Dissolved Oxygen Management

WineEng 2018

Experiences in Brewing and Beer by David Medlyn, Coopers Brewery

Coopers Brewery

- Established 1862 by Thomas Cooper as an ale brewery
- Began brewing lager beers in the 1960s
- Moved from Leabrook to Regency Park in 2001
- Maltings constructed adjacent to brewery 2016-2017

An Overview of the Production of Beer

Raw Materials
-Malted Barley
-Hops
-Water

Brewhouse

Raw materials are processed and boiled to produce "wort"

Wort Transfer to Fermentation Cellar

Oxygen Control Important

Fermentation

Yeast is added to the oxygenated wort. It ferments, consuming the oxygen and sugars and converting them to alcohol and CO_2.

Wort becomes "Beer"

Oxygen minimisation is critical from here on

Cellaring

Beer is centrifuged, lagered and filtered

Oxygen is measured at every step

Packaging

Oxygen measured again

Oxygen Management in the Brewhouse

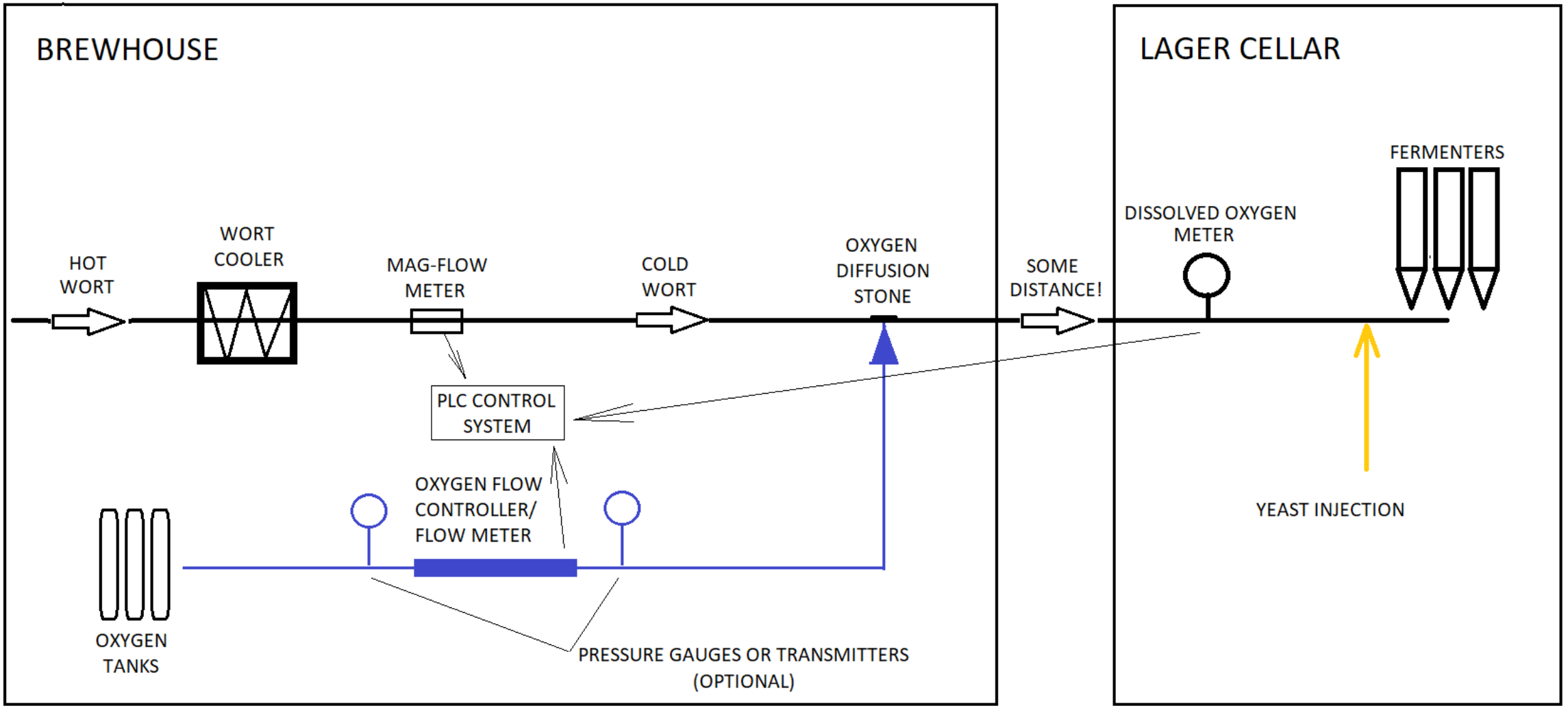
Dissolved Oxygen (DO) in the Brewery

- Controlling and measuring DO in wort for fermentation and propagation
- Minimisation of DO where its unwanted in the final product
- Finding sources of unwanted DO
- Future Improvements we would like

Oxygen addition and control

- Done widely in brewing for fermentation and propagation. Wort from the brewhouse containing sugars is oxygenated as it is transferred to the lager cellar fermenters.
- Oxygen provides yeast a major building block for cell wall material to duplicate and grow.

AN OVERVIEW OF THE AUTOMATED OXYGENATION OF WORT FOR FERMENTATION



Mag flowmeter – measure flowrate of product

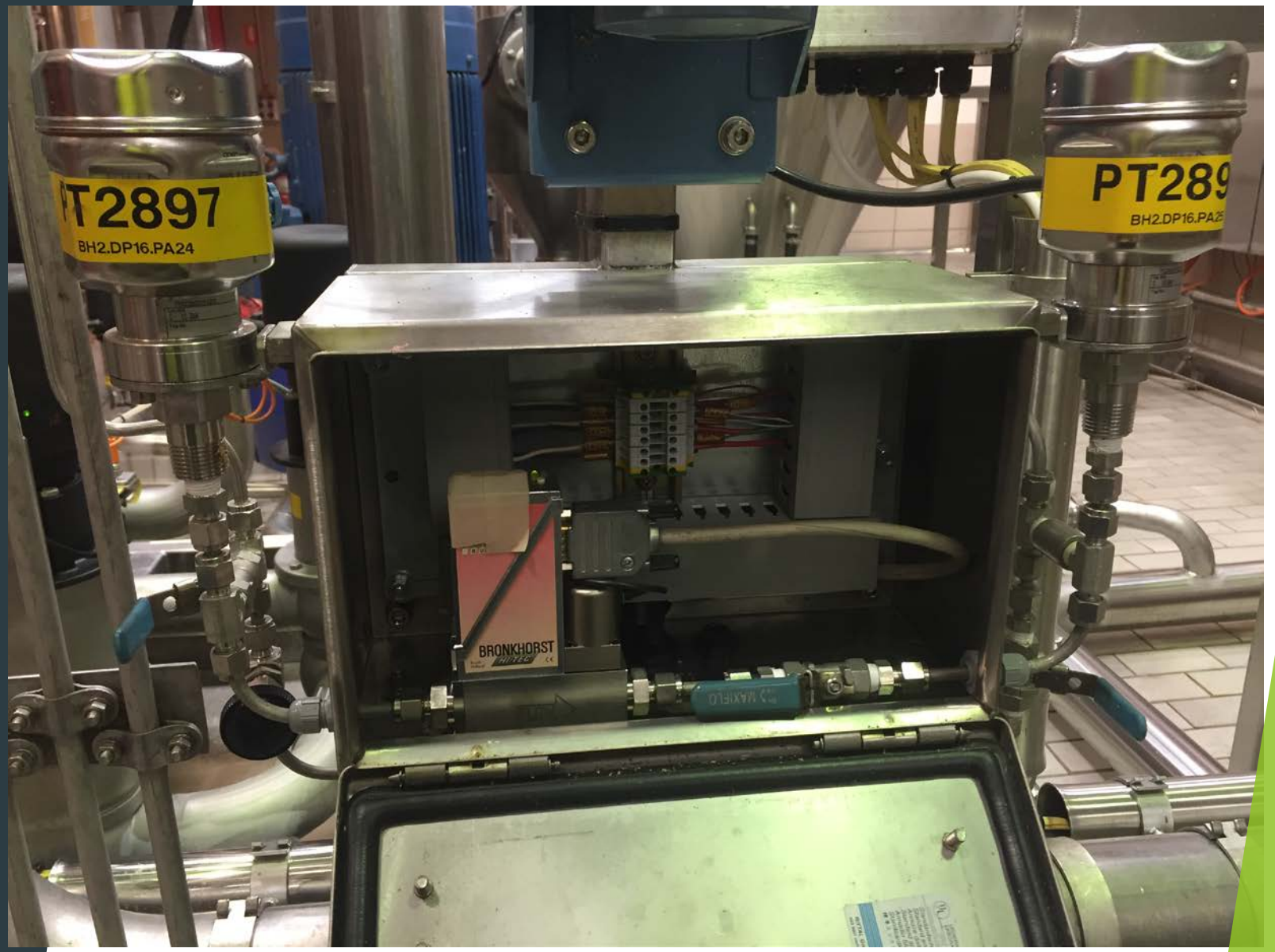
- Measure the flowrate of any non-corrosive conductive liquid.
- Will even measure RO water flow as long as conductivity is above approx. 25 microSiemens.
- Simple, reliable, commonplace in manufacturing

Oxygen tanks

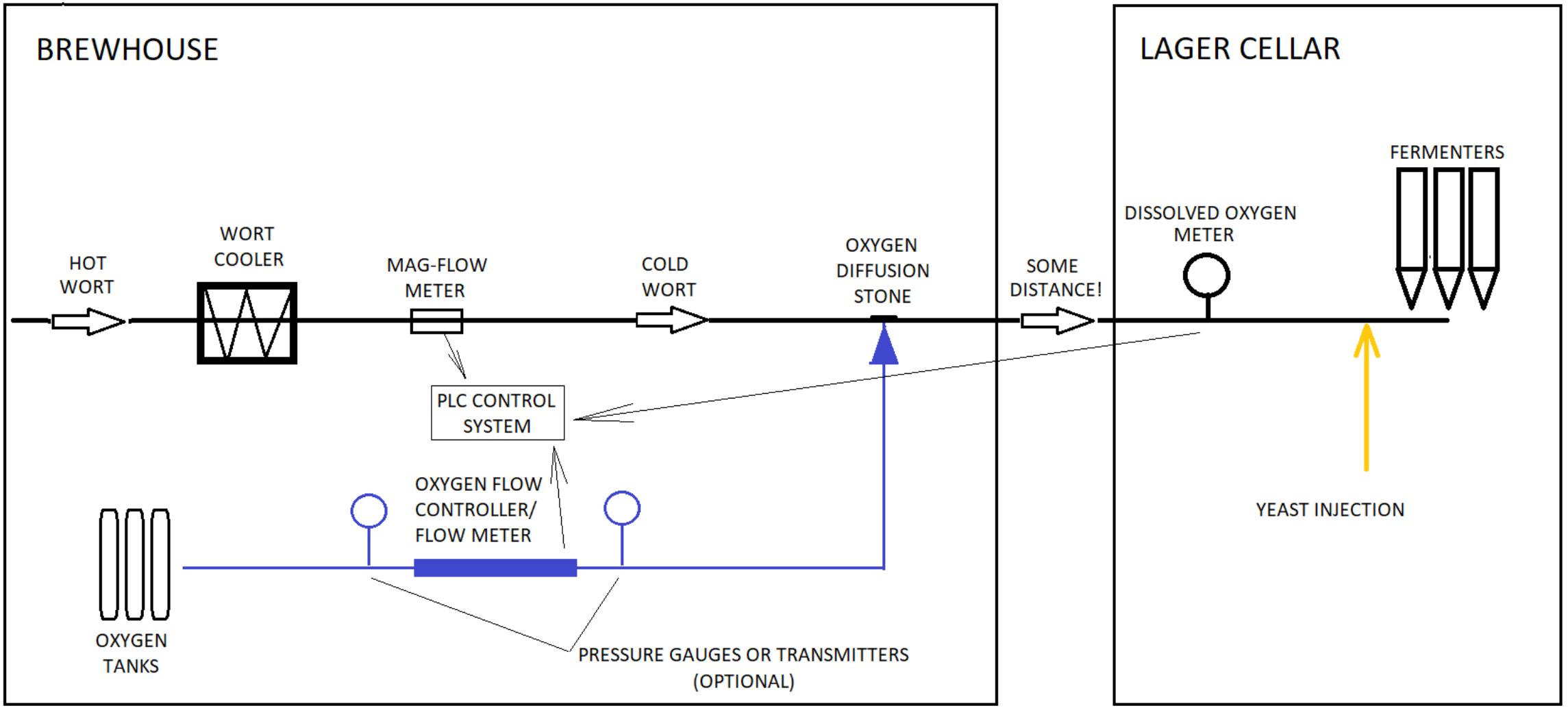
- Two sets of tanks
- Levels in both are monitored from offsite by supplier
- System automatically switches from empty set to the full set
- Supplier swaps over empty set in timely fashion
- Pure oxygen, no air filter required

Oxygen Dosing

- Flow controller is given a setpoint percentage to open from the PLC.
- Controller measures and feeds the actual flowrate back to the PLC.
- Actual flowrate is displayed on SCADA and monitored for correct flow and triggers alarms accordingly.
- Note that the DO meter downstream is used for monitoring and alarm only, not control.
- Pressure transmitters either side to assist in fault finding when necessary. Very nice to have but have been unnecessary!



AN OVERVIEW OF THE AUTOMATED OXYGENATION OF WORT FOR FERMENTATION



Oxygenation Stone

- 0.5-2 micron porosity
- Clean often!

Optical DO Meter

- Good accuracy and low maintenance

Calculating the required O2 flowrate

- Setpoint O2 flowrate = Wort mass flow rate multiplied by the required DO fraction
- Wort flowrate Fw = 850hl/hr
- Density is 1.032kg/l so mass flow is 87,720kg/hr
- Desired DO is 8ppm
- Oxygen flowrate required is then:
- DO multiplied by Fw = 87720 * 8/1000000 = 0.702kg/hr or 702 g/hr.

Yeast Propagation

Very similar control as that used for wort fermentation.

Main difference is that the yeast and wort slurry is recirculated.

Higher Oxygenation rate is used as we are trying to achieve yeast growth, not fermentation.

Oxygenation System for Propagation

- Larger oxygenation system used for the shorter pipeline

Minimisation of Dissolved Oxygen

- This is extremely important in the final production of beer
- Note that beer with yeast in it will get any residual DO “mopped up”. Coopers Ales and Stouts have yeast in the bottle and keg and hence have very little problems with DO until they are significantly older.
- Brightly filtered beers such as lagers have no yeast and are pasteurised.
- Too much DO in lagers can lead to undesirable flavours after pasteurization.
- Too much DO in lagers leads to early staling of the beer.

Minimisation of Dissolved Oxygen

- Tanks that are used for storing beer need a CO2 top pressure, or at the very least a CO2 “blanket” to prevent exposure to air or oxygen.
- Transfer of beer between vessels for processing must be done through pipes that have previously been flushed and filled with water to prevent further pick up or exposure to air.
- The water used for flushing and filling these lines needs to be deaerated.
- De-aerated water must be used for dilution of beer to sales gravity.

Deaerated Water Plant

DAW Pipe Filling and Chasing

- Tanks are on common lines to centrifuge and filter (and from brewhouse)
- Long lines are filled and flushed with DAW
- Beer then flows from the tank into the line and chases out the DAW to the centrifuge or filter

CO2 Top Pressure on Vessels

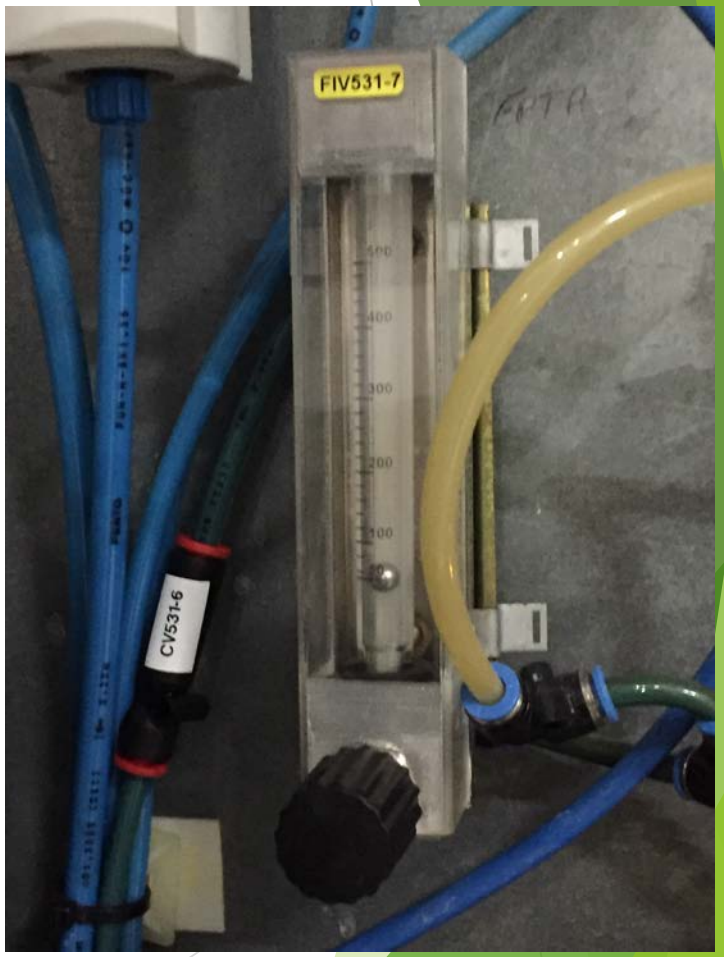
Product should not be exposed to air within the vessels.

CO2 top pressure should be maintained at all times or at the very least a CO2 “blanket” on the surface of the beer.

Careful of the swingbends!

Empty = FULL of AIR!

Centrifugation



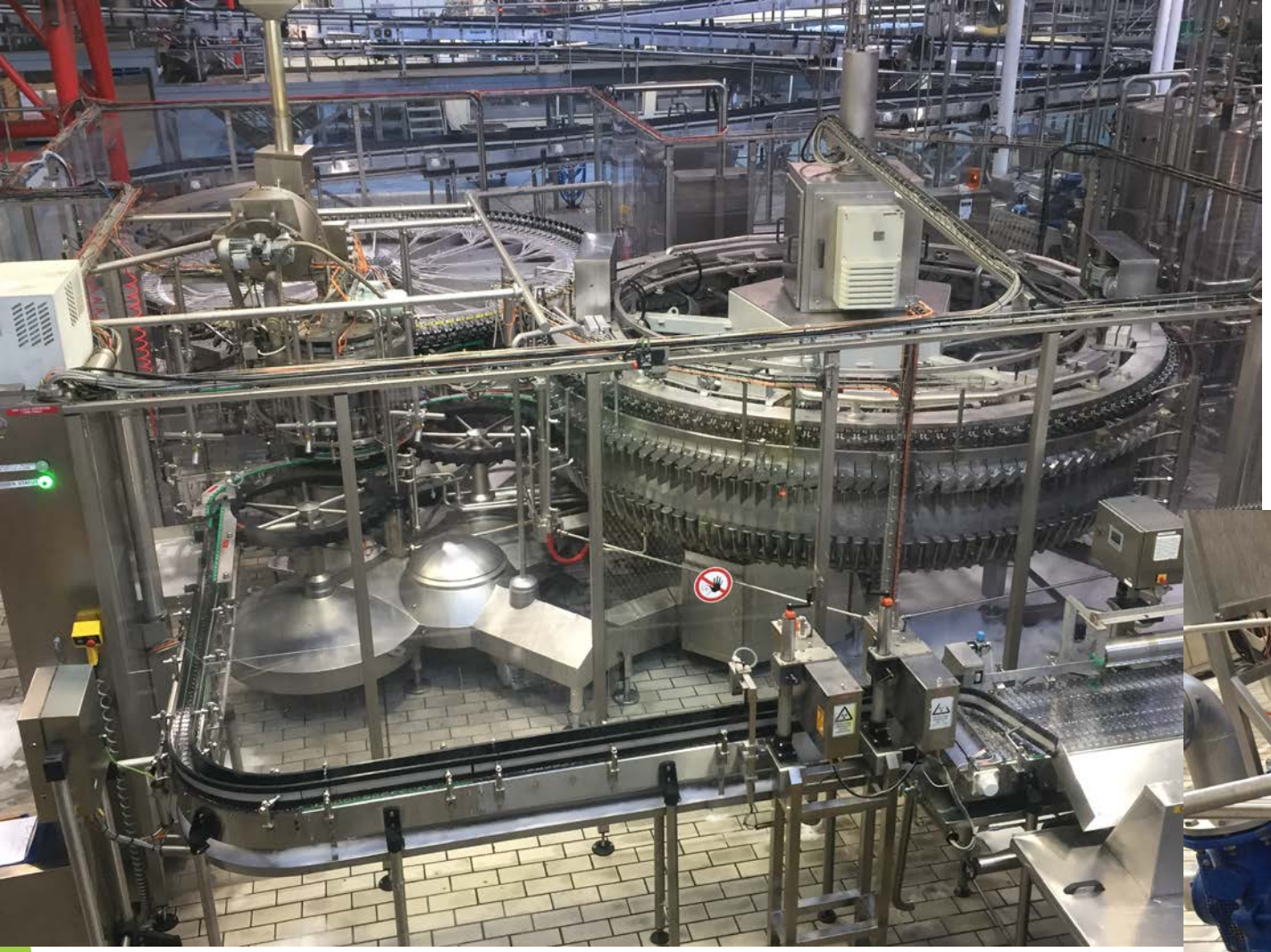
Filtration to Bright Beer Tanks

- DO measured prior to and after Filtration.
- Filtered Beer should be ready for Packaging…. unless the DO is too high

Bottling Tanks

- Last chance to fix!

Bottle Filler



The TPO Machine

- Detects DO in beer in the bottle or can
- Measures oxygen in the headspace and the volume of the headspace
- Calculates the Total Package Oxygen
- Test a number of bottles and take the average

Ball Valves – Friend or Foe?

Provide a double seal between two fluids when closed.

When closed, they empty out.

Empty = FULL of AIR

Ultrasonic Testing

- Can be used to find Vacuum Leaks!
- Very hard to find as there is no obvious leak
- Rubber seals may leak air under vacuum
- Check all valves and BSM fittings

Future Improvements

- A CO2 Injection system into our bottling tanks
- A CO2 flowmeter on the older centrifuge for the liquid seal.
- Swap the water on the liquid seal over to DAW from RO
- More accuracy from our low-range DO meters.
- Replace a centrifuge with a filter?

The Glass is NEVER half full!

- Its not half full
- Its not half empty
- Its full of beer and AIR!

- (Or wine and air)

- Thanks!!