9 February 2021

APPLICATION NOTE: ORP Proportional Band, Duty Cycle and Control Cycle v1.1

ORP Proportional Band

The ORP proportional band is the mV band within which the controller cycles the ORP output ON and OFF. Outside of this mV band, the ORP output is either continuously ON or continuously OFF.

Lets explain by way of an example:

Setpoint = 500mV
Proportional Band = 10% (i.e. 50mV)
ORP Output is continuously OFF when ORP > 500mV
ORP Output is continuously ON when ORP < 450mV
Proportional Control occurs between 450mV and 500mV (This is the Proportional Band).

Proportional Control is achieved by cycling the ORP output ON and OFF.
The ON/OFF ratio is called the DUTY CYCLE.
A small duty cycle would be ON/OFF = 5/95 seconds, for example (ON=5, OFF=95 sec).
A large duty cycle would be ON/OFF = 80/20 seconds, for example (ON=80, OFF=20 sec).
The Duty Cycle Repeats, but the ON/OFF ratio changes from one cycle to the next, if the mV varies.

The closer the mV gets to the ORP setpoint, the smaller the Duty Cycle gets.
The idea of this is to reduce the dose rate to prevent overshoot, the closer the mV reaches the ORP setpoint.

Lets explain by way of an analogy:

Red Traffic Light = Setpoint
Distance from Traffic Light you apply your brakes to start slowing down = Proportional Band.
The speed of the vehicle = The speed at which the ORP changes when you dose

If you are travelling fast, you apply your brakes further away from the Traffic Light to slow down in time. (i.e. In a small tower, where the ORP responds rapidly when dosing occurs, you want to slow down further away from your setpoint, so that you do not overshoot. So you set a large Proportional Band).

If you are travelling slowly, you apply your brakes closer to the Traffic Light as you have plenty of time to slow down sufficiently to stop at the red light (i.e. In a large tower, where the ORP responds very slowly when dosing occurs, it is better to slow down much closer to the setpoint, otherwise your dose rate will be too weak and you will never reach the setpoint).

Hence, you set a small Proportional Band.

In the case where the Proportional Band is too large, the mV never reaches the ORP setpoint, and the ORP Dose Timer Alarm Times out. (In Firmware version 0.90 and later, there is a menu setting called "Dose Timer Alarm Hysteresis". For example, if this is set to 5%, the ORP Dose Timer alarm will cancel as long as the mV reaches 95% of the setpoint, e.g. 475mV in the case of our 500mV setpoint example.)

Control Cycle

Control Cycle = Time it takes to change the Duty Cycle = ON+OFF time of Duty Cycle
Lets explain by way of 2 examples:

Example 1: Control Cycle = 100 seconds.
Duty Cycle ON+OFF time = 100 seconds.
Close to Setpoint, Duty Cycle may be ON/OFF = 5/95 seconds (ie on for 5 sec, off for 95sec)
Far away from Setpoint, Duty Cycle may be ON/OFF = 80/20 seconds.
Right in the dead centre of the 10% proportional band, i.e. 475mV, which is ½ (500-450mV), the Duty Cycle will be ON/OFF = 50/50 seconds.
(You will notice that ON+OFF time of any of the duty cycles is ALWAYS 100 seconds)

Example 2: Control Cycle = 20 seconds.
Duty Cycle ON+OFF time = 20 seconds.
Close to Setpoint, Duty Cycle may be ON/OFF = 2/18 seconds (ie on for 2 sec, off for 18 sec)
Far away from Setpoint, Duty Cycle may be ON/OFF = 16/4 seconds.
Right in the dead centre of the 10% proportional band, i.e. 475mV, which is ½ (500-450mV), the Duty Cycle will be ON/OFF = 10/10 seconds.
(You will notice that ON+OFF time of any of the duty cycles is ALWAYS 20 seconds)

The Control Cycle does not have such a large effect on the performance of the ORP control, unless the Tower is very small, and a small dose of oxidant increases the mV sharply.

In this instance, if the mV is close to the setpoint, and the Duty Cycle is small, say 5%, i.e. a ratio of 5:95, it is better to have the Control Cycle dosing ON/OFF = 5/95 rather than 2/9.5. (You would probably expect the smaller duty cycle to be 0.5/9.5. However, the ON time has been limited in the controller to a MINIMUM of 2 seconds. If it was any shorter, such as 0.5 seconds, it would be too short to dose, and could cause issues switching pumps and/or solenoid valves on for such a short period of time. Hence, a 5/95 dose ratio is more lean than a 2/9.5 ratio).

Suggested Initial Settings (Gauge performance from here and adjust to suit)

Small Tower (< 2,500 litres)
Proportional Band = 50%
Control Cycle = 100 seconds
Dose Timer Alarm Hysteresis = 10% (software version 0.90 and higher)

Small to Medium Tower (2,500 to 10,000 litres)
Proportional Band = 20%
Control Cycle = 60 seconds
Dose Timer Alarm Hysteresis = 5% (software version 0.90 and higher)

Large Tower (> 10,000 litres)
Proportional Band = 10%
Control Cycle = 30 seconds
Dose Timer Alarm Hysteresis = 3% (which is the default setting)

Rule of Thumb for Adjusting These Settings

The smaller the tower, the larger the Proportional Band
The smaller the tower, the larger the Control Cycle

If you experience overshoot, increase the Proportional Band in increments of 10% and increase the Control Cycle in increments of 10sec.
If you have an ORP Dose Timer Alarm, reduce the Proportional Band 10% and increase the Dose Timer Alarm Hysteresis by 2% (software version 0.90 and higher only)