Controller need Tuning

Chapter 19

Goal to achieve

- The system respond quickly to errors
- The system remain stable (PV does not oscillate around SP)
- **Gain: (Proportional sensitivity)**

= Δ output (%) / **Δ** input (%)

Proportional Band (PB) = 100/gain

= 100x **Δ** input (%) / **Δ** output (%)

Case 1	Gain (increase)	small change Δ input	for 100% output	PB (Decrease)	System is unstable (needs Faster controller)
Case 2	Gain (Decrease)	Large Change **Δ** input	100% output	PB (increase)	System is stable (slower controller)
Case 3	infinite	**Δ** input =0	100% output	PB=0	System is unstable (no action of controller)

Physical meaning:

Convey measurement and instructions to other instrument in a control loop to maintain the highest level of safety and efficiency.

ON-OFF controller:

If PB = 0, System operates either fully open or fully closed position.

Band width is approximately zero

- Fast process (Small volume) may require less gain to achieve stability.

- Slow process (Large volume) requires Higher gain

- **Proportional Action:** is used to set the basic gain value of the controller.
- Expressed as
  - proportional gain and
  - proportional band

Proportional gain: already discussed

Proportional band: Another way of representing the same information.

$$PB = \Delta \text{ input } \% / 100\% \text{ output}$$

what percentage change in controller input span will cause a 100 % change in controller output

eg. change in input controller 10%

change in output controller 20%

Gain = 20 / 10

=2

- PB = Δ input % (span) for 100% output
  - PB= 100/Gain
  - Gain=100%/PB

    Gain =2
- PB =100 %/2

  =50%

Limits of proportional action:

- Respond only to change in error: magnitude of error return
- Does not return PV to set point: PV to a value that is within a defined span

Determining the controller output:

Output is a function of error and control Gain

controller output:

output change % = (error change, %) x gain

if the step point change by 10%

with PB =50%

output change %= Δ input % x gain

= Δ input % x 100 /PB

= 10x 100/50 = 20%

Proportional Action- closed loop

- Gain (increase) means Band (Decrease)

PB

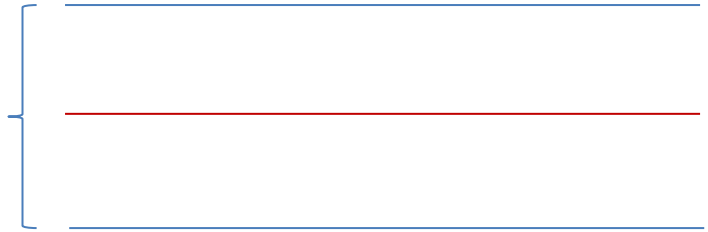
Set point

Process variable (PV) will cycle around the set point hence process will become unstable as Output increase

- Gain (Decrease) means Band (increase)

Loop is very stable as Output Decrease

PB



Set point

Proportional summary

Δ Output = (Change in error)x gain

Gain = Δ Output $_{\text{(fully open)}}$/(Change in error)

Setting :

- Small PB(%) minimize offset
- High gain Possible cycling
- Large PB (%) Large offset
- Low Gain Stable loop