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WATER QUALITY CONTROL

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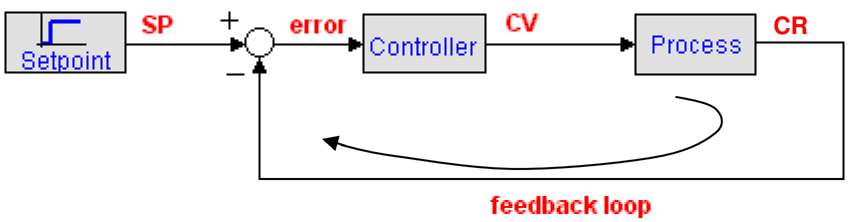
Proportional Controller

Proportional controls are designed to reduce the oscillations associated with on-off control by allowing the gain to be adjusted. A standard proportional control loop is shown in the figure below. The controller tries to steer the process in a way that minimizes the difference between the set point and the current reading. In other words, the controller tries to get the reading as close as possible to the given set point.

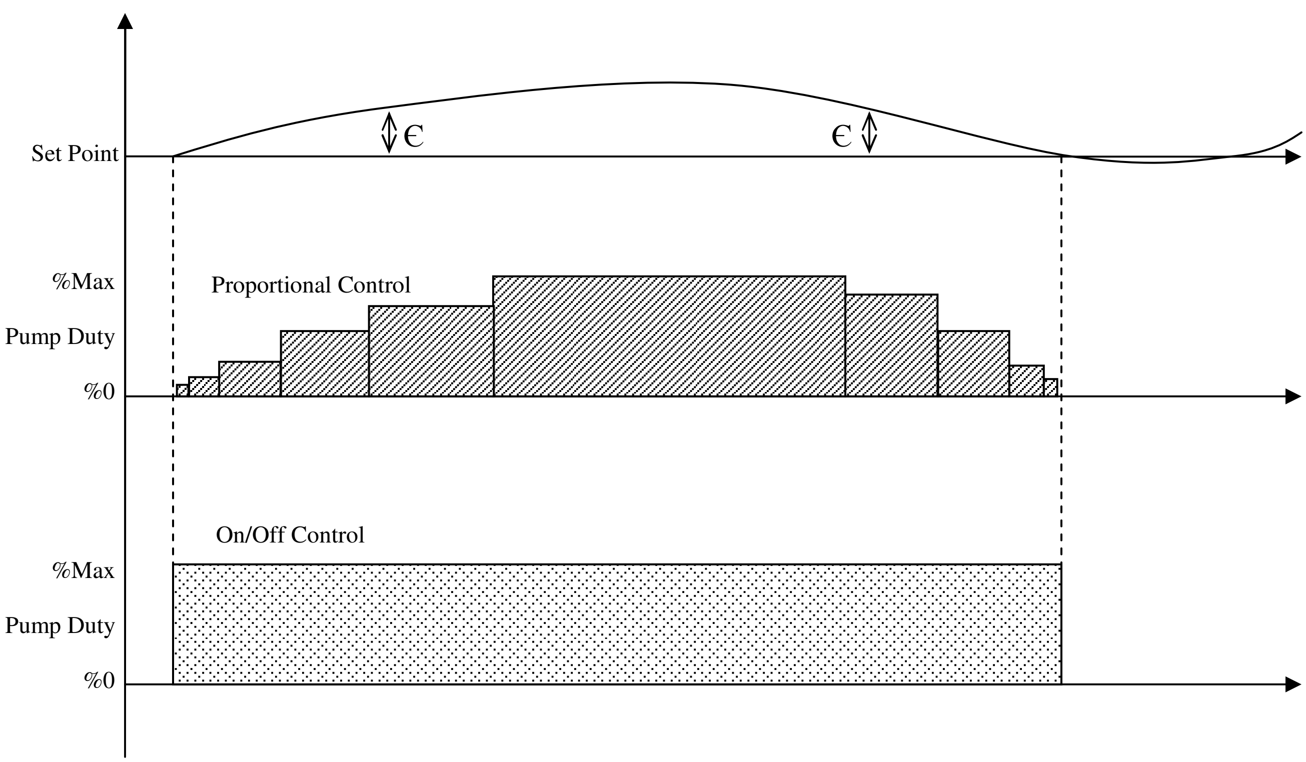


The **set point** (**SP**) is where the process output should match. The proportional action of a controller means that the controller moves in proportion to the error (€) between set point (SP) and current reading (CR):

error = (SP - CR)

*Controller output = K*error*

where K is called the proportional gain and can be adjusted.



Dosing Comparison between On/Off and Proportional Control to a given set point.

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It can be seen in the above figure, Proportional control doses less the closer it is to the set point and more up to a maximum the further away it gets from the set point allowing better control.

On/Off vs Proportional Control (an analogy example)

An analogy for on-off control is driving a car by applying either **full** power or **no** power and varying the duty cycle, to control speed. The power would be **fully on** until the target speed is reached, and then suddenly the power would be removed, so the car reduces speed. When the speed falls below the target, **full** power would again be applied. It can be seen that this would create a saw tooth like pattern around the set point obviously resulting in poor control and large variations in speed. The more powerful the engine, the greater the instability/overshooting.

Proportional control is a better way than on/off for a driver to control the speed of the car. The further away you are from the desired speed the more power you will apply. If the car is at target speed and the speed increases slightly, the power is reduced slightly so that the car reduces speed gradually and reaches the target point with minimal "overshoot", so the control is better than on-off control.

Proportional Control Advantages:

- It is relatively simple and easy to design
- It provides better stability with less overshoot
- Dynamically it is more stable than On/Off
- Dosing is proportional to the magnitude of the error.

Proportional Control Disadvantages:

- It will never settle exactly on the Set point. This difference from the set point is called an Offset.
- The system will overshoot the set point which may cause oscillations for a period of time.
- It requires operators to manually adjust the system to achieve desired performance.
- Proportional control does not consider the rate of change in the system. I.e. it does not consider the speed with which it approaches or moves away from the set point. More sophisticated control methods use this information to improve performance.
- Proportional control does not consider the direction of the Error. More sophisticated control methods use this direction to improve system performance. I.e. if moving towards the set point sophisticated dosing will reduce dosing or if is moving away from the set point dosing will be increased in an attempt to reduce the overshoot and errors.