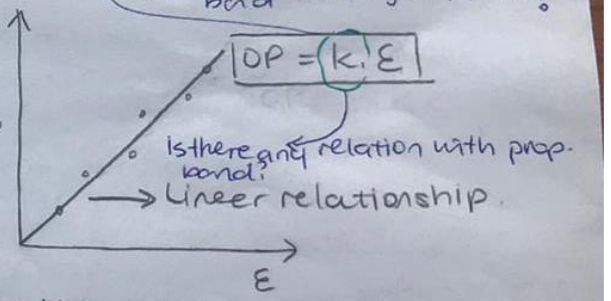
Measure the output in electronik panel
Çıkış ölçülür, elektronik göstergede görülür.

E (Ayrılma/Sapma) = Measured value − Set Point
Offset / Deviation "Electronik panel"

Remember that in prop. control the output of the controller was proportional to deviation. You will indicate this proportion!
Bu kontrol edici çıktısının sapma ile orantılı olduğunu hatırlayın. Bu orantıyı gözlemlemiş olacaksınız.

NASIL / HOW
→ Proportional band ile ilgisi var mı?

$OP = k \cdot E$



Plot this graph for each measurement

Aynı basamaklar farklı set değerleri ve oransal band için tekrarlanır. / Same steps are repeated for various prop. band and set points.

Fill the table giving in your Lab. manual. Follow the calculations you are going to do, in your lab. manual.

DATA will be announced in my AVESIS page after you performed the experiment.

2- ORANSAL BANDIN ANLAMI
THE MEANING OF THE PROPORTIONAL BAND

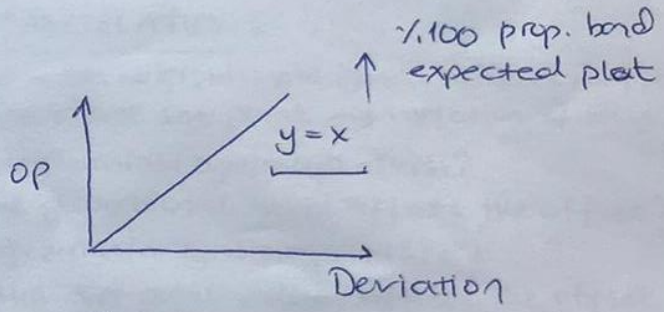
For instence ;

OB	SP (°C)	MV (°C) (Isıtıcı kapalı.)	Deviation (°C) (Hesaplanmalı.)	OP (will be given.)
%100	24,8	24	0,8	0,8
%100	40	23,9	16,1	16,1
%100	60	23,9	36,1	36,1
%100	80	23,9	56,1	56,1
%100	100	23,9	76,1	76,1

→ electronik panelden okunacak.
It will be record by using electronic panel.

Do not forget heater is OFF

You will calculate (Dev. = SP − MV)



Plot the graph and see the equation. $y = x$

$OP = (k)$ Deviation

$k = 1$

$OP = \%100$

Gain : $\%100 / \%100 = 1$

So it is gain.

If the prop. band is %50 %
Gain : 2
So the slope of the plot (Dev − OP) should be 2.

Oransal band %50 ise kazanç 2 olur.
Bu durumda grafik eğimi 2 olmalıdır.

2-The meaning of proportional band section

The experimental results obtained for this part was given in following table.

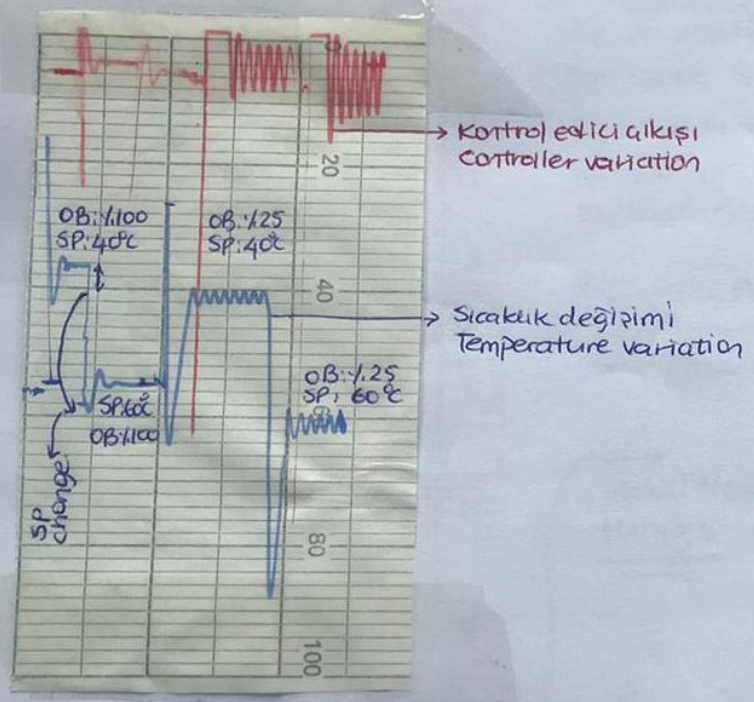
Hint: *Please comment on the controller output value by taking into consideration of the proportional controller nature. And see that decreased in proportional band results in increase of controller output but somehow the controller output remains constant for some set point values. Please be careful and reveal that what reason can cause this situation. Moreover, check that whether you can use the constant output values to reveal the linear relationship between error and output.*

Proportional Band (%)	Set value (°C)	Measured Value (°C)	Controller output (%)
400	25	20.3	1.1
400	35	20.3	3.6
400	45	20.3	6.1
400	60	20.3	9.9
400	75	20.3	13.6
400	100	20.3	19.9
100	25	19.7	5.3
100	35	19.7	15.2
100	45	19.8	25.2
100	60	19.8	40.2
100	75	19.8	55.1
100	100	19.8	80.1
50	25	20.2	9.6
50	35	20.2	29.5
50	45	20.2	49.5
50	60	20.2	79.7
50	75	20.1	100
50	100	20.1	100
25	25	20.0	20.2
25	35	20.0	60.1
25	45	20.0	100
25	60	20.0	100
25	75	20.0	100
25	100	20.0	100

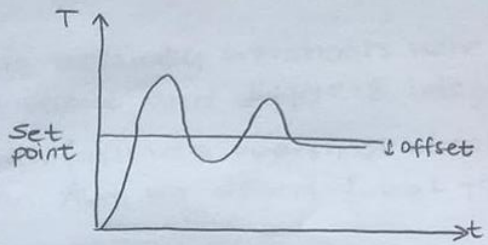
Please carefully indicate why the controller output remain constant.

Please carefully indicate why the controller output remain constant.

3- ORANSAL KONTROL : Verilen ya da kesilen güç sapma ile orantılıdır.
PROPORTIONAL CONTROL Output of the controller is proportional with the deviation.



OB: (Oransal Bond) : Oscillations occur.
(Proportional Bond) : Salınımlar oluşuyor.



HESAPLAMALAR / CALCULATIONS

1- Set noktasında bir adım değişimi olduğunda sıcaklık değişimi?
Step rise in temperature set point → variation of temp.?

2- Oransal band değişiminin ayrılmaya etkisi?
How changing the proportional band affects the offset?

3- Set noktası değişiminin ayrılmaya etkisi?
How changing the set point value affects the offset?

4- Oransal bandın değişiminin kontrol edici kararlılığına etkisi?
Describe how changing the proportional band affects the stability of the controller?

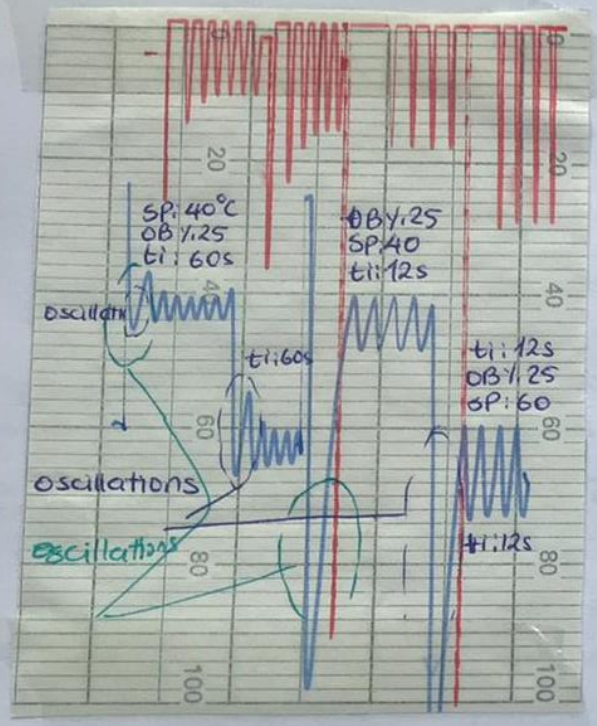
! Results and Discussion.

Bu çıkarımların nedenini oransal kontrol edici doğasını düşünerek açıklayınız.
Explain the reason of these findings by taking into consideration of the nature of the proportional controller.

* Oransal bandın düşmesi ile set değeri etrafındaki salınım artmakta ve kararlı duruma gelinmesi zorlaşmakta.
Decrease in proportional band value results in increase of the oscillations around the set point and stability of the controller output ~~easily~~ almost breaked down.

4- ORANSAL İNTEGRAL KONTROL
PROPORTIONAL INTEGRAL CONTROL

Aşırı yükselme ve alçalma ile karakterizedir.
Characterized by overshoots and undershoots. (Blue and green)



The extreme oscillations actually overshoots were indicated in the output for same set value and different integral time.

Aşırı salınımlar (aslında overshoot olarak ifade edilir) çıktı üzerinde işaretlenmiştir. Aynı set değeri fakat farklı integral zaman sabiti kullanımı ile.

HESAPLAMA / CALCULATIONS

See them in your lab. manual.

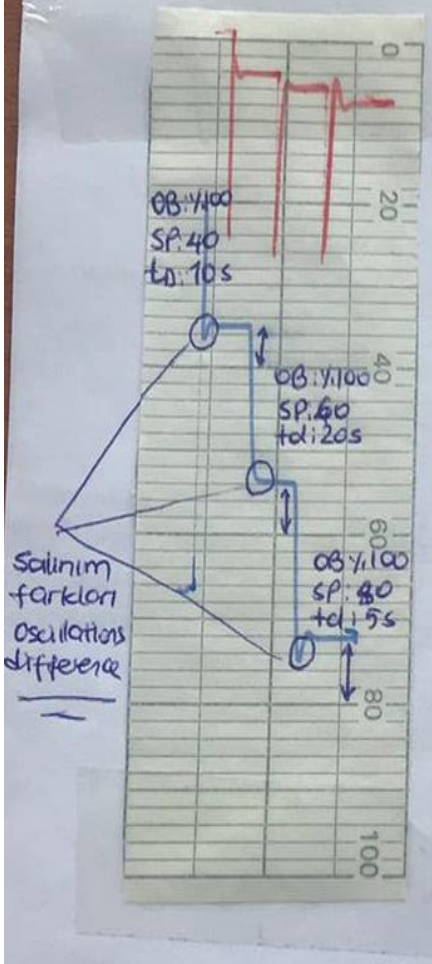
Additional things

Ek olarak //

Oransal band %100 iken sonuçlar nasıl olurdu?
Explain that if the PB is equal %100 how the results affected?

Salınım / overshootlar arasındaki farklılıklar @ ti: 60s, ti: 12s
Differences in overshoots @ ti:60s ?
@ ti:12s.

5 - ORANSAL TÜREVSEL KONTROL
PROPORTIONAL DERIVATIVE CONTROL



- Türevsel zaman sabitinin 10, 20 ve 5 s olma durumları için deneyler gerçekleştirilmişti.
- The experiments were carried out using 10, 20 and 5s derivative time respectively.

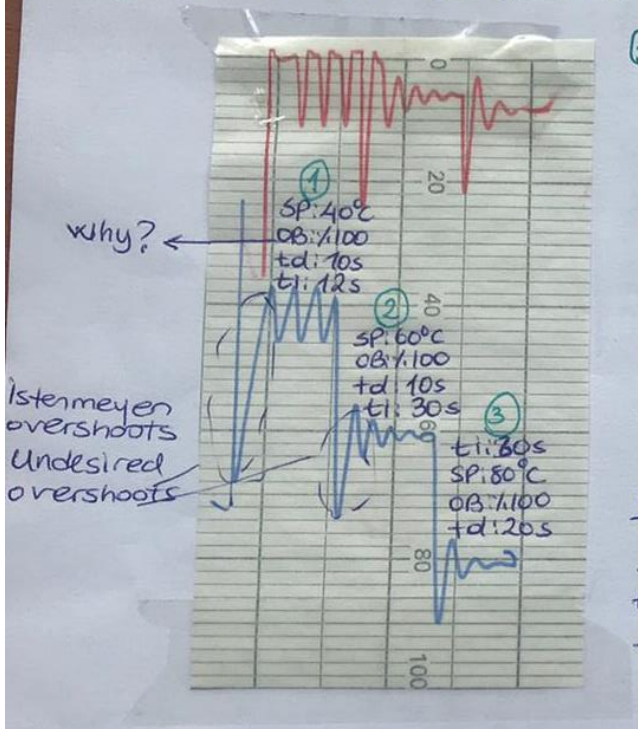
CALCULATIONS / HESAPLAMALAR

See them in your lab. manual.

* Bu kontrol edici türünde kullanılan türevsel zaman sabiti değerinin proses kararlılığına ve sapmaya etkisi görülmektedir. Lütfen bu bulguları detaylı olarak yorumlayınız.

* Here in the effect of applied derivative time changes on stability and deviation of the process is clearly seen. Please comment on these findings, detailly.

6-ORANSAL İNTEGRAL TÜREVSEL KONTROL
PROPORTIONAL INTEGRAL DERIVATIVE CONTROL



(1) For the first one;
- The stability of the controller
- overshoots

↓ Adjustement

(2) Increase in integral time
- Decrease in oscillations and overshoots.
- Increase in stability

(3) Increase in derivative time
- Time to reach the steady stead condition is shorthened.

(1) İlk deney için;
- Kontrol edici kararlılığı
- Aşırı yükselmeler

↓ Düzenleme

(2) İntegral zaman sabitini arttırma
- Aşırı yükselmelerde ve salınımlarda düşüş
- Kararlılıkta artış

(3) Türevsel zaman sabitini arttırma
- Kararlı hale gelme süresi azaldı.

The parameters of the controller should be determined according to the process requirements to obtain the best process curve.

Proses gerekliliklerine göre sistem parametreleri seçmek gerekmektedir.

Please explain that ~~how~~ the controller parameters affect on the process response.

Bu parametre değişikliklerine sistem cevabını açıklayınız.

* Bu tip kontrol edicide sistem özellikleri göz önüne alınarak en iyi kontrol edici özellikleri belirlenir.

* Kontrol edici parametrelerinin kontrol edici çıkışına etkisini detaylı olarak anlatınız.

HESAPLAMALAR / SONUÇLAR

See them in your lab. manual.

Föyden takip ediniz.